**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR**
**COLLEGE OF ENGINEERING (Autonomous), ANANTHAPURAMU**

# B.Tech (Chemical Engineering) 2013-14
# COURSE STRUCTURE & SYLLABUS (R13 REGULATIONS)

**I YEAR I Semester**

| S.No | Code | Subject | L | P | C |
|---|---|---|---|---|---|
| 1 | Theory | English | 4 | - | 3 |
| 2 | Theory | Mathematics -I | 4 | - | 3 |
| 3 | Theory | Physical Chemistry | 4 | - | 3 |
| 4 | Theory | Environmental Studies | 4 | - | 3 |
| 5 | Theory | Basic Engineering Drawing | 4 | - | 3 |
| 6 | Lab | Physical Chemistry Lab | - | 3 | 2 |
| 7 | Lab | Engineering Workshop & IT Workshop | - | 3 | 2 |
| 8 | Lab | English Language Communication Skills Lab. | - | 3 | 2 |
| | | **Total** | **20** | **9** | **21** |

**I YEAR II Semester**

| S.No | Code | Subject | L | P | C |
|---|---|---|---|---|---|
| 1 | Theory | Technical Communication and Presentation Skills | 4 | - | 3 |
| 2 | Theory | Mathematics -II | 4 | - | 3 |
| 3 | Theory | Applied Physics | 4 | - | 3 |
| 4 | Theory | Computer Programming | 4 | - | 3 |
| 5 | Theory | Engineering Mechanics | 4 | - | 3 |
| 6 | Theory | Introduction to Chemical Engineering | 4 | - | 3 |
| 7 | Lab | Computer Programming Lab | - | 3 | 2 |
| 8 | Lab | Engineering Physics Lab | - | 3 | 2 |
| | | **Total** | **24** | **6** | **22** |

# B.Tech (Chemical Engineering)-COURSE STRUCTURE

## II YEAR I SEMESTER

| S.No | Code | Subject | T | P | C |
|---|---|---|---|---|---|
| 1 | Theory | Mathematical Methods | 4 | 0 | 3 |
| 2 | Theory | Electrical and Electronics Engineering | 4 | 0 | 3 |
| 3 | Theory | Chemical Engineering Fluid Mechanics | 4 | 0 | 3 |
| 4 | Theory | Energy Engineering | 4 | 0 | 3 |
| 5 | Theory | Organic Chemistry | 4 | 0 | 3 |
| 6 | Theory | Chemical Process Calculations | 4 | 0 | 3 |
| 7 | Theory | Human Values & Professional Ethics(Audit) | 2 | 0 | 0 |
| 8 | Lab | Chemical Engineering Fluid Mechanics Lab | 0 | 3 | 2 |
| 9 | Lab | Organic Chemistry Lab | 0 | 3 | 2 |
| | | **Total** | **26** | **6** | **22** |

## II YEAR II SEMESTER

| S.No | Code | Subject | T | P | C |
|---|---|---|---|---|---|
| 1 | Theory | Probability and Statistics | 4 | 0 | 3 |
| 2 | Theory | Process Heat Transfer | 4 | 0 | 3 |
| 3 | Theory | MaterialsScience for Chemical Engineers | 4 | 0 | 3 |
| 4 | Theory | Analytical Chemistry | 4 | 0 | 3 |
| 5 | Theory | Chemical Engineering Thermodynamics | 4 | 0 | 3 |
| 6 | Theory | Mechanical Unit Operations | 4 | 0 | 3 |
| 7 | Theory | Process Heat Transfer Lab | 0 | 3 | 2 |
| 8 | Lab | MechanicalUnit Operations Lab | 0 | 3 | 2 |
| | | **Total** | **26** | **6** | **22** |

# B.Tech (Chemical Engineering)-COURSE STRUCTURE

## III YEAR I SEMESTER

| S.No | Code | Subject | T | P | C |
|---|---|---|---|---|---|
| 1 | Theory | Process Instrumentation | 4 | 0 | 3 |
| 2 | Theory | Process Dynamics & Control | 4 | 0 | 3 |
| 3 | Theory | Phase and Chemical Equilibria | 4 | 0 | 3 |
| 4 | Theory | Chemical Reaction Engineering-I | 4 | 0 | 3 |
| 5 | Theory | Mass Transfer Operations-I | 4 | 0 | 3 |
| 6 | Theory | Petroleum Refining and Petrochemicals | 4 | 0 | 3 |
| 7 | Theory | Energy & Environmental Engineering Lab | 0 | 3 | 3 |
| 8 | Lab | Process Dynamics & Control Lab | 0 | 3 | 2 |
| | | **Total** | **24** | **06** | **22** |

## III YEAR II SEMESTER

| S.No | Code | Subject | T | P | C |
|---|---|---|---|---|---|
| 1 | Theory | Industrial Engineering and Management | 4 | 0 | 3 |
| 2 | Theory | Chemical Technology | 4 | 0 | 3 |
| 3 | Theory | Mass Transfer Operations – II | 4 | 0 | 3 |
| 4 | Theory | Chemical Reaction Engineering-II | 4 | 0 | 3 |
| 5 | Theory | Process Modeling and Simulation | 4 | 0 | 3 |
| 6 | Theory | Chemical Plant Design and Economics | 4 | 0 | 3 |
| 7 | Theory | Chemical Reaction Engineering Lab | 0 | 3 | 2 |
| 8 | Lab | Mass Transfer Operations Lab | 0 | 3 | 2 |
| 9 | Lab | Advanced Communication Skills Lab (Audit) | 2 | 0 | 0 |
| | | **Total** | **26** | **6** | **22** |

## B.Tech (Chemical Engineering)-COURSE STRUCTURE

### IV YEAR I SEMESTER

| S.No | Code | Subject | T | P | C |
|---|---|---|---|---|---|
| 1 | Theory | Transport Phenomena | 4 | 0 | 3 |
| 2 | Theory | Chemical Process Equipment Design | 4 | 0 | 3 |
| 3 | Theory | Optimization of Chemical Processes | 4 | 0 | 3 |
| 4 | Theory | Separation Techniques for Bioprocessing | 4 | 0 | 3 |
| 5 | Theory | **OpenElective**<br>Basics of Nanotechnology<br>Industrial Safety & Hazard Management<br>Nuclear Engineering<br>Solid Waste Management | 4 | 0 | 3 |
| 6 | Theory | **Elective – I (Through MOOC)** | 4 | 0 | 3 |
| 7 | Lab | Process Equipment Design& Drawing Lab | 0 | 3 | 2 |
| 8 | Lab | Simulation Lab | 0 | 3 | 2 |
| 9 | | Project Work – Part A | 0 | 0 | 2 |
| | | **Total** | **24** | **06** | **22** |

### IV YEAR II SEMESTER

| S.No | Code | Subject | L | P | C |
|---|---|---|---|---|---|
| 1 | Theory | Biochemical Engineering | 4 | 0 | 3 |
| 2 | Theory | Industrial Pollution Control Engineering | 4 | 0 | 3 |
| 3 | Theory | **Elective-II**<br>Technology of Pharmaceutical &<br>Fine Chemicals<br>Interfacial Engineering<br>Polymer Technology<br>Design & Analysis of Experiments | 4 | 0 | 3 |
| 4 | Theory | **Elective – III**<br>Computer Aided Process Design<br>Food Processing Technology<br>Entrepreneurship Development<br>Corrosion Engineering | 4 | 0 | 3 |
| 5 | | Seminar& Comprehensive Viva-Voce | 0 | 0 | 3 |
| 6 | | Project Work | 0 | 0 | 10 |
| 7 | | **Total** | **16** | **0** | **25** |

**Note:** All End Examinations (Theory and Practical) are of three hours duration.

**L – Theory P – Practical/Drawing C – Credits**

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| | | | |
|---|---|---|---|
| **I Year B.Tech - I Semester** | **L** | **P** | **C** |
| | **3+1*** | **0** | **3** |

**ENGLISH**

**(Common to all Branches)**

**OBJECTIVES:**

1. To enable the students to communicate in English for academic and social purpose
2. To enable the students to acquire structure and written expressions required for their profession.
3. To develop the listening skills of the students
4. To inculcate the habit of reading for pleasure
5. To enhance the study skills of the students with emphasis on LSRW skills

**SYLLABUS:**

**UNIT –I**

**Chapter entitled *Humour* from "Using English"**
**Chapter entitled '*Homi Jehangir Bhabha'* from "New Horizons"**

L- Listening -Techniques - Importance of phonetics

L- Meet & Greet and Leave taking, Introducing Oneself and rs (Formal and Informal situations)

R- -Reading Strategies -Skimming and Scanning

W- Writing strategies- sentence structures

G-Parts of Speech –Noun-number, pronoun-personal pronoun, verb- analysis

V-Affixes-prefix and suffix, root words, derivatives

**UNIT –II**

**Chapter entitled *Inspiration* from "Using English"**
**Chapter entitled 'My Struggle for an Education' from "New Horizons"**

L- Listening to details

S- Apologizing, Interrupting, Requesting and Making polite conversations

R-note making strategies

W- Paragraph-types- topic sentences, unity, coherence, length , linking devices

G-Auxiliary verbs and question tags

V- synonyms-antonyms, homonyms , homophones, homographs, words often confused

## UNIT –III

**Chapter entitled *Sustainable Development* from "Using English"**

**Chapter entitled 'The Autobiography of Abraham Lincoln' from "New Horizons"**

L- Listening to themes and note taking

S- Giving instructions and Directions, making suggestions, Accepting ideas, fixing a time and Advising

R- Reading for details -1

W- Resume and cover letter

G- Tenses – Present tense, Past tense and Future tense

V-Word formation and One-Word Substitutes

## UNIT –IV

**Chapter entitled *Relationships* from "Using English"**
**Chapter entitled ' T*he Happy Prince* from "New Horizons"**

L- Listening to news

S- Narrating stories, Expressing ideas and opinions and telephone skills

R- Reading for specific details and Information

W- Technical Report writing-strategies, formats-types-technical report writing

G- Voice and Subject – Verb Agreement

V- Idioms and prepositional Phrases

## UNIT –V

**Chapter entitled Science and Humanism from "Using English"**

**Chapter entitled 'If'from "New Horizons"**

L- Listening to speeches

S- Making Presentations and Group Discussions

R- Reading for Information

W- E-mail drafting

G- Conditional clauses and conjunctions

V- Collocations and Technical Vocabulary and using words appropriately

**EXPECTED OUTCOME:**

The students will get the required training in LSRW skills through the prescribed texts and develop communicative competence

**Prescribed Books:**

1. **Using English (for detailed study)** published by Orient Black Swan, 2013
2. **New Horizons** published by Pearson, 2013

**Suggested Reading:**

1. **Raymond Murphy's English Grammar with CD,** Murphy, Cambridge University Press, 2012.
2. **English Conversation Practice –**Grant Taylor, Tata McGraw Hill,2009.
3. **Communication Skills, Sanjay Kumar & Pushpalatha** Oxford University Press, 2012.
4. **A Course in Communication Skills**- Kiranmai Dutt & co. Foundation Books, 2012.
5. **Current English grammar and usage-**S M Guptha, PHI, 2013.
6. **Modern English Grammar-**Krishna SWAMI .McMillan, 2009.
7. **Powerful Vocabulary Builder**- Anjana Agarwal New Age International Publishers, 2011.
8. **Writing with a Purpose, Tickoo and Sasi Kumar, OUP, 20 1**
9. **Strengthen Your Writing, Orient Blackswan**

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**I Year B.Tech-I semester**

| L | P | C |
|---|---|---|
| 3+1* | 0 | 3 |

## MATHEMATICS – I
## (Common to All Branches)

**OBJECTIVES:**

- To train the students thoroughly in Mathematical concepts of ordinary differential equations and their applications in electrical circuits, deflection of beams, whirling of shafts.
- To prepare students for lifelong learning and successful careers using mathematical concepts of differential and Integral calculus, ordinary and partial differential equations.
- To develop the skill pertinent to the practice of the concepts including the students abilities to formulate the problems, to think creatively and to synthesize information.

**UNIT – I**

Exact, linear and Bernoulli equations.Applications to Newton's law of cooling, law of natural growth and decay, orthogonal trajectories.

Non-homogeneous linear differential equations of second and higher order with constant coefficients with RHS term of the type $e^{ax}$, sin ax, cos ax, polynomials in x, $e^{ax}$ V(x), xV(x), method of variation of parameters. Applications to oscillatory electrical circuits, Deflection of Beams, whirling of shafts.

**UNIT – II**

Taylor's and Maclaurin's Series - Functions of several variables – Jacobian – Maxima and Minima of functions of two variables, Lagrange's method of undetermined Multipliers with three variables only. Radius of curvature, center of curvature, Involutes, e nd envelopes..

**UNIT – III**

Curve tracing – Cartesian, polar and parametric curves. Length of curves.

**UNIT – IV**

Multiple integral – Double and triple integrals – Change of Variables – Change of order of integration. Applications to areas and volumes, surface area of solid of revolution in Cartesian and polar coordinates using double integral.

**UNIT – V**

Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions – Method of separation of variables – Solutions of one dimensional wave equation, heat equation and two-dimensional Laplace's equation under initial and boundary conditions.

**TEXT BOOKS:**

1. Higher Engineering Mathematics, B.S.Grewal, Khanna publishers.
2. Engineering Mathematics, Volume - I, E. Rukmangadachari & E. Keshava Reddy, Pearson Publisher.

**REFERENCES:**


1. Engineering Mathematics Volume-I, by T.K.V. Iyengar, B.Krishna Gandhi, S.Ranganatham d M.V.S.S.N.Prasad, S.Chand publication.
2. Engineering Mathematics, Volume - I, by G.S.S.Raju, CENGAGE publisher.
3. Advanced Engineering Mathematics, by Erwin Kreyszig, Wiley India.
4. Higher Engineering Mathematics, by B.V.Ramana, Mc Graw Hill publishers.
5. Advanced Engineering Mathematics, by Alan Jeffrey, Elsevier.


**Outcomes:**

- The students become familiar with the application of differential and integral calculus, ordinary and partial differential equations to engineering problems.
- The students attain the abilities to use mathematical wledge to analyze and solve problems in engineering applications.

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| **I Year B.Tech - I Semester** | **L** | **P** | **C** |
|---|---|---|---|
| | **3+1*** | **0** | **3** |

## ENVIRONMENTAL STUDIES

## (Common to all Branches)

**OBJECTIVE:** To make the students to get awareness on environment, understand the importance of protecting natural resources, ecosystems for future generations and pollution causes due to the day to day activities of human life to save earth from the inventions by the engineers.

**UNIT – I**

**MULTIDISCIPLINARY NATURE OF ENVIRONMENTAL STUDIES: –** Definition, Scope and Importance – Need for Public Awareness.

**NATURAL RESOURCES :** Renewable and non-renewable resources – Natural resources and associated problems – Forest resources – Use and over – exploitation, deforestation, case studies – Timber extraction – Mining, dams and other effects on forest and tribal people – Water resources – Use and over utilization of surface and ground water – Floods, drought, conflicts over water, dams – benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. – Energy resources:

**UNIT – II**

**ECOSYSTEMS:** Concept of an ecosystem. – Structure and function of an ecosystem – Producers, consumers and decomposers – Energy flow in the ecosystem – Ecological succession – Food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the following ecosystem:

a. Forest ecosystem.
b. Grassland ecosystem
c. Desert ecosystem
d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

**BIODIVERSITY AND ITS CONSERVATION :** Introduction 0 Definition: genetic, species and ecosystem diversity – Bio-geographical classification of India – Value of biodiversity: consumptive use, Productive use, social, ethical, aesthetic and option values – Biodiversity at global, National and local levels – India as a mega-diversity nation – Hot-sports of biodiversity – Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – Endangered and endemic species of India – Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

**UNIT – III**

**ENVIRONMENTAL POLLUTION:** Definition, Cause, effects and control measures of :

a. Air Pollution.
b. Water pollution
c. Soil pollution

d. Marine pollution
e. Noise pollution
f. Thermal pollution
g. Nuclear hazards

**SOLID WASTE MANAGEMENT :**Causes**,** effects and control measures of urban and industrial wastes – Role of an individual in prevention of pollution – Pollution case studies – Disaster management: floods, earthquake, cyclone and landslides.

**UNIT – IV**

**SOCIAL ISSUES AND THE ENVIRONMENT:** From Unsustainable to Sustainable development – Urban problems related to energy – Water conservation, rain water harvesting, watershed management – Resettlement and rehabilitation of people; its problems and concerns. Case studies – Environmental ethics: Issues and possible solutions – Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies – Wasteland reclamation. – Consumerism and waste products. – Environment Protection Act. – Air (Prevention and Control of Pollution) Act. – Water (Prevention and control of Pollution) Act – Wildlife Protection Act – Forest Conservation Act – Issues involved in enforcement of environmental legislation – Public awareness.

**UNIT – V**

**HUMAN POPULATION AND THE ENVIRONMENT:** Population growth, variation among nations. Population explosion – Family Welfare Programmed. – Environment and human health – Human Rights – Value Education – HIV/AIDS – Women and Child Welfare – Role of information Technology in Environment and human health – Case studies.

**FIELD WORK :** Visit to a local area to document environmental assets River/forest grassland/hill/mountain – Visit to a local polluted site-Urban/Rural/Industrial/Agricultural Study of common plants, insects, and birds – river, hill slopes, etc..

**TEXT BOOKS** :

(1) Text book of Environmental Studies for Undergraduate Courses by Erach Bharucha for University Grants Commission, Universities Press.
(2) Environmental Studies by Palaniswamy – Pearson education
(3) Environmental Studies by Dr.S.Azeem Unnisa, Academic Publishing Company

**REFERENCES :**

(1) Textbook of Environmental Science by Deeksha Dave and Baba Reddy, Cengage Pubilications.
(2) Text book of Environmental Sciences and Technology by M.Anji Reddy, BS Publication.
(3) Comprehensive Environmental studies by J.P.Sharma, Laxmi publications.
(4) Environmental sciences and engineering – J. Glynn Henry and Gary W. Heinke – Printice hall of India Private limited.
(5) A Text Book of Environmental Studies by G.R.Chatwal, Himalaya Pubilishing House
(6) Introduction to Environmental engineering and science by Gilbert M. Masters and Wendell P. Ela - Printice hall of India Private limited.

**Outcomes:**

- Gain a higher level of personal involvement and interest in understanding and solving environmental problems.
- Comprehend environmental problems from multiple perspectives with emphasis on human modern lifestyles and developmental activities.
- Demonstrate knowledge relating to the biological systems involved in the major global environmental problems of the 21st century
- Recognize the interconnectedness of — human dependence — on the earth’s ecosystems
- Influence their society in proper utilization of goods and services.
- Learn the management of environmental hazards and to mitigate disasters and have a clear understanding of environmental concerns and follow sustainable development practices.

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**I Year B.Tech - I Semester**

| | L | P | C |
|---|---|---|---|
| | **3+1*** | **0** | **3** |

## PHYSICAL CHEMISTRY

**OBJECTIVES:**:

- To acquire basic knowledge of basic types of reactions
- To acquire knowledge about the mechanisms through which the chemical reactions proceed.
- To understand the impact of nature on metals.

### Unit-I: Kinetics

Introduction to chemical kinetics-theories of reaction rates-Collision theories-Modified collision theory – Absolute reaction rate theory (Transition state theory)-reaction between ions, reactions-Hydrogen and bromine, hydrogen and oxygen (Steady state treatment)-.

### UNIT-II: Colloids

Definition of colloids, classification of colloids, solids in iquids (Sols) – properties, kinetics, optical and electrical, stability of colloids, protective action, Hardy-Schultze Law, Gold Number. Liquids in liquids (Emulsions) -Types of Emulsions, preparation, Emulsifier.Liquids in solids (Gels) – Classification, preparation & properties, Inhibition, General, applications of colloids.

### UNIT-III: Catalysis

Definition-Homogeneous and heterogeneous Catalysis- Characteristics of a good catalyst-Theories of Catalysis: Intermediate compound formation theory and adsorption theory, relevant examples- Types of catalysis: Acid-base catalysis and enzymatic catalysis

### Unit-IV: Surface Chemistry

Adsorption, characteristics of adsorption, physical & l adsorption, Langumuir adsorption isotherm, B.E.T. equation, BET plot, surface area determination of solids. Numerical calculations of surface area, Heterogenous catalysis, Mechanism of catalysis-Langmuir-Hinsel Wood mechanism of surface catalyzed reactions, Eley-Rideal mechanism surface catalysed reactions. Applications of catalysis in industry.

### UNIT-V: Electrochemistry

i).Review of electrochemical cells, Numerical calculat ies: Rechargeable batteries (Lead acid, Ni-Cd, Lithium Ion Batteries),Fuels cells: (Hydrogen-Oxygen and Methanol-Oxygen)
ii).Electrochemical sensors: Potentiometric Sensors and Voltammetric sensors. Examples : analysis of Glucose and urea
iii).Corrosion: Electrochemical Theory of corrosion, Factors affecting the corrosion. Prevention: Anodic and cathodic protection and electro and electro ing

## BOOKS:

1. Quantitative analysis, R.A.Day & A.L. Underwood , 5th edition, Printice- Hall of India Pvt. Ltd., 2000.
2. Vogel's Text Book of Qualitative chemical analysis, J. Mendham, R.C.Denney, J. Darnes, M.J.K. Thomas, Persar education 6th edition, 2002.
3. Elements of Physical Chemistry-Peter Atkins, Oxford Uni.Press, 3rd Edition, 2010.

## REFERENCES:

1. Atkin's Physical Chemistry – P. Atkins and J. De Paula, Oxford Univ.Press, 9th Edition, 2012
2 Instrumental lMethods of Chemical Analysis, Gurdeep R.Chatwal, Sham K.Ananad, Himalayha publishing House,5th Edition, 2012.
3. Advanced physical chemistry – Gurudeepraj, Goel Publishing House, 2000
4. Essentials of Physical Chemistry- Arun Bahl, B.S.Bahl and G.D.Tuli, S.Chand Publishers, New Delhi.

## Outcomes:

- Apply the fundamental concepts of chemistry to solve the problems in their respective fields of work
- Realize and formulate new energy initiatives to meet the present and future needs of society
- Understand the corrosion factors and implement the prevention measures
- Get well equipped with basic understanding and developments in solar energy and can assimilate the applications of it in all aspects of science and engineering

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**I- Year B.Tech. I-Sem**

| L | P | C |
|---|---|---|
| 3+1* | 0 | 3 |

## ENGINEERING GRAPHICS
## (CIVIL, EEE, ECE, CSE & CHEMICAL)

**OBJECTIVES:**

- Give Clear picture about the Importance of Engineering Graphics in the field of Engineering
- Develop drawing skills and impart the student to follow standards prescribed by Bureau of Indian standards
- Give an idea about Engineering curves, Orthographic projections and Pictorial projections
- Develop an imagination about the orientation of points, lines, surfaces and solids.

**Unit-I**

Introduction to Engineering Drawing: Principles of Engineering Graphics and their significance Drawing Instruments and their Use – BIS Conventions in drawing and Lettering.

Curves used in practice:

a) Conic sections including the Rectangular Hyperbola
b) Cycloid, Epicycloid and Hypocycloid –Normals and Tangents
c) Involute of a circle –Normals and Tangents

Principles of orthographic projection, I and III angle projections –Conventions –Projections of points.

**Unit –II**

Projection of lines inclined to both planes –traces, Projection of plane figures inclined to both planes.

**Unit –III**

Projection of simple solids inclined to both planes.

**Unit –IV**

Sections and Developments: Sections and Sectional views of Regular solids –Prism, Cylinder, Pyramid, Cone – True shapes.

**Unit –V**

Isometric projections: Principles of pictorial representations-Isometric projection- Isometric scale-Isometric views- conventions- Isometric views of plane figures, solids-Isometric projection of objects with non isometric lines-Isometric projection of spherical parts.

**TEXT BOOKS:**


1. Engineering Drawing, N.D. Bhat, Charotar Publishers
2. Engineering Drawing, K.L. Narayana& P. Kannaih, Scitech Publishers, Chennai.

**REFERENCES:**

1. Engineering Drawing, Johle, Tata McGraw-Hill Publishers.
2. Engineering Drawing, Shah and Rana,2/e, Pearson Education
3. Engineering Drawing and Graphics, Venugopal/New age Publishers
4. Engineering Graphics, John&john.

**Outcomes:**

On Completion of the course the student will be able to

- perform free hand sketching of basic geometrical constructions and
- multiple views of objects.
- do orthographic projection of lines and plane surfaces.
- draw projections and solids and development of surfaces.
- prepare isometric and perspective sections of simple solids.

***Suggestions:***

*Student is expected to buy a book mentioned under 'Tex ooks' for better understanding.*

*Student should prepare rough sketches for all the problems given at the end of each chapter to improve his / her imaginations. Student should also pr tice Auto CAD or any other drawing software to help understanding better.*

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| | L | P | C |
|---|---|---|---|
| **I Year B.Tech - I Semester** | **L** | **P** | **C** |
| | **0** | **3** | **2** |

## ENGLISH LANGUAGE COMMUNICATION SKILLS (ELCS) LAB

The **Language Lab** focuses on the production and practice of sounds of language and familiarizes the students with the use of English in everyday situations and contexts.

**OBJECTIVES:**

1. To train students to use language effectively in everyday conversations, to participate in group discussions, to help them face interviews, and sharpen public speaking skills
2. To expose the students to a varied blend of self-instructional learner-friendly modes of language learning through computer-aided multi-media instruction.
3. To enable them to learn better pronunciation through stress on word accent, intonation, and rhythm.
4. To help the second language learners to acquire fluency in spoken English and neutralize mother tongue influence
5. To train students to use language appropriately for interviews, group discussion and public speaking

**SYLLABUS:**

**UNIT- I**

**Phonetics – Introduction to Sounds of Speech – Vowels – Consonants – Phonetic Transcription & Orthographic Transcription**

**UNIT – II**

**Syllabification – Word Stress – Rules of word stress – Intonation – Falling tone and Rising tone**

**UNIT – III**

**Situational Dialogues – Role-play – Expressions in various situations – Self Introduction – Introducing others – Greetings – Apologies – Requests – Social and Professional etiquettes – Telephone Etiquettes**

**UNIT – IV**

**JAM – Describing object/person/place/situation – Giving directions**

**UNIT – V**

**Debates and Group Discussions**

**OUTCOMES** :

- Develop linguistic and communicative competence through the development of the language skills.
- Becoming active participants in the learning process and acquiring proficiency in spoken English of the students
- Speaking with clarity and confidence thereby enhancing employability skills of the students

**MINIMUM REQUIREMENT FOR ELCS LAB:**

The English Language Lab shall have two parts:

1. Computer Assisted Language Learning (CALL) Lab:
   The Computer aided Language Lab for 60 students with 60 systems, one master console, LAN facility and English language software for self- study by learners.
2. The Communication Skills Lab with movable chairs and audio-visual aids with a P.A. system, Projector, a digital stereo-audio & video system and camcorder etc.

System Requirement (Hardware component):

Computer network with LAN with minimum 60 multimedia systems with the following specifications:

- i) P – IV Processor
  - a) Speed – 2.8 GHZ
  - b) RAM – 512 MB Minimum
  - c) Hard Disk – 80 GB
- ii) Headphones of High quality

**Suggested software:**

1. Clarity Pronunciation Power – Part I (Sky Pronunciation)
2. Clarity Pronunciation Power – part II
3. K-Van Advanced Communication Skills
4. TOEFL & GRE (KAPLAN, AARCO & BARRONS, USA, Cracking GRE by CLIFFS)
5. *DELTA's key to the Next Generation TOEFL Test: Advanced Skills Practice.*
6. Lingua TOEFL CBT Insider, by Dreamtech
7. English Pronunciation in Use (Elementary, Intermediate, Advanced) CUP
8. Cambridge Advanced Learners' English Dictionary with CD.

**Reference books:**

1. **A Textbook of English Phonetics for Indian Students** $2^{nd}$ Ed T. Balasubramanian. (Macmillian),2012.
2. **A Course in Phonetics and Spoken English**, Dhamija Sethi, Prentice-Hall of India Pvt.Ltd
3. **Speaking English Effectively**, $2^{nd}$ Edition Krishna Mohan & NP Singh, 2011. (Mcmillan).
4. **A Hand book for English Laboratories**, E.Suresh kumar, P.Sreehari, Foundation Books,2011
5. **English Pronunciation in Use. Intermediate &Advanced** ,Hancock, M. 2009. CUP
6. **Basics of Communication in English** ,Soundararaj, Francis. 2012.. *New Delhi: Macmillan*
7. **Spoken English** (CIEFL) in 3 volumes with 6 cassettes, OUP.
8. **English Pronouncing Dictionary**, Daniel Jones Current Edition with CD.Cambridge, $17^{th}$ edition, 2011.

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**I Year B.Tech - I Semester**

| L | P | C |
|---|---|---|
| 0 | 3 | 2 |

## PHYSICAL CHEMISTRY LAB

**OBJECTIVES::**

- Introduce the fundamental principles of chemistry lab experiments to students which include volumetric analysis
- To confirm the formation and nature of the product in chemical processes, as the knowledge of some physical, chemical and instrumental methods is essential for a chemical engineer.
- To acquaint the students with the determination of molecular weight of a polymer

## I. PHYSICAL CHEMISTRY LAB:

1. Determination of Specific rotation of substance by Polarimeter.
2. Study of inversion of Sucrose by Polarimetry.
3. Conductometric titration of Strong acid Vs Strong base.
4. Conductometric titration of Weak acid Vs Strong base.
5. Potentiometric titration between Potassium Dichromate and Ferrous iron.
6. Potentiometric Titration of Strong acid Vs Strong base
7. Determination of the specific rate (Second order kinetics) of the alkaline hydrolysis of ethyl acetate by Volumetric method.
8. Study of Adsorption characteristics of acetic acid on Charcoal.
9. Estimation of critical solution temperature of Phenol-Water System.
10. Determination of Molecular weight of a given Polymer from Visicocity measurements.

(Any 10 experiments from the above list)

**Outcomes**

- The students will be outfitted with hands-on knowledge in the quantitative chemical analysis
- Would be confident in handling energy storage systems and would be able combat chemical corrosion
- Would have acquired the practical skill to handle the analytical methods with confidence.
- Would feel comfortable to think of design materials with the requisite properties

**TEXT BOOKS:**

1. Vogel’s Text book of Quantitative Chemical Analysis, Sixth Edition – J. Mendham et al, Pearson Education.
2. Chemistry Practical – Lab Manual by Chandra Sekhar, GV Subba Reddy and Jayaveera.

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**Engineering & IT Workshop**
**(Common to All Branches)**

## Part – A: Engineering Workshop Lab

**OBJECTIVES::**

- Make the students correctly use measuring and marking tools
- Practice the correct use of hand tools
- Apply safe workshop practices when performing basic fitting, carpentry, tin smithy and electrical wiring skills
- Develop the fabrication skills among the students
- Read and interpret the component drawings
- Gain practical skills to apply student's knowledge of theory concepts in real time practice

**1. TRADES FOR EXERCISES:**

**At least 2 exercise In each:**

1. Carpentry
2. Fitting
3. House-wiring
4. Black Smithy
5. Tin smithy
6. Power Tools Demonstration

**TEXT BOOK:**

1. Work shop Manual / P.Kannaiah/ K.L.Narayana/ Scitech Publishers.

**Objective**: The objective of this subject is to provide the basic about different manufacturing processes and use of various workshop tools the exposer to the Power tools used in the inclusion

Question Paper pattern : Test in any two out of 6 trades.

**Outcomes:**

- Expected to improve practical skills
- Able to develop and fabricate the experimental setups for academic and research purposes.
- Able to assemble components for making various systems

## PART – B: IT Workshop

**OBJECTIVES:**

- To provide Technical training to the students on Productivity tools like Word processors, Spreadsheets, Presentations
- To make the students know about the internal parts of a computer, assembling a computer from the parts, preparing a computer for use by installing the operating system
- Disassemble and Assemble a Personal Computer and prepare the computer ready to use
- Prepare the Documents using Word processors
- Prepare Slide presentations using the presentation tool
- Install single or dual operating systems on computer

**Preparing your Computer (4 weeks)**

**Task 1:** Identify the internal parts of a computer of a computer, and its peripherals. Represent the same in the form of diagrams including Block diagram.

**Task 2:** Disassemble and assemble the PC back to working condition. Students should be able to trouble shoot the computer and identify working and non-working parts. Student should identify the problem correctly by various methods available. Students should record the process of assembling and trouble shooting a computer.

**Task 3: S**tudent should install Linux on the computer. Student may install another operating system (including proprietary software) and make the system dual boot or multi boot. Students should record the entire installation process.

**Task 4**: Students should record the various features that are supported by the operating system installed and submit it.

**Productivity tools (3 weeks)**

**Task 5: Word Processor:** Students should be able to create documents using the word processor tool. Some of the tasks that are to be performed are inserting and deleting the characters, words and lines, Alignment of the lines, Inserting header an Footer, changing the font, changing the colour, including images and tables in the word file, making page setup, copy a of text, images, tables etc, linking the images which are present in other directory, formatting paragraphs, spell checking, etc. Students should be able to prepare project cover pages etc at the end of the task. Students should submit a user manual of the word processor considered.

**Task 6: Spreadsheet:** Students should be able to create, open, save the appl ation documents and format them as per the requirement.Some of the tasks that may be practiced are Managing the worksheet environment, creating cell data, inserting and deleting cell data, format cells, adjust the cell size, applying formulas and functions, preparing charts, sorting cells. Students should submit a user manual of the Spreadsheet application considered.

**Task 7: Presentations :** creating, opening, saving and running the presentations; Selecting the style for slides, formatting the slides with different fonts, colours; creating charts and tables, inserting and deleting text, graphics and animations; bulleting and numbering; hyperlinking, running the slide show, setting the timing for slide show. Students should submit a user manual of the Presentation tool considered.

**References:**


1. "Introduction to Computers", Peter Norton, Mc Graw Hill
2. "LaTeX Companion" – Leslie Lamport, PHI/Pearson.
3. "MOS study guide for word, Excel, Powerpoint & Outlook Exams", Joan Lambert, Joyce Cox, PHI.
4. "Introduction to Information Technology", ITL Education Solutions limited, Pearson Education.
5. "Networking your computers and devices", Rusen, PHI "Trouble shooting, Maintaining & Repairing PCs", Bigelows, TMH.


**Outcomes:**

- Students attain complete knowledge of a computer i.e. hardware as well as operating systems.
- Students will be technically strong in using Word processors, Spreadsheets.
- Prepare Slide presentations that helps them in their career

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## MATHEMATICS - II
## (Common to All Branches)

**OBJECTIVES:**

- Get an idea of Fourier series expansion, various types of Fourier series and about Fourier Transforms of different functions.
- The knowledge of Laplace transforms to solve Differential Equations with initial conditions.
- To acquaint the student with the concepts of vector ca needed for problems in all engineering disciplines.
- To make the student appreciate the purpose of using transforms to create a new domain in which it is easier to handle the problem that is being investigated.

**UNIT – I**

Fourier Series: Determination of Fourier coefficients – Fourier series – Even and odd functions – Fourier series in an arbitrary interval – Even and odd periodic continuation – Half-range Fourier sine and cosine expansions.

**UNIT – II**

Fourier integral theorem (only statement) – Fourier sine and cosine integrals. Fourier transform – Fourier sine and cosine transforms – Properties – Inverse transforms – Finite Fourier transforms.

**UNIT – III**

z-transform – Inverse z-transform – Properties – Damping rule – Shifting rule – Initial and final value theorems. Convolution theorem – Solution of difference equations by z-transforms.

**UNIT – IV**

Laplace transform of standard functions – Inverse transform – First shifting Theorem, Transforms of derivatives and integrals – Unit step function – Second shifting theorem – Dirac's delta function – Convolution theorem – Laplace transform of Periodic function.

Differentiation and integration of transform – Application of Laplace transforms to ordinary differential equations of first and second order.

**UNIT – V**

Vector Calculus: Gradient – Divergence – Curl and their properties; Vector integration – Line integral - Potential function – Area – Surface and volume integrals. Vector integral theorems: Green's theorem – Stoke's and Gauss's Divergence Theorem (Without proof). Application of Green's, Stoke's and Gauss's Theorems.

**TEXT BOOKS:**

1. Higher Engineering Mathematics, B.S.Grewal, Khanna publishers.

2. Engineering Mathematics, Volume - II, E. Rukmangadachari & E. Keshava Reddy, Pearson Publisher.

**REFERENCES:**

1. Engineering Mathematics, Volume - II, by G.S.S.Raju, CENGAGE publisher.
2. Mathematical Methods by T.K.V. Iyengar, B.Krishna Gandhi, S.Ranganatham and M.V.S.S.N.Prasad S. Chand publication.
3. Higher Engineering Mathematics, by B.V.Ramana, Mc Graw Hill publishers.
4. Advanced Engineering Mathematics, by Erwin Kreyszig, W ley India.

## Outcomes:

- Evaluate any type of integrals that arises in many branches of engineering and science to convert from Cartesian to polar, cylindrical and spherical and vice versa and also well verse with finding area, surface and volume depending on the geometry of the physical configuration.
- Determine or analyze the position, rate of a particle object in a space, conservative medium, circulations of the flows and also converting complicated geometries to simple geometry by transforming line to double, double to triple integrals and vice versa for physical problems.
- Find the solution of the real problems that arise in many fields like fluid mechanics, heat and mass transfer, chemical reactions, environmental fields and so on by different analytical methods.

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## TECHNICAL COMMUNICATION & PRESENTATION SKILLS (Theory)

**Preamble:**

In the increasingly globalized world, technical communication and presentation skills are assuming great importance. Industries and employers constantly complain that young engineers have adequate technical knowledge, but no communication and presentation skills. Success is defined these days in terms of possessing these skills. The syllabus has been designed to develop communicative competencies of the students.

**Objectives:**

1. To develop awareness in students of the relevance and of technical communication and presentation skills.
2. To prepare the students for placements
3. To provide students with interactive practice sessions to make them internalize these skills

**UNIT 1:**

Basics of Technical Communication – Introduction – Objectives & Characteristics of Technical Communication – Importance and need for Technical communication - LSRW Skills – Barriers to effective communication

**UNIT II**

Informal and Formal Conversation - Verbal and Non-verbal communication –Kinesics, Proxemics, Chronemics, Haptics, Paralanguage

**UNIT III**

Written communication – Differences between spoken and written communication – Features of effective writing –Advantages and disadvantages of spoken and written communication

**UNIT IV**

Presentation Skills – Nature and importance of oral presentation – Defining the purpose – Analyzing the audience - Planning and preparing the presentation, organizing and rehearsing the presentation –Individual and group presentations - Handling stage fright

**UNIT V**

Interview Skills – The Interview process –Characteristics of the job interview – Pre-interview preparation techniques – Projecting the positive image – Answering Strategies

**Prescribed Books**

1. Effective Technical Communication, Ashrif Rizvi, TataMcGrahill, 2011
2. Technical Communication by Meenakshi Raman & Sangeeta Sharma, O U Press 2009

**Reference Books**

1. Communication Skills by Pushpalatha & Sanjay Kumar, Oxford Univsesity Press
2. Books on TOEFL/GRE/GMAT/CAT/ IELTS by Barron's/DELTA/Cambridge University Press.2012.
3. Soft Skills for Everyone, Butterfield Jeff, Cengage Publications, 2011.
4. Management Shapers Series by Universities Press (India) Pvt Ltd., Himayatnagar, Hyderabad 2008.
5. Handbook for Technical Writing by David A McMurrey Joanne Buckely CENGAGE Learning 2008.
6. English for Technical Communication for Engineering Students, Aysha Vishwamohan, Tata Mc Graw-Hill 2009.

**Outcomes:**

- Turning out the students with a clear concept of communication like speaking convincingly, express their opinions clearly, initiate a discussion, negotiate, and argue using appropriate communicative strategies
- Read different genres of texts, infer implied meanings and critically analyse and evaluate them for ideas as well as for method of presentation
- Getting them ready for placements and equipping them with readiness to implement their communication and Presentation skills at work place.

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## COMPUTER PROGRAMMING

**OBJECTIVES:**

- To understand the core aspects of computer problem solving techniques
- To understand the programming language constructs
- To understand the programming paradigms
- To understand the compound data types
- To understand dynamic memory allocation concepts

### Unit - I

**Introduction to Computers:** Computer Systems, Computing Environment, Computer Languages, Creating and Running Programs, System Developments.

**Introduction to the C Language:** Introduction, C programs, Identifiers, Types, Variables, Constants, Input and Output, Programming Examples.

**Introduction to Computer Problem Solving:** Introduction , The Problem-Solving Aspect, Top-down Design, Bottom - up Approach, Flowcharts, Implementation of Algorithms, Program Verification, The Efficiency of Algorithms, The Analysis of Algorithms.

### Unit – II

**Structure of C program:** Expressions, Precedence and Associatively, Evaluating Expressions, Type Conversion, Statements, Sample Programs.

**Selections and Making Decisions:** Logical Data and Operators, Two way Selection, Multiway Selection.

**Repetition:** Concept of Loop, Pretest and Posttest Loops, Initialization and Updation, Event and Counter Controller Loop, Loops in C, Looping Applications.

**Fundamental Algorithms:** Exchanging the values between two variables, Counting, Summation of a set numbers, Factorial Computation, Sine Function Computation, Generation of the Fibonacci Sequence, Reversing the digits of a integer, Basic conversions, Character to Number Conversion

### Unit – III

**Factoring Methods:** Finding Square root of a Number, The Smallest Deviser an Integer, The GCD of two Integers, Generating Prime Numbers, Computing Prime Factor of an Integer, Computing the prime factors of an Integer, Generation Pseudo Random Number, Raising the number to Large Power, Computing the $n^{th}$ Fibonacci.

**Functions:** Introduction, User Defined Functions, Inter Function Communication, Standard Functions, Scope, Programming Examples.

**Array Techniques:** Array Order Reversal, Array Counting, Finding the Maximum Number Set, Removal Duplicates from an Ordered Array, Partitioning an Array, Finding $k^{th}$ smallest Element, Longest Monotone Subsequence.

**Arrays:** Introduction, Two Dimensional Arrays, Multi Dimensional Arrays, Inter Function Communication, Array Applications, Exchange Sort, Binary Search, Linear Search.

**Unit – IV**

**Strings:** String Concepts, C Strings, Sting Input/Output Functions, Arrays of Strings, String Manipulation Functions, String/Data Conversion.

**Enumerated, Structure, and Union Types:** The Type Definition, Enumerated Types, Structure, Unions, Programming Applications.

**Bitwise Operators:** Exact Size Integer Types, Logical Bitwise Operators, Shift Operators, Mask.

**Unit – V**

**Pointers:** Introduction, Pointers for Inter Function Communication, Pointers to Pointers, Compatibility, Lvalue and Rvalue.

**Pointer Applications:** Array and Pointers, Pointer Arithmetic and Arrays, Passing an Array to a Function, Memory Allocation Functions, Array of Pointers, Programming Applications.

**Binary Input/output:** Text Versus Binary Streams, Standard Library Functions for Files, Converting File Type.

**Text Books :**

1. How to Solve it by Computer by R.G. Dromey, Pearson
2. Computer Science, A Structured Programming Approach Using C by Behrouz A. Forouzan & Richard F. Gilberg, Third Edition, Cengage Learning

**Reference Books :**

1. Programming in C: A Practical Approach, Ajay Mittal, Pearson.
2. The C programming Language, B. W. Kernighan and Dennis M. Ritchi, Pearson Education.
3. Problem Solving and Programming Designs in C, J. R. Hanly and E.B. Koffman.,
4. Programming with C Rema Theraja, Oxford
5. Problem Solving with C, M.T.Somashekara, PHI
6. C Programming with problem solving, J.A. Jones & K. Harrow,Dreamtech Press
7. Programming with C, R.S.Bickar, Universities Press.

**Outcomes:**

- Able to design the flowchart and algorithm for real world problems
- Able to learn and understand new programming languages
- Able to construct modular and readable programs
- Able to write C programs for real world problems using simple and compound data types
- Adapt programming experience and language knowledge to other programming language contexts
- Employee good programming style, standards and practices during program development

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## APPLIED PHYSICS

**OBJECTIVES:**

- To enrich the understanding of various types of materials and their applications in engineering and technology.
- Gaining the factual knowledge and analytical skills necessary in understanding of physical phenomena.
- To provide the working knowledge in the areas of Lasers and Laser based Communication principles.
- To introduce the latest developments and understanding of the solid-state physics especially the Nanotechnology and Engineering materials like Dielectric and Magnetic materials

### UNIT 1:PHYSICAL OPTICS, LASERS AND FIBRE OPTICS

*Physical Optics:* Introduction - Interference in thin films by reflection – Newton's Rings – Fraunhofer diffraction due to single slit, double slit and diffraction grating.

*Lasers:* Introduction - Characteristics of laser – Spontaneous and stimulated emission of radiation –- Einstein's coefficients –– Population inversion – Pumping mechanisms - Ruby laser - He-Ne laser – Applications of lasers.

Fibre optics: Introduction– Construction and working principle of optical fiber –Numerical aperture and acceptance angle – Types of optical fibers –Optical fiber communication system – Applications of optical fibers.

### UNIT 2:CRYSTALLOGRAPHY AND QUANTUM MECHANICS

*Crystallography:* Introduction – Space lattice –Unit cell – Lattice parameters –Bravias lattice – Crystal systems – Packing fractions of SC, BCC and FCC -Directions and planes in crystals – Miller indices – Interplanar spacing in cubic crystals – X-ray diffraction - Bragg's law –Bragg's Spectrometer.

*Quantum Mechanics:* Introduction to matter waves – de'Broglie hypothesis - Schrodinger's time independent wave equation – Significance of wave function - Particle in a one dimensional infinite potential well.

### UNIT 3: FREE ELECTRON THEORY AND SEMICONDUCTORS

*Free electron theory:* Classical free electron theory –- Sources of electrical resistance - Equation for electrical conductivity - Quantum free electron theory – Fermi-Dirac distribution –Kronig-Penny model(qualitative) – Origin of bands in solids – Classification of solids into conductors, semiconductors and insulators.

*Semiconductor physics:* Introduction – Intrinsic and extrinsic semiconductors – Drift & diffusion currents and Einstein's equation – Continuity equation -Hall Effect.

**UNIT 4**: **DIELECTRICS AND MAGNETIC MATERIALS**

*Dielectrics:* Introduction – Dielectric Polarization – Types of Polarization – Lorentz field – Clausius-
Mosotti equation – Dielectric strength, loss, breakdown.

*Magnetic materials:* Introduction and basic definitions – Origin of magnetic moment – Classification of magnetic materials into dia, para, ferro, antiferro and ferri magnetic materials – Hysteresis - Soft and hard magnetic materials – Applications of magnetic materials.

**UNIT 5**: **SUPERCONDUCTIVITY AND PHYSICS OF NANOMATERIALS**

*Superconductivity:* Introduction - Properties of superconductors – Meissner effect– Type I and type II superconductors – Flux quantization – London penetration depth – ac and dc Josephson effects – BCS theory(qualitative) - Applications of superconductors.

*Physics of Nanomaterials*: Introduction - Significance of nanoscale - Surface area and quantum confinement – Physical properties, optical, thermal, mechanical and properties – Synthesis of nanomaterials: ball milling, chemical vapour deposition, sol-gel – Carbon nanotubes & its properties.

**Prescribed Text books:**

1. Engineering physics – S. ManiNaidu, Pearson Education
2. Engineering Physics – P.K.Palanisamy, Scitech Publications

**Reference Books:**

1. Engineering Physics – V. Rajendran, K.Thyagarajan Tata MacGraw Hill Publishers
2. Engineering Physics – D K Pandey, S. Chaturvedi, Cengage Learning
3. Engineering Physics - Sanjay D. Jain, D. Sahasrambudhe and Girish University Press
4. Engineering Physics – M. Arumugam, Anuradha Publications
5. Engineering physics – M.N. Avadhanulu and P.G. KrshiSagar, Chand and Co
6. Nanomaterials – A.K.Bandopadhyaya, New Age Publishers
7. Carbon nanotubes and Graphene Device Physics – H.S. Philip Wong, Deji Akinwande, Cambridge University Press

**Outcomes:**

- The students will have the knowledge on physics of materials and that knowledge will be used by them in different engineering and technology applications

- Understand concepts of electric and magnetic fields helps the students to understand Electromagnetic wave propagation which is required for Electro Magnetic Theory, Electrical circuits
- Application of quantum mechanics basic concepts in the various fields

- Use of lasers and OPTICAL FIBERS in modern communication

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## ENGINEERING MECHANICS

**OBJECTIVES:**

• Comprehensive, theory based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline.
• In-depth understanding of specialist bodies of knowledge within the engineering discipline.
• Application of established engineering methods to complex engineering problem solving.
• Application of systematic engineering synthesis and design processes.

**UNIT – I**

**INTRODUCTION OF ENGINEERING MECHANICS –** Basic concepts - System of Forces – Moment of Forces and its Application – Couples and Resultant of Force System – Equilibrium of System of Forces - Degrees of Freedom – Free body diagrams –Types of Supports – Support reactions for beams with different types of loading – concentrated, uniformly distributed and uniformly varying loading.

**UNIT – II**

**FRICTION :** Types of friction– laws of Friction – Limiting friction- Cone of limiting friction– static and Dynamic Frictions – Motion of bodies – Wedge, Screw jack and differential Screw jack.

**UNIT – III**

**CENTROID AND CENTER OF GRAVITY:** Centroids of simple figures – Centroids of Composite figures – Centre of Gravity of bodies – Area moment of Inertia - Parallel axis and perpendicular axis theorems - Moments of Inertia of Composite Figures.

**MASS MOMENT OF INERTIA:** Moment of Inertia of Simple solids – Moment of Inertia of composite masses.( Simple problems only)

**UNIT – IV**

**KINEMATICS:** Rectilinear and Curvilinear motion – Velocity and Acceleration – Motion of A Rigid Body – Types and their Analysis in Planar Motion.

**KINETICS :** Analysis as a particle and Analysis as a Rigid Body in Translation – Central Forces of motion – Equations of Plane Motion – Fixed Axis Rotation – Rolling Bodies – Work Energy Method – Equation for Translation – Work Energy application to Particle Motion, Connection System – Fixed axis Rotation and Plane Motion.

**UNIT – V**

**ANALYSIS OF PERFECT FRAMES:** Types of frames – cantilever frames and simply supported frames – Analysis of frames using method of joints, method of sections and tension coefficient method for vertical loads, horizontal loads and inclined loads.

**MECHANICAL VIBRATIONS:** Definitions, Concepts-Simple Harmonic motion-Free vibrations-Simple Compound and Torsional pendulum- Numerical problems

**TEXT BOOKS**:

(1) Engineering Mechanics by Shames & Rao – Pearson Education.
(2) Engineering Mechanics by Dr.R.k.Bansal, Lakshmi Publications.
(3) Engineering Mechanics – B. Bhattacharyya, Oxford University Publications.

**REFERENCES:**

(1) Engineering Mechanics by Fedrinand L.Singer – Harper Collings Publishers.
(2) Engineering Mechanics by Seshigiri Rao, Universities Press, Hyderabad.
(3) Engineering Mechanics by Rajsekharan, Vikas Publications.
(4) Engineering Mechanics (Statics and Dynamics) by Hibller and Gupta; Pearson Education
(5) Engineering Mechanics by S.Timoshenko, D.H.Young and J.V.Rao, Tata McGraw-Hill Company
(6) Engineering Mechanics by Chandramouli, PHI publications.
(7) Engineering Mechanics –Arthur P. Boresi and Richard J. Schmidt. – Brooks/Cole – Cengage Learning

**Outcomes:**

1. Use scalar and vector analytical techniques for analysing forces in statically determinate structures.
2. Apply fundamental concepts of kinematics and kinetics of particles to the analysis of simple, practical problems.
3. Apply basic knowledge of maths and physics to solve real-world problems

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## INTRODUCTION TO CHEMICAL ENGINEERING

**OBJECTIVES:**

- Differentiate and explain the significance of each unit operation and unit process.
- Identify, relate and assess the importance of dimensionless groups.
- Describe the material balance, energy balance. Explain Humidity and saturation.
- Distinguish the types of fluids, fluid flow, the basic concepts related to heat transfer and mass transfer.
- Write about the importance and operation of chemical engineering equipment.

**Unit-I**

Introduction, Unit operations, basic laws, units and dimensions.

Energy, equivalent mass, solutions, humidity and saturation.Material balance, Energy balance.

**Unit-II**

Flow of fluids: Introduction, nature of fluid, viscosity, velocity profile, flow field, types of fluid motion, laminar and turbulent flow, flow of a fluid past a solid surface, iprocating, rotary, and centrifugal pumps

**Unit-III**

Heat transfer: Conduction, convection (omit correlations for calculation of heat transfer coefficients, heat transfer with change in phase) and radiation. Flow arrangement in heat exchangers, variation of fluid temperatures in heat exchangers, heat transfer equipment (double pipe & Shell and tube heat exchanger),evaporation, long tube vertical type and forced circulation type evaporators, multiple effect evaporation, methods of feeding

**Unit-IV**

Mass transfer: Diffusion, mass transfer operation, absorption, Vapour-Liquid Equilibrium, Relative Volatility, Boiling point diagram. Distillation, reflux, Equipment for gas-liquid operations, selection of equipment for gas-liquid operations,

**Unit-V:**

Liquid-liquid extraction, extraction schemes, distribution coefficient, triangular diagram, selection of disperse phase, classification of industrial liquid-liquid contactors, industrial liquid-liquid contactors. Selection of liquid-liquid extraction contactors.Introduction of humidification and dehumidification - equipments, introduction of drying, equipment for drying.Introduction to crystallization, classification of crystallization equipment, crystallization equipment, adsorption, adsorption equipment.

Types of reactions and reactors.

**TEXT BOOK:**


1. Introduction to chemical engineering by S. K. Ghosal, S. K. Sanyal and S. Dutta, TMH publications, 1993.

**REFERENCE:**

1. Unit operations in chemical engineering by W.L. McCabe and J.C. Smith and Peter Harriott, Mc Graw Hill 5th ed. 1993.

**Outcomes:**

- Students acquire knowledge of the unit operations and processes their significance and applications
- Acquaintance of material and energy balance which will help them in knowing the importance, operation of chemical engineering equipment and designing of equipment
- Fundamentals of fluid flow and basic concepts of heat and mass transfer

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## APPLIED PHYSICS LABORATORY

**OBJECTIVES:**

- Develop Laboratory skills for the measurement of Physical parameters
- Train the students for systematic recording of experimental findings of various parameters.
- Students learn data analysis and comprehend basic phenomenon involving in the experiment
- Understand and realization of physics concepts by doing experiments
- Establish practical knowledge and gain confidence to do experiments individually

**Any EIGHT of the following experiments has to be performed during the SEMESTER**

1. Determination of wavelengths of various colours of mercury spectrum using diffraction grating in normal incidence method.
2. Determination of dispersive power of the prism
3. Determination of thickness of thin object by wedge met d.
4. Determination of radius of curvature of lens by Newton's rings.
5. Laser : Diffraction due to single slit
6. Laser : Diffraction due to double slit
7. Laser: Determination of wavelength using diffraction grating
8. Determination of Numerical aperture of an optical fiber.
9. Meldes experiment: Determination of the frequency of tuning fork
10. Sonometer: Verification of the three laws of stretched strings
11. Energy gap of a material using p-n junction diode
12. Electrical conductivity by four probe method
13. Determination of thermistor coefficients ( a, ß)
14. Hall effect : Determination of mobility of charge carr rs in semiconductor
15. B-H curve
16. Magnetic field along the axis of a current carrying co – Stewart and Gee's method.
17. Determination of lattice constant using X-ray spectrum.

**Outcomes:**

- The students will demonstrate the laboratory skills in handling of optical instruments
- The students are able to understand and experience physical principles of Sound, Optics
- The students are able to apply the principles of physics and measure the properties of materials
- The students able to characterize dielectric and semiconducting material devices
- Students able to analyze and study the emission spectral properties of light

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## COMPUTER PROGRAMMING LAB
## (Common to Civil, EEE, ME, CSE, Chemical)

**OBJECTIVES:**

- Learn program development steps like coding, compilation, execution and debugging
- Develop programs using Branching & Looping statements
- Develop applications using structures and unions
- Understand the use of recursion
- Experiment different file operations

**Week-1**

1) Write an algorithm and draw a flowchart to make the following exchange between the variables a-> b -> c->d - > a
2) Write an algorithm and draw a flowchart to generate the first n terms of the sequence. A Fibonacci sequence is defined as follows: the first and second terms in the sequence are 0 and 1. Subsequent terms are found by adding the preceding two terms in the sequence.
3) Write a algorithm and draw a flowchart to carry out the arithmetic operations addition, subtraction, multiplication, and division between two variables
4) Write a algorithm and draw a flowchart for printing prime numbers between 1 and n.

**Week-2**

1) Write a C program to construct a multiplication table for a given number.
2) Write a program to reverse the digit of a given integer.
1) Write a C program to calculate the factorial of a given number

**Week-3**

Write a program to calculate tax, given the following conditions:

a) If income is less than 1,50,000 then no tax.
b) If taxable income is in the range 1,50,001 – 300,000 then charge 10% tax
c) If taxable income is in the range 3,00,001 – 500,000 then charge 20% tax
d) If taxable income is above 5,00,001 then charge 30% tax

**Week-4**

1) Write a program to print the calendar for a month given the first Week- day of the month.

Input the first day of the month (Sun=0,Mon=1,Tue=2,Wed=3,.....) :: 3

Total number of days in the month : 31

Expected output

| *Sun* | *Mon* | *Tue* | *Wed* | *Thu* | *Fri* | *Sat* |
|---|---|---|---|---|---|---|
| - | - | - | *1* | *2* | *3* | *4* |
| *5* | *6* | *7* | *8* | *9* | *10* | *11* |
| *12* | *13* | *14* | *15* | *16* | *17* | *18* |
| *19* | *20* | *21* | *22* | *23* | *24* | *25* |
| *25* | *26* | *27* | *28* | *29* | *30* | *31* |

**Week-5**

1) Write a program to print the Pascal triangle for a given number
2) Write a program to calculate the following expression for given x value

$$f(x) = a_0 + \sum_{n=1}^{\infty}\left(a_n \cos\frac{n\pi x}{L} + b_n \sin\frac{n\pi x}{L}\right)$$

**Week-6**

1) Write C code to define a function cash_dispense, which takes an amount as its input, and returns the number of 1000, 500, 100, 50, 20, 10, 5, 2, 1 rupee denomination that make up the given amount.
2) Write C code to reverse the contents of the array. For example, [1,2,3,4,5] should become [5,4,3,2,1]
3) Write a program that will search and find out the position where the given key element exist in a user chosen array and print it as output.

**Week-7**

1) Write C code to compute the frequency table of survey given by 20 users. The survey responses range from 1 to 5 and are stored in an array. For example, 10 responses are stored in the array [1,1,5,2,3,3,5,5,2,2]. The frequency table will be as shown below:
   a. 1 = 2
   b. 2 = 3
   c. 3 = 2
   d. 4 = 0
   e. 5 = 3
2) Write a program to define a function to sort an array integers in ascending order by using exchange sort.

**Week-8**

1) Write a C program to check whether a given string is a palindrome or not, without using any built-in functions
2) Write a function that accepts a string and delete the first character.
3) Write a function that accepts a string and delete all the leading spaces.

**Week-9**

Write a program to accept a string from user and display number of vowels, consonants, digits and special characters present in each of the words of the given string.

**Week-10**

1) Write a C program to define a union and structure both having exactly the same numbers using the sizeof operators print the sizeof structure variables as well as union variable
2) Declare a structure *time* that has three fields *hr, min, secs.* Create two variables, *start_time* and *end_time.* Input there values from the user. Then while *start_time* is not equal to *end_time* display GOOD DAY on screen.

**Week-11**

1) Write a program to read in an array of names and to sort them in alphabetical order. Use sort function that receives pointers to the functions strcmp, and swap, sort in turn should call these functions via the pointers.
2) Write a program to read and display values of an integer array. Allocate space dynamically for the array using the *malloc()*.
3) Write a program to calculate area of a triangle using function that has the input parameters as pointers as sides of the triangle.

**Week-12**

1) Two text files are given with the names text1 and text2. These files have several lines of text. Write a program to merge (first line of text1 followed by first line of text2 and so on until both the files reach the end of the file) the lines of text1 and text2 and write the merged text to a new file text3.
2) Write a program to split a given text file into n parts. Name each part as the name of the original file followed by .part<**n>** where n is the sequence number of the part file.

**Reference Books:**

1. Computer Science, A Structured Programming Approach Using C by Behrouz A. Forouzan & Richard F. Gilberg, Third Edition, Cengage Learning
2. C Programming A Problem-Solving Approach, Behrouz A. Forouzan & E.V. Prasad, F Gilberg, Third Edition, Cengage Learning
3. Programming with C Rema Theraja, Oxford
4. “C Test Your Skills”, Kamthane, Pearson Education
5. Programming in C: A Practical Approach, Ajay Mittal, Pearson
6. Problem solving with C, M.T.Somasekhara, PHI
7. C Programming with problem solving, J.A. Jones & K. Harrow,Dreamtech Press
8. Programming withc, Byron S Gottfried, Jitender Kumar Chhabra, TMH, 2011

**Outcomes:**

- Plan a solution for a problem by writing a program
- Develop searching and sorting algorithms using loop statements
- Develop stacks, queues and trees programs using structures and pointers concepts

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| **II Year B.Tech. I-Sem** | **L** | **P** | **C** |
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## MATHEMATICAL METHODS

**OBJECTIVES:**

- This course aims at providing the student with the concepts of Matrices, Numerical Techniques and Curve fitting.
- Derive appropriate numerical methods to solve non-linear algebraic and transcendental equations and linear system of equations
- Develop appropriate numerical methods to approximate a function and calculate a definite integral and to evaluate a derivative at a value
- Develop appropriate numerical methods to solve an ordinary differential equation and understand the various techniques to solve Partial differential equations
- Perform an error analysis for various numerical methods

**UNIT – I**

Elementary row transformations-Rank – Echelon form, normal form – Consistency of System of Linear equations.Linear transformations.Hermitian, Skew-Hermitian and Unitary matrices and their properties. Eigen Values, Eigen vectors for both real and complex matrices. Cayley – Hamilton Theorem and its applications – Diagonolization of matrix.Calculation of powers of matrix. Quadratic forms – Reduction of quadratic form to canonical form and their nature.

**UNIT – II**

Solution of Algebraic and Transcendental Equations: The Bisection Method – The Method of False Position– Newton-Raphson Method.

**UNIT – III**

**Interpolation:** Newton's forward and backward interpolation formulae – Lagrange's formulae. Gauss forward and backward formula, Stirling's formula, Bessel's formula,

**UNIT – IV**

Curve fitting: Fitting of a straight line – Second degree curve – Exponentional curve-Power curve by method of least squares. Numerical Differentiation and Integration – Trapezoidal rule – Simpson's 1/3 Rule – Simpson's 3/8 Rule.

**UNIT – V**

Numerical solution of Ordinary Differential equations: Solution by Taylor's series-Picard's Method of successive Approximations-Euler's Method-Runge-Kutta Methods – Predictor-Corrector Method – Milne's Method. Numerical solutions of Laplace equation using finite difference approximation.

**TEXT BOOKS:**

3. Higher Engineering Mathematics, B.S.Grewal, Khanna publishers.
4. Introductory Methods of Numerical Analysis, S.S. Sastry, PHI publisher.

**REFERENCES:**

3. Engineering Mathematics, Volume - II, E. Rukmangadachari & E. Keshava Reddy, Pearson Publisher.

4. Engineering Mathematics, Volume - II, by G.S.S.Raju, CENGAGE publisher.
5. Mathematical Methods by T.K.V. Iyengar, B.Krishna Gandhi, S.Ranganatham and M.V.S.S.N.Prasad, S. Chand publication.
4. Higher Engineering Mathematics, by B.V.Ramana, Mc Graw Hill publishers.
5. Advanced Engineering Mathematics, by Erwin Kreyszig, W ley India.

**Outcomes:**

- The student will be able to analyze engineering problems using the concepts of Matrices and Numerical methods
- Solve a linear system of equations and non-linear algebraic or transcendental equation using numerical method
- Approximate a function, calculate a definite integral and evaluate a derivative at a value using appropriate numerical methods
- Solve an Ordinary differential equation and partial differential equations using numerical methods

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## ORGANIC CHEMISTRY

**Objectives:**

- The Mechanism of organic chemical reaction is essentia to synthesis new organic compounds in drug and pharmaceutical industries. In order to study their kinetics of reactions to regulate the process for optimization of uction of drugs and pharmaceutical, the principles of organic chemistry are essential.
- For chemical engineer to carry out a processes industrially for the manufacture of drgus and pharmaceuticals, Comprehension on basic reactions, reagents and their applications is needed.
- He/She should know the electronic behavior of organic molecules, their special and geometrical arrangement of functional groups.
- He/She should have insight of reaction mechanisms for different types of reactions.
- He/She must have knowledge to conduct the most common reactions like addition, substitution, oxidation, reduction etc., on large scale.

**UNIT I:**

Polar effects – Inductive effect, electromeric effect, resonance, hyper conjugation, steric hindrens, and aromaticity – examples.

**UNIT II:**

Electrophilic reactions: a) Friedel-Craft reaction b) Riemer- Teimenn Reaction c) Backmann rearrangement.

Nucleophillic reactions : a) Aldol condensation b) Perkin Reaction c) Benzoin condensation.

**UNIT – III:**

Stereo isomerism; Optical isomerism; Symmetry and chirality; Optical isomerism in lactic acid and tartaric acid; Sequence rules; Enantiomers, diastereomers; Geometrical Isomerism; E-Z system of nomenclature, conformational analysis of ethane and Cyclohexane.

**UNIT.IV**

Some Reagents of Synthetic importance:

Preparation and applications of Aluminum Chloride, N-Bromosuccnamide (NBS), Diazomethane, Dicyclohexylcarbodiimide(DCC), Potassiumtertiarybutoxide and Grignard reagent

**UNIT.V:**

Some Useful Reactions in Organic Synthesis:

i). Protection of functional groups: Hydroxyl, Carbonyl and amino groups

ii). Oxidation: Oxidation of alcohols and carbonyl compounds with suitable examples

iii). Reduction: Reduction of double and triple bonds and carbonyl compounds with suitable examples.

**TEXTBOOKS**:

1. Text book of  Organic Chemistry – Morrsion and Boyd.
2. Organic Reaction Mechanisms by VK Ahulwalia and RK Parashar

**REFERENCES:**

1. Reaction mechanism – Peter Skyes.
2. Text book of Organic Chemistry – P.L. Soni.
3. Organic Chemistry Vol- I-IL. Finar.
4. Reactions and Reagents – O.P. Agrawal.
5. A Text Books of Organic Chemistry- Bahl and Arun Bahl, S. Chand company, New Delhi
6. Polymer Science and Technology- Hema Singh, Acme Learning, New Delhi

**Outcomes:**

1. Will be able to understand the essentiality of organic chemical reaction to synthesis new organic compounds in drug and pharmaceutical industries.
2. To gain knowledge on basic reactions, reagents and their applications.
3. To gain knowledge on electronic behavior of organic molecules, their special and geometrical arrangement of functional groups.
4. To gain necessary knowledge to conduct the most common reactions like addition, substitution, oxidation, reduction etc., on large scale.

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# ELECTRICAL AND ELECTRONICS ENGINEERING

**(Common to Mech. Engg. & Chem. Engg.)**

## PART – A

## ELECTRICAL ENGINEERING

**OBJECTIVES:**

- To understand the basic concepts of different types of electrical machines and their performance.
- To understand the basic types of Circuits, DC generators & motors, Transformers, Induction motors and their performance aspects.
- To understand the concepts of semiconductors, various of semiconductors, diodes rectifiers, transistors, amplifiers and number systems for digital electronics

**UNIT – I Introduction to DC & AC Circuits**

Ohm's Law, Basic Circuit Components, Kirchhoff's Laws, Types of Sources, Resistive Networks, Series Parallel Circuits, Star Delta and Delta Star Transformation. Principle of AC Voltages, Waveforms and Basic Definitions, Root Mean Square and Average Values of Alternating Currents and Voltage, Form Factor and Peak Factor, Phasor Representation of Alternating Quantities, The J Operator and Phasor Algebra, Analysis of Ac Circuits With Single Basic Network Element, Single Phase Series.

**UNIT-II DC Machines**

**D.C Generators:** Principle of Operation of Dc Machines, Types of D.C Generators, E.M.F Equation in D.C Generator, O.C.C. of a D.C. Shunt Generator

**D.C Motors**:Principle of Operation of Dc Motors, Types of D.C Motors, Torque Equation, Losses and Efficiency Calculation in D.C Motor- Swinburne's Test

**UNIT-III AC Machines**

**Transformers:** Principles of Operation, Constructional Details, Losses and Efficiency, Regulation of Transformer, Testing: OC & SC Tests.

**Three Phase Induction Motors**: Principle of Operation, Slip and Rotor Frequency, To ue (Simple Problems).

**Alternators:** Principle of Operation-Constructional Details-EMF Equation-Voltage Regulation by Synchronous Impedance Method.

## PART-B

## ELECTRONICS ENGINEERING

**UNIT I**

**Semiconductor Devices:** Intrinsic semiconductors-Electron-Hole Pair Generation, Conduction in Intrinsic Semiconductors, Extrinsic Semiconductors-N-Type and P-Type Semiconductors, Comparison of N-Type and P-Type Semiconductors. The p-n Junction - Drift and Diffusion Currents, The p-n Junction Diode-Forward Bias, Reverse Bias, Volt-Ampere Characteristics-Diode Specifications, Applications of Diode, Diode as Switch. Diode as a Rectifier-Half-wave Rectifier, Full-Wave Rectifier, Full-Wave Bridge Rectifier, Rectifiers with Filters, Zener iode-Volt-Ampere Characteristics, Zener Diode as Voltage Regulator. Silicon Controlled Rectifier-Two Transistor Analogy of an SCR, Characteristics, Applications of SCR, DIAC, TRIAC.

**UNIT II**

**BJT and FETs:** Bipolar Junction Transistor (BJT) **–** Types of Transistors, Operation of NPN and PNP Transistors, Input-Output Characteristics of BJT-CB, CE and CC Configurations, Relation between $I_{C,}$ $I_B$ and $I_E$.Transistor Biasing- Fixed Bias, Voltage Divider Bias, Transistor Applications- Transistor as an Amplifier, Transistor as a Switch,. Junction Field Effect Transistor (JFET)- Theory and Operation of JFET, Output Characteristics, Characteristics, Configurations of JFET-CD, CS and CG Configurations, JFET Applications-JFET as an Amplifier, JFET as a Switch, Comparison of and JFET,MOSFET-The Enhancement and Depletion MOSFET, Static Characteristics of MOSFET, Applications of MOSFET.

**UNIT III**

**Digital Electronics:** Number Systems-Decimal System, Binary System, Octal System, Hexadecimal System, Code Conversions, Binary Arithmetic- Binary Addition, Binary Subtraction, Logic Gates and Truth Tables-NOT, OR, AND, EX-OR, EX-NOR, Universal Gates- NAND, NOR Gates. Boolean algebra and De Morgan’s Theorems, Combinational Circuits-Adders and Subtractors.

**TEXT BOOKS:**

1. Basic Electrical Engineering - By M.S.Naidu and S. Kamakshiah – TMH.
2. Basic Electrical Engineering –By T.K.Nagasarkar and M.S. Sukhija Oxford University Press.
3. Electrical and Electronic Technology-By Hughes – Pearson Education.
4. Basic Electrical and Electronics Engineering, M.S.Sukhija, T.K.Nagsarkar, Oxford University Press, 1st Edition, 2012.
5. Basic Electrical and Electronics Engineering, S.K Bhattacharya, Pearson Education, 2012.

**REFERENCES:**

1. Theory and Problems of Basic Electrical Engineering by D.P.Kothari & I.J. Nagrath PHI.
2. Principles of Electrical Engineering by V.K Mehta, S.Chand Publications.
3. Fundamentals of Electrical Electronics Engineering by T.Thyagarajan, SCITECH Publications 5th Edition-2007

**<u>Outcome:</u>**

1: Students shall gain knowledge on basics of Electrical Circuits, DC Machines, Transformers, Induction motors, Alternators.

2: Students shall gain knowledge on various types of semiconductor devices, transistors, amplifier and digital electronics.

3: Students shall be able to apply the knowledge of Electrical and Electronic systems real-world Chemical Engineering problems and applications.

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# CHEMICAL ENGINEERING FLUID MECHANICS

**OBJECTIVES:**

- Understand concepts on nature of fluids, pressure concepts and measurement of pressure by various experimental methods and by mathematical relations and enhancement of problem solving skills.
- Learn detailed explanation on types of fluids, stress d velocity relations, type of fluid flow and boundary layer relations.
- Understand relationship between kinetic energy, potential energy, internal energy and work complex flow systems using Bernoulli's equation with application to industrial problems.
- Understand clear concepts on Flow of incompressible fluids in conduits and thin layers and friction factor variations with velocity and friction losses using Bernoulli Equations and they will be demonstrated experimentally.
- Study Flow of compressible fluids, Dimensional analysis, Dimensional homogeneity and various dimensionless numbers and their applications.
- Understand principles and working of various types of ps, transportation and metering of fluids using various experimental techniques and applications to industry.

**UNIT- I**

Unit operations and unit processes, unit systems, basic concepts, nature of fluids, hydrostatic equilibrium, applications of fluid statics.

Fluid flow phenomena-Laminar flow, Shear rate, Shear stress, Rheological properties of fluids, Turbulence, Boundary layers, Basic equation of fluid flow –Mass balance in a flowing fluid; continuity equation, differential momentum balance; equations of motion, Macroscopic momentum balances, Bernoulli equation, pump work in Be i equation.

**UNIT- II**

Incompressible Flow in pipes and channels- shear stress and skin friction in pipes, laminar flow in pipes and channels, turbulent flow in pipes and channels, friction from changes in velocity or direction, Dimensional analysis including Buckingham p Theorem and Rayleigh's method.

**UNIT- III**

Flow of compressible fluids- Definitions and basic equations, Processes of compressible flow, Isentropic flow through nozzles, adiabatic frictional low, and isothermal frictional flow.

**UNIT -IV**

Flow past immersed bodies, Drag and Drag coefficient, friction in flow through beds of solids, Kozeny-Carman, Blake-Plummer and Ergun equations, and motion of particles through fluids.

Fluidization, Conditions for fluidization, Minimum fluidization velocity, Types of fluidization, Expansion of fluidized beds, Applications of fluidizat Continuous fluidization; slurry and pneumatic transport.

**UNIT- V**

Transportation and Metering of fluids- Pipes, fittings and valves, Fluid- moving machinery, Fans, blowers, and compressors.

Measurement of flowing fluids- variable head meters- Orifice meter, Venturi meter, Pitot tube; Area meters- Rota meter.

**TEXTBOOKS**


1. Unit Operations of Chemical Engineering by W.L.McCabe, J.C.Smith & Peter Harriot, McGraw-Hill, $7^{th}$ ed, 2007


**REFERENCES:**


1. Transport processes and unit operations by Christie J. Geankoplis, PHI
2. Unit operations, Vol-1 –Chattopadhya, Khanna publishers
3. Principles of Unit Operations, Foust *et al*, $2^{nd}$ ed., John Wiley, 1999
4. Chemical Engineering, Vol-I, Coulson and Richardson, Pergamon Press.


**Outcomes:**

- Analyze different types of fluids and they will be able to measure pressure difference for flow of fluids.
- Understand and analyze the relationship between kinetic and potential energy, internal energy, work, and heat in complex flow systems using Bernoulli’s equation, macroscopic energy balances.
- Analyze and calculate friction factor for different types of flow in various types of constructions.
- Develop mathematical relations using Dimensional analysis by Rayleighs and Buckinghm –p method
- Identify the concepts and formulae of transportation of fluids.
- Identify the concepts and formulae of metering of fluids.
- Classify various pipes, valves and fittings based on usage.
- Classify and suggest the type and capacity of the pump for a specific purpose

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## ENERGY ENGINEERING

**OBJECTIVES:**

- To acquaint the student with the conventional energy sources and their utilization.
- To understand the importance of heat recovery and energy conservation methods and energy audit

**UNIT -I**

Sources of energy, types of fuels- energy and relative forms. Calorific value- gross and net value, calculation of calorific value from fuel analysis, experimental determination energy resources present and future energy demands with reference to India.

**Coal:** origin, occurrence, reserves, petrography, classificat ranking, analysis, testing, storage, coal carbonization and byproduct recovery, liquefaction of coal, gasification of coal, burning of coal and firing mechanism, burning of pulverized coal.

**UNIT- II**

**Liquid fuels:** petroleum: origin, occurrence, reserves, composition, ification, characteristics, fractionation, reforming, cracking, petroleum products, specification of petroleum products, burning of liquid fuels.

Natural gas, coke oven gas, producer gas, water gas, LPG, burning of gaseous fuels, hydrogen (from water) as future fuel, fuel cells, flue gas, analysis: orsat apparatus

**UNIT -III**

**Steam Plant:** Run time cycle, boiler plant, steam cost, steam distribution and utilization, combined heat and power systems, energy from biomass a biogas plants, gas purification, solar energy, wind energy, energy storage

**UNIT -IV**

Waste heat recovery, sources of waste heat and potential application, various types of heat recovery systems, regenerators, recuperators, waste heat boilers

**Energy conservation:** conservation methods in process industries, theoretica analysis, practical limitations.

**UNIT-V**

**Energy auditing:** short term, medium term, long term schemes, energy conversion, energy index, energy cost, representation of energy consumption, Sankey diagram, energy auditing.

**TEXT BOOKS:**

1. Fuels, Furnaces and Refractories, O.P.Gupta
2. Fuels and Combustion, 3rd ed., Samir Sarkar, Universities Press, 2009.

**REFERENCES:**

1. Non-conventional Energy Resources, G.D.Rai, Khanna Publishers
2. Fuel and Energy, Harker and Backhurst, Academic press London 1981
3. Fuel Science- Harker and Allen, Oliver and Boyd, 1972

**Outcomes:**

- Students would have a good knowledge about conventional energy sources and their audit.
- Ability to apply the fundamentals of energy conversion and applications

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**CHEMICAL PROCESS CALCULATIONS**

## OBJECTIVES:

- Learn basic laws about the behavior of gases, liquids  nd solids and some basic mathematical tools.
- Learn what material balances are, how to formulate and apply them, how to solve them.
- Understand the heat properties such as heat capacity,                                  iven compound/mixtures
- To learn the concepts of heat of reaction, exothermic and endothermic reactions, heat of formation, combustion; standard heat of formation, combustion and reaction
- Study the different types of fuels useful and their air requirements for combustion

**UNIT- I**

**Stoichiometric & Composition relations**: Stoichiometric relation, basis of calculations, methods of expressing compositions of mixtures and solutions, density and specific gravity, Baume and API gravity scales.

**Behavior of Ideal gases**: Kinetic theory of gases, application of ideal gas law, gaseous mixtures, gases in chemical reactions.

**UNIT -II**

**Vapor pressure**: Liquefaction and liquid state, vaporization, boiling point, effect of temperature on vapor pressure, Antoine equation, vapor pressure plots, estimation of critical properties, vapor pressure of immiscible liquids and ideal solutions, Raoult's law, Non volatile solutes.

**Humidity and Saturation**: Partial saturation, Humidity- Absolute Humidity, Vaporization process, Molal humidity, Relative and percentage saturation, dew point, humid heat, wet bulb and dry bulb temperatures, use of humidity charts, adiabatic vaporization.

**UNIT- III**

**Material balances**: Tie substance, Yield, conversion, limiting reactant, excess reactant, processes involving reactions, Material balances with      help of Stoichiometric equations, Material balances involving drying, dissolution, & crystallization. Material balance calculations for processes involving recycle, bypass and purge.

**UNIT -IV**

**Thermo physics**: Energy, energy balances, heat capacity of gases, liquid and mixture solutions. Kopp's rule, latent heats, heat of fusion and heat of vaporization, Trouton's rule, Kistyakowsky equation for non polar liquids enthalpy and its evaluation.

**Thermo chemistry**: Calculation and applications of heat of reaction, combustion, formation and neutralization, Kirchoff's equation, enthalpy concentration change, calculation of theoretical and actual flame temperatures.

**UNIT- V**

**Combustion Calculations**: Introduction, fuels, calorific value of fuels, coal, liquid fuels, gaseous fuels, air requirement and flue gases, combustion calculations, incomplete combustion, material and energy balances, thermal efficiency calculations.

**TEXTBOOKS**

**1.** Chemical process principles, Part -I, Material and Energy Balance, Hougen O A, Watson K.M. and Ragatz R.A. $2^{nd}$ Edition,John Wiley and Sons, New York, 1963.

**REFERENCES:**

1. Basic principles and calculations in chemical engineering by D.H. Himmelblau, $7^{th}$ Ed. PHI, 2013
2. Stoichiometry by B.I. Bhatt and S.M. Vora (3rd Ed.) Tata McGraw Hill publishing company, Ltd. New Delhi (1996)

**<u>Outcomes:</u>**

- Express the composition of mixtures and solutions in different modes that are required for design calculations ex: weight percent, volume percent and mole fraction
- Calculate partial pressure of the mixture using Raoult's law and find the different variables from the humidity chart for a given conditions(variables)
- Perform the calculations for single units involving drying, evaporation, dissolution and crystallization
- Determine the percentage conversion, yield in a given l process involving reaction
- Estimate the enthalpy change of a non reactive system with and without phase change in a isobaric systems
- Deduce the outlet temperature of reaction products under adiabatic systems
- Calculate the product gas composition for complete and incomplete combustion reactions

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## HUMAN VALUES AND PROFESSIONAL ETHICS

**OBJECTIVES:**

• To create awareness on Engineering Ethics and Human Values.

•To instill Moral and Social Values and Loyalty.

• To appreciate the rights of others.

**Unit I:**

**HUMAN VALUES**

Morals, Values and Ethics-Integrity-Work Ethic-Service learning – Civic Virtue – Respect for others – Living Peacefully – Caring – Sharing – Honesty - Courage- Co Operation – Commitment – Empathy –Self Confidence Character – Spirituality.

**Unit II:**

**ENGINEERING ETHICS**

Senses of 'Engineering Ethics- Variety of moral issued – Types of inquiry – Moral dilemmas – Moral autonomy –Kohlberg's theory- Gilligan's theory- Consensus and controversy – Models of professional roles- Theories about right action- Self interest - Customs and religion –Uses of Ethical theories – Valuing time –Co operation – Commitment.

**Unit III** :

**ENGINEERING AS SOCIAL EXPERIMENTATION**

Engineering As Social Experimentation – Framing the problem – Determining the facts – Codes of Ethics – Clarifying Concepts – Application issues – Common Ground - General Principles – Utilitarian thinking respect for persons.

**UNIT IV:**

**ENGINEERS RESPONSIBILITY FOR SAFETY AND RISK**

Safety and risk – Assessment of safety and risk – Risk benefit analysis and reducing risk- Safety and the Engineer- Designing for the safety- Intellectual Property rights (IPR).

**UINIT V:**

**GLOBAL ISSUES**

Globalization – Cross culture issues- Environmental Ethics – Computer Ethics – Computers as the instrument of Unethical behavior – Computers as the object of Unethical acts – Autonomous Computers- Computer codes of Ethics – Weapons Development - Ethics and Research – Analyzing Ethical Problems in research – Intellectual property Rights( IPR).

**Text Books**

1. “Engineering Ethics includes Human Values” by M.Govindarajan, S.Natarajan and V.S.SenthilKumar-PHI Learning Pvt. Ltd
2. “Engineering Ethics” by Harris, Pritchard and Rabins, CENGAGE Learning, India Edition, 2009.
3. “Ethics in Engineering” by Mike W. Martin and Roland Schinzinger – Tata McGraw-Hill– 2003.
4. “Professional Ethics and Morals” by Prof.A.R.Aryasri, ikota Suyodhana-Maruthi Publications.
5. “Professional Ethics and Human Values” by A.Alavudeen, R.Kalil Rahman and M.Jayakumaran- Laxmi Publications.
6. “Professional Ethics and Human Values” by Prof.D.R.Kiran.
7. Indian Culture, Values and Professional Ethics” by PSR Murthy-BS Publication

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## CHEMICAL ENGINEERING FLUID MECHANICS LAB

**OBJECTIVES:**

- Know the different types of flow using Reynolds apparatus.
- Verify the Bernoulli's equation by using Bernoulli's apparatus.
- Calibrate the Rotameter.
- Find out the variation of orifice coefficients with Reynolds Number.
- Determine the venturi coefficient by using venturimeter.
- Find out the frictional losses in flow through pipes.
- Study the coefficient of contraction in an open orifice.
- Study the coefficient of discharge in V- Notches.
- Study the characteristic of a centrifugal pump.
- Find out the pressure drop in packed bed for different velocities.

1. Identification of laminar and turbulent flows
   Major equipment - Reynolds apparatus
2. Measurement of point velocities
   Major equipment - Pitot tube setup
3. Verification of Bernoulli's equation
   Major equipment – Bernoulli's Apparatus
4. Calibration of Rotameter
   Major equipment – Rotameter Assembly
5. Variation of Orifice coefficient with Reynolds Number
   Major equipment - Orifice meter Assembly
6. Determination of Venturi coefficient
   Major equipment – Venturi meter Assembly
7. Friction losses in Fluid flow in pipes
   Major equipment - Pipe Assembly with provision for Pressure measurement
8. Pressure drop in a packed bed for different fluid velocities
   Major equipment - Packed bed with Pressure drop measurement
9. Pressure drop and void fraction in a fluidized bed
   Major equipment - Fluidized bed with Pressure drop measurement
10. Studying the coefficient of contraction for a given open orifice
    Major equipment - Open Orifice Assembly
11. Studying the coefficient of discharge in a V-notch
    Major equipment - V-notch Assembly
12. Studying the Characteristics of a centrifugal pump
    Major equipment - Centrifugal Pump

**OUTCOME:**

- Student will be able to understand the concept of fluid flow phenomena and types of flow by calculating Reynolds number
- Calibrate the flow meters with actual discharge
- Characterize of a centrifugal pump and its efficiency.
- Calculate the pressure drop in packed bed for different velocities.

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## ORGANIC CHEMISTRY LAB

**OBJECTIVES:**

To confirm the formation and nature of the product in a chemical processes, the knowledge of some physical, chemical and instrumental methods is essential for a chemical engineer.

**ORGANIC CHEMISTRY LAB:**

1. Criteria of Purity of Solid and Liquid, Determination of Melting Point & Boiling Point. Detecting Nitrogen, Sulphur, and Halogens in Organic Compounds.
2. Identification of an Unknown Substance from the following classes of Organic Compounds, Alcohols, Phenols, Aldehydes, Ketenes, Carbohydrates and Carboxylic acids.
3. Preparation of Aspririn
4. Preparation of Paracetamol
5. Preparation of Acetanilide
6. Preparation of Sulphonic acid
7. Preparation of derivatives for Aldehydes and Amines.
8. Beckman Rearrangement (Preparation of Benzanilide from Benzophenone oxime).
9. Determination of strength of a Glycine Solution.
10. Estimation of an Aldehyde.

**Outcome:**

CO1: Students will get the knowledge of methods to confirm the formation and the nature of the product.

CO2: Students will get the knowledge of some physical, chemical and instrumental methods that are essential for a chemical engineer.

**TEXT BOOKS:**

1. Vogels Text Book of Qualitative Organic Analysis.

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## PROBABILITY AND STATISTICS

**OBJECTIVES:**

- To help the students in getting a thorough understanding of the fundamentals of probability and usage of statistical techniques like testing of hypothesis, ANOVA, Statistical Quality Control and Queuing theory
- Solve problems related to conditional and joint probability, problems based on density functions and cumulative density functions, mean, vari and standard deviations of random signals, joint and conditional distribution functions

### UNIT – I

Conditional probability – Baye's theorem. Random variables – Discrete and continuous Distributions – Distribution functions. Binomial and poison distributions Normal distribution – Related properties.

### UNIT – II

Test of Hypothesis: Population and Sample - Confidence interval of mean from Normal distribution - Statistical hypothesis - Null and Alternative hypothesis - Level of significance - Test of significance - Test based on normal distribution - Z test for means and proportions; Small samples - t- test for one sample and two sample problem and paired t-test, F-test and Chi-square test (testing of goodness of fit and independence).

### UNIT – III

Analysis of variance one way classification and two way classification (Latic square Design and RBD)

### UNIT – IV

Statistical Quality Control: Concept of quality of a manufactured product -Defects and Defectives - Causes of variations - Random and assignable - The principle of Shewhart Control Chart-Charts for attribute and variable quality characteristics- Constructions and operation of X-bar Chart, R-Chart, P-Chart and C-Chart.

### UNIT – V

Queuing Theory: Pure Birth and Death process, M/M/1 & & their related simple problems.

### TEXT BOOKS:

1. Probability & Statistics for engineers by Dr. J. Ravichandran WILEY-INDIA publishers.

2. Probability & Statistics by T.K.V. Iyengar, B.Krishna hi, S.Ranganatham and M.V.S.S.N.Prasad, S.Chand publications.

**REFERENCES:**


1. Probability & Statistics by E. Rukmangadachari & E. Keshava Reddy, Pearson Publisher.
2. Statistical methods by S.P. Gupta, S.Chand publications.
3. Probability & Statistics for Science and Engineering by G.Shanker Rao, Universities Press.
4. Probability and Statistics for Engineering and Sciences by Jay L.Devore, CENGAGE.
5. Probability and Statistics by R.A. Jhonson and Gupta C.B.


**Outcomes:**

- The student will be able to analyze the problems of engineering & industry using the techniques of testing of hypothesis, ANOVA, Statistical Quality Control and Queuing theory and draw appropriate inferences.
- Fundamental knowledge of the concepts of probability. Have knowledge of standard distributions which can describe real life phenomenon. Have notion of sampling distributions and statistical techniques used in management problems.

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## ANALYTICAL CHEMISTRY

**OBJECTIVES:**

- To acquire basic principles of simple instrumental methods for estimation of organic/inorganic species.
- To acquire basic knowledge of industrial separations
- To acquire Knowledge in Characterization of the Materials synthesized by chemical industry
- To understand the Preparations, properties and reactions of materials

**UNIT-I: Basic Principles of Quantitative Analysis**

Limitations of analytical methods, Classification of errors, Acuracy, Precision, How to reduce systematic errors, Significant figures, Calculators and Computers, Mean and Standard deviation, Distribution of Random errors, Reliability of Results, Confidence interval , Comparison of results, Comparing the means of two samples, Paired T-test, Correlation and regression, Standard editions.

**UNIT-II: Chromatographic Methods:**

Column chromatography-general principles, terminology: retention time, rotat volume, separation factor, resolution of peaks. Principles of gas chromatography, block diagram of gas chromatograph - detectors (FID, ECD), stationary phases for column, mobile phases, chromatogram, qualitative analysis, special plots, quantitative analysis, HPLC: Principles of High Performance Liquid Chromatography. Block diagram of HPLC Systems, function of each component, stationary phases, eluting solvents, pumps, detectors, quantitative applications of HPLC. Ion chromatography-seperation of anions and cations. Suppressed & non-suppressed ion chromatography. Numerical calculations.

**Unit-III: Thermal methods of Analysis:**

Introduction to Thermal methods, Thermogravimetric Analysis (TGA)-principles, and applications (determination of drying temperatures, kinetic methods, automatic thermo gravimetric Analysis) DTA: Differential thermal analysis-Principles and applications (exothermic and endothermic peaks, heat of reaction, catalysis, decompositions etc.,)
DSC: Differential scanning calorimettry, principles & ications (exothermic & endothermic peaks, compound purity determination, percentage crystallinity, glass transition temperature).

**Unit-IV: Electro-Analytical Techniques**

i). Polarography: Definition, advantage of dropping mercury electrode, factors affecting on limiting current, Half wave potentials and significance, Applications of Polarography
ii), Amperometric Titrations: Basic principle involved in the Amperometry, Amperometric Titrations and applications, Advantages and disadvantages of Amperometric Titrations

**Unit-V: Spectrophotometric Methods:**

Introduction to Analysis: Qualitative & Quantitative Analysis; Conventional & Instrumental methods of analysis. Molecular spectrophotometry-Beer's law Block diagram of UV-Visible Spectrophotometer – quantitative analysis direct method for the determination metal ions: Chromium, Manganese, Iron, etc in alloys. Simultaneous Spectrophotometric determination of chromium, manganese. Infrared spectrometry-Functional group analysis of organic compounds using infrared spectra. Quantitative analysis of organic molecules.Flame photometry-principles & applications.(Determination of Sodium, Potassium and Calcium.)

**Course Outcome:**

**The student may acquire enough knowledge on industrial processes and Identification of Products using different analytical and instrumental techniques.**

**BOOKS:**


1. Quantitative analysis, R.A.Day & A.L. Underwood , 5th edition, Printice- Hall of India Pvt. Ltd., 2000.
2. Vogel's Text Book of Qualitative chemical analysis, J. Mendham, R.C.Denney, J. Darnes, M.J.K. Thomas, Persar education 6th edition, 2002.
3. Elements of Physical Chemistry-Peter Atkins, Oxford Uni.Press, 3rd Edition, 2010.


**REFERENCES:**


1. Atkin's Physical Chemistry – P. Atkins and J. De Paula, Oxford Univ.Press, 9th Edition, 2012
2 Instrumental lMethods of Chemical Analysis, Gurdeep R.Chatwal, Sham K.Ananad, Himalayha publishing House,5th Edition, 2012.
3. Advanced physical chemistry – Gurudeepraj, Goel Publishing House, 2000
4. Essentials of Physical Chemistry- Arun Bahl, B.S.Bahl and G.D.Rulasi, S.Chand Publishers, New Delhi.


**Outcomes:**

CO1: Shall gain To acquire basic principles of simple instrumental methods for estimation of organic/inorganic species.

CO2: Shall gain the basic knowledge of industrial separations.

CO3: Shall gain knowledge in Characterization of the Materials synthesized by chemical industry.

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## PROCESS HEAT TRANSFER

**OBJECTIVES:**

- Study various modes of Heat transfer and their fundamental relations.
- Study conduction heat transfer and develop mathematical relations for various solid geometries.
- Understand different types of heat transfer coefficients and their estimations in various types of flows in different geometries.
- Understand the working of Heat exchangers and to learn design of double pipe, shell and tube heat exchangers and design of evaporators and conduct experiments and to submit the report.
- Understand the phenomenon of radiation, radiation shields and estimation of emissivity.

**UNIT -I**

**Introduction:** Nature of heat flow, conduction, convection, natural and forced convection, radiation.

**Heat transfer by conduction in Solids:** Fourier’s law, thermal conductivity, steady state conduction in plane wall & composite walls, compound resistances in series, heat flow through a cylinder, conduction in spheres.

**Unsteady state heat conduction:** Equation for one-dimensional conduction, Semi-infinite solid.

**UNIT- II**

**Principles of heat flow in fluids:** Typical heat exchange equipment, countercurrent and parallel current flows, energy balances, rate of heat transfer, overall heat transfer coefficient, electrical analogy, critical radius of insulation, logarithmic mean temperature difference, variable overall coefficient, multi-pass exchangers, individual heat transfer coefficients, resistance form of overall coefficient, fouling factors, classification of individual heat transfer coefficients, magnitudes of heat transfer coefficients, effective coefficients for unsteady-state heat transfer.

**UNIT- III**

**Heat Transfer to Fluids without Phase change:** Regimes of heat transfer in fluids, thermal boundary layer, heat transfer by forced convection in flow, heat transfer by forced convection in turbulent flow, the transfer of heat by ulent eddies and analogy between transfer of momentum and heat, heat transfer to liquid metals, heating and cooling of fluids in forced convection outside tubes.

**UNIT -IV**

**Natural convection:** Natural convection to air from vertical shapes and horizontal planes, effect of natural convection in laminar-flow heat transfer.

**Heat transfer to fluids with phase change:** Heat transfer from condensing vapors, heat transfer to boiling liquids.

**Radiation:** Introduction, properties and definitions, black body radiation, real surfaces and the gray body, absorption of radiation by opaque solids, radiation between surfaces, radiation shielding, radiation to semi transparent materials, combined heat transfer by conduction, convection and radiation.

**UNIT- V**

**Heat exchange equipment:** General design of heat exchange equipment, heat exchangers, condensers, boilers and calendrias, extended surface equipment, heat transfer in agitated vessels, scraped surface heat exchangers, heat transfer in packed beds, heat exchanger effectiveness (NTU method)

**Evaporators:** Evaporators, performance of tubular evaporators, capacity and economy, multiple effect evaporators, methods of feeding, vapor recompression.

**TEXT BOOK:**

1. Unit Operations of Chemical Engineering, 6th ed., W.L. McCabe, J.C. Smith and P. Harriot, McGraw-Hill, New York, 2001

**REFERENCES:**

1. Process Heat Transfer, D.Q. Kern, Tata McGraw-Hill, New Delhi, 1997.
2. Heat Transfer, 4th ed., J.P. Holman, McGraw-Hill, New York, 1976.
3. Chemical Engineering, Volume-I, J. Coulson and R.F. Richardson, Pergamon Press

**Outcomes:**

- Student will be able to use the heat transfer principles in selection and design of heat exchanger, evaporator, etc. for a chemical industry.
- Utilize heat transfer coefficient correlations to determine overall heat transfers coefficients through individual heat transfer coefficients.
- Use the appropriate correlations to calculate convection heat transfer coefficient and rate of heat transfer in laminar and turbulent flow conditions.
- Design different types of heat exchanger like shell-and-tube heat exchangers, double pipe heat exchangers, evaporators etc.
- Apply energy and material balances determine performance (capacity, Economy) of evaporator.
- Design of single effect Evaporators
- Analyze radiation heat transfer between different surfaces.

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## MATERIALS SCIENCE FOR CHEMICAL ENGINEERS

**OBJECTIVES:**

- Understand concepts on properties and selection of metals, ceramics, and polymers for design and manufacturing.
- Study variety of engineering applications through knowledge of atomic structure, electronic structure, chemical bonding, crystal structure, x-rays and x-ray diffraction, defect structure.
- Study Microstructure and structure-property relationships, Phase diagrams, heat treatment of steels.
- Study detailed information on types of corrosion and its prevention.
- Learn information on selection of materials for design and manufacturing.

**UNIT- I**

**Introduction**:Engineering Materials – Classification – levels of structure.

**Crystal Geometry and Structure Determination**: Space lattice and Unit cell. Bravais lattices, crystal systems with examples. Lattice coordinates, Miller indices, Bravais indices for directions and places: crystalline and non crystalline solids; ionic, covalent and metallic solids; packing efficiency, coordination number; structure determination by Bragg's X-ray diffraction and powder methods.

**UNIT -II**

**Crystal Imperfection**: Point defects, line defects-edge and screw dislocation, Berger's circuit and Berger's vectors, dislocation reaction, dislocation motion, multiplication of dislocations during deformation , role of dislocation on crystal properties; surface defects, density and stress required to move dislocations.

**UNIT -III**

**Basic thermodynamic functions**: phase diagrams and phase transformation: Primary and binary systems-general types with examples; tie line& lever rule, non equilibrium cooling: phase diagrams of Fe-$Fe_3$-C, Pb-Sn, Cu-Ni systems.

Phase transformations in Fe-$Fe_3$-C steels, Time-Temperature-Transformation (TTT) curves for eutectoid steels and plain carbon steels; effect of al elements on properties of steels; types of steels, alloys and other metals used in chemical industry.

**UNIT -IV**

Elastic, an elastic and plastic deformations in solid ls; rubber like elasticity, visco elastic behavior (models); shear strength of real and perfect crystals, work hardening mechanisms, cold working, hot working; dynamic recovery, recrystallization, grain growth, grain size and yield stress, Brief description of heat treatment in steels.

**Magnetic materials**: Terminology and classification, magnetic moments due to electron spin, ferro-magnetism and related phenomena, domain structure, hysteresis loop, soft and hard magnetic materials.

**UNIT- V**

**Fracture in ductile and brittle materials, creep**: mechanism of creep and methods to reduce creeping in materials, creep rates and relations. Fatigue-mechanisms and methods to improve fatigue resistance in materials. Composite materials: stress-strain relations in composite materials, applications.

**Oxidation and Corrosion**: Mechanisms of oxidation, oxidation resistant materials, principles and types of corrosion, protection against corrosion.

**TEXT BOOK:**

1. Materials Science and Engineering, 5$^{th}$ed. V. Raghavan, PHI Learning Pvt. Ltd., New Delhi, 2009.

**REFERENCES:**

1. Elements of Materials Science, L.R. Van Vlack,

2. Science of Engineering Materials, vols. 1&2, Manas da, McMillan Company of India Ltd.

**<u>Outcomes:</u>**

- Identify various crystal systems.
- Calculate parameters for simple crystal structures predict the behavior of crystal systems due to imperfections.
- Predict the properties of simple alloys and steels based on their phase diagrams, phase transitions and heat treatment.
- Describe the mechanical behavior, failure and strengthening mechanisms of various metals, alloys and plastics.
- Identify various types of corrosion, illustrate methods to mitigate corrosion and select suitable material for various chemical processes
- Proper selection of materials for designing various equipment in a chemical industry.

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## CHEMICAL ENGINEERING THERMODYNAMICS

**OBJECTIVES:**

- Students will learn PVT behaviour of fluids, laws of thermodynamics, thermodynamic property relations and their application to fluid flow, power generation and refrigeration processes.
- To provide the students with the terminology of thermodynamics like system, properties, processes, reversibility, equilibrium, phases, compone the relationship between heat and work by understanding the significance of the thermodynamic laws.
- Understand the clear concepts on P-V-T behavior, Equations of state, thermodynamic diagrams and compressibility charts, entropy, irreversibility and problem solving skills.
- Be able to understand the concept of refrigeration
- Able to explain the various liquefaction processes and their working principle

**UNIT -I**

**Introduction**: The scope of thermodynamics, temperature, defined quantities; volume, pressure, work, energy, heat, Joules Experiments.

**The first law and other basic concepts:** The first law of thermodynamics, thermodynamic state and state functions, enthalpy, the steady-state steady-flow process, equilibrium, the phase rule, the reversible process, constant-V and constant- P processes, heat capacity, isobaric, isochoric, isothermal, adiabatic and polytrophic processes.

**UNIT -II**

**Volumetric properties of pure fluids:** The PVT behavior of pure substances, virial equations, the ideal gas, the applications of the virial equations, second virial coefficients from potential functions. Cubic equations of state, generalized corre ions for gases, generalized correlations for liquids, molecular theory of fluids.

**Heat effects**: Sensible heat effects, Internal energy of ideal gases: Microscopic view, Latent heats of pure substances, heat effects of industrial reactions, heat effects of mixing processes.

Standard heat of reaction, Standard heat of formation, Standard heat of combustion, temperature dependence of heat of reaction

**UNIT- III**

**The second law of thermodynamics:** Statements of the second law, heat engines, thermodynamic temperatures scales, thermodynamic temperature and the ideal gas scale

Entropy, Entropy changes of an ideal gas, mathematical statement of the second law, the third law of thermodynamics, entropy from the microscopic view point, calculation of ideal work and lost work.

**UNIT -IV**

**Power cycles:** Carnot cycle, Rankine cycle, Otto cycle, Diesel cycle.

**Refrigeration and liquefaction:** The Carnot refrigerator, the vapor compression cycle, comparison of refrigeration cycles, the choice of refrigerant, absorption refrigeration, the heat pump, liquefaction processes.

**UNIT –V**

**Thermodynamic properties of fluids:** Property relations for homogeneous phases, residual properties, two phase systems, thermodynamic diagrams, tables of thermodynamic properties, generalized property correlation for gases.

**TEXT BOOKS**

1. J.M.Smith and HC Van Ness, Introduction to Chemical Engineering Thermodynamics, $6^{th}$ ed, McGraw Hill,2003.

**REFERENCE**

1. Y.V. C. Rao, Chemical Engineering Thermodynamics, University publications.
2. K. V. Narayanan, Chemical Engineering Thermodynamics, PHI,2001

**Outcome**:

- Understand the terminology associated with engineering thermodynamics. Understand the concepts of heat, work and energy conversion, and can Calculate heat and work quantities for industrial processes
- Analyze and find properties such as Pressure, Volume and temperature for equations of states and form the fundamentals of first law of thermodynamics.
- Find the feasibility and extent of conversion for any reaction.

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## MECHANICAL UNIT OPERATIONS

**OBJECTIVES:** This course deals with the different mechanical unit operations in chemical engineering. Specific attention is given on particle and separation techniques.

**UNIT- I**

Properties, handling and mixing of particulate solids: Characterization of solid particles, properties of particulate masses, storage and mixing of solids, types of mixers, mixers for cohesive solids, mixers for free flowing solids: Transportation of solid particulate mass, belt, screw, apron conveyers, bucket elevators, pneumatic conveying.

**UNIT- II**

Size reduction: Principles of comminution, computer simulation of milling operations, size reduction equipment-crushers, grinders, ultra fine grinders, cutting machines, Equipment operation. Laws of crushing: Kick's law, Bond's law, Rittinger's law

Screening, Industrial screening equipments, Effectiveness of the screen, differential & cumulative analysis.

**UNIT -III**

Filtration, cake filters, centrifugal filters, cyclone separators, electro-static precipitators.

Principles of cake filtration, Clarifying filters, liquid clarification, gas cleaning, principles of clarification.

Cross flow filtration, types of membranes, permeate flux for ultra-filtration, Concentration polarization, particle rejection of solutes, micro filtration.

**UNIT- IV**

Separations based on motion of particles through fluids, gravity settling processes and centrifugal settling processes, float and sink method, differential settling, coagulation, Flotation-separation of ores, flotation agents; ***Agitation and mixing of liquids:*** Agitation of liquids, circulation velocities, power consumption in agitated vessels. Blending and mixing of liquids, suspension of solid particles, dispersion operations.

**UNIT- V**

Crystallization: crystal geometry, principles of crystallization equilibria and yields, nucleation, crystal growth, ? L law, crystallization equipment including MSMPR crystallizers.

**TEXT BOOK:**

1. Unit Operations in Chemical Engineering by W.L. McCabe and J.C. Smith and Peter Harriott, Mc Graw Hill 7$^{th}$ ed. 2001.

**REFERENCES:**

1. Chemical engineers hand book, J.H. Perry, 7th ed. Mc Graw Hill
2. Introduction to Chemical Engineering by J.T.Banchero & W.L. Badger., TMH, 1997.

**OUTCOME:**

- Student will gain knowledge on various mechanical separation operations used in chemical industry.
- Classify and identify the storage, mixing and transportation equipment.
- Calculate the average size of solid particles of a given solid sample. Describe size reduction equipment and distinguish between different size reduction equipment.
- Choose the type of filtration process for a solid liquid separation.
- Explain the flow patterns in an agitator.
- Describe the stages involved for converting saturated to crystals and explain crystallization equipment.

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## PROCESS HEAT TRANSFER LAB

**OBJECTIVES:**

- This lab will provide practical knowledge on various heat transfer process and equipment like heat exchangers and evaporators.
- Learn basic Heat transfer principles.
- Impart the knowledge in heat transfer measurements and different heat transfer equipment
- Learn how the convection takes place in natural and forced convection and gain knowledge of the heat transfer taking place in different heat exchangers.

1. Determination of total thermal resistance and thermal conductivity of composite wall.
   Major equipment - Composite wall Assembly
2. Determination of thermal conductivity of a metal rod.
   Major equipment - Thermal Conductivity apparatus
3. Determination of natural convective heat transfer coefficient for a vertical tube.
   Major equipment - Natural convection heat transfer apparatus
4. Determination of critical heat flux point for pool boiling of water.
   Major equipment- Pool boiling apparatus
5. Determination of forced convective heat transfer coefficient for air flowing through a pipe
   Major equipment – Forced convection heat transfer apparatus
6. Determination of overall heat transfer coefficient in double pipe heat exchanger.
   Major equipment - Double pipe heat exchanger apparatus
7. Determination of heat transfer coefficient for a helical coil in an agitated vessel.
   Major equipment – Helical coil in a agitated vessel.
8. Study of the temperature distribution along the length of a pin-fin under natural and forced convection conditions
   Major equipment - Pin fin apparatus
9. Estimation of un-steady state film heat transfer coefficient between the medium in which the body is cooled.
   Major equipment - Heat transfer coefficient determination apparatus
10. Determination of Stefan – Boltzmann constant.
    Major equipment - Stefan Boltzmann apparatus
11. Determination of emissivity of a given plate at va ious temperatures.
    Major equipment - Emissivity determination apparatus

**OUTCOME:** The student will be able to understand the thermal conductivity measurement, heat transfer coefficient, calculation in natural and forced convection and some of the radiation aspects.

- Demonstrate basic Heat transfer principles
- Apply thermal conductivity concept in industrial pipelines to control the heat losses.
- Design heat exchangers.
- Understand the concept of boiling & condensation processes.
- Identify appropriate heat exchanger for a set of process conditions.

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## MECHANICAL UNIT OPERATIONS LAB

**OBJECTIVES:**

- To enable the students to develop a sound working knowledge on different types of crushing equipments and separation characteristics of different mechanical operation separators.

1. To determine the time of grinding in a ball mill for producing a product with 80 % passing a given screen.
Major equipment - Ball mill Apparatus, Sieve shaker, Different sizes of sieves, weighing balance.
2. To verify the laws of crushing using any size reduction equipment like crushing rolls or vibrating mills and to find out the working index of the material.
Major equipment – Jaw Crusher, Sieve shaker, Different sizes of sieves, WeighingBalance, Energy meter.
3. To find the effectiveness of hand screening and vibrating screen of a given sample.
Major equipment - Vibrating Sieve shaker, Different sizes of sieves, WeighingBalance.
4. To achieve beneficiation of a ore using froth flotation technique.
Major equipment - Froth flotation cell
5. To obtain batch sedimentation data and to calculate the minimum thickner area under given conditions.
Major equipment- Sedimentation apparatus
6. To determine the specific cake resistance and filter medium resistance of a slurry in plate and frame filter press.
Major equipment - Plate and frame filter press.
7. To separate a mixture of particles by Jigging.
Major equipment - Jigging apparatus
8. To calculate separation efficiency of particles in a mixture using cyclone separator.
Major equipment - Cyclone separator
9. To determine reduction ratio of a given sample in a pulverizer.
Major equipment - Pulverizer
10. To determine reduction ratio of a given sample in .a grinder Major equipment - Grinder

**Outcomes:**

- Students would gain the practical knowledge and hands on various separation
- techniques like filtration, sedimentation, screening and centrifugation

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**III Year B.Tech. Chem. Engg. I-Sem** **L P C**

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# PROCESS INSTRUMENTATION

**OBJECTIVES:** The course will give an idea about different instruments for measuring T, P, flow rate, level and composition of various process streams in chemical industry.

**UNIT I**

Elements of instruments, static and dynamic characteristics, basic concepts of response of first order type instruments, mercury in glass thermometer, ic thermometer, pressure spring thermometer, static accuracy and response of thermometers.

**Unit II:**

**Thermo electricity:** Industrial thermocouples, thermocouple wires, thermo couple wells and response of thermocouples. Thermal coefficient of resistance, industrial resistance thermometer bulbs and circuits, radiation receiving elements, radiation, photoelectric and optical pyrometers.

**Unit III:**

Composition analysis, spectroscopic analysis by absorp emission, mass and color measurement spectrometers, gas analysis by thermal conductivity, analysis of moisture, gas chromatography, refractometer.

**Unit IV:**

**Pressure vacuum and head:** liquid column manometers, measuring elements for gauge pressure and vacuum, indicating elements for pressure gauges, measurement of absolute pressure, measuring pressure in corrosive liquids, static accuracy and response of pressure gauges.

Head, density and specific gravity, direct measurement of liquid level, pressure measurement in open vessels, level measurements in pressure vessels, of interface level, density measurement, and level of dry materials.

**Unit V:**

Head flow meters, area flow meters, open channel meters, viscosity meters, quantity meters, flow of dry materials, viscosity measurements.

Recording instruments, indicating and signaling instruments, transmission of instrument readings, control center, instrumentation diagram, process analysis.

**TEXT BOOK:**

1. Industrial instrumentation by Donald P.Eckman, Wiley eastern, 1950.

**REFERENCE:**

1. Principles of industrial instrumentation by Patra Nabis, TMH.
2. Instruments for measurements and control by Holbrock W.C. Van Nostrand
East West.
3. Hand book Instrumentation, Considine, McGraw Hill,

**Outcomes:**

- Identify the various elements and characteristics of an instrument required for measuring process variables.
- Recall the working principles of different instruments required for measuring temperature, pressure, composition, level, flow rate, density and viscosity.
- Describe the construction and working limitation of an instrument for measuring a process variable.
- Compare and choose the appropriate instrument for measuring a given process variable based on its working principle and measuring range.
- Apply the necessary method of monitoring the variable controlling and efficient running of the process.

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**III Year B.Tech. Chem. Engg. I-Sem**

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## PROCESS DYNAMICS AND CONTROL

**Objectives:**

- Develop mathematical and transfer function models for dynamic processes.
- Analyze process stability and dynamic responses.
- Empirically determine process dynamics for step response data.
- Development of block diagrams, reading block diagrams, process and instrumentation diagrams
- Familiarity with different types of PID feedback controllers..
- Ability to understand feed forward control, cascade control and Smith predictors and their applications
- Knowledge of real time applications of process control implementation.

**UNIT I**

**Introduction to process dynamics and control**: Laplace transforms, Inverse Laplace transform, Response of First Order Systems. Physical examples of first order systems- Liquid level, mixing process, R- C circuit. Linearization.

**UNIT II**

Response of first order systems in series- interacting and non- interacting systems, second order systems, transportation lag.

**Control system**: Components of a control system, Servo Vs regulator p blem, development of block diagram.

**Controllers and final control elements**: Control valve and its construction, sizing and characteristics, P, PD, PI, PID controllers.

**UNIT III**

**Stability**: Concept of Stability, Stability criterion, Routh test for stability

**Root locus**: concept of root locus, plotting the root locus diagram.

**UNIT IV**

Introduction to frequency response, Bode diagrams,

**Control systems design by frequency response**: Bode stability criterion, Gain and Phase margins.

Tuning of P, PD, PI, PID controllers, trial and error od, Ultimate gain and ultimate period, Ziegler-Nichols technique, Cohen and Coon rules.

**UNIT V**

**Advanced control strategies**: Cascade control, feed forward control, ratio control, predictor, internal model control.

**TEXT BOOK:**

1. Process Systems Analysis and Control, 2nd ed., D.R. Coughanowr, McGraw-Hill, 1991

**REFERENCES:**

1. Chemical Process Control, G. Stephanopoulos, PHI Learning Pvt. Ltd., New Delhi, 2010
2. Process Control, B.W. Bequette, PHI Learning Pvt. Ltd., New Delhi, 2010

**OUTCOME:** Ability to model the dynamic processes, to analyze the dynamic processes, to design feedback control system for chemical, mechanical & electrical engineering systems and to design advanced control system for complex and normal processes.

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## PHASE AND CHEMICAL EQUILIBRIA

**OBJECTIVES:**

To introduce the concepts of chemical potential, partial properties, property relations for ideal gases, fugacity excess properties and to develop the theoretical foundation for applications of thermodynamics to gas mixtures and liquid solutions an to perform the phase equilibrium calculations using simple models for VLE, Gamma/Phi approach and equation of state approach.

**UNIT I**

**Solution Thermodynamics:** Theory,Fundamental property relation, chemical potential as a criterion for phase equilibrium, partial properties, ideal gas mixtures, fugacity and fugacity coefficient for pure species, fugacity and fugacity coefficient for species in solutions, generalized correlations for Fugacity coefficient, The ideal solutions, excess properties.

**UNIT II**

**Solution Thermodynamics:** Applications: The liquid phase properties from VLE data, models for the excess Gibbs energy, property changes of mixing

**VLE at low to moderate pressures:** The nature of equilibrium, the phase rule, Duhems theorem, VLE: Qualitative behavior, the gamma /Phi formulation of VLE, Dew point and bubble point calculations, flash calculations, solute (1)/solvent (2) systems

**UNIT III**

**Thermodynamic Properties and VLE from Equations of State:** properties of fluids from the virial equations of state, properties of fluids from cubic equations of state, fluid properties from correlations of the Pitzer type, VLE from cubic equations of state

**Topics in Phase Equilibria:** Equilibrium and stability, Liquid-Liquid Equilibrium (LLE), Vapor- Liquid–Liquid Equilibrium (VLLE), Solid-Liquid Equilibrium (SLE), Solid Vapor Equilibrium (SVE).

**UNIT IV**

**Chemical Reaction Equilibria:** The reaction coordinate, application equilibrium criterion to chemical reactions, The standard Gibb’s energy change the equilibrium constant, effect of temperature on equilibrium constants, relation of equilibrium constants to composition, equilibrium conversion for single reactions, Phase rule and Duhem’s theorem for reacting systems.

**UNIT V**

**Introduction to Molecular Thermodynamics :** Molecular Theory of Fluids,Second Virial Coefficients from Potential Functions,Internal Energy Ideal Gases: Microscopic view, Thermodynamic Properties and Statistical Mechanics ,Hydrogen Bonding and Charge-Transfer Complexing ,Behaviour of Excess Properties ,Molecular is for Mixture Behaviour,VLE by Molecular Simulation.

**TEXT BOOK:**

1. Introduction to Chemical Engineering Thermodynamics, $6^{th}$ ed., J.M. Smith, H.C. Van Ness and M.M. Abbott, Tata McGraw-Hill, New Delhi, 2003.

**REFERENCE:**

1. Chemical Engineering Thermodynamics, Pradeep Ahuja, PHI Learning Pvt. Ltd., New Delhi, 2009
2. A Text Book of Chemical Engineering Thermodynamics, K.V. Narayanan, PHI Learning Pvt. Ltd., New Delhi, 2001.

**Outcome:**

1. Students will learn the concepts of chemical potential, partial properties, property relations for ideal gases, fugacity excess properties and to develop the theoretical foundation for applications of thermodynamics to gas mixtures and liquid solution.
2. Students will be able to understand the procedures for estimating the thermodynamic properties and perform thermodynamic calculations oriented to the analysis and design of chemical processes.

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## CHEMICAL REACTION ENGINEERING – I

**OBJECTIVES:**

- The emphasis of this course is on the fundamentals of reaction kinetics and chemical reactor operation.
- The overall goal of this course is to develop a critical approach toward understanding complex reaction systems and elucidating chemical reactor design.
- Integrate concepts from science & engineering to constitute a basis for the design of chemical reactor, a key element in the design of chemical process.
- Provide a foundation on deriving rate expressions for parallel, reversible reactions and the knowledge about product distribution in multip reactions, recycle reactors and auto catalytic reactions

**UNIT I**

Overview of chemical reaction engineering-classification of reactions, variables affecting the rate of reaction definition of reaction rate, kinetics of homogenous reactions- concentration dependent term of rate equation, Temperature dependent term of rate equation, searching for a mechanism, predictability of reaction rate from theory.

**Interpretation of batch reactor data- constant volume batch reactor**:- Analysis of total pressure data obtained in a constant-volume system, the conversion, Integral method of analysis of data– general procedure, irreversible unimolecular type first order reactions, irreversible bimolecular type second order reactions, irreversible imolecular type third order reactions, empirical reactions of nth order, zero-order reactions, overall order of irreversible reactions from the half-life, fractional life method, irreversible reactions in parallel, homogenous catalyzed reactions, autocatalytic reactions, irreversible reactions in series.

**UNIT II**

**Constant volume batch reactor–** first order reversible reactions, second order reversible reactions, reversible reactions in general, reactions shifting order, Differential method of analysis of data. Varying volume batch reactor–differential method of analysis, integral method of analysis, zero order, first order, second order, nth order reactions, temperature and reaction rate, the search for a rate equation.

**UNIT III**

**Introduction to reactor design**- general discussion, symbols and relationship between $C_A$ and $X_A$. Ideal reactors for a single reaction- Ideal batch reactor, Steady-state mixed flow reactor, Steady-state plug reactors.

**Design for single reactions**- Size comparison of single reactors, Multiple- reactor systems, Recycle reactor, Autocatalytic reactions.

**UNIT IV**

**Design for parallel reactions-** introduction to multiple reactions, qualitative discussion about product distribution, quantitative treatment of product distribution and of reactor size.

**Multiple reactions-**Irreversible first order reactions in series, quantitative discussion about product distribution, quantitative treatment, plug flow or batch reactor, quantitative treatment, mixed flow reactor, first-order followed by zero-order reaction, zero order followed by first order reaction.

**UNIT V**

**Temperature and Pressure effects-** single reactions- heats of reaction from thermodynamics, heats of reaction and temperature, equilibrium constants from thermodynamics, equilibrium conversion, general graphical design procedure, optimum temperature progression, heat effects, adiabatic operations, non adiabatic operations, comments and extensions. Exothermic reactions in mixed flow reactors-A special problem, multiple reactions.

**TEXT BOOK:**

1. Chemical Reaction Engineering, 3rd ed., O. Levenspiel, John Wiely & Sons, 1999.

**REFERENCES:**

1. Elements of Chemical Reaction Engineering, 2nd ed., H.S. Fogler, PHI Learning Pvt. Ltd., New Delhi, 2010.

2. Chemical Engineering Kinetics, 3rd ed., J.M. Smith, McGraw-Hill, New York, 1981.

**Outcome:**

- This course provides necessary knowledge for selection of the chemical reactors for a particular process.
- Analyze and interpret experimental data from batch reactors and determine the order of simple chemical reactions.
- Compare ideal reactor types (batch, CSTR and PFR) and apply quantitative methods to design and size reactors for simple chemical reaction schemes.
- Determine optimal ideal reactor design for multiple reactions for yield or selectivity.
- Predict reactor performance for reactors when the temperature is not uniform within the reactor

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## MASS TRANSFER OPERATIONS-I

**OBJECTIVES:**

- To discuss the fundamental concepts of mass transfer principles and to apply those concepts to real engineering problems.
- To impart the basic concepts of molecular diffusion, mass transfer coefficients and analysis of different mass transfer processes
- Applies the concepts of diffusion mass transfer, mass transfer coefficients, convective mass transfer, inter-phase mass transfer, equipment for gas-liquid operations.

**UNIT- I**

The Mass Transfer Operations: Classification of the Mass-Transfer Operations, Choice of Separation Method, Methods of Conducting the Mass-Transfer Operations, Design Principles, Unit Systems

Molecular Diffusion In Fluids: Molecular Diffusion, Equation of Continuity, binary solutions, Steady State Molecular Diffusion in Fluids at Rest and in Laminar Flow, estimation of diffusivity of gases and liquids, Momentum and Heat Transfer in Laminar flow

Diffusion:Diffusion in Solids, Fick’s Diffusion, Unsteady State Diffusion, Types of Solid Diffusion, diffusion through polymers, diffusion through crystalline solids, Diffusion through porous solids & hydrodynamic flow of gases.

**UNIT- II**

Mass Transfer Coefficients: Mass Transfer Coefficients, Mass Transfer Coefficients in Laminar Flow (Explanation of equations only and no derivation), Mass Transfer Coefficients in Turbulent Flow, eddy diffusion, Film Theory, Penetration theory, Surface-renewal Theory, Combination Film-Surface-renewal theory, Surface-Stretch Theory, Mass, Heat and Momentum Transfer Analogies, Turbulent Flow in Circular Pipes. Mass transfer data for simple situations.

Inter Phase Mass Transfer: Concept of Equilibrium, Diffusion between Phases, Material Balances in steady state co-current and counter current stage processes, Stages, Cascades, Kremser – Brown equation.

**UNIT-III**

Equipment For Gas-Liquid Operations: Gas Dispersed, Sparged vessels (Bubble Columns), Mechanical agitated equipments(Brief description),Tray towers, General characteristics, Sieve design for absorption and distillation (Qualitative Treatment), Different types of Tray Efficiencies, Liquid Dispersed venturi Scrubbers, Wetted-Wall Towers, Packed Towers, Counter current flow of Liquid & Gas through packing, Mass transfer coefficients for packed towers, End effects and Axial Mixing Tray tower vs Packed towers.

**UNIT-IV**

Absorption And Stripping: Absorption equilibrium, ideal and non ideal solutions selection of a solvent for absorption, one component transferred: material balances. Determination of number of Plates (Graphical), Absorption Factor, estimation of number of plates by Kremser Brown equation, Continuous contact equipment; HETP, Absorption of one component, Determination of number of Transfer Units and Height of the Continuo   Absorber, overall coefficients and transfer units, dilute solutions, overall height of transfer units.

**UNIT-V**

Humidification Operations: Vapor-Pressure Curve, Definitions, Psychometric Charts, Enthalpy of gas-vapor Mixtures, Humidification and Dehumidification, Operating lines and Design of Packed Humidifiers, Dehumidifiers and Cooling towers, Spray Chambers

**TEXT BOOK:**

1. Mass transfer operations by R.E. Treybal, 3$^{rd}$ ed. Mc Graw Hill, 1980.
2. Separation process C.J King, Tata Mc Graw Hill
3. Principles of Mass Transfer and Separation Processes b  B K Dutta, Printice Hall of India Pvt Limited, New Delhi

**REFERENCE:**

1. Diffusion  mass transfer in fluid system by E. L. Cussler.
2. Transport processes and unit operations by Christie J. Geankoplis
3. Separation Process Principles, J D Seader and E. J. Henley, John Wiley & Sons, Inc,. New York

**Pre-requisite:---Nil---**

***Codes/Tables:*** *Psychometric Charts may be provided*

**Outcome:**

- Recognize the various modes of mass transfer, Determine mass transfer rates using Fick's Law.
- Fundamental knowledge on mass transfer mechanisms and operations like absorption, stripping, drying and humidification.
- Estimate diffusion coefficients, Solve unsteady state diffusion problems
- Determine convective mass transfer rates & mass transfer coefficients
- Determine the number of transfer units and height requirements for a packed column

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## PETROLEUM REFINING AND PETROCHEMICALS

**OBJECTIVES:**

- Learn the formation, refining of crude oil and products of refinery.
- Understand the means of processing data including thermal properties, important products characteristics.
- Develop skills in drawing neat flow diagrams of different petroleum refining processes
- (cracking/reforming/alkylation/isomerization / hydrocracking etc.,) that are aimed at producing high value/demand products.
- Identify important testing methods for important petroleum products.
- Have idea on Indian standards for major petroleum products

**UNIT-I:**

Origin, formation and composition of petroleum: Origin and formation of petroleum, Reserves and deposits of world, Indian Petroleum Industry. Petroleum processing data: Evaluation of petroleum, thermal properties of petroleum fractions, products, properties and test methods.

**UNIT-II:**

Fractionation of petroleum: Dehydration and desalting of crudes, heating of crude pipe still heaters, distillation of petroleum, blending of gasoline. Treatment techniques: fraction-impurities, treatment of gasoline, treatment of kerosene, treatment of lubes.

**UNIT-III:**

Thermal and catalytic processes: Cracking, catalytic cracking, catalytic reforming, Naphtha cracking, coking, Hydrogenation processes, Alkylation processes, Isomerization process.

**UNIT-IV:**

Petrochemical Industry – Feed stocks Chemicals from methane: Introduction, prod of Methanol, Formaldehyde, Ethylene glycol, PTFE, Methylamines.

**UNIT-V:**

Chemicals from Ethane-Ethylene-Acetylene: Oxidation of ethane, production of Ethylene, Manufacture of Vinyl Chloride monomer, vinyl Acetate manufacture, Ethanol from Ethylene, Acetylene manufacture, Acetaldehyde from Acetylene.

**TEXT BOOKS:**

1. Nelson. W.L. “Petroleum refining Engineering”, 4 Ed ion, Mc Graw Hill, New York, 1969.

2. Rao, B.K.B. “Modern Petroleum Refining Processes”, Edition, Oxford and IBH Publishing, 2002.

**REFERENCES:**

1. Goldstine. R.F. “The Petroleum Chemicals Industry”, Taylor and Francis, London, 1967.

2. Gruese. W.S.and Stevens, D.R. “Chemical Technology of Petroleum”, McGraw Hill, 1980.

3 Chauvel. A. and Lefevrev, “Petro Chemicals”, Volume and 2, Gulf Publishing company 1989.

**Outcomes:**

- Describe the formation of crude oil, its refining techniques.
- Describe the chemical composition and physical properties of crude oil
- Understand various processes employed in petroleum refinery such that we can meet customer demand in terms of quality & quantity.
- Demonstrate the different methods available for remova of impurities from crude and products manufacture
- Understand, draw and describe the process flow diagrams of various refinery processes like distillation, cracking and reforming etc.,
- Understand the difference between thermal and catalytic cracking.

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## PROCESS DYNAMICS AND CONTROL LAB

**OBJECTIVES:**

- To evaluate response of fist and higher order characteristics.
- Study the installed characteristics of the valve.
- Study if there is a hysteresis in the control valve and sensor.
- Evaluate the tuning of a PID control via manual and automatic tuning.
- Evaluate the effect controller on the control system

1. Calibration and determination of time lag of various first and second order instruments
   Major equipment - First order instrument like Mercury-in-Glass thermometer and
   Overall second order instrument like Mercury-in-Glass thermometer in a thermal well

2. Experiments with single tank system.
   Single tank - Step Response
   Single tank - Impulse Response

3. Experiments with two tank systems with and without interaction.
   Non Interacting Tanks – Step Response
   Interacting Tanks – Step Response
   Non Interacting Tanks – Impulse Response
   Interacting Tanks – Impulse Response

4. Level control trainer
   Major equipment - Level control trainer set up with computer

5. Temperature control trainer
   Major equipment - Temperature control trainer with computer

6. Experiments on proportional, reset, rate mode of control etc.
   Major equipment – PID control apparatus

7. Control valve characteristics
   Major equipment – Control valve set up

8. Estimation of damping coefficient for U-tube manometer
   Major equipment - U-tube manometer.

**Outcome**:

- Estimate the dynamic behavior of the control systems
- Understand the controllability, speed of response the control systems.
- Select proper control valve to meet process needs.
- Understand direct digital control systems handling and operation.
- Tuning of a PID control via manual and automatic tuning.
- Choose PID modes that effect controllability, speed of response the control systems

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## ENERGY AND ENVIRONMENTAL ENGINEERING LAB

**List of Experiments:**

1. Estimation of chemical and physical parameters of Ground and Surface water:
   $P^H$, TDS & Conductivity, Hardness, Turbidity, Fluoride, Color analysis.
   Pesticide Microbial analysis: e-coli/ total coli forms bacteria
2. Estimation of physical parameters of waste water:
   $P^H$, TDS, Hardness, Turbidity, Alkalinity etc.
3. Estimation of chemical parameters of waste water:
   COD, BOD, TSS
4. Water and waste water treatment:
   Small RO system for treatment of ground water.
   Same above system with UF membrane for turbidity removal and water disinfection.
5. Analysis of Air:
   Estimation of SPM, RSPM, Sox, Nox, CO and ozone in atmospheric air to study air pollution.
6. Fuel cell Test Kit [Energy]
   A small ½ watt to 1 watt fuel cell with water electrolysis kit ($H_2$ and $O_2$ Generation) plus small voltmeter and ammeter for measuring fuel cell performance.
7. Measurement of Flash point, fire point and calorific value of petroleum products.
8. Proximate Analysis of Coal – Moisture, Volatile Matter, Fixed Carbon and Ash. (Hot air Oven & Muffle Furnace)
9. Calorific value of Solid Fuels.
10. Energy auditing of your Department.

**List of Equipment**

$P^H$ meter, Colorimeter, TDS meter, Aerobic /Anaerobic reactor 25L capacity, BOD incubator, High accuracy analytical balance (5 digit), Desiccators, RO system with domestic 2’’x12’’ Membrane module, $H_2S$ vial kit, Water analysis kit, UV-Vis spectrophotometer, High volume air sampler, Bomb calorimeter, Fuel cell test kit, Microscope.

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## INDUSTRIAL ENGINEERING AND MANAGEMENT

**OBJECTIVES:** The objective of the course, is to equip the Engineering students about the fundamental knowledge of general management, management of materials, human resource management, marketing management, inspection and quality control and will be exposed to the latest and contemporary issues of industrial management.

**UNIT I**

**Introduction to Management:**

Management-Concept and meaning-Nature-Functions-Management as a science and art and both- Schools of management thought-Taylor's Scientific Theory- Henry Fayol's Principles-Weber's Ideal Bureaucracy –Eltan Mayo's Human relations – Systems theory- Situational or Contingency theory- Social responsibilities of management. **Organizational structure and design**: Features of organizational structure- Work specialization-Departmentation-Span of control-Centralization and Decentralization **Organisational designs**-Line Organization-Line & Staff Organization-Functional Organization- Matrix Organization-Project Organization-Committee form of Organisation

**UNIT II**

**Plant Location and Material Management:**

Definition- Factors affecting the plant location- comparison of rural and urban sites-methods for selection of plant-Types of Plant Layout-Methods of production (Job, batch and Mass Production)- Work Study. **Materials Management:** Inventory-functions-Inventory classification techniques-EOQ, ABC and VED analysis- Inventory Control System- Purchase-Procedure - Stores Management. **Marketing Mangement:** Definition- Functions of Marketing-Marketing Mix-Marketing strategies based on Product Life Cycle- Channels of distribution.

**UNIT III**

**Human Resources Management (HRM):**

HRM- Definition and meaning – Nature-Managerial and Operative functions-Evolution of HRM-Human Resource Planning(HRP)-Employee Recruitment-Sources of Recruitment - Employee Selection- Process and tests in employee selection- Employee training and development-On- the- job and Off –the- job training methods-Performance Appraisal systems-Concept-methods of Performance Appraisal-Placement-Employee Induction-Wage and Salary Administration-Objectives-Essentials of Wage and Salary Administration-Job Analysis-Process - Job Evaluation-Employee Grievances-Techniques of handling Grievances.

**UNIT IV**

**Inspection and Quality Control**: Types of inspections - Difference between Inspection & Quality Control- Statistical Quality Control techniques-Variables and Attributes- Variable control charts - R charts -Attributes control charts-P charts - C charts. Acceptance sampling plan-Single sampling - Double sampling plans-OC curves-Introduction to TQM-Quality Circles-ISO 9000 series procedures.

**UNIT V**

**Contemporary Issues in Management:**

The concept of MIS- Materials Requirement Planning (MRP)- Just-In-Time (JIT) System- Total Quality Management (TQM)- Six Sigma Concept- Supply Chain Management- Enterprise Resource Planning (ERP)- Performance Management- Business Process Outsourcing (BPO)- Business Process Re-engineering and Bench Marking- Balanced Score Card-Knowledge Management.

***The students are required to submit any one of the following - two assignments/ a mini project/submission of any two case studies in the subject.***

**Outcome**: After completion of this course, the prospective engineering technocrats will be able to understand various fundamentals of functional areas such general management, plant and materials management, marketing management,human resource management, statistical quality control techniques, strategic management and also aware of the latest and contemporary issues of industrial management.

**Text Books:**

1. GuptaA.K.EngineeringManagement,SChand&CompanyLimitedNewDelhi-2014(Reprint)
2. Khanna O.P and Dhanpat Rai Industrial Engineering &Management.

**Reference Books:**

1. A.R Aryasri: Management Science, TMH, 2013.
2. Stoner. Freeman. Gilbert. Managemem. 6th Ed, Pearson Education. New Delhi, .
3. Fanner Selvam, Production and Operations Management, PHI.
4. Dr. C. Nadha Muni Reddy and Dr. K. Vijaya Kumar Reddy, Reliability Engineering & Quality Engineering. Galgotia Publications, Pvt Limited.
5. Ralph M Barnes. Motion and Time Studies. John Wiley and Sons. 2004.
6. Chase. Jacobs. Aquilano. Operations Management. TM Ii 10th Edition. 2013.

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## CHEMICAL TECHNOLOGY

**OBJECTIVES:**

- Unit operations unit processes involved in manufacture of important and widely employed organic and inorganic chemicals.
- Develop skills in preparing /presenting a neat Engineering drawing Chemical Process Industries.
- Impart clear description of one latest process along w its Chemistry, Process parameters, Engineering Problems and Optimum Conditions.
- Demonstrate the importance of updating the latest technological developments in producing products economically and environment friendly.
- Appreciate the usage of other engineering principles such as Thermodynamics, Heat, mass and momentum transfer in operation and maintain the productivity

**UNIT – I**

Water and Air: Importance of water, sources, plant location factors related to water, water shortage problems, methods of treating fresh water, methods of obtaining fresh water from saline waters, waste water treatment and disposal, air as a chemical raw material.

Soda ash, caustic soda and chlorine, Glass: manufacture of special glasses

**UNIT – II**

Industrial gases: carbon dioxide, hydrogen and oxygen – products of water gas, producer gas. Nitrogen industries: synthetic ammonia, urea, nitric acid (ammonium nitrate), ammonium chloride, ammonium phosphate and complex fertilizers

Sulphur and sulphuric acid, manufacture of sulphuric acid, hydrochloric acid and some other chemicals –Aluminum sulphate and alum.

**UNIT – III**

Cement manufacture, special cements, miscellaneous calcium compounds, magnesium compounds.

Manufacture of phenols, formaldehyde, vinyl chloride and vinyl acetate, manufacture of phenol-formaldehyde resin and polyvinyl chloride polymer, SBR

**UNIT – IV**

Oils: Definition, constitution, extraction and expression of vegetable oils, refining and hydrogenation of oils.

Synthetic fibers: Classification, manufacture of Nylon 66, polyester fiber and viscose rayon fiber.

Soaps and detergents: Definitions, continuous process the production of fatty acids, glycerin and soap, production of detergents.

**UNIT – V**

Pulp and paper industry: methods of pulping, production of sulphate and sulphite pulp, production of paper –wet process

Pharmaceutical Industries: Classification, Alkylation, Carboxylation and Acetylation, Condensation and Cyclization, Dehydration,Halogenation, Oxidation, Sulfonation, Amination, Radio isotopes in Medicine, Fermentation and Life processing for Antibiotics, Hormones, and Vitamines, Biologicals, Steroid hormones, isolates and Animals.

**Text books:**

1. Shreve's Chemical Process Industries edited by Austin, Mc.graw-Hill.5$^{th}$ ed.1985.
2. Dryden's Outlines of Chemical Technology edited by Gopal Rao and M. Sittig, 2$^{nd}$ ed. 1973.

**References:**

1. Industrial Chemistry by B.K. Sharma,
2. Hand book of industrial chemistry Vol 1& II K.H.Dav & F.S. Berner Edited by S.C. Bhatia, CBS publishers
3. Chemical Technology: G.N. Panday, Vol 1& Vol II.

**Pre-requisite:---Nil---**

**Outcomes:**

Upon successful completion of the course the students will be able to:

1. Make a neat and easy to understand the plant process flow sheet.
2. Keeps up the productivity while maintaining all safety norms stipulated, during their job.
3. Solve Engineering problems that are likely to come across during the operation of plants.
4. Suggest alternative manufacturing process in terms of Economic viability of the product.

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## MASS TRANSFER OPERATIONS-II

**OBJECTIVES:**

- Study of the stage wise mass transfer operations, principles of various stage wise contact processes like distillation, extraction and leaching and drying
- Design aspects of the equipments utilized for above mentioned operations.
- Attain practical knowledge of separation processes, conduct experiments and submit the report.

### UNIT-I

Distillation: Fields of applications, VLE for miscible liquids, immiscible liquids, steam distillation, Positive and negative deviations from ideality, enthalpy-concentration diagrams, flash vaporization and differential distillation for binary and multi component mixtures, Batch distillation with Reflux.

### UNIT-II

Continuous rectification-binary systems, multistage tray towers –method of Mc Cabe and Thiele, enriching section, Stripping section, feed introduction, total reflux, minimum and optimum reflux ratios, use of open steam, types of condensers, partial condensers, effect of cold reflux, multiple feeds , tray efficiencies, continuous-contact equipment (packed towers)

Multistage (tray) towers –the method of Ponchon and Savarit, the enriching and stripping sections, feed tray location, total reflux, minimum and optimum reflux ratios, types of reboilers, use of open steam, condenser and reflux accumulators, Azeotropic distillation, extractive distillation, comparison of Azeotropic and extractive distillation.

### UNIT- III

Liquid-Liquid operations: fields of usefulness, liquid-liquid equilibrium, equilateral triangular co-ordinates, choice of solvent, stage wise contact, multistage cross-current extraction, Multi stage counter current without reflux

Multi stage counter current with reflux, Differential s contact) extractors, spray towers, packed towers, mechanically agitated counter-current extractors, centrifugal extractors, dilute solutions, super critical fluid extraction, fractional extraction.

### UNIT-IV

Drying: Equilibrium, Definitions, Drying Conditions- Rate of Batch Drying under constant drying conditions, Mechanisms of batch drying, Drying time Through Circulation Drying.

Classification Of Drying Operations: Batch and Continuous Drying Equipment, Material and Energy Balances of Continuous Driers, rate of drying for continuous direct heat driers.

### UNIT-V

Leaching: Fields of applications, preparation of solid for leaching, of leaching, leaching equilibrium, single stage and multi stage leaching calculations, constant under flow conditions, equipment for leaching operation.

**TEXT BOOK:**

1. Mass transfer operations by R.E. Treybal, 3rd ed. Mc Graw Hill, 1980.

**REFERENCE:**

1. Principles of Mass Transfer and Separation Processes by B K Dutta, Printice Hall of India Pvt Limited, New Delhi
2. Transport processes and unit operations by Christie J. Geankoplis
3. Separation Process Principles, J D Seader and E. J. Henley, John Wiley & Sons, New York

**Pre-requisite:---**Mass Transfer Operations-I

**Outcome:**

- Have complete insight of stage wise contact processes absorption; distillation, extraction and leaching that are used in separation processes in industries.
- Explain the underlying principles and apply them for related separation processes in industries.
- Suggest and design equipment for various mass transfer operations mentioned above.
- Apply these separation processes for specific purposes by using the experience obtained while conducting experiments in laboratory.
- Can operate, design and debug any problems emanating in equipment used in industries for the above operations.
- Be able to operate and debug any problems emanating in equipments used in industries for the above operations.

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## CHEMICAL REACTION ENGINEERING – II

**OBJECTIVES:**

- Learn the importance of RTD and the compartmental models for modeling of Non-ideal flow reacting vessels.
- Calculate the conversions based on segregated flow model, dispersion model and tanks-in-series models.
- Knowledge of rate law given the rate controlling step in catalytic reactions, internal and external diffusion effects.
- Learn the factors influencing catalyst decay, the role of pore diffusion on catalyst activity rate.
- Shrinking core model for spherical particles of unchanging size and design the fluid-solid reactors.

### UNIT I

**Basics of non-ideal flow**: E, the exit age distribution function of fluid, the RTD, conversion in non-ideal flow reactors, diagnosing reactors (qualitative discussion only).

**The dispersion model**: axial dispersion, correlations for axial dispersion, chemical reaction and dispersion.

### UNIT II

**The tanks in series model**: pulse response experiments and the RTD, chemical con n. The convection model for laminar flow- the convective model and its RTD, chemical conversion laminar flow reactors

**Earliness of mixing, segregation and RTD**: self-mixing of a single fluid, mixing of two miscible fluids.

### UNIT III

**Catalysis and Catalytic reactors**: catalysts, steps in catalytic reactions, synthesizing a rate law, mechanism and rate limiting step. (From chapter 10, Fogler)

**Heterogeneous reactions**: Introduction to Solid catalyzed reactions: The rate for Surface Kinetics- Pore diffusion resistance combined with surface kinetics, Porous catalyst particles, heat effects during reaction, Performance equations for reactors containing porous catalyst particles.

### UNIT IV

Solid catalyzed reactions- Experimental methods for finding rates. Deactivating catalysts- mechanisms of catalyst deactivation, the rate and performance equations.

### UNIT–V

**Fluid-fluid reactions**: kinetics- the rate equation.

**Fluid-particle reactions**: kinetics- selection of a model, shrinking core model for spherical particles of unchanging size, rate of reaction for shrinking spherical particles, extensions, determination of rate controlling step.

**TEXT BOOKS:**

1. Chemical Reaction Engineering, 3rd ed., O. Levenspiel, John Wiley & Sons, 1999.
2. Elements of Chemical Reaction Engineering, 4th ed., H.S. Fogler, PHI Learning Pvt. Ltd., New Delhi, 2010.

**REFERENCES:**

1. Chemical Engineering Kinetics, 3rd ed., J.M. Smith, McGraw-Hill, New York, 1981.
2. The Engineering of Chemical Reactions, 2nd ed., L.D. Schmidt, Oxford University Press, New Delhi, 2010

**Outcome:**

- Modeling of compartmental models for Non-ideal flow reacting vessels.
- Calculation of conversions based on various models
- Students can design the fluid-solid reactors

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## PROCESS MODELING AND SIMULATION

**OBJECTIVES:**

- Learn to develop mathematical model for problems.
- To impart knowledge on modeling of various equipment and their simulation using different numerical techniques.
- Formulate a chemical engineering problem as a mathematical model, and select an appropriate solution method.
- Understand the computational requirements of various solution options and use this understanding in the selection of the solution method
- Formulate and solve process design problems, based on damental analysis and using mathematical models of chemical processes

**UNIT I**

**Mathematical models for chemical engineering systems**: classification of mathematical models- steady state vs dynamic models, lumped vs distributed models, deterministic vs stochastic models. **Examples of mathematical models-** Two heated tanks, batch reactor, constant volume CSTRs, non-isothermal CSTR, reactor with mass transfer, ideal binary distillation column, batch distillation with holdup.

**UNIT II**

**Empirical model building-** method of least squares, linear, polynomial and multiple regression, non-Linear regression. **Solution of Non- Linear Algebraic equations-** bisection, false position, Quasi Newton and Newton- Raphson methods.

**UNIT III**

**Numerical integration-** Trapezoidal rule, Simpson's rule and Newton– Cotes formula. **Numerical solution of differential equations-** Euler's method, Runge- Kutta methods, predictor corrector methods.

**UNIT IV**

**Numerical solution of partial differential equations-** elliptic, parabolic and hyperbolic equations.finite difference methods, Leibman's method, Crank Nicholson od. Apllications to steady state and Unsteady state heat conduction and temperature distribution problems.

**UNIT V**

**Process Simulation examples**: VLE dew point and bubble point calculations, binary distillation column, gravity flow tank, batch reactor, Non- isothermal CSTR, countercurrent heat exchanger.

**Process simulation using modular and equation based solving approaches**: Developing a simulation model, a simple flow sheet, Sequential modular approach, Simultaneous modular approach, Equation solving approach.

**TEXTBOOKS:**

1. Process modeling, Simulation and Control for Chemical Engineers, $2^{nd}$ ed., W. L. Luyben, McGraw-Hill, New York, 1990.
2. Numerical Methods for Engineers, S.K. Gupta, Wiley Eastern, New Delhi, 1995.

**REFERENCE:**

1. Numerical Methods for Engineers and Scientists, S.S. Rao
2. Introduction to Numerical Methods in Chemical Engineering, P. Ahuja, PHI learning Pvt. Ltd., New Delhi, 2010
3. Process Modeling and Simulation, Amiya K. Jana, 2012.

**Outcome**:

- Understand the stages involved in the development of a process model.
- Formulate a chemical engineering problem as a mathematical model from basic engineering principles.
- Identify the appropriate numerical solutions used in solving the models
- Apply various simulation tools for solving the chemica ineering models developed.
- Understand the solution techniques for solving ODEs.

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## CHEMICAL PLANT DESIGN AND ECONOMICS

**OBJECTIVES:**

- To familiarize the students about various economic aspects of chemical processes
- Learn basics of Cost estimation, Working Capital and Capital Investment and understand the time value of money
- Learn the importance of Cash flow diagrams and Break-even analysis.
- Study depreciation methods and methods of estimation of profitability of an industry
- Study the procedures adopted for Replacement and Selection from Alternatives.

**UNIT I**

Introduction, Process Design development. General design considerations, Cost and asset accounting.Cash flow for industrial operations, factors effecting investment and production cost, capital investments, estimation of capital investments, cost indices, cost factors in capital investment

**UNIT II**

Organizations for presenting capital investments, estimates by compartmentalization, estimation of total product of cost direction, production costs, charges, plant overhead costs, financing.

Interest and investment cost, type interest, nominal and effective interest rates, continuous interest, present worth and discount annuities, cost due interest on investment, source of capital.

**UNIT III**

Taxes and insurances, type of taxes: federal income taxes, insurance-types of insurance, self insurance.

Depreciation : types of depreciation, services life, salvage value, present value, methods for determining depreciation, single unit and group depreciation.

**UNIT IV**

Profitability: alternative investments and replacements, profitability standards, discounted cash flow, capitalized cost, pay out period ,alternative investments, analysis with small investments, increments and replacements.

**UNIT V**

Optimum design and design strategy, incremental cost, general procedure for determining optimum condition, comparison of graphical and analytical methods, optimum production rates, semi continuous cyclic operation, fluid dynamics, mass transfer strategy of linearization

**TEXT BOOK:**

1. Plant Design and Economics for Chemical Engineering, 4$^{th}$ ed., M.S. Peters and K.D. Timmerhaus, McGraw-Hill, 1991

**REFERENCE:**

1. Process Engineering Economics, Schweyer

**<u>Outcome</u>:**

- Estimate various costs involved in a process industry and evaluate the tax burden of an establishment
- They will be ready with tools to estimate profitability of a company
- Find the replacement costs of an equipment and select best one from different alternatives
- Compute break even period for an investment and rate of return

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## CHEMICAL REACTION ENGINEERING LAB

**OBJECTIVES:**

- Operate lab equipments like CSTR, Batch, PFR reactors.
- Analyze the concentration versus time data and determine the specific rate constant and the order of the reaction.
- Compare theoretical and experimental conversions in a CSTR and PFR.
- Estimate RTD and model parameters in a CSTR, PFR, packed bed and CSTRin-series.

1. Determination of the order of a reaction using a batch reactor and analyzing the data by (a) differential method (b) integral method.
2. Determination of the activation energy of a reaction using a batch reactor .
3. To determine the effect of residence time on conversion and to determine the rate constant using a CSTR.
4. To determine the specific reaction rate constant of a ion of a known order using a batch reactor.
5. To determine the order of the reaction and the rate constant using a tubular reactor.
6. CSTRs in series- comparison of experimental and theoretical values for times and volumes of reactors.
7. Mass transfer with chemical reaction (solid-liquid system) – determination of mass transfer coefficient.
8. Mass transfer with chemical reaction (liquid-liquid system) – determination of mass transfer coefficient
9. Axial mixing in a packed bed. Determination of RTD and dispersion number for a packed-bed using tracer
10. Determination of RTD and dispersion number in a tubular reactor using a tracer.

**Outcomes**:

- Skills of deriving the kinetic expressions by performing the experiments on batch and continuous flow reactors.
- Understand the effects of non ideal flow.
- Proficient to estimate RTD and model parameters in a CSTR, PFR, packed bed and CSTRin-series

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## MASS TRANSFER OPERATIONS LAB

**OBJECTIVES:** This lab gives an overall idea of various mass transfer operations used in the industry.

1. Estimation of diffusivity coefficients for vapor in gas
2. Estimation of solid diffusion coefficient in air
3. Steam distillation
4. Simple distillation
5. Evaluation of HETP in packed towers
6. Vapor Liquid Equilibria
7. Batch Drying
8. Evaluation of Mass transfer coefficients for Surface Evaporation
9. Evaluation of Mass transfer coefficients for Wetted wall column
10. Liquid- Liquid Equilibria (Tie line data)
11. Ternary Liquid Equilibria (binodal curve)
12. Leaching
13. Adsorption studies

**Outcomes:**

1: The student will be able to perform VLE, LLE related experiments and can estimate diffusivity coefficients.

2: The student will be able to learn about the calculation of different parameters in distillation, absorption, drying and evaporation.

3: The student will be able to design distillation units, drying and evaporation units.

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**ADVANCED ENGLISH LANGUAGE COMMUNICATION SKILLS LAB**
**(AUDIT Lab)**

## Objectives:

This lab focuses on using computer-aided multimedia instruction for language development o meet the following targets:

- To expose the students to a variety of self instructional, learner-friendly modes of language learning.
- To enable the students to learn better pronunciation and accent through listening and reading exercises.
- To train students to use language appropriately for interviews, group discussion and public speaking.
- To initiate them to greater use of the computer in resume preparation, format-making etc.
- To help the students to cultivate the habit of reading passages from the computer monitor, thus providing them with the required facility to face computer based competitive exams such as GRE, TOFEL, and GMAT etc.
- To enable the students to acquire good communication skills as well as soft skills to meet global demands.

**Syllabus:**

**Unit I:**

**Reading &Listening Comprehension:** Skimming –scanning- Extensive and Intensive reading. Reading for making inferences. Active VS passive listening. Listening and Note taking, - Listening for making inferences.

**Unit II:**

Writing Skills: Formal and informal writing- Resume Writing-E-Correspondence.

**Unit III:**

**Technical Presentations (Oral) :** Planning-Preparation-Presentation . Art of Persuasion- Audience analysis- Handling questions.

**Unit IV:**

**Interview Skills:** Types of Interviews - pre-interview planning- answering strategies. Analysis of One to one –interviews – group interviews - Mock interviews.

**Unit V:**

**Soft Skills**: Inter Personal Skills- Goal setting – Etiquettes and good manners – Team Working – Work Ethics--Time management – Problem Solving.

**Minimum Requirements**

The English Language Lab shall have two parts:

The Computer Aided Language Lab for 60 students with 60 systems, one master console, LAN facility and English language software for self-study by learners.

The Communication Skills Lab with movable chairs and audio-visual aids with a PA System, a TV, a digital stereo-audio and video system, a Camcorder, etc

System Requirement (Hardware Component):

Computer network with LAN with a minimum of 60 multimedia systems with the following specifications:

P-IV Processor

Speed-2.8 GHZ

RAM_512 MB minimum

Hard Disk-80 GB

Headphones

**Prescribed Software:**

9. K-Van Advanced Communication Skills
10. Walden Infotech Advanced Communication Skills.

**Books Suggested for English Language Lab Library (to be located within the lab in addition to the CDs of the text book which are loaded systems):**

1. **Technical Writing and Professional Communication, Huckin and Olsen** Tata Mc Graw-Hil 2009.
2. **Technical Communication** by Meenakshi Raman & Sangeeta Sharma, Oxford University Press 2009.
3. **Cambridge English for Job-Hunting** by Colm Downes, Cambridge University Press, 2008
4. **Resume's and Interviews** by M.Ashraf Rizvi, Tata Mc Graw-Hill, 2008

**5.**. **English Language Communication : A Reader cum Lab Manual** Dr A Ramakrishna Rao, Dr G Natanam & Prof SA Sankaranarayanan, Anuradha Publications, Chennai 2008.

**6. Managing Soft Skills** by K R Lakshminarayan and T.Muruguvel, Sci-Tech Publications, 2010

**7. The ACE of Soft Skills** by Gopal Ramesh and Mahadevan Ramesh, Pearson Education, 2010

8. **Soft Skills** by Dr. K. Alex, S.Chand

9. **Study Skills for Professional Students in Higher Education** by Dr. M. Adithan, S.Chand.

10. **Personality Development and Soft Skills by Barun** K. Mitra, Oxford Higher Education.

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## TRANSPORT PHENOMENA

**OBJECTIVES:**

- Different types of fluids, their flow characteristics different mathematical models applied to actual situations
- Mechanism of fluids in motion under different conditions.

**UNIT-I**

Viscosity and the mechanisms of momentum transfer: Newton's law of viscosity (molecular momentum transport), generalization of Newton's law of viscosity, pressure and temperature dependence of viscosity, molecular theory of the viscosity of gases at low density, molecular theory of the viscosity of liquids. Thermal conductivity and the mechanisms of energy transport: Fourier's law of heat conduction (molecular energy transport), temperature and pressure dependence of thermal conductivity, and theory of thermal conductivity of gases at low density. Diffusivity and the mechanisms of mass transport: Fick's law of binary diffusion (molecular mass transport), temperature and pressure dependence of diffusivities, theory of diffusion in gases at low density.

**UNIT -II**

Shell momentum balances and velocity distributions in laminar flow: shell momentum balances and boundary conditions, flow of a falling film, flow a circular tube, flow through annulus, flow of two adjacent immiscible fluids, creep low around a sphere.

**UNIT -III**

Shell energy balances and temperature distributions in solids and laminar flow: shell energy balances; boundary conditions, heat conduction with an electrical heat source, heat conduction with a nuclear heat source, heat conduction with a viscous heat source, heat conduction with a chemical heat source, heat conduction through composite walls, heat conduction in a cooling fin, forced convection, free convection.

**UNIT -IV**

Concentration distributions in solids and laminar flow: shell mass balances; boundary conditions, diffusion through a stagnant gas film, diffusion with a heterogeneous chemical reaction, diffusion with a homogeneous chemical reaction, diffusion into a falling liquid film (gas absorption), diffusion into a falling liquid film (solid dissolution), diffusion and chemical reaction inside a porous catalyst.

**UNIT -V**

The equations of change: Derivation of the equation of continuity in Rectangular and Polar coordinates, the equation of motion, the equation of energy, the equation of continuity of a component in multi component mixture (in rectangular coordinates only) the equations of change in terms of the substantial derivative. Use of equations of change to solve one dimensional steady state problems of momentum, heat and component transfer, Introduction to Turbulent transport, Time smoothing of equation change.

**TEXT BOOK:**

1. Transport Phenomena by Bird R.B., Stewart W.C., Lightfoot F.N., 2$^{nd}$ ed. John Wiley &Sons

Inc,U.S.A,1960.

**Reference:**


1. Transport phenomena for engineers by L. Theodore, International text book company, U.S.A.1971.
2. Transport processes and unit operations by C.J. Geankoplis, PHI, 3rd ed. 1997.
3. Fundamental of heat, momentum and mass transfer, Welty, Wicks and Wilson, John Wiley.


**Pre-requisite:** Fluid Mechanics for Chemical Engineers, Process heat transfer, Mass Transfer operations- I & II and Chemical Reaction Engineering I and II

**Codes / Tables:** 1. Leonard – Jones potential parameters and critical properties.
2. Equations of change (from Bird)

**Outcomes:**

1. Ability to understand the chemical and physical transport processes and their mechanism.
2. Ability to do heat, mass and momentum transfer analysis.
3. Ability to analyze industrial problems along with appropriate approximations and boundary conditions.
4. Ability to develop steady and time dependent solutions along with their limitations.

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# CHEMICAL PROCESS EQUIPMENT DESIGN

**OBJECTIVES:**

- Study design safe process and design appropriate equipment like reactors, mass transfer heat transfer equipment, pipelines storage tanks etc.
- Study relevant codes for design of chemical plant equipment as per the standard procedures specified by design code books.
- Learn the fabrication techniques and testing methods.
- Learn design and engineering skills directly applied in design, installation and commissioning of equipments.

**UNIT-I**

**Basic Considerations in Process Equipment Design:** Introduction, general design procedure, fabrication techniques, equipment classification, power for rotational motion, drives for process equipment

**Materials of Construction:** Mechanical properties, materials, corrosion, corrosion prevention, choice of material.

**UNIT-II**

**Design Considerations:** Introduction, stress created due to static and dynamic loads, design stress, combined stresses and theories of failure, fat gue, brittle fracture, creep, effects of temperature, radiation and fabrication methods.

**Process Hazards and Safety Mechanisms in Equipment Design:** Introduction, hazards in process industries, safety measures, safety measures in equipment design, pressure relief devices.

**UNIT-III**

**Material Handling Equipment Design:** Piping in fluid transportation process-selection of piping material, design of piping system, pumping of fluids: selection of pumps, design procedures for pumps, compression and expansion of fluids: selection of compressors, fans and blowers, vacuum system equipment, turbines and expanders, design procedures for compressors, turbines and expanders

**Heat Transfer Equipment Design:** Selection of heat exchangers types- key heat exchanger types available, preliminary selection of heat exchanger types, Design of key heat exchanger types- Double pipe and multiple double pipe exchangers, shell and tube heat exchangers, plate exchangers, compact exchangers, air cooled exchangers.

**UNIT-IV**

**Seperation Equipment Design:** Distillation design procedures for columns with sieve trays, with random packing, with structural packing, Absorption and Stripping design procedures for trayed columns, packed columns separating dilute solutions

**Equipment Selection for liquid-liquid extraction:** Design procedure for liquid liquid extraction, selection of sorbent for separation by adsorption, basic adsorption cycles, selection of appropriate adsorption cycles, general design for separation by adsorption

**UNIT-V**

**Pressure Vessels:** Introduction, operating condition, pressure vessel codes, selection of materials, vessels operating at low temperatures and elevated temperatures, Design conditions and stresses.

Design of shell and its components, Fabrication, Inspection and Tests.

**TEXT BOOKS:**

1. Joshi's Process Equipment Design, Fourth Edition by V. V. Mahajani and S. B. Umarji, Macmillan Publishers India Ltd., 2009.
2. Plant Design and Economics for Chemical Engineers, Fifth Edition by Max. S. Peters, Klans Timmerhaus and Ronald E. West, McGrawHill International Edition, 2004.

**REFERENCE BOOKS:**

1. Coulson J.M. and Richardson J.F., Chemical Engineering Vol.VI (An introduction to Chemical Engineering Design), Pergamon Press, 1993.

**Outcome:**

The student will be able to do

1. Mechanical design of pressure vessels
2. Process design of separation equipments for distillation, absorption, stripping, liquid-liquid extraction, adsorption
3. Selection of piping materials, pumps, compressors, com fans and blowers, vacuum system equipment, turbines and expanders
4. Design of material handling equipment like piping system, pumps, compressors, turbines and expanders.

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## OPTIMIZATION OF CHEMICAL PROCESSES

**OBJECTIVES:**

- To learn problem formulation of optimization.
- To realize the numerical methods of un-constrained optimization.
- To learn linear programming and its applications
- To understand the use of genetic algorithms in optimization
- To know the applications of numerical optimization.

**UNIT I**

Nature and organization of optimization problems- introduction to optimization scope and hierarchy of optimization, examples of applications of optimization, essential features of optimization problems, general procedure for solving optimization problems, Optimization of a manufacturing problem with a stepwise procedure, obstacles of optimization, constraints in optimization, examples and formulation of constrained optimization problems.

**Basic concepts of optimization**: Continuity of functions, unimodal versus Multimodel functions. Convex and Concave functions, Convex region, Necessary and sufficient conditions for an extremum of an unconstrained function.

**UNIT II**

**Optimization of unconstrained single variable functions:** Region elimination methods: Fibonacci search, Golden section search. Polynomial approximation methods- Sequential search,. Methods specifying optimum by a point: Newton method, Secant method, Quadratic interpolation, Cubic interpolation. Applications of one- dimensional search methods to chemical engineering problems.

**UNIT III**

**Unconstrained multivariable optimization:** Random search methods, grid search, uni-variate search, multivariable Newton's method, Steepest descent method, Conjugate search directions, Conjugate gradient method, Powell's method.

Constrained multi variable optimization- direct substitution, penalty function approach, slack variables, method of Lagrangian multipliers, Kuhn- Tucker conditions.

**UNIT IV**

**Optimization of Unit operations:** Optimal pipe diameter, minimum work of compression, Economic operation of a fixed bed filter, optimizing recovery of waste heat, optimization of multiple effect evaporator, optimization of flow rates in Liquid- Liquid extraction column, Determination of optimal reflux ratio for staged disti lation column.

**UNIT V**

**Linear programming and applications:** Basic concepts in linear programming, graphical solution, artificial variable technique, exceptional cases in LPP, non-existing feasible solution, degeneracy, duality in linear programming, dual simplex method, revised simplex method, linear programming applications including optimization of a thermal cracker.

**TEXT BOOKS:**

1. Optimization of Chemical Processes, T.F. Edgar and Himmelblau, McGraw-Hill, New York, 2001.
2. Optimization for Engineering Design, Kalyan Moy Deb, PHI Pvt. Ltd., New Delhi, 2000

**Outcome**:

- Knowledge of optimization to formulate the problems and analyze the optimization criterion for solving problems
- Apply different methods of optimization and to suggest a technique for specific problem
- Advanced optimization techniques like Genetic algorithms and other optimization techniques can be used to solve the industrial problems of relevance to the chemical industry

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## SEPARATION TECHNIQUES FOR BIOPROCESSING

**OBJECTIVES:**

- Learn the fundamentals of adsorptive separations and modeling
- Study the Pressure swing & thermal swing adsorption, Counter current separations.
- Study the basic concepts and design procedures of chromatographic columns.
- Learn different membrane separation technological processes and their design

**UNIT -I**

Crystallization: crystal geometry, principles of crystallization equilibria and yields, nucleation, crystal growth, adsorption and mass transfer theories, precipitation, crystallization from melts. (Textbook 3)

**UNIT -II**

Adsorption: Adsorption, types of adsorption, nature of adsorbents, adsorption equilibrium, single gases and vapors, Adsorption Hysteresis, effect of temperature, Heat of adsorption, vapor and gas mixtures: One component adsorbed, Effect of change of temperature or pressure. Liquids, Adsorption of solute from dilute solution, The Freundlich equation, Adsorption from concentrated solutions, adsorption operations, stage wise operation, application of Freundlich equation to single and Multistage adsorption (cross current & counter current).

Fluidized and teeter beds, adsorption of vapor from a fluidized bed, continuous contact, steady state moving bed adsorbers, unsteady state–fixed bed adsorbers, adsorption wave, elution, adsorption-desorption operations- thermal desorption of gases, activated carbon solvent recovery, pressure swing and vacuum swing adsorption (qualitative treatment), regeneration with purge and desorbent, ion-exchange: principles of ion exchange, techniques and applications. (Textbook 2)

**UNIT -III**

Chromatography: Types of chromatography: Gas and liquid chromatography, paper and thin layer chromatography, polarization chromatography, and continues chromatography, large-scale chromatography. Electrophoretic separations: Theory of electrophoresis, basic concepts of electrophoresis, forces in electrophoresis, complicating factors in electrophoresis, methods of electrophoresis: Moving boundary electrophoresis, gel and paper electrophoresis, zone spreading in zonal electrophoresis, affinity electrophoresis, free solution and capillary electrophoresis. (Textbook 1)

**UNIT-IV**

Pressure driven membrane separation processes, reverse osmosis, ultrafiltration, micro filtration, nano filtration, governing equations, effect of operating parameters on flux and rejection, applications. Concentration and electrical driven membrane processes(Text book 1)

**UNIT -V**

Gas separation in porous and non-porous membrane, pervaporation, dialysis, liquid membranes, governing equations, effect of operating parameters on flux and selectivity, applications, concentration polarization, approximate analysis for concentration polarization, mass transfer correlations, gel formation and fouling, membrane modules. (Textbook 1)

**Text Book:**

1. Rate controlled separation by Phillip C. Wankat, Springer international, 2005
2. Mass transfer operations by R.E. Tryebal, Mc Graw H ll, 3rd ed. 1980.
3. Unit operations of Chemical Engineering by Mc.Cabe    Smith, McGraw-Hill, 5th edition 1993

**References:**

1. Separation processes, C. J. King, Tata McGraw Hill.
2. Transport processes and unit operations, C.J. Geankoplis, Prentice-Hall India, 3rd edition, 2000

**Pre-requisite:** Mass Transfer operations-I, II, Phase and Chemical Equilibria, Chemical Process Calculations.

**Outcome:**

- The students would fully understand key concepts of separation processes including equilibrium stages, reflux, counter current contacting, limiting cases, efficiency and mass transport effects.
- The student will know about handling of separations using solid- fluid and separation techniques for the low-temperature, heat sensitive materials.
- Facilitate the students with the novel techniques that are required in downstream processing of biotechnology based industries.

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## BASICS OF NANOTECHNOLOGY (OPEN ELECTIVE)

**OBJECTIVES:**

- Basic knowledge of nanotechnology, classification and properties of nanomaterials
- Various methods of synthesis and characterization of nanomaterials
- Applications of nanomaterials

**Unit I**

**Introduction:** History and Scope, Can Small Things Make a Big Difference? Classification of Nanostructured Materials, Fascinating Nanostructures, ions of Nanomaterials, Nature: The Best of Nanotechnologist, Challenges and Future Prospects.

**Unit II**

**Unique Properties of Nanomaterials: Microstructure and Defects in Nanocrystalline Materials**:Dislocations, Twins,stacking faults and voids, Grain ndaries, triple and disclinations. **Effect of Nano-dimensions on Materials Behavior:** Elastic properties, Melting Point, Diffusivity, Grain growth characteristics, Enhanced solid solubility.

**Magnetic Properties**: Soft magnetic nanocrystalline alloy, Permanent magnetic nanocrystalline materials, Giant Magnetic Resonance, Electrical Properties, Optical Properties, Thermal Properties and Mechanical Properties.

**Unit III**

**Synthesis Routes: Bottom up approaches:** Physical Vapor Deposition, Inert Gas Condensation, Laser Ablation, Chemical Vapor Deposition, Molecular Beam Epitaxy, Sol-gel method ,Self assembly,

**Top down approaches:** Mechanical alloying, Nano-lithography.

**Consolidation of Nanopowders**: Shock wave consolidation, Hot isostatic pressing and Cold isostatic pressing Spark plasma sintering.

**Unit IV**

**Tools to Characterize nanomaterials:** X-Ray Diffraction (XRD), Small Angle X-ray scattering (SAXS), Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Atomic Force Microscopy (AFM), Scanning Tunneling Microscope (STM), Field Ion Microscope (FEM), Three-dimensional Atom Probe (3DAP), Nanoindentation.

**Unit V**

**Applications of Nanomaterials:** Nano-electronics, Micro- and Nano-electromechanical systems (MEMS/NEMS), Nanosensors, Nanocatalysts, Food and Agricultural Industry, Cosmetic and Consumer Goods, Structure and Engineering, Automotive Water- Treatment and the environment, Nano-medical applications, Textiles, Paints, Energy, Defence and Space Applications, Concerns and challenges of Nanotechnology.

**TEXT BOOKS**

1. Text Book of Nano Science and Nano Technology – B.S. Murthy, P. Shankar, Baldev Raj, B.B. Rath and James Munday, University Press-IIM.
2. Introduction to Nanotechnology – Charles P. Poole, Jr., and Frank J. Owens, Wley India Edition, 2012.

**REFERENCES:**

1. Nano: The Essentials by T.Pradeep, Mc Graw- Hill Education.
2. Nanomaterials, Nanotechnologies and Design by Michael F. Ashby, Paulo J. Ferreira and Daniel L.Schodek
3. Transport in Nano structures- David Ferry, Cambridge University press 2000
4. Nanofabrication towards biomedical application: Techniques, tools, Application and impact – Ed. Challa S.,S. R. Kumar, J. H. Carola.
5. Carbon Nanotubes: Properties and Applications- Michael J. O'Connell.
6. Electron Transport in Mesoscopic systems - S. Dutta, Cambridge University press.

**Outcomes:**

- Understand the methods of fabrications and applications of nanomaterials
- Understand principle and operations of applied analytical instruments.

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## INDUSTRIAL SAFETY AND HAZARD MANAGEMENT (OPEN ELECTIVE)

**OBJECTIVES:**

- Have awareness of different hazards in process industries
- Classification of hazards and their identifications
- Precautions in chemical storage and handling
- Learn risk analysis techniques and quantify them
- Learn emergency management plans

**Unit – I**

Introduction, Factors Contributing to the Costs of Accidents, List of some Notable accidents in the process industry/selected case histories, some common features of high cost accidents, reasons for high priority towards safety.

**Unit – II**

Material hazards1: Introduction Hazardous substances-categories, Toxicity, Radiation, Flammability, Ignition, Fires and explosions.

**Unit – III**

Material hazards 2: Fire balls, Fire damage, run away reaction, incompatible materials, material safety and data sheets

Process and plant Hazards: Hazards of pressure, causes of over pressures, flow deviations, effects of leakages/releases, hazards of temperatures.

**Unit – IV**

Hazard analysis: process safety management, process hazards analysis, hazards analysis methods, check list, preliminary hazard analysis, what-if / check list, hazard and operability analysis, FMEA, Fault tree analysis, cause and consequence analysis.

**Unit – V**

Preventive and protective measures: Safety options, process safety approaches, inherent safety and design, plant layout, inherent security, explosion prevention and protection, personal protective systems, plant modifications and management change, relief valves and rupture discs, breather vents for storage tanks, explosions vents, flame arresters, flare systems

**TEXT BOOK:**


1. Chemical process industry safety by K S N Raju, Mc-Graw Hill education (India) Pvt.Ltd,2014
2. Chemical process Safety by Crowl


**REFERENCES:**


1. Chemical process safety by sanders

**Outcome**:

- The student will be equipped with the knowledge by which thorough safety is ensured in the organization.
- Classify and identify hazards in chemical industries
- Take precautions in chemical storage and handling
- Perform fault tree and event tree risk analysis and quantify them
- Suggest and make others in the plant about emergency management plans

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## NUCLEAR ENGINEERING (OPEN ELECTIVE)

**UNIT-1**

**Introduction:** Motivation for Nuclear Energy, India’s Nuclear Power Program

**Nuclear Physics:** Nuclear model of the atom - Equivalence of mass and energy - Binding - Radio activity - Half life - Neutron interactions - Cross sections.

**UNIT-II**

**Nuclear Reactions and Reactor Materials**

Mechanism of nuclear fission and fusion - Radio activity - Chain reactions - Critical mass and composition - Nuclear fuel cycles and its characteristics - Uranium production and purification - Zirconium, thorium, beryllium.

**UNIT-III**

**Reprocessing**

Nuclear fuel cycles - spent fuel characteristics - Role of solvent extraction in reprocessing - Solvent extraction equipment.

**UNIT-IV**

**Nuclear Reactors**

Reactors - Types of fast breeding reactors - Design and construction of fast breeding reactors - heat transfer techniques in nuclear reactors - reactor shielding.

**UNIT-V**

**Safety, Disposal and Proliferation**

Nuclear plant safety- Safety systems - Changes and consequences of an accident - Criteria for safety - Nuclear waste - Type of waste and its disposal - Radiation hazards and their prevention - Weapons proliferation.

**Text Book**s:

1. Thomas J.Cannoly, " Fundamentals of Nuclear Engineering ", John Wiley (1978).
2. G,Vaidyanathan,” Nuclear Reactor Engineering”, Chand Publishers, 2013

**References**:

1. Collier J.G., and G.F.Hewitt, " Introduction to Nuclear Power ", (198 , Hemisphere Publishing, New York.
2. Lamarsh U.R. " Introduction to Nuclear Engineering Edition ", (1983), Addison Wesley M.A.
3. Lipschutz R.D. " Radioactive Waste - Politics, Technology and Risk ", (1980), Ballingor, Cambridge. M.A.

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**3+1* 0 3**

**SOLID WASTE MANAGEMENT (OPEN ELECTIVE)**

**OBJECTIVES:**

- Material flow in society and generation of solid waste source
- Clarification of solid waste on characterization of the same
- Understand the sense of onsite handling storage and collection systems including transportation
- Understand processing technologies with mechanical volume reduction and thermal volume reduction corporate land filling, deep well injections.
- Learn to estimate material recovery a energy recovery a given waste data using case standing

**Unit I**

**Introduction:** Definition, characteristics and perspectives of solid waste. Types of solid waste. Physical and chemical characteristics. Variation of composition and characteristics. Municipal, industrial, special and hazardous wastes.

**General aspects:** Overview of material flow in society. Reduction in raw material usage. Reduction in solid waste generation. Reuse and material recovery. General effects on health and environment. Legislations.

**Unit II**

**Engineered systems:** Typical generation rates.Estimation and factors effecting generation rates. On site handling.Storage and processing. Collection systems and devices. Transfer and transport.

**Unit III**

**Processing Techniques:** Mechanical volume reduction. Thermal volume reduction. Component separation. Land filling and land forming. Deep well injection.

**Unit IV**

**Material recovery:** Mechanical size alteration. Electromagnetic separation. Drying and dewatering. Other material recovery systems. Recovery of biological conversion products. Recovery of thermal conversion products.

**Energy recovery:** Energy recovery systems and efficiency factors. Determination of output and efficiency. Details of energy recovery systems. Combustion incineration and heat recovery. Gasification and pyrolysis. Refuse derived fuels (RDF).

**Unit V**

**Case studies:** Major industries and management methods used in typical industries – Coal fired power stations, textile industry, oil refinery, distil ry, sugar industry, and radioactive waste generation units.

**Text Books:**

1. Howard S. Peavy, Environmental Engineering, McGraw Hill International Edition, 1986.

2. Dutta, Industrial Solid Water Management and Land Fill Practice, Narose Publishing House, 1999.

**Reference Books:**

1. Sastry C.A., Waste Treatment Plants, Narose Publishing House, 1995.
2. Lagrega, Hazardous Waste Management, McGraw Hill, 1994.

**<u>Outcomes</u>:**

The student should be able to

- Apply his knowledge of characterization of waste and develop a suitable management plan
- Assess the cost of transportation laboratory processing of solid waste
- Identify hazardous nature of waste if any and can suggest suitable dumping methods.
- Suggest processing waste for material for energy recovery.
- Develop a management plan for land filling composting well injection for non-recoverable waste.

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**PROCESS EQUIPMENT DESIGN AND DRAWING LAB**

**OBJECTIVES:** To make the student familiar with design and drawing aspects of chemical processes equipments.

1. Drawing of flow sheet symbols.
2. Drawing of instrumentation symbols.
3. Drawing of instrumentation diagrams.
4. Mechanical aspects chemical equipment design and drawing of following equipment.

    a) Double pipe heat exchanger

    b) Shell and tube heat exchanger

    c) Evaporator

    d) Distillation column

    e) Batch reactor.

**Text Book:**

1. Process Equipment Design by M. V. Joshi
2. Chemical Process Equipment Design and Drawing, S.C. idargi, PHI, 2013

**Reference**:

1. Process Equipment Design by Brownell and Young
2. Chemical Process Equipment Design by Bhattacharya
3. Process Equipment Design by Wallas

**Pre-requisite:** Chemical Process equipment design

**Outcome:**

- Students would gain knowledge to develop key concepts d techniques to design the process equipment in a process plant. These key concepts would be utilized to make design and operating decisions.

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## SIMULATION LAB

**Objective**: To make the student familiar with software's and simulation of chemical processes equipments.

The following experiments have to be conducted using C and MATLAB

1. General introduction to MATLAB
2. Functions (log, exp, conv, roots).
3. Matlab Scripts and function files
4. Gravity Flow tank.
5. Three CSTRs in series – open loop
6. Three CSTRs in series – Closed loop
7. Non isothermal CSTR
8. Binary Distillation column
9. Batch Reactor isothermal; Batch reactor non isothermal – closed loop
10. Isothermal batch reactor – open loop
11. Heat Exchanger
12. Interacting System- two tank liquid level
13. Non interacting system-two tank liquid level
14. Plug flow reactor
15. Bubble point calculations
16. Dew point calculations

**TEXT BOOKS**:

1. A Guide to MATLAB for Chemical Engineering Problem Solving, Kip D. Hauch
2. Understanding MATLAB A Textbook for Beginners by S.N. Alam

**Pre-requisite**: Fluid mechanics for chemical Engineers, Process Heat transfer, Mass transfer operation- 1 & 2, Chemical Reaction Engineering.

**Outcomes:**

1. Helps to interconnect knowledge of mathematics, science, and engineering to real world problems.
2. Helps to identify, formulate, and solve engineering problems
   (for ex: most of chemical engineering problems are based on transport equations consisting broader areas of kinetics, thermodynamics and mass transfer which can be thoroughly solved using MATLAB inbuilt functions)
   - The complex multi component distillation column design can be modeled and simulated
   - System of ordinary and partial differential equations obtained in multiple reactors in series/parallel can be solved
   - Process control and optimization of reactors can be handled easily
3. “Genetic algorithms” can be implemented at a more pronounced way via MATLAB to solve various linear and non linear models of chemical engineering systems.
4. Most fascinating approach of Artificial Neural Networks (ANN) for electrical related concepts of chemical engineering systems can also be well handled in MATLAB
5. Steady state and unsteady state problems of chemical engineering and allied fields can be modeled and solved using MATLAB

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## BIOCHEMICAL ENGINEERING

**OBJECTIVES:**

- Study introduction to the application of chemical engineering principles in biochemical systems.
- Be enabled to understand the biological systems and kinetics of enzymatic reactions.
- Learn the kinetics of growth of micro organisms, hence be able to control the process.
- Be able to design equipments for handing biological processes.
- Study Operations utilized in the purification of biological products enable them to recommend, install and easily learn to operate the equipments.

**UNIT I**

Introduction to microbiology: Biophysics and the cell the structure of cells, important cell types, from nucleotides to RNA and DNA, amino acids into proteins. Kinetics of enzyme catalyzed reaction: the enzyme substrate complex and enzyme action, simple enzyme kinetics with one and two substrates, other patterns of substrate concentration dependence, modulation and regulation of enzyme activity, other influences on enzyme activity.

**UNIT II**

Immobilized enzyme technology: enzyme immobilization, processes, utilization and regeneration of cofactors.Immobilized enzyme kinetics: effect of external mass transfer resistance, analysis of intraparticle diffusion and reaction.

Kinetics of cellular growth in batch and continuous culture, models for cellular growth – unstructured, structured and cybernetic models. Thermal death kinetics of cells and spores

**UNIT III**

Introduction to metabolic pathways, biosynthesis, transport across cell membranes, end products of metabolism, stoichiometry of cell growth and product formation.

Design and analysis of biological reactors: batch reactors, fed-batch reactors, enzyme catalyzed reactions in CSTR, CSTR reactors with recycle and cell growth, ideal plug flow reactors, sterilization reactors, sterilization of gases, packed bed reactors using immobilized catalysts. Fermentation technology: medium formulation, design and operation of a typical aseptic, aerobic fermentation process.

**UNIT IV**

Transport phenomena in bioprocess systems: Gas-liquid mass transfer in cellular systems, determination of oxygen transfer rates, overall $k_La$’ estimates and power requirements for sparged and agitated vessels, scaling of mass transfer equipment, heat transfer.

**UNIT V**

Downstream processing: Strategies to recover and purify products; separation of insoluble products-filtration and centrifugation; cell disruption-mechanical and non-mechanical methods; separation of soluble products: liquid-liquid extractions, membrane separation (dialysis, ultra filtration and reverse osmosis), chromatographic separation-gel permeation chromatography, electrophoresis, final steps in purification – crystallization and drying.

**TEXT BOOKS:**

1. Biochemical Engineering Fundamentals, $2^{nd}$ ed., J.E. Bailey and D.F. Ollis, McGraw-Hill, New York, 1987.
2. Bioprocess Engineering, $2^{nd}$ ed., M. L. Shuler and F. Kargi, PHI Learning Pvt. Ltd, New Delhi, 2009.

**REFERENCES:**

1. Biochemical Engineering, J. M. Lee, Prentice-Hall, New Jersey 1992.
2. Bioprocess Engineering Principles, P. M. Doran, Elsevier, Gurgaon, 2005.

**Outcome:**

- This course will help the students to understand and a the principles of biochemical engineering in analysis and design of industrial biochemical processes.
- Upon completion of this course, the students would develop the ability to design novel bioprocesses for their research in various areas. They will have the ability to find solutions to the problems which occur when materials and processes interact with the environment.
- Explain operations utilized in the purification of biological products are also studied by the students. This will enable them to recommend, install and easily learn to operate the equipment.

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**3+1* 0 3**

## INDUSTRIAL POLLUTION & CONTROL ENGINEERING

**OBJECTIVES:** The aim of this course is that the students will learn the essential principles used in industrial pollution abatement and understand important issues in industrial pollution abatement and pertinent environmental legislations.

**UNIT I**

Types of emissions from chemical industries and effects of environment, environment legislation, Type of pollution, sources of wastewater, Effluent guidelines and standards.

Characterization of effluent streams, oxygen demands and their determination (BOD, COD, and TOC), Oxygen sag curve, BOD curve mathematical, controlling of BOD curve, self purification of running streams, sources and characteristics of pollutants in fertilizer, paper and pulp industry, petroleum and petroleum industry.

**UNITII**

General methods of control and removal of sulfur dioxide, oxides of nitrogen and organic vapors from gaseous effluent, treatment of liquid and gaseous effluent in fertilizer industry.

Air pollution sampling and measurement: Types of pollutant and sampling and measurement, ambient air sampling: collection of gaseous air pollutants, collection of particulate air pollutants. Stack sampling: sampling system, particulate sampling, and gaseous sampling. Analysis of a pollutants: Sulphur dioxide, nitrogen oxides, carbon monoxide, oxidants and Ozones, hydrocarbons, particulate matter.

**UNIT III**

Air pollution control methods and equipments: Source c ion methods: raw material changes, process changes, and equipment modification. Cleaning gaseous equipments particulate emission control: collection efficiency, control equipment like gravitational settling chambers, Cyclone separators, fabric filters, ESP and their constructional details and design aspects. Scrubbers: wet scrubbers, spray towers, centrifugal scrubbers, packed beds and plate columns, venturi scrubbers, their design aspects. Control of gaseous emissions: absorption by liquids, absorption equipments, adsorption by solids, equipment and the design aspects.

**UNIT IV**

Introduction to waste water treatment, biological treatment of wastewater, bacterial and bacterial growth curve, aerobic processes, suspended growth processes, activated aerated lagoons and stabilization ponds,

Attached growth processes, trickling filters, rotary drum filters, anaerobic processes.

**UNIT V**

Methods of primary treatments: screening, sedimentation, flotation, neutralization, and methods of tertiary treatment. A brief study of carbon absorption, ion exchange, reverse osmosis, ultra filtration, chlorination, ozonation, treatment and disposal.

Hazardous waste management: Nuclear wastes: health and environment effects, sources and disposal methods. Chemical wastes: health and environmental effects, treatment and disposal:treatment and disposal by industry, off site treatment and disposal, treatment practices in various countries. Biomedical wastes: types of wastes and their control.

**TEXT BOOKS:**

1. Environmental Pollution and Control Engineering, C. S. Rao – Wiley Eastern Limited, India, New Delhi, 1993.

2. Pollution Control in Process Industries, S.P. Mahajan, Tata McGraw-Hill, New Delhi, 1985.

**REFERENCES:**

1. Wastewater Treatment, M. Narayana Rao and A.K.Datta, Oxford and IHB publ. New Delhi.

**OUTCOMES:**

2. Understand the different types of wastes generated in an industry, their effects on living and non-living things.
3. Understand environmental regulatory legislations and standards and climate changes.
4. Understand about the quantification and analysis of wastewater and treatment.
5. Understand the different unit operations and unit processes involved in conversion of highly polluted water to potable standards.
6. Understand the atmospheric dispersion of air pollutants, and operating principles, design calculations of particulate control devices.

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**TECHNOLOGY OF PHARMACEUTICALS AND FINE CHEMICALS (Elective- II)**

**UNIT I**

A brief outline of grades of chemicals, sources of impurities in chemicals, principles (without going into details of individual chemicals) of limit test for arsenic, lead, iron, chloride and sulfate in Pharmaceuticals.

**UNIT II**

Outlines of Preparation, properties, uses and testing of the following Pharmaceuticals - sulfacetamide, paracetamol, riboflavin, nicotinamide,

Outlines of Preparation, properties, uses and testing the following fine chemicals - Methyl orange, fluorescence, procaine hydrochloride, paramino salicylic acid, isonicatinic acid hydrazide.

**UNIT III**

Manufacture with flowsheets, properties uses and testing of the following Pharmaceuticals – aspirin, penicillin, calcium gluconate.

**UNIT IV**

Manufacture with flowsheets, properties uses and testing of the following ferric ammonium citrate, pthallic anhydride and phenol flourobenzene process and benzene sulfate process, other processes in outline only.

**UNIT V**

Tablet making and coating, granulation equipments, Preparation of capsules, extraction of crude drugs. Sterilization: introduction, risk factor, methods of sterilization, heat (dry and moist), heating with bactericide, filtration, gaseous steriliz and radiation sterilization, suitable example to be discussed.

**TEXT BOOKS:**

1. Remington’s Pharmaceutical Science,16th ed, Mac publishing company, 1980.
2. Industrial Chemicals, 3rd ed., Faith, Kayes and Clark, John Wiley & Sons,. 1965.

**REFERENCE:**

1. Blently’s Text Book of Pharmaceutical Chemistry, 8th ed, H A Rawlins,
2. B Tindell and Box,. Oxford University Press, London, 1977.

**Outcomes:**

1: Understand the principle of plant design in Pharmaceutical Industry.
2: Understand the knowledge of base chemicals and drug intermediates.
3: Understand kinetics, thermodynamics and plant construction material for the production of bulk drugs and fine chemicals.

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**3+1* 0 3**

## INTERFACIAL ENGINEERING (Elective- II)
## (Qualitative Treatment only)

## Objectives:

1. Importance of various components of interfacial science in different chemical engineering industries viz. food, paint and pharmaceutical industries are emphasized.
2. The properties and functioning of surfactants and detergency are made familiarized. Interfacial and vander Waals forces play important role in the nano particles

**UNIT-I:**

Basic concepts of Colloids and Interfaces: Introduction, Examples of Interfacial Phenomena, Solid-Fluid Interfaces, Colloids. Properties of Colloid Dispersions: Introduction, Sedimentation under Gravity, Sedimentation in a Centrifugal Field, B Motion, Osmotic pressure, Optical properties, Electrical Properties, Rheological Properties of Colloid Dispersions.

**UNIT-II:**

Surfactants and their properties: Introduction, Surfactants and their Properties, Emulsions and Microemulsions, foams.

**UNIT-III:**

Surface and Interfacial Tension: Introduction, Surface tension, Interfacial Tension, Contact Angle and Wetting, Shape of the Surfaces and interfaces.Measurement of Surface and Interfacial Tension, Measurement of Contact Angle;

**UNIT-IV:**

Intermolecular and Surface Forces: Introduction, Vanderwalls Forces.Intermolecular and Surface Forces: Electrostatic double layer force, The DLVO theory, Non-DLVO forces.

**UNIT-V:**

Adsorption at interfaces: Introduction, The Gibbs Dividing surface, Gibbs Adsorption Equation, Langmuir and Frumkin Adsorption Isotherms, Surface Equation of state(EOS), Effect of Salt on Adsorption of Surfactants.Adsorption Isotherms incorporating the Electrostatic Effects, Calculation of Free energy of Adsorption.

**TEXT BOOKS:**


1. **Foundations of Colloid Science by** R. J. Hunter, 2$^{nd}$ edition, Oxford University Press, USA, 2001.
2. **Principles of Colloid and Surface Chemistry**, Third edition, Revised and Expanded, Paul C. Hiemenz and Raj Rajagopalan.
3. **Physical Chemistry of Sciences**, 6$^{th}$ edition, A. Adamson, 1997.

4. **Interfacial Science: An Introduction by** G.Barnes, I.Gentle, Oxford University Press, USA, 2006.
5. **Coloid and Interface Science by** Pallab Ghosh, PHI, NEWDELHI.

**Outcomes:**

1. Realize the factors influencing stability of dispersions & emulsions.
2. Get the knowledge to measure surface tension & contact angle and apply them for practical problems.
3. Comprehend about detergency, surfactants and their applications.

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**3+1* 0 3**

## POLYMER TECHNOLOGY(Elective- II)

**OBJECTIVES:**

To enable the students to compute molecular weight ave es from the molecular weight distribution, Condensation polymerization and transition in polymers

**Unit I**

Introduction; definitions: polymer& macro molecule, monomer, functionality, average functionality, co-polymer, polymer blend., plastic and resin. Classification of polymers: based on source, structure, applications, thermal behavior, mode of polymerization. Concept of average molecular weight of polymers, molecular weight distribution, poly disparity index. Determination of average molecular weights: End group osmometry, light scattering techniques, viscometer, Gel permeation chromatography.

**Unit II**

Natural polymers: brief study of i) Natural rubber ii) shellac iii) rosin iv) cellulose v) proteins.

Mechanism and kinetics of: Addition or chain polymerization

a) Free radical addition polymerization b) Ionic addit ions

c) Coordination polymerization d) Coordination or step growth or condensation polymerization.

**Unit III**

Methods of polymerization: mass or bulk polymerization process, solution polymerization process, suspension polymerization process and emulsion polymerization method comparison of merits and demerits of these methods. Properties of polymers: crystalline and amorphous status, melting and glass transition temperatures and their determination, effect of polymer structure on mechanical, physical, chemical and thermal properties.

**Unit IV**

Degradation of polymers, Role of the following additives in the polymers: i) Fillers and reinforcing fillers ii) Plasticizers iii) Lubricants i and UV stabilizers v) Blowing agents vi)Coupling agents vii)Flame retardants viii) Inhibitors

Brief description of manufacture, properties and uses i) Polyethylene (HDPE&LDPE), ii) Poly propylene iii) Polyvinylchloride iv) Polystyrene Polytetra fluoroethylene vi) Polymethyl mehacrylate vii) Polyvinylacetate & Polyvinylalcohol.

**Unit V**

Brief description of manufacture, properties and uses i) Polyesters (Polyethylene terephthalate polycarbonate and unsaturated polyesters) ii) Nylon(Nylon 66) iii) Phenol-Formaldehyde resins iv) Epoxy resins v) Polyurethane vi) Silicones

Compounding of polymer resins, brief description of: i) Compression and transfer moulding ii) Injection moulding iii) Extrusion iv) Blow moulding v) Calendaring vi) Laminating and pultrusion

**TEXT BOOKS:**

1. Polymer Science & Technology, 2nd ed., J.R. Fried, PHI Learning Pvt. Ltd., New Delhi, 2009
2. Plastic materials, J.A. Brydson, Newnes-Butterworth (London) 1989.

**REFERENCES:**

1. Text book of polymer science, F.W.Jr. Bill Meyer, (3rd ed.) John Wiely&sons 1984
2. Introduction to Plastics, J.H. Brison and C.C. Gosselin, Newnes-Butterworth, London 1968.

**Outcome:**

- Classify the polymers and also able to identify the structural configurations of any polymer.
- Distinguish the modification of a polymer and also in position to examine the mechanism of a polymerization.
- Synthesize any elastomer and optimize their deformation properties on applying force.
- Explain the processing of polymer, identify the mode of deformation of a polymer and test the mechanical strength of a polymer.

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**3+1* 0 3**

## DESIGN AND ANALYSIS OF EXPERIMENTS (Elective – II)

### Objectives:

- Which factors affect a given experiment?
- Find the most significant factor for an experiment.
- Calculate the factor levels that optimize the outcome of an experiment.
- Factorial Design of experiments.

**UNIT- I**

Introduction to probability, probability laws, Baye's bability distributions, parameters and statistics. Normal and t-distributions, central limit theorem, random sampling and declaration of independence significance tests

**UNIT- II**

Randomization and blocking with paired comparisons significance tests and confidence interval for means, variances, proportions and frequencies.

**UNIT-III**

Analysis of variance, experiments to compare k-treatment means, Two-way factorial designs, blocking, Yate's algorithm

**UNIT- IV**

Fractional factorial designs at two levels, concept of design resolution, Simple modeling with least squares (regression analysis), Matrix versions of normal equations

**UNIT- V**

Mechanistic model building, Empirical and mechanistic models, model building model testing with diagnostic parameters.

**Text Book:**

1. Statistics for experimenters by G.E.P. Box, William G. Hunter and J.S. Hunter, John Wiley & Sons.

**Reference:**

1. "Design and analysis of experiments" by D.C. Montgomery, 2nd edition John Wiley and sons, NewYork (1984).

**<u>Outcome</u>:**

- Predict how many numbers of experiments are to be carried out, given the number of important factor
- Design an experiment and calculate the factor levels that optimize a given objective.
- Use response surface methodology to optimize the process, by considering curvature effects.
- Understand strategy in planning and conducting experiments
- Choose an appropriate experiment to evaluate a new product design or process improvement

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**COMPUTER AIDED PROCESS DESIGN (Elective – III)**

## Objectives:

- To impart the basics of process design, flash calculations and optimization in process design.
- To impart the knowledge of using simulation software for process design of chemical systems like UniSim/Aspen Plus.

**UNIT I**

Introduction to process design; General design considerations; Hierarchy of chemical process design; Nature of process synthesis and analysis; Developing a conceptual design and flow sheet synthesis; Optimum process design. Material and Energy balance, Introduction to special software for steady state and dynamic simulation of chemical engineering systems – UniSim Design/Aspen Plus

**UNIT II**

Use of computers for physical property evaluation, Thermodynamic properties of gases, Liquids and binary mixtures, Methods of calculating vapour liquid equilibrium data for ideal and non-ideal mixture, Bubble point and dew point calculations, Flash calculations. Design of multi phase Flash drum.

**UNIT III**

Design of Pipe lines, Filter press, Centrifuge, Cyclone. Computer aided design of heat exchanger systems - double pipe and shell and tube heat exchangers; Computer aided design of evaporators - design of single effect evaporator and multiple effect evaporator systems.

**UNIT IV**

Computer aided design of Absorption tower- both plate as well as packed type and extraction columns; Computer aided design of bubble - cap distillation column.

Design of chemical reactors: Design of multiphase reactors - Fixed, fluidized, trickle bed, and slurry reactors.

**UNIT V**

Pinch analysis; Heat integration of heat exchangers, Reactors, Distillation columns, Evaporators and driers; Process change for improved heat integration; Heat and mass exchange networks and network design. Applications of simulation software in process design (UniSim/ Aspen).

**Text books:**


1. James M. Douglas "Conceptual Design of Chemical Processes", McGraw Hill, New York, 1988.
2. B.C. Bhattacharyya and C.M. Narayanan, "Computer Aided Design of Chemical Process Equipment", 1st Edtn., New Central Book Agency (P) Ltd., New Delhi, 1992.

**References:**

1. Douglas Erwin P E,“Industrial Chemical Process Design”, McGraw hill.
2. Brownel and Young, “Process Equipment Design ”.Wiley (    68).
3. G.F. Froment, K.B. Bischoff, "Chemical Reactor Analysis and Design", 2nd ed., John Wiley, New York, 1990.

**Outcome**:

- Through the course the student is expected to learn.
- Optimum design of chemical process equipments like flash drum, heat exchangers, evaporators, absorbers, distillation column, multiphase reactors.
- Knowledge of heat integration in process plants to reduce the energy costs.

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**3+1* 0 3**

## FOOD PROCESSING TECHNOLOGY (Elective – III)

**Objectives:** To impart knowledge to the students about food processing and various unit operations involved in it, packaging, storing and preservation.

**UNIT I**

**Food process engineering - Fundamentals**: Fundamentals of food process engineering, application of quantitative methods of material and energy balances in food engineering practices.

**UNIT II**

**Unit Operations in food industries**: Fluid flow, thermal process calculations, refrigeration, evaporation and dehydration operations in food processing.

**UNIT III**

**Microwave heating:** Theory of microwave heating, microwave properties of foods, comparison of microwave and conventional heating, benefits of microwave heating, applications in food processing, microwave heating equipment, hazards of microwave heating.

**UNIT IV**

**Mechanical Operations in food processing**: Conversion operations, Size reduction and screening of solids, mixing and emulsification, filtration and membrane separation, centrifugation, crystallization, extraction.

**UNIT V**

**Preservation operations:** Preservation methods & Strategies, Thermal Methods, Nabla Factor Sterilization Types Pasteurization Dehydro freezing Irradiation Dosimetry Transport of food & Preservation strategies Cheap and applicable everywhere.

**TEXT BOOKS**

1. R. T. Toledo, "Fundamentals of Food Process Engineering", AVI Publishing Co., 1980.
2. R. Angold,G.Beech and J.Taggart, " Food Biotechnology", Cambridge versity Press, 1989.
3. Fundamentals of Food Engineering, D G Rao, PHI, New De , 2012.

**REFERENCES**

1. J. M. Jackson and B. M. Shinn, "Fundamentals of Food Canning Technology", AVI Publishing Co., 1978.
2. J. G. Bernnan, J. R. Butters, N. D. Cowell and A.E.V.Li ey, "Food Engineering Operations", 2$^{nd}$Edn., Applied Science, 1976.

**Outcomes:**

1. Understanding the various causes of food deterioration and food poisoning.
2. Identification of appropriate processing, preservation, and packaging method.
3. Analyze product quality and effect of processing technique on it.

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## ENTERPRENEURSHIP DEVELOPMENT (Elective – III)

**OBJECTIVES:**

1. To make the students aware of the importance of entrepreneurship opportunities available in the society for the entrepreneur.
2. Acquaint them with the challenges faced by the entrepreneur

**UNIT – I:**

**Introduction to entrepreneurship:** Definition of entrepreneur, Entrepreneurial Traits, Entrepreneur vs. Manager, Entrepreneur vs Intrapreneur. The Entrepreneurial decision process.Role of Entrepreneurship in Economic Development, Ethics and social responsibility of Entrepreneurs.Opportunities for Entrepreneurs in India and abroad.Woman as Entrepreneur.

**UNIT – II:**

**Creating and starting the Venture:** Sources of new Ideas, Methods of generating Ideas, Creating problem solving, product planning and development process.

**The Business Plan:** Nature and scope of business plan , Writing Business ,Evaluating Business plans, Using and implementing business plans. Marketing plan, financial plan and the organizational plan, Launching formalities

**UNIT – III:**

**Financing and Managing the new venture:** Sources of capital, Record keeping, recruitment, motivating and leading teams, financial controls, Marketing and sales controls. E-commerce and Entrepreneurship, internet advertising.

**New venture Expansion Strategies and Issues:** Features and evaluation of joint ventures , acquisitions, merges, franchising. Public issues, right issues, bonus issues and stock splits.

**UNIT – IV:**

**Choosing location and layout. Production and Marketing Management:** Thrust of production management, Selection of production techniques, plant utilization and Designing the work place, Inventory control, material and quality control, Marketing functions, market segmentation, market research and channels of distribution, Sales promotion and product pricing.

**UNIT – V: Global aspects of Entrepreneurship.**

**TEXT BOOK :**

1. Robert Hisrich, & Michael Peters: Entrepreneurship, TMH,$5^{th}$ Edition.
2. Dollinger: Entrepreneurship, 4/e , Pearson, 2004.

**REFERENCES :**


1. Vasant Desai:Dynamics of Entrepreneurial Development and management,Himalaya publishing house, 2004.
2. Harvard Business Review on Entrepreneurship. HBR paper back, 1999.
3. Robert J. calvin : Entrepreneurial management, TMH, 2004 .
4. Gurmeet Naroola: The Entrepreneurial Connection,TMH,2001.
5. BOLton &Thompson: Entrepreneurs-Talent, Temperament, Technique, Butterworth Heinemann,2001.
6. Agarwal :Indian Economy, Wishwa Prakashan 2005.
7. Dutt& Sundaram:Indian Economy.s.chand,2005.
8. Srivastava: Industrial Relations &Labour laws , Vikas,2005.
9. Aruna Kaulgud:Entrepreneurship Management by, Vikas publishing house,2003.
10. Thomos W.zimmerer & Norman M. Scarborough: Essential of Entrepreneurship and small business management,PHI,4/e,2005.
11. Mary coulter: Entrepreneurship in Action,PHI,2/e.2005.
12. Kaplan: Patterns of Entrepreneurship ,Willey,2005.
13. ND Kapoor:Industrial Law, Sultan chand &Sons,2005.

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## CORROSION ENGINEERING (Elective – III)

**OBJECTIVES:**

The course will enable the students to:

1. Be introduced to the principles of electrochemistry as well as the essential elements of electrochemical corrosion.
2. Lay a foundation for understanding the forms of corrosion, the mecha of corrosion, electrochemical methods.
3. Develop the thermodynamic and kinetic aspects of electrochemistry, including potential-pH (Pourbaix) diagrams, mixed potential theory, and the theory and application of polarization.
4. Design methods for combating corrosion, the principles and methods leading to mitigation of corrosion problems that might occur in engineering practice.

**UNIT- I:**

**Introduction**

Definitions of Corrosion - Overall classification of types of corrosion-Basic electrochemistry – Galvanic and electrolytic cells – Potential measurements - EMF and Galvanic series – Galvanic corrosion and bimetallic contacts – Eh – pH diagrams, Cost of Corrosion, Metallurgical properties influencing corrosion.

**UNIT-II:**

**Forms of Corrosion**

Uniform attack, galvanic, crevice, pitting, Inter granular, selective leaching, erosion and stress corrosion – Mechanisms, testing procedures and their protection.

**UNIT- III:**

**Electrode kinetics and polarization phenomena**

Electrode – solution interface – Electrode kinetics and polarization phenomena – Exchange current density – Polarization techniques to measure corrosion rates – Mixed potential theory – Activation and diffusion controlled mixed electrodes.

**UNIT IV:**

**Methods of corrosion prevention and control**

Design, coatings and inhibition – Cathodic protection – Stray current corrosion – Passivity phenomena and development of corrosion resistant alloys – Anodic control.

**UNIT-V:**

**Industry Approach**

Selection for a given Chemical Engineering Service Environment- Materials for Chemical Engineering Industry to resist the given chemical Environment.-Ferritic, Austenitic steels and stainless steels- Copper and its alloys-Brasses, bronzes, Nickel and its alloys- Monel alloys-materials for a petroleum refinery industry.

**TEXT BOOKS:**

1. M. G. Fontana, Corrosion Engineering (Third Edition) McGraw-Hill Book Company.

2. Denny A Jones, Principles and Prevention of Corrosion (second edition), Prentice-Hall, N. J. (1996).

**REFERENCE:**

1. H. H. Uhlig and R. W. Revie, Corrosion and Corrosion Control, Wiley (NY) (1985).

**<u>Outcomes</u>:**

At the end of the course, the students will be able to:

1. Understand the electrochemical and metallurgical behavior of corroding systems.
2. Apply the electrochemical and metallurgical aspects of combating eight forms of corrosion.
3. Select or choose the testing procedures for corroding systems.
4. Evaluate the polarization behavior of corroding systems.
5. Design of suitable materials, methods to combat corrosion.
6. Predict the function of corrosion inhibitors.

# JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR
# COLLEGE OF ENGINEERING (Autonomous), ANANTHAPURAMU
# B.Tech (Chemical Engineering) 2015-16
## COURSE STRUCTURE & SYLLABUS

### I YEAR I SEMESTER

| S.No | Code | Subject | L | P | C |
|---|---|---|---|---|---|
| 1 | 15A55101 | English | 4 | - | 4 |
| 2 | 15A51101 | Mathematics -I | 4 | - | 4 |
| 3 | 15A53102 | Physical Chemistry | 4 | - | 4 |
| 4 | 15A01101 | Environmental Studies | 4 | - | 4 |
| 5 | 15A01103 | Engineering Mechanics & Strength of Materials | 4 | - | 4 |
| 6 | 15A53104 | Physical Chemistry Lab | - | 4 | 2 |
| 7 | 15A35101 | Engineering Workshop & IT Workshop | - | 4 | 2 |
| 8 | 15A55102 | English Language Communication Skills Lab. | - | 4 | 2 |
| | | **Total** | **20** | **12** | **26** |

### I YEAR II SEMESTER

| S.No | Code | Subject | L | P | C |
|---|---|---|---|---|---|
| 1 | 15A55201 | Technical Communication and Presentation Skills | 4 | - | 4 |
| 2 | 15A51201 | Mathematics -II | 4 | - | 4 |
| 3 | 15A52201 | Engineering Physics | 4 | - | 4 |
| 4 | 15A05201 | Problem Solving & Computer Programming | 4 | - | 4 |
| 5 | 15A03202 | Engineering Graphics | 4 | - | 4 |
| 6 | 15A08201 | Introduction to Chemical Engineering | 4 | - | 4 |
| 7 | 15A05202 | Computer Programming Lab | - | 4 | 2 |
| 8 | 15A52202 | Engineering Physics Lab | - | 4 | 2 |
| | | **Total** | **24** | **8** | **28** |

# B.Tech (Chemical Engineering)-COURSE STRUCTURE

## II YEAR I SEMESTER

| S.No | Code | Subject | L | P | C |
|---|---|---|---|---|---|
| 1 | 15A51301 | Mathematical Methods | 4 | - | 4 |
| 2 | 15A24301 | Electrical and Electronics Engineering | 4 | - | 4 |
| 3 | 15A53301 | Organic Chemistry | 4 | - | 4 |
| 4 | 15A08301 | Materials Science for Chemical Engineers | 4 | - | 4 |
| 5 | 15A08302 | Momentum Transfer | 4 | - | 4 |
| 6 | 15A08303 | Chemical Process Calculations | 4 | - | 4 |
| 7 | 15A54302 | Human Values & Professional Ethics (Audit) | 2 | - | 0 |
| 8 | 15A08304 | Momentum Transfer Lab | - | 4 | 2 |
| 9 | 15A53302 | Organic Chemistry Lab | - | 4 | 2 |
| | | **Total** | **26** | **8** | **28** |

## II YEAR II SEMESTER

| S.No | Code | Subject | L | P | C |
|---|---|---|---|---|---|
| 1 | 15A51401 | Probability and Statistics | 4 | - | 4 |
| 2 | 15A53401 | Analytical Chemistry | 4 | - | 4 |
| 3 | 15A08401 | Process Instrumentation | 4 | - | 4 |
| 4 | 15A08402 | Process Heat Transfer | 4 | - | 4 |
| 5 | 15A08403 | Chemical Engineering Thermodynamics | 4 | - | 4 |
| 6 | 15A08404 | Mechanical Operations | 4 | - | 4 |
| 7 | 15A08405 | Process Heat Transfer Lab | - | 4 | 2 |
| 8 | 15A08406 | Mechanical Operations Lab | - | 4 | 2 |
| | | **Total** | **24** | **8** | **28** |

# B.Tech (Chemical Engineering)-COURSE STRUCTURE

## III YEAR I SEMESTER

| S.No | Code | Subject | L | P | C |
|---|---|---|---|---|---|
| 1 | 15A08501 | Energy Engineering | 4 | - | 4 |
| 2 | 15A08502 | Process Dynamics & Control | 4 | - | 4 |
| 3 | 15A08503 | Phase and Chemical Equilibria | 4 | - | 4 |
| 4 | 15A08504 | Chemical Reaction Engineering-I | 4 | - | 4 |
| 5 | 15A08505 | Mass Transfer Operations-I | 4 | - | 4 |
| 6 | 15A08506 | Chemical Technology | 4 | - | 4 |
| 7 | 15A08507 | Energy & Environmental Engineering Lab | - | 4 | 2 |
| 8 | 15A08508 | Process Dynamics & Control Lab | - | 4 | 2 |
| | | **Total** | **24** | **8** | **28** |

## III YEAR II SEMESTER

| S.No | Code | Subject | L | P | C |
|---|---|---|---|---|---|
| 1 | 15A08601 | Biochemical Engineering | 4 | - | 4 |
| 2 | 15A08602 | Process Modeling and Simulation | 4 | - | 4 |
| 3 | 15A08603 | Mass Transfer Operations – II | 4 | - | 4 |
| 4 | 15A08604 | Chemical Reaction Engineering-II | 4 | - | 4 |
| 5 | 15A08605 | Chemical Plant Design and Economics | 4 | - | 4 |
| 6 | <br>15A08606a<br>15A08606b<br>15A08606c<br>15A08606d | **(OpenElective)**<br>Basics of Nanotechnology<br>Green Technology<br>Nuclear Engineering<br>Solid Waste Management | 4 | - | 4 |
| 7 | 15A08607 | Chemical Reaction Engineering Lab | - | 4 | 2 |
| 8 | 15A08608 | Mass Transfer Operations Lab | - | 4 | 2 |
| 9 | 15A55601 | Advanced Communication Skills Lab (Audit) | - | 4 | 0 |
| | | **Total** | **24** | **12** | **28** |

# B.Tech (Chemical Engineering)-COURSE STRUCTURE

## IV YEAR I SEMESTER

| S.No | Code | Subject | L | P | C |
|---|---|---|---|---|---|
| 1 | 15A08701 | Transport Phenomena | 4 | - | 4 |
| 2 | 15A08702 | Chemical Process Equipment Design | 4 | - | 4 |
| 3 | 15A08703 | Optimization of Chemical Processes | 4 | - | 4 |
| 4 | 15A08704 | Separation Techniques for Bioprocessing | 4 | - | 4 |
| 5 | 15A08705 | Industrial Engineering and Management | 4 | - | 4 |
| 6 | 15A08706 | **Elective – I (Through MOOC)** | 4 | - | 4 |
| 7 | 15A08707 | Process Equipment Design& Drawing Lab | - | 4 | 2 |
| 8 | 15A08708 | Simulation Lab | - | 4 | 2 |
| 9 | 15A08709 | Project work-A | - | - | - |
| | | **Total** | **24** | **10** | **28** |

## IV YEAR II SEMESTER

| S.No | Code | Subject | L | P | C |
|---|---|---|---|---|---|
| 1 | | **Elective-II** | 4 | 0 | 4 |
| | 15A08801a | Design and analysis of Experiments | | | |
| | 15A08801b | Industrial Safety & Hazard Management | | | |
| | 15A08801c | Chemical Plant Utilities | | | |
| 2 | | **Elective-III** | 4 | 0 | 4 |
| | 15A08802a | Industrial Pollution Control Engineering | | | |
| | 15A08802b | Computational fluid dynamics | | | |
| | 15A08802c | Introduction to statistical thermodynamics | | | |
| 3 | | **Elective-IV** | 4 | 0 | 4 |
| | 15A08803a | Fluidization Engineering | | | |
| | 15A08803b | Interfacial Engineering | | | |
| | 15A08803c | Polymer Technology | | | |
| 4 | | **Elective –V** | 4 | 0 | 4 |
| | 15A08804a | Petroleum Refining and Petrochemicals | | | |
| | 15A08804b | Food Processing Technology | | | |
| | 15A08804c | Rheology of Polymers | | | |

| | | | | | |
|---|---|---|---|---|---|
| | 15A08804d | Corrosion Engineering | | | |
| 5 | 15A08805 | Seminar | 0 | 4 | 2 |
| 6 | 15A08806 | Project Work | 0 | 20 | 10 |
| | | **Total** | **16** | **24** | **28** |

**Note:** All End Examinations (Theory and Practical) are of three hours duration.

**L – Theory P – Practical/Drawing C – Credits**

**College Vision:**

- Committed to expanding the horizon and inspiring young minds towards academic excellence.
- Aims at scaling new heights through advanced research and innovative technologies to keep pace with the changing needs of industry and society at large.

**College Mission:**

- To identify and implement proven, prevention-oriented, forward-looking solutions to critical scientific and technological problems.
- To make technology a principal instrument of economic development of the country and to improve the quality of life of the people through technological education, innovation, research, training and consultancy.

**Department of Chemical Engineering:**

The Department of Chemical Engineering was established in 1989 with an intake of 30 students and the current intake is 60 students. The department has recently celebrated its Silver Jubilee in the year 2014. The department is accredited with NBA for three years during 2005-2008 and for two years during 2013-2015 and offers UG, PG, MS and PhD programs. The department has good infrastructural facilities for all the programs and maintains excellent academic standards. The faculty members are actively involved in research and development activities of the department. The department has research collaborations with reputed organizations like BRNS, BHEL, UCIL, etc.

**Department Vision:**

- To become a globally recognized Chemical Engineering program coupled with excellence in education, training, research and consultancy in Chemical Engineering and to serve as a valuable resource for industry and society.
- To inspire young minds towards academic excellence through advanced research and innovative technologies coupled with professional ethics and human values.

**Department Mission:**

- To provide students with broad curriculum in the basic sciences, process systems and design, unit operations and modern experimental and computing techniques to make them competent and practicing chemical engineers without compromising professional ethics and moral values.
- To develop infra-structure that promotes internationally recognized research, creativity and an entrepreneurial culture.
- To foster ethical leadership and activities those support the administration, advancements, governance and regulation of chemical engineering education and the engineering profession.
- To undertake collaborative projects/consultancy works which provide opportunities for long - term interaction with academia, industry and other research organizations.

**Program Outcomes:**

*The program outcomes for* ***Chemical Engineering*** *are:*

PO 1: An ability to apply the knowledge of Mathematics, Science, Engineering and fundamentals for understanding and solving of complex Engineering problems in Chemical Engineering

PO 2: Be capable of designing and conducting experiments and be able to analyze and interpret data

PO 3: An ability to design systems, components, and processes to meet desired needs applicable to Chemical Engineering within realistic constraints such as economic, environment, social, political, ethical, health and safety, manufacturability and sustainability

.PO 4: An ability to function effectively as individual, as a member or leader in diversified teams and multidisciplinary areas.

PO 5: Ability to identify, formulate, and solve Chemical Engineering related problems.

PO 6: An understanding of professional and ethical responsibility to the chemical engineering profession and to society at large

PO 7: An ability to communicate effectively by conveying technical material through both formal written medium and through oral presentations.

PO 8: To attain broad education necessary to understand the impact of chemical engineering related solutions in a global, economic, environmental and societal context.

PO 9: An ability to recognize the need for continuous professional development through lifelong learning

PO 10: Ability to possess knowledge of contemporary chemical engineering related issues

PO 11: An ability to use the techniques, skills, and modern engineering tools necessary for chemical engineering practice.

PO 12: Ability to design, analyze and control physical and chemical processes. (Project Management and Finance)

*****

**JNTUA College of Engineering (Autonomous), Ananthapuramu**

| I Year B.Tech - I Semester | L | P | C |
|---|---|---|---|
| | 4 | 0 | 4 |

**ENGLISH (15A55101)**
**(Common to all Branches)**

**OBJECTIVES:**

1. To enable the students to communicate in English for academic and social purpose
2. To enable the students to acquire structure and written expressions required for their profession.
3. To develop the listening skills of the students
4. To inculcate the habit of reading for pleasure
5. To enhance the study skills of the students with emphasis on LSRW skills

**SYLLABUS:**

**UNIT –I**

**Chapter entitled *Humour* from "Using English"**
**Chapter entitled '*Homi Jehangir Bhabha'* from "New Horizons"**

L- Listening -Techniques - Importance of phonetics
L- Meet & Greet and Leave taking, Introducing Oneself and Others (Formal and Informal situations)
R- -Reading Strategies -Skimming and Scanning
W- Writing strategies- sentence structures
G-Parts of Speech –Noun-number, pronoun-personal pronoun, verb- analysis
V-Affixes-prefix and suffix, root words, derivatives

**UNIT –II**

**Chapter entitled *Inspiration* from "Using English"**
**Chapter entitled 'My Struggle for an Education' from "New Horizons"**

L- Listening to details
S- Apologizing, Interrupting, Requesting and Making polite conversations
R-note making strategies
W- Paragraph-types- topic sentences, unity, coherence, length , linking devices
G-Auxiliary verbs and question tags
V- synonyms-antonyms, homonyms , homophones, homographs, words often confused

**UNIT –III**

**Chapter entitled *Sustainable Development* from "Using English"**
**Chapter entitled 'The Autobiography of Abraham Lincoln' from "New Horizons"**
L- Listening to themes and note taking
S- Giving instructions and Directions, making suggestions, Accepting ideas, fixing a time and Advising
R- Reading for details -1

W- Resume and cover letter
G- Tenses – Present tense, Past tense and Future tense
V-Word formation and One-Word Substitutes

**UNIT –IV**

**Chapter entitled *Relationships* from "Using English"**
**Chapter entitled ' T*he Happy Prince* from "New Horizons"**

L- Listening to news
S- Narrating stories, Expressing ideas and opinions and telephone skills
R- Reading for specific details and Information
W- Technical Report writing-strategies, formats-types-technical report writing
G- Voice and Subject – Verb Agreement
V- Idioms and prepositional Phrases

**UNIT –V**

**Chapter entitled Science and Humanism from "Using English"**
**Chapter entitled 'If' from "New Horizons"**
L- Listening to speeches
S- Making Presentations and Group Discussions
R- Reading for Information
W- E-mail drafting
G- Conditional clauses and conjunctions
V- Collocations and Technical Vocabulary and using words appropriately

**EXPECTED OUTCOME:**
The students will get the required training in LSRW skills through the prescribed texts and develop communicative competence

**Prescribed Books:**

1. **Using English (for detailed study)** published by Orient Black Swan, 2013
2. **New Horizons** published by Pearson, 2013

**Suggested Reading:**

1. **Raymond Murphy's English Grammar with CD,** Murphy, Cambridge University Press, 2012.
2. **English Conversation Practice –**Grant Taylor, Tata McGraw Hill,2009.
3. **Communication Skills, Sanjay Kumar & Pushpalatha** Oxford University Press, 2012.
4. **A Course in Communication Skills**- Kiranmai Dutt & co. Foundation Books, 2012.
5. **Current English grammar and usage-**S M Guptha, PHI, 2013.
6. **Modern English Grammar-**Krishna SWAMI .McMillan, 2009.
7. **Powerful Vocabulary Builder**- Anjana Agarwal New Age International Publishers, 2011.
8. **Writing with a Purpose, Tickoo and Sasi Kumar, OUP, 2011**
9. **Strengthen Your Writing, Orient Blackswan**

**JNTUA College of Engineering (Autonomous), Ananthapuramu**

| I Year B.Tech - I Semester | L | P | C |
|---|---|---|---|
| | 4 | 0 | 4 |

**MATHEMATICS – I (15A51101)**

(Common to All Branches)

**Objectives**

- To train the students thoroughly in Mathematical concepts of ordinary differential equations and their applications.
- To prepare students for lifelong learning and successful careers using mathematical concepts of differential and Integral calculus, ordinary differential equations and vector calculus.
- To develop the skill pertinent to the practice of the mathematical concepts including the students abilities to formulate and modeling the problems, to think creatively and to synthesize information.

**UNIT – I**

Exact, linear and Bernoulli equations, Applications to first order equations.

Non-homogeneous linear differential equations of second and higher order with constant coefficients with RHS term of the type $e^{ax}$, sin ax, cos ax, polynomials in x, $e^{ax}$ V(x), xV(x), method of variation of parameters, linear equations with variable coefficients: Euler-Cauchy Equations, Legendre's linear equation. Applications of linear differential equations- Mechanical and Electrical oscillatory circuits and Deflection of Beams.

**UNIT – II**

Taylor's and Maclaurin's Series - Functions of several variables – Jacobian – Maxima and Minima of functions of two variables, Lagrange's method of undetermined Multipliers with three variables only. Radius of curvature, center of curvature, Involutes, evolutes and envelopes..

**UNIT – III**

Curve tracing – Cartesian, polar and parametric curves. Length of curves, surface area of solid of revolution (single integrals)

**UNIT – IV**

Multiple integral – Double and triple integrals – Change of Variables – Change of order of integration. Applications to areas and volumes in Cartesian and polar coordinates using double and triple integral.

**UNIT – V**

Vector Calculus: Gradient – Divergence – Curl and their properties; Vector integration – Line integral - Potential function – Area – Surface and volume integrals. Vector integral theorems: Green's theorem – Stoke's and Gauss's Divergence Theorem (Without proof). Application of Green's, Stoke's and Gauss's Theorems.

**TEXT BOOKS:**

1. Engineering Mathematics-I, E. Rukmangadachari & E. Keshava Reddy, Pearson Publisher
2. Higher Engineering Mathematics, B.S.Grewal, Khanna publishers.

**REFERENCES:**

1. Engineering Mathematics Volume-I, by T.K.V. Iyengar, B.Krishna Gandhi, S.Ranganatham and M.V.S.S.N.Prasad, S.Chand publication.
2. Advanced Engineering Mathematics, by Erwin Kreyszig, Wiley India.
3. Higher Engineering Mathematics, by B.V.Ramana, Mc Graw Hill publishers.
4. Advanced Engineering Mathematics, by Alan Jeffrey, Elsevier.

**Outcomes:**

- The students become familiar with the application of differential and integral calculus, ordinary differential equations and vector calculus to engineering problems.
- The students attain the abilities to use mathematical knowledge to analyze, formulate and solve problems in engineering applications.

**JNTUA College of Engineering (Autonomous), Ananthapuramu**

| I Year B.Tech - I Semester | L | P | C |
|---|---|---|---|
| | 4 | 0 | 4 |

**PHYSICAL CHEMISTRY (15A53102)**

**Course Objectives:**

- To acquire basic knowledge of basic types of reactions
- To acquire knowledge about the mechanisms through which the chemical reactions proceed.
- To understand the impact of nature on metals.

**Unit-I: Kinetics**

Introduction to chemical kinetics-theories of reaction rates-Collision theories-Modified collision theory – Absolute reaction rate theory (Transition state theory)-reaction between ions, Chain reactions-Hydrogen and bromine, hydrogen and oxygen (Steady state treatment)-.explosion limits.

**UNIT-II: Colloids**

Definition of colloids, classification of colloids, solids in liquids (Sols) – properties, kinetics, optical and electrical, stability of colloids, protective action, Hardy-Schultze Law, Gold Number. Liquids in liquids (Emulsions) -Types of Emulsions, preparation, Emulsifier. Liquids in solids (Gels) – Classification, preparation & properties, Inhibition, General, applications of colloids.

**UNIT-III: Catalysis**

Definition-Homogeneous and heterogeneous Catalysis- Characteristics of a good catalyst-Theories of Catalysis: Intermediate compound formation theory and adsorption theory, relevant examples- Types of catalysis: Acid-base catalysis and enzymatic catalysis (10h)

**Unit-IV: Surface Chemistry**

Adsorption, characteristics of adsorption, physical & chemical adsorption, Langumuir adsorption isotherm, B.E.T. equation, BET plot, surface area determination of solids. Numerical calculations of surface area, Heterogenous catalysis, Mechanism of catalysis-Langmuir-Hinsel Wood mechanism of surface catalyzed reactions, Eley-Rideal mechanism surface catalysed reactions. Applications of catalysis in industry. (12h)

**UNIT-V: Electrochemistry**

i)Review of electrochemical cells, Numerical calculations, Batteries: Rechargeable batteries (Lead acid, Ni-Cd, Lithium Ion Batteries),Fuels cells: (Hydrogen-Oxygen and Methanol-Oxygen)

ii)Electrochemical sensors: Potentiometric Sensors and Voltammetric sensors. Examples : analysis of Glucose and urea

iii)Corrosion: Electrochemical Theory of corrosion, Factors affecting the corrosion. Prevention: Anodic and cathodic protection and electro and electroless plating. (12h)

**Course Outcome:**

The student may acquire enough knowledge on industrial processes and Products

**BOOKS:**

1. Quantitative analysis, R.A.Day & A.L. Underwood , 5th edition, Printice- Hall of India Pvt. Ltd., 2000.
2. Vogel's Text Book of Qualitative chemical analysis, J. Mendham, R.C.Denney, J. Darnes, M.J.K. Thomas, Persar education 6th edition, 2002.
3. Elements of Physical Chemistry-Peter Atkins, Oxford Uni.Press, 3rd Edition, 2010.

**REFERENCES:**

1. Atkin's Physical Chemistry – P. Atkins and J. De Paula, Oxford Univ.Press, 9th Edition, 2012
2 Instrumental lMethods of Chemical Analysis, Gurdeep R.Chatwal, Sham K.Ananad, Himalayha publishing House,5th Edition, 2012.
3. Advanced physical chemistry – Gurudeepraj, Goel Publishing House, 2000
4. Essentials of Physical Chemistry- Arun Bahl, B.S.Bahl and G.D.Tuli, S.Chand Publishers, New Delhi.

**JNTUA College of Engineering (Autonomous), Ananthapuramu**

| **I Year B.Tech - I Semester** | **L** | **P** | **C** |
|---|---|---|---|
| | **4** | **0** | **4** |

**ENVIRONMENTAL STUDIES (15A01101)**

**(Common to all Branches)**

**OBJECTIVE:** To make the students to get awareness on environment, to understand the importance of protecting natural resources, ecosystems for future generations and pollution causes due to the day to day activities of human life to save earth from the inventions by the engineers.

**UNIT – I**

**MULTIDISCIPLINARY NATURE OF ENVIRONMENTAL STUDIES: –** Definition, Scope and Importance – Need for Public Awareness.

**NATURAL RESOURCES :** Renewable and non-renewable resources – Natural resources and associated problems – Forest resources – Use and over – exploitation, deforestation, case studies – Timber extraction – Mining, dams and other effects on forest and tribal people – Water resources – Use and over utilization of surface and ground water – Floods, drought, conflicts over water, dams – benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. – Energy resources:

**UNIT – II**

**ECOSYSTEMS:** Concept of an ecosystem. – Structure and function of an ecosystem – Producers, consumers and decomposers – Energy flow in the ecosystem – Ecological succession – Food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the following ecosystem:

a. Forest ecosystem.
b. Grassland ecosystem
c. Desert ecosystem
d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

**BIODIVERSITY AND ITS CONSERVATION :** Introduction 0 Definition: genetic, species and ecosystem diversity – Bio-geographical classification of India – Value of biodiversity: consumptive use, Productive use, social, ethical, aesthetic and option values – Biodiversity at global, National and local levels – India as a mega-diversity nation – Hot-sports of biodiversity – Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – Endangered and endemic species of India – Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

**UNIT – III**

**ENVIRONMENTAL POLLUTION:** Definition, Cause, effects and control measures of :

a. Air Pollution.
b. Water pollution

c. Soil pollution
d. Marine pollution
e. Noise pollution
f. Thermal pollution
g. Nuclear hazards

**SOLID WASTE MANAGEMENT :**Causes**,** effects and control measures of urban and industrial wastes – Role of an individual in prevention of pollution – Pollution case studies – Disaster management: floods, earthquake, cyclone and landslides.

**UNIT – IV**

**SOCIAL ISSUES AND THE ENVIRONMENT:** From Unsustainable to Sustainable development – Urban problems related to energy – Water conservation, rain water harvesting, watershed management – Resettlement and rehabilitation of people; its problems and concerns. Case studies – Environmental ethics: Issues and possible solutions – Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies – Wasteland reclamation. – Consumerism and waste products. – Environment Protection Act. – Air (Prevention and Control of Pollution) Act. – Water (Prevention and control of Pollution) Act – Wildlife Protection Act – Forest Conservation Act – Issues involved in enforcement of environmental legislation – Public awareness.

**UNIT – V**

**HUMAN POPULATION AND THE ENVIRONMENT:** Population growth, variation among nations. Population explosion – Family Welfare Programmed. – Environment and human health – Human Rights – Value Education – HIV/AIDS – Women and Child Welfare – Role of information Technology in Environment and human health – Case studies.

**FIELD WORK :** Visit to a local area to document environmental assets River/forest grassland/hill/mountain – Visit to a local polluted site-Urban/Rural/Industrial/Agricultural Study of common plants, insects, and birds – river, hill slopes, etc..

**TEXT BOOKS** :

(1) Text book of Environmental Studies for Undergraduate Courses by Erach Bharucha for University Grants Commission, Universities Press.
(2) Environmental Studies by Palaniswamy – Pearson education
(3) Environmental Studies by Dr.S.Azeem Unnisa, Academic Publishing Company

**REFERENCES :**

(1) Textbook of Environmental Science by Deeksha Dave and E.Sai Baba Reddy, Cengage Pubilications.
(2) Text book of Environmental Sciences and Technology by M.Anji Reddy, BS Publication.
(3) Comprehensive Environmental studies by J.P.Sharma, Laxmi publications.
(4) Environmental sciences and engineering – J. Glynn Henry and Gary W. Heinke – Printice hall of India Private limited.
(5) A Text Book of Environmental Studies by G.R.Chatwal, Himalaya Pubilishing House
(6) Introduction to Environmental engineering and science by Gilbert M. Masters and Wendell P. Ela - Printice hall of India Private limited.

**<u>Outcomes:</u>**

- Gain a higher level of personal involvement and interest in understanding and solving environmental problems.
- Comprehend environmental problems from multiple perspectives with emphasis on human modern lifestyles and developmental activities.
- Demonstrate knowledge relating to the biological systems involved in the major global environmental problems of the 21st century
- Recognize the interconnectedness of — human dependence — on the earth's ecosystems
- Influence their society in proper utilization of goods and services.
- Learn the management of environmental hazards and to mitigate disasters and have a clear understanding of environmental concerns and follow sustainable development practices.

**JNTUA College of Engineering (Autonomous), Ananthapuramu**

| I Year B.Tech - I Semester | L | P | C |
|---|---|---|---|
| | 4 | 0 | 4 |

**ENGINEERING MECHANICS & STRENGTH OF MATERIALS (15A01103)**

**Objective:** This course will serve as a basic course by introducing the concepts of basic mechanics which will help as a foundation to various courses.

**UNIT – I**

**Introduction of Engineering Mechanics** – Basic concepts – System of Forces – Momentum of forces and its applications – Couples and Resultant of Force system – Equilibrium of System of Forces – Degree of Freedom – Free body diagrams – Types of Supports –Support reaction for beams with different types of loading – Concentrated, uniformly distributed and uniformly varying loading.

**UNIT – II**

**Friction –** Types of friction – laws of friction – limiting friction – Cone of limiting friction – Static and Dynamic frictions – Motion of bodies – Wedge, Screw jack and differential screw jack.

**Centroid and Center of Gravity:** Centroid of simple figures – Centroids of Composite figures – Centre of Gravity of bodies – Area moment of Inertia – parallel axis and perpendicular axis theorems – Moment of Inertia of Composite figures.

**Mass Moment of Inertia**: Moment of inertia of simple solids – Moment of Inertia of composite masses (Simple problems only)

**UNIT – III**

**Simple Stresses and Strains:**Deformable bodies – Elasticity and plasticity – Types of stresses and strains – Hooke’s law – Stress – strain diagram for mild steel – working stress – Factor of safety – lateral strain, Poisson’s ratio and volumetric strain –

Elastic moduli and the relationship between them – Bars of Varying section – Composite bars – Temperature stresses. Strain energy – Resilence – Gradual, Sudden, impact and shock loadings – simple applications.

**UNIT – IV**

**Shear Force and Bending Moment:** Definition of beam – types of beams – Concept of Shear force and bending moment – S.F and B.M diagrams for cantilever, simply supported and over changing beams subjected to point loads, uniformly distributed load, uniformly varying loads and combination of these loads – point of contra flexure – Relation between S.F, B.M and rate of loading at section of a beam.

**UNIT – V**

**Flexural Stresses:** Theory of simple bending – Assumptions – Derivation of bending equation: $M/I = f/Y = E/R$ – Neutral axis – Determination of bending stresses – Section modulus of rectangular and circular sections (Solid and Hallow), I, T, Angle and Channel Sections – Design of simple beam sections.

**Shear Stresses**: Derivation of formula – Shear stress distribution across various beam sections like rectangular, circular, triangular, I, T and angle sections.

**TEXT BOOKS:**

(1) Engineering Mechanics by Shames & Rao – Pearson Education
(2) Engineering Mechanics by Dr. R.K Bansal, Lakshmi Publications

(3) Strength of Materials by Ghosh & Datta, New Age Publishers
(4) Strength of Materials by B.C Punmia – laxmi publications

**REFERENCES**:

(1) Engineering Mechanics by Fedrinand L.Singer – Harper Collings publishers
(2) Engineering Mechanics by Shesigiri Rao, Universities Press, Hyderabad
(3) Engineering Mechanics by B.Bhattacharya, Oxford University Publications
(4) Engineering Mechanics by Rjasekharan , Vikas Publications
(5) Engineering Mechanics by S.Timoshenko, D.H Young and J.V Rao, Tata McGraw-Hill Company
(6) A Text book of strength of materials by R.K Bansal – Laxmi publications (p) Ltd, New Delhi
(7) Strength of Materials by R.Subramanian, Oxford University Press

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**PHYSICAL CHEMISTRY LAB (15A53104)**

**Course Objectives:**
To confirm the formation and nature of the product in a chemical processes, the knowledge of some physical, chemical and instrumental methods is essential for a chemical engineer.

**I. PHYSICAL CHEMISTRY LAB:**
1. Determination of Specific rotation of substance by Polarimeter.
2. Study of inversion of Sucrose by Polarimetry.
3. Conductometric titration of Strong acid Vs Strong base.
4. Conductometric titration of Weak acid Vs Strong base.
5. Potentiometric titration between Potassium Dichromate and Ferrous iron.
6. Potentiometric Titration of Strong acid Vs Strong base
7. a)Determination of the specific rate (first order kinetics) of the hydrolysis of Methyl acetate by volumetric method.
   b) Study of first order kinetics(hydrolysis of methyl acetate by raising $10^oC$
8. Study of Adsorption characteristics of acetic acid on Charcoal.
9. Estimation of critical solution temperature of Phenol-Water System.
10. Determination of Molecular weight of a given Polymer from Viscosity measurements.

(Any 10 experiments from the above list)

**Course Outcomes**

- Would be confident in handling energy storage systems and would be able combat chemical corrosion
- Would have acquired the practical skill to handle the analytical methods with confidence.
- Would feel comfortable to think of design materials with the requisite properties
- Would be in a postion to technically address the water related problems.

**TEXT BOOKS:**
1. Vogel's Text book of Quantitative Chemical Analysis, Sixth Edition – J. Mendham et al, Pearson Education.
2. Chemistry Practical – Lab Manual by Chandra Sekhar, GV Subba Reddy and Jayaveera.

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**Engineering & IT Workshop (15A35101)**
**(Common to All Branches)**

## Part – A: Engineering Workshop Lab

**Objectives:**

- Make the students correctly use measuring and marking tools
- Practice the correct use of hand tools
- Apply safe workshop practices when performing basic fitting, carpentry, tin smithy and electrical wiring skills
- Develop the fabrication skills among the students
- Read and interpret the component drawings
- Gain practical skills to apply student's knowledge of theory concepts in real time practice

**1. TRADES FOR EXERCISES:**
**At least 2 exercise In each:**

1. Carpentry
2. Fitting
3. House-wiring
4. Black Smithy
5. Tin smithy
6. Power Tools Demonstration

**TEXT BOOK:**
1. Work shop Manual / P.Kannaiah/ K.L.Narayana/ Scitech Publishers.

**Objective**: The objective of this subject is to provide the basic concepts about different manufacturing processes and use of various workshop tools the exposer to the Power tools used in the inclusion

Question Paper pattern: Test in any two out of 6 trades.

**Outcomes:**

- Expected to improve practical skills
- Able to develop and fabricate the experimental setups for academic and research purposes.
- Able to assemble components for making various systems

**PART – B: IT Workshop**

**Objectives:**

- To provide Technical training to the students on Productivity tools like Word processors, Spreadsheets, Presentations
- To make the students know about the internal parts of a computer, assembling a computer from the parts, preparing a computer for use by installing the operating system
- Disassemble and Assemble a Personal Computer and prepare the computer ready to use
- Prepare the Documents using Word processors
- Prepare Slide presentations using the presentation tool
- Install single or dual operating systems on computer

**Preparing your Computer (4 weeks)**

**Task 1:** Identify the internal parts of a computer of a computer, and its peripherals. Represent the same in the form of diagrams including Block diagram.

**Task 2:** Disassemble and assemble the PC back to working condition. Students should be able to trouble shoot the computer and identify working and non-working parts. Student should identify the problem correctly by various methods available. Students should record the process of assembling and trouble shooting a computer.

**Task 3: S**tudent should install Linux on the computer. Student may install another operating system (including proprietary software) and make the system dual boot or multi boot. Students should record the entire installation process.

**Task 4**: Students should record the various features that are supported by the operating system installed and submit it.

**Productivity tools (3 weeks)**

**Task 5: Word Processor:** Students should be able to create documents using the word processor tool. Some of the tasks that are to be performed are inserting and deleting the characters, words and lines, Alignment of the lines, Inserting header and Footer, changing the font, changing the colour, including images and tables in the word file, making page setup, copy and paste block of text, images, tables etc, linking the images which are present in other directory, formatting paragraphs, spell checking, etc. Students should be able to prepare project cover pages etc at the end of the task. Students should submit a user manual of the word processor considered.

**Task 6: Spreadsheet:** Students should be able to create, open, save the application documents and format them as per the requirement.Some of the tasks that may be practiced are Managing the worksheet environment, creating cell data, inserting and deleting cell data, format cells, adjust the cell size, applying formulas and functions, preparing charts, sorting cells. Students should submit a user manual of the Spreadsheet application considered.

**Task 7: Presentations :** creating, opening, saving and running the presentations; Selecting the style for slides, formatting the slides with different fonts, colours; creating charts and tables, inserting and deleting text, graphics and animations; bulleting and numbering; hyperlinking, running the slide show, setting the timing for slide show. Students should submit a user manual of the Presentation tool considered.

**References:**


1. "Introduction to Computers", Peter Norton, Mc Graw Hill
2. "LaTeX Companion" – Leslie Lamport, PHI/Pearson.
3. "MOS study guide for word, Excel, Powerpoint & Outlook Exams", Joan Lambert, Joyce Cox, PHI.
4. "Introduction to Information Technology", ITL Education Solutions limited, Pearson Education.
5. "Networking your computers and devices", Rusen, PHI "Trouble shooting, Maintaining & Repairing PCs", Bigelows, TMH.


**Outcomes:**

- Students attain complete knowledge of a computer i.e. hardware as well as operating systems.
- Students will be technically strong in using Word processors, Spreadsheets.
- Prepare Slide presentations that helps them in their career

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**ENGLISH LANGUAGE COMMUNICATION SKILLS (ELCS) LAB (15A55102)**

The **Language Lab** focuses on the production and practice of sounds of language and familiarizes the students with the use of English in everyday situations and contexts.

**OBJECTIVES:**

1. To train students to use language effectively in everyday conversations, to participate in group discussions, to help them face interviews, and sharpen public speaking skills
2. To expose the students to a varied blend of self-instructional learner-friendly modes of language learning through computer-aided multi-media instruction.
3. To enable them to learn better pronunciation through stress on word accent, intonation, and rhythm.
4. To help the second language learners to acquire fluency in spoken English and neutralize mother tongue influence
5. To train students to use language appropriately for interviews, group discussion and public speaking

**SYLLABUS:**

**UNIT- I**

Phonetics – Introduction to Sounds of Speech – Vowels – Consonants – Phonetic Transcription & Orthographic Transcription

**UNIT – II**

Syllabification – Word Stress – Rules of word stress – Intonation – Falling tone and Rising tone

**UNIT – III**

Situational Dialogues – Role-play – Expressions in various situations – Self Introduction – Introducing others – Greetings – Apologies – Requests – Social and Professional etiquettes – Telephone Etiquettes

**UNIT – IV**

JAM – Describing object/person/place/situation – Giving directions

**UNIT – V**

Debates and Group Discussions

**OUTCOMES** :

- Develop linguistic and communicative competence through the development of the language skills.
- Becoming active participants in the learning process and acquiring proficiency in spoken English of the students
- Speaking with clarity and confidence thereby enhancing employability skills of the students

**MINIMUM REQUIREMENT FOR ELCS LAB:**

The English Language Lab shall have two parts:

1. Computer Assisted Language Learning (CALL) Lab:
   The Computer aided Language Lab for 60 students with 60 systems, one master console, LAN facility and English language software for self- study by learners.
2. The Communication Skills Lab with movable chairs and audio-visual aids with a P.A. system, Projector, a digital stereo-audio & video system and camcorder etc.

System Requirement (Hardware component):
Computer network with LAN with minimum 60 multimedia systems with the following specifications:

i) P – IV Processor
   a) Speed – 2.8 GHZ
   b) RAM – 512 MB Minimum
   c) Hard Disk – 80 GB

ii) Headphones of High quality

**Suggested software:**

1. Clarity Pronunciation Power – Part I (Sky Pronunciation)
2. Clarity Pronunciation Power – part II
3. K-Van Advanced Communication Skills
4. TOEFL & GRE (KAPLAN, AARCO & BARRONS, USA, Cracking GRE by CLIFFS)
5. *DELTA's key to the Next Generation TOEFL Test: Advanced Skills Practice.*
6. Lingua TOEFL CBT Insider, by Dreamtech
7. English Pronunciation in Use (Elementary, Intermediate, Advanced) CUP
8. Cambridge Advanced Learners' English Dictionary with CD.

**Reference books:**

1. **A Textbook of English Phonetics for Indian Students** 2nd Ed T. Balasubramanian. (Macmillian),2012.
2. **A Course in Phonetics and Spoken English**, Dhamija Sethi, Prentice-Hall of India Pvt.Ltd
3. **Speaking English Effectively**, 2nd Edition Krishna Mohan & NP Singh, 2011. (Mcmillan).
4. **A Hand book for English Laboratories**, E.Suresh kumar, P.Sreehari, Foundation Books,2011
5. **English Pronunciation in Use. Intermediate &Advanced** ,Hancock, M. 2009. CUP
6. **Basics of Communication in English** ,Soundararaj, Francis. 2012.. *New Delhi: Macmillan*
7. **Spoken English** (CIEFL) in 3 volumes with 6 cassettes, OUP.
8. **English Pronouncing Dictionary**, Daniel Jones Current Edition with CD.Cambridge, 17th edition, 2011.

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**TECHNICAL COMMUNICATION & PRESENTATION SKILLS (15A55201)**

**Preamble:**

In the increasingly globalized world, technical communication and presentation skills are assuming great importance. Industries and employers constantly complain that young engineers have adequate technical knowledge, but no communication and presentation skills. Success is defined these days in terms of possessing these skills. The syllabus has been designed to develop communicative competencies of the students.

**Objectives:**

1. To develop awareness in students of the relevance and importance of technical communication and presentation skills.
2. To prepare the students for placements
3. To provide students with interactive practice sessions to make them internalize these skills

**UNIT 1:**

Basics of Technical Communication – Introduction – Objectives & Characteristics of Technical Communication – Importance and need for Technical communication - LSRW Skills – Barriers to effective communication

**UNIT II**

Informal and Formal Conversation - Verbal and Non-verbal communication –Kinesics, Proxemics, Chronemics, Haptics, Paralanguage

**UNIT III**

Written communication – Differences between spoken and written communication – Features of effective writing –Advantages and disadvantages of spoken and written communication

**UNIT IV**

Presentation Skills – Nature and importance of oral presentation – Defining the purpose – Analyzing the audience - Planning and preparing the presentation, organizing and rehearsing the presentation –Individual and group presentations - Handling stage fright

**UNIT V**

Interview Skills – The Interview process –Characteristics of the job interview – Pre-interview preparation techniques – Projecting the positive image – Answering Strategies

**Prescribed Books**

1. Effective Technical Communication, Ashrif Rizvi, TataMcGrahill, 2011
2. Technical Communication by Meenakshi Raman & Sangeeta Sharma, O U Press 2009

**Reference Books**

1. Communication Skills by Pushpalatha & Sanjay Kumar, Oxford Univsesity Press

2. Books on TOEFL/GRE/GMAT/CAT/ IELTS by Barron's/DELTA/Cambridge University Press.2012.
3. Soft Skills for Everyone, Butterfield Jeff, Cengage Publications, 2011.
4. Management Shapers Series by Universities Press (India) Pvt Ltd., Himayatnagar, Hyderabad 2008.
5. Handbook for Technical Writing by David A McMurrey & Joanne Buckely CENGAGE Learning 2008.
6. English for Technical Communication for Engineering Students, Aysha Vishwamohan, Tata Mc Graw-Hill 2009.

**Outcomes:**

- Turning out the students with a clear concept of communication like speaking convincingly, express their opinions clearly, initiate a discussion, negotiate, and argue using appropriate communicative strategies
- Read different genres of texts, infer implied meanings and critically analyse and evaluate them for ideas as well as for method of presentation
- Getting them ready for placements and equipping them with readiness to implement their communication and Presentation skills at work place.

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**MATHEMATICS – II (15A51201)**
**(Common to All Branches)**

**Objectives:** Our emphasis will be more on conceptual understanding and application of Fourier series, Fourier, Z and Laplace transforms and solution of partial differential equations.

**UNIT – I**

Laplace transform of standard functions – Inverse transform – First shifting Theorem, Transforms of derivatives and integrals – Unit step function – Second shifting theorem – Dirac's delta function – Convolution theorem – Laplace transform of Periodic function.

Differentiation and integration of transform – Application of Laplace transforms to ordinary differential equations of first and second order.

**UNIT – II**

Fourier Series: Determination of Fourier coefficients – Fourier series – Even and odd functions – Fourier series in an arbitrary interval – Even and odd periodic continuation – Half-range Fourier sine and cosine expansions- Parseval's formula- Complex form of Fourier series.

**UNIT – III**

Fourier integral theorem (only statement) – Fourier sine and cosine integrals. Fourier transform – Fourier sine and cosine transforms – Properties – Inverse transforms – Finite Fourier transforms.

**UNIT – IV**

Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions – Method of separation of variables – Solutions of one dimensional wave equation, heat equation and two-dimensional Laplace's equation under initial and boundary conditions.s

**UNIT – V**

z-transform – Inverse z-transform – Properties – Damping rule – Shifting rule – Initial and final value theorems. Convolution theorem – Solution of difference equations by z-transforms.

**TEXT BOOKS:**

1. Higher Engineering Mathematics, B.S.Grewal, Khanna publishers.
2. Engineering Mathematics, Volume - II, E. Rukmangadachari Pearson Publisher.

**REFERENCES:**

1. Mathematical Methods by T.K.V. Iyengar, B.Krishna Gandhi, S.Ranganatham and M.V.S.S.N.Prasad S. Chand publication.
2. Higher Engineering Mathematics, by B.V.Ramana, Mc Graw Hill publishers.
3. Advanced Engineering Mathematics, by Erwin Kreyszig, Wiley India.

**Outcomes:**The student gains the knowledge to tackle the engineering problems using the concepts of Fourier series, various transforms and partial differential equations.

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**ENGINEERING PHYSICS (15A52201)**

(Common to Civil, Mechanical & Chemical Engg.)

**Objectives:**

- To evoke interest on applications of superposition effects like interference and diffraction, the mechanisms of emission of light, achieving amplification of electromagnetic radiation through stimulated emission, study of propagation of light through transparent dielectric waveguides along with engineering applications.
- To understand and employ the concepts of waves & oscillations and acoustics to engineering applications.
- To open new avenues of knowledge in dielectric and magnetic materials which find potential in the emerging micro device applications.
- To give an impetus on the subtle mechanism of superconductors using the concept of BCS theory and their fascinating applications. Considering the significance of micro miniaturization of electronic devices and significance of low dimensional materials, the basic concepts of nano and smart materials, their properties and applications in modern emerging technologies are elicited.
- To enlighten the characterization of materials by different techniques, the periodic arrangement of atoms in crystals, Bragg's law and X-Ray diffraction technique.

**UNIT 1: PHYSICAL OPTICS, LASERS AND FIBRE OPTICS**

***Physical Optics****:* Introduction to interference – Colours in thin films – Newton's Rings – Michelson interferometer - Fraunhoffer diffraction due to single slit, double slit – Diffraction grating.

***Lasers****:* Introduction – Characteristics of laser – Spontaneous and stimulated emission of radiation –- Einstein's coefficients –– Population inversion – Pumping mechanisms - Ruby laser – He-Ne laser – Applications of lasers.

**Fiber optics**: Introduction – working principle of optical fiber – Numerical aperture and acceptance angle – Types of optical fibers –Optical fiber communication system – Attenuation and losses in optical fibers – Applications of optical fibers.

**UNIT 2: WAVES & OSCILLATIONS AND ACOUSTICS**

***Waves & Oscillations****:* Categories of waves: Mechanical, electromagnetic, matter and gravitational – Reflection and transmission of waves at a boundary – Free oscillations – Damped Oscillations – Forced oscillations – Resonance – Coupled oscillations.

***Acoustics****:* Sound absorption – Absorption coefficient and its measurement – Reverberation time – Sabine's formula – Eyring's formula.

**UNIT 3**: **DIELECTRICS AND MAGNETIC MATERIALS**

***Dielectrics:*** Introduction – Dielectric Polarization – Types of Polarization – Lorentz field – Clausius- Mosotti equation – Dielectric strength, loss, breakdown.

***Magnetic materials:*** Introduction – Basic definitions – Origin of magnetic moment – Classification of magnetic materials into dia, para, ferro, antiferro and ferri magnetic materials – Hysteresis – Soft and hard magnetic materials – Applications of magnetic materials.

**UNIT 4**: **ADVANCED MATERIALS**

***Superconductors:*** Introduction – Properties of superconductors – Meissner effect– Type I and Type II superconductors – ac and dc Josephson effects – BCS theory (qualitative treatment) – High $T_c$ superconductors – Applications of superconductors.

***Nanomaterials***: Introduction – Significance of nanoscale – Surface area and quantum confinement – Physical properties: optical, thermal, mechanical and magnetic – Carbon nanotubes & their properties – Applications of nanomaterials.

***Smart Materials***: Shape Memory Alloys: Definition – Two phases – One way and two way memory effect – Pseudo elasticity – Applications
of shape memory alloys.

**UNIT 5: MATERIAL CHARACTERIZATION AND CRYSTALLOGRAPHY**

***Material Characterization:*** Electron microscopy: SEM, TEM, AFM – UV-Visible and IR Spectroscopy – Non-destructive testing: objectives – Methods: Pulse-echo method.

***Crystallography:*** Introduction – Space lattice –Unit cell – Lattice parameters –Bravias lattice – Crystal systems – Packing fractions of SC, BCC and FCC - Miller indices – Interplanar spacing in cubic crystals – X-ray diffraction – Bragg's law – Laue method.

**Prescribed Text books:**

1. Engineering Physics – Dr. M.N. Avadhanulu & Dr. P.G. Kshirsagar, S.Chand and Company
2. Engineering physics – S. Mani Naidu, Pearson Education
3. Instrumental methods of analysis - Willard and Meritt

**Reference Books:**

1. Introduction to modern optics – Grant R Fowles
2. A text book on Optics – Brijlal & Subramanyam
3. Laser Fundamentals – William T. Silfvast, Cambridge University Press
4. Fundamentals of Physics – Halliday, Resnick and Walker, John Wiley &Sons
5. Introduction to Nanotechnology – C P Poole and F J Owens, Wiley
6. Shape Memory Alloys-Modeling and Engg. Applications – C Lagoudas, Springer
7. Hand Book of Non-destructive evaluation, C.J.Hellier, McGraw-Hill
8. Engineering Physics – V. Rajendran, K.Thyagarajan Tata MacGraw Hill Publishers
9. Engineering Physics – M.R.Srinivasan, New Age Publications
10. Engineering Physics – D K Pandey, S. Chaturvedi, Cengage Learning
11. Engineering Physics - Sanjay D. Jain, D. Sahasrambudhe and Girish, University Press
12. Engineering Physics – M. Arumugam, Anuradha Publications

**Outcomes:**

- The different realms of physics and their applications in both scientific and technological systems are achieved through the study of physical optics, lasers and fiber optics.
- The concepts of types of waves and oscillations ,acoustics are highlighted
- The dielectric and magnetic response of materials are focussed.
- The importance of superconducting materials, nano and smart materials along with their engineering applications are well elucidated.
- Characterization of materials by advanced techniques, the important properties of crystals like the presence of long-range order and periodicity, structure determination using X-ray diffraction technique are focused.

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**PROBLEM SOLVING & COMPUTER PROGRAMMING (15A05201)**

**Course Objectives:**

- To understand the various steps in Program development.
- To understand the basic concepts in C Programming Language.
- To learn how to write modular and readable C Programs
- To understand the basic concepts such as Abstract Data Types, Linear and Non Linear Data structures.
- To understand the notations used to analyze the Performance of algorithms.
- To understand and analyze various searching and sorting algorithms.

**UNIT - I**

**Introduction:** Programs and Programming, Programming Languages, Compiler, Interpreter, Loader and Linker, Program Execution, Classification of Programming, Structured Programming Concept, Algorithms, Flowcharts, System Developments.

**Fundamentals Algorithms:** Exchange the Values between two variables, Counting, Summation of set of numbers, Factorial Computation, Generation of the Fibonacci sequence, Reversing the digits of a integer.

**Basics Of C:** Introduction**,** Developing Programs in C, A Simple C program, Parts of C Program Revisited.

**UNIT – II**

**Structure of C:** Structure of a C Program, Concept of a Variable, Data Types in C, Program Statements, Declaration, Tokens, Operators and Expressions, Type conversion in C.

**Input and Output:** Introduction, Basic Screen and Keyboard I/O in C, Non-Formatted Input and Output, Formatted Input and Output Function.

**Control Statements:** Introduction, Specifying Test Condition for Selection and Iteration, Writing Test Expression, Conditional Execution and Selection, Iteration and Repetitive Execution. Nested Loops.

**UNIT – III**

**Arrays And Strings:** Introduction, One-Dimensional Array, Strings, Multidimensional Arrays, Arrays of Strings.

**Function:** Introduction, Concept of Functions, Using Functions, Call by Value Mechanism, Working with Functions, Passing Arrays to Functions, Scope and Extent, Inline Function, Recursion.

**UNIT - IV**

**Factoring Methods:** Finding Square root of a Number, The Smallest Deviser of an Interger, The GCD of Two Integers, Generating Prime Numbers.

**Pointers** – Introduction, Understanding Memory, Address Operator, Pointer, Void Pointer, Null Pointer, Use of pointer, Arrays and Pointers, Pointers and string, Pointers and string, Pointers to pointers, Array of pointers, Pointers to Function, Dynamic Memory Allocation,.

**UNIT – V**

**User-Defined Data Types and Variables:** Introduction, User-defined Data Types, Structures, Union, Enumeration Types.

**Files in C:** Introduction, Using Files in C, Working with text Files, Working with Binary Fields, Direct File Input and Output, Files of Records, Random Access to Files of Records.

**TEXT BOOKS:**

1. Programming in C, Pradip Dey, Manas Ghosh, Second Edition, OXFORD,
2. How to Slove it by Computer by R.G. Dromey, Pearson.

**REFERENCES:**

1. Programming in C and Data Structures, Jeri R. Hanly, Elliot B. Koffman, Ashok Kamthane and A.Ananda Rao, Pearson Education.
2. C Programming with problem solving, J.A. Jones & K. Harrow, dreamtech Press
3. Programming In C, Remma Teraja, Second Edition OXFORD.
3 Programming in C – Stephen G. Kochan, III Edition, Pearson Eductaion.
3. C for Engineers and Scientists, H.Cheng, Mc.Graw-Hill International Edition
4. Education / PHI
5. C Programming & Data Structures,E.Balagurusamy,TMH.

**Outcomes:**

- Able to design the flowchart and algorithm for real world problems
- Able to learn and understand new programming languages
- Able to construct modular and readable programs
- Able to write C programs for real world problems using simple and compound data types
- Adapt programming experience and language knowledge to other programming language contexts
- Employee good programming style, standards and practices during program development

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**ENGINEERING GRAPHICS (15A03202)**

(Civil, EEE, ECE, CSE & Chemical)

**Unit-I**

Introduction to Engineering Drawing: Principles of Engineering Graphics and their significance Drawing Instruments and their Use – BIS Conventions in drawing and Lettering.

Curves used in practice:

a) Conic sections including the Rectangular Hyperbola
b) Cycloid, Epicycloid and Hypocycloid –Normals and Tangents
c) Involute of a circle –Normals and Tangents

Principles of orthographic projection, I and III angle projections –Conventions –Projections of points.

**Unit –II**

Projection of lines inclined to both planes –traces, Projection of plane figures inclined to both planes.

**Unit –III**

Projection of simple solids inclined to both planes.

**Unit –IV**

Sections and Developments: Sections and Sectional views of Regular solids –Prism, Cylinder, Pyramid, Cone – True shapes.

**Unit –V**

Isometric projections: Principles of pictorial representations-Isometric projection- Isometric scale-Isometric views- conventions- Isometric views of plane figures, solids-Isometric projection of objects with non isometric lines-Isometric projection of spherical parts.

**TEXT BOOKS:**

1. Engineering Drawing, N.D. Bhat, Charotar Publishers
2. Engineering Drawing, K.L. Narayana& P. Kannaih, Scitech Publishers, Chennai.

**REFERENCES:**

1. Engineering Drawing, Johle, Tata McGraw-Hill Publishers.
2. Engineering Drawing, Shah and Rana,2/e, Pearson Education
3. Engineering Drawing and Graphics, Venugopal/New age Publishers
4. Engineering Graphics, John&john.

***Suggestions:***

*Student is expected to buy a book mentioned under 'Text books' for better understanding.*

*Student should prepare rough sketches for all the problems given at the end of each chapter to improve his / her imaginations.*

*Student should also practice Auto CAD or any other drawing software to help understanding better.*

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## INTRODUCTION TO CHEMICAL ENGINEERING (15A08201)

**Unit-I**

Introduction, Chemical Engineering in everyday life, Scaling up or down, Engineering applications of portable devices, challenges in petroleum sector, versatility of a Chemical Engineer, role of Chemical Engineers in Biomediacal Engineering, similarities in dissimilar applications.

Batch Processing, paint manufacture, transition from batch to continuous processing, Case study: Manufacture of Sulphuric acid, role of basic sciences in Chemical Engineering (Introduction) (Text Book 1)

**Unit-II**

Introduction, Unit operations, basic laws, units and dimensions, partial pressure, vapor pressure. Solutions, concentration measurements,humidityand saturation. Material and Energy balances.

Flow of fluids: Introduction, nature of fluid, viscosity, velocity profile, flow field, types of fluid motion, laminarand turbulent flow, flow of a fluid past a solid surface, Reciprocating, rotary, and centrifugal pumps(Text Book 2)

**Unit-III**

Heat transfer: Conduction, convection (omit correlations for calculation of heat transfer coefficients, heattransfer with change in phase) and radiation. Flow arrangement in heat exchangers, variation of fluidtemperatures in heat exchangers, heat transfer equipment (double pipe & Shell and tube heat exchanger),evaporation, long tube vertical type and forced circulation type evaporators, multiple effect evaporation,methods of feeding(Text Book 2)

**Unit-IV**

Mass transfer: Introduction - Diffusion, mass transfer operation, equipment for gas-liquid operations, contact patterns, classification of separation processes and applications, basic definitions of separation processes, VLE, LLE, boiling point diagram.(Text Book 2)

**Unit-V:**

Introduction to mechanical operations: Size reduction, filtration, basic differences between agitation and mixing.

Types of reactions and reactors.

Introduction to environmental pollution: types and their effect.

Safety in chemical process industries (case study on DDT, environmental hazards of a green project)(Text Book 1&2)

**TEXT BOOK:**

1. Introduction to chemical engineering by S. Pushpavanam, PHI, 2012.
2. Introduction to chemical engineering by S. K. Ghosal, S. K. Sanyal and S. Dutta, TMH publications, 1993.

**REFERENCE:**

1. Unit operations in chemical engineering by W.L. McCabe and J.C. Smith and Peter Harriott, McGraw Hill5th ed. 1993.

**Objectives:**

1. To impart the role of Chemical Engineers in everyday life and the importance of Chemical Engineering.
2. To learn the role of various Unit Operations and Unit Processes in Chemical industries.
3. To learn the role of Chemical Engineers in environmental and safety aspects in process industries.

**Outcomes:**

The student will be able to explain:

1. The role of Chemical Engineers in everyday life and the importance of Chemical Engineering.
2. The role of various Unit Operations and Unit Processes in Chemical industries.
3. The role of Chemical Engineers in environmental and safety aspects in process industries.

**JNTUA College of Engineering (Autonomous), Ananthapuramu**

**I Year B.Tech II Semester**

| L | P | C |
|---|---|---|
| 0 | 4 | 2 |

**COMPUTER PROGRAMMING LAB (15A05202)**

**(Common to Civil, EEE, ME, CSE, Chemical)**

**Objectives:**

- To work with the compound data types
- To explore dynamic memory allocation concepts
- Able to design the flowchart and algorithm for real world problems
- Able to write C programs for real world problems using simple and compound data types
- Employee good programming style, standards and practices during program development

**Week-1**

1) Write an algorithm and draw a flowchart to make the following exchange between the variables a-> b -> c->d - > a
2) Write an algorithm and draw a flowchart to generate the first n terms of the sequence. A Fibonacci sequence is defined as follows: the first and second terms in the sequence are 0 and 1. Subsequent terms are found by adding the preceding two terms in the sequence.
3) Write a algorithm and draw a flowchart to carry out the arithmetic operations addition, subtraction, multiplication, and division between two variables
4) Write a algorithm and draw a flowchart for printing prime numbers between 1 and n.

**Week-2**

1) Write a C program to construct a multiplication table for a given number.
2) Write a program to reverse the digit of a given integer.
1) Write a C program to calculate the factorial of a given number

**Week-3**

Write a program to calculate tax, given the following conditions:

a) If income is less than 1,50,000 then no tax.
b) If taxable income is in the range 1,50,001 – 300,000 then charge 10% tax
c) If taxable income is in the range 3,00,001 – 500,000 then charge 20% tax
d) If taxable income is above 5,00,001 then charge 30% tax

**Week-4**

1) Write a program to print the calendar for a month given the first Week- day of the month.

Input the first day of the month (Sun=0,Mon=1,Tue=2,Wed=3,.....) :: 3

Total number of days in the month : 31

Expected output

| *Sun* | *Mon* | *Tue* | *Wed* | *Thu* | *Fri* | *Sat* |
|---|---|---|---|---|---|---|
| *-* | *-* | *-* | *1* | *2* | *3* | *4* |
| *5* | *6* | *7* | *8* | *9* | *10* | *11* |
| *12* | *13* | *14* | *15* | *16* | *17* | *18* |
| *19* | *20* | *21* | *22* | *23* | *24* | *25* |
| *25* | *26* | *27* | *28* | *29* | *30* | *31* |

**Week-5**

1) Write a program to print the Pascal triangle for a given number
2) Write a program to calculate the following expression for given x value

$$f(x) = a_0 + \sum_{n=1}^{\infty} \left( a_n \cos\frac{n\pi x}{L} + b_n \sin\frac{n\pi x}{L} \right)$$

**Week-6**

1) Write C code to define a function cash_dispense, which takes an amount as its input, and returns the number of 1000, 500, 100, 50, 20, 10, 5, 2, 1 rupee denomination that make up the given amount.
2) Write C code to reverse the contents of the array. For example, [1,2,3,4,5] should become [5,4,3,2,1]
3) Write a program that will search and find out the position where the given key element exist in a user chosen array and print it as output.

**Week-7**

1) Write C code to compute the frequency table of survey responses given by 20 users. The survey responses range from 1 to 5 and are stored in an array. For example, 10 responses are stored in the array [1,1,5,2,3,3,5,5,2,2]. The frequency table will be as shown below:
   a. 1 = 2
   b. 2 = 3
   c. 3 = 2
   d. 4 = 0
   e. 5 = 3
2) Write a program to define a function to sort an array of integers in ascending order by using exchange sort.

**Week-8**

1) Write a C program to check whether a given string is a palindrome or not, without using any built-in functions
2) Write a function that accepts a string and delete the first character.
3) Write a function that accepts a string and delete all the leading spaces.

**Week-9**

Write a program to accept a string from user and display number of vowels, consonants, digits and special characters present in each of the words of the given string.

**Week-10**

1) Write a C program to define a union and structure both having exactly the same numbers using the sizeof operators print the sizeof structure variables as well as union variable
2) Declare a structure *time* that has three fields *hr, min, secs.* Create two variables, *start_time* and *end_time.* Input there values from the user. Then while *start_time* is not equal to *end_time* display GOOD DAY on screen.

**Week-11**

1) Write a program to read in an array of names and to sort them in alphabetical order. Use sort function that receives pointers to the functions strcmp, and swap, sort in turn should call these functions via the pointers.

2) Write a program to read and display values of an integer array. Allocate space dynamically for the array using the *malloc()*.
3) Write a program to calculate area of a triangle using function that has the input parameters as pointers as sides of the triangle.

**Week-12**

1) Two text files are given with the names text1 and text2. These files have several lines of text. Write a program to merge (first line of text1 followed by first line of text2 and so on until both the files reach the end of the file) the lines of text1 and text2 and write the merged text to a new file text3.
2) Write a program to split a given text file into n parts. Name each part as the name of the original file followed by .part<**n**> where n is the sequence number of the part file.

**Reference Books:**


1. Computer Science, A Structured Programming Approach Using C by Behrouz A. Forouzan & Richard F. Gilberg, Third Edition, Cengage Learning
2. C Programming A Problem-Solving Approach, Behrouz A. Forouzan & E.V. Prasad, F. Gilberg, Third Edition, Cengage Learning
3. Programming with C Rema Theraja, Oxford
4. “C Test Your Skills”, Kamthane, Pearson Education
5. Programming in C: A Practical Approach, Ajay Mittal, Pearson
6. Problem solving with C, M.T.Somasekhara, PHI
7. C Programming with problem solving, J.A. Jones & K. Harrow,Dreamtech Press
8. Programming with C, Byron S Gottfried, Jitender Kumar Chhabra, TMH, 2011


**Outcomes:**

- Able to have fundamental concept.
- Able to write, compile and debug programs in C language.
- Able to formulate problems and implement algorithms in C.
- Able to effectively choose programming components that efficiently solve computing problems in real-world.
- Able to use different data types in a computer program.
- Able to design programs involving decision structures, loops and functions.

**JNTUA College of Engineering (Autonomous), Ananthapuramu**

**I- Year B.Tech. II-Sem** **L P C**
**4 0 4**

**ENGINEERING PHYSICS LABORATORY (15A52202)**

**Objectives:**

- To evoke interest on applications of superposition effects like interference and diffraction, the mechanisms of emission of light, achieving amplification of electromagnetic radiation through stimulated emission, study of propagation of light through transparent dielectric waveguides along with engineering applications.
- To understand and employ the concepts of waves & oscillations and acoustics to engineering applications.
- To open new avenues of knowledge in dielectric and magnetic materials which find potential in the emerging micro device applications.
- To give an impetus on the subtle mechanism of superconductors using the concept of BCS theory and their fascinating applications. Considering the significance of micro miniaturization of electronic devices and significance of low dimensional materials, the basic concepts of nano and smart materials, their properties and applications in modern emerging technologies are elicited.
- To enlighten the characterization of materials by different techniques, the periodic arrangement of atoms in crystals, Bragg's law and X-Ray diffraction technique

**Any EIGHT of the following experiments has to be performed during the SEMESTER**

1. Determination of wavelengths of various colours of mercury spectrum using diffraction grating in normal incidence method
2. Determination of dispersive power of prism
3. Determination of thickness of thin object by wedge method
4. Determination of radius of curvature of lens by Newton's rings
5. Laser : Diffraction due to single slit
6. Laser : Diffraction due to double slit
7. Laser: Determination of wavelength using diffraction grating
8. Determination of Numerical aperture of an optical fiber
9. Meldes experiment: Determination of the frequency of tuning fork
10. Sonometer: Verification of the three laws of stretched strings
11. Energy gap of a material using p-n junction diode
12. Electrical conductivity by four probe method
13. Hall effect: Determination of mobility of charge carriers in semiconductor
14. B-H curve
15. Magnetic field along the axis of a current carrying coil – Stewart and Gee's method
16. Determination of dielectric constant and Curie temperature of a ferroelectric material

**Outcomes:**

- The different realms of physics and their applications in both scientific and technological systems are achieved through the study of physical optics, lasers and fiber optics.
- The concepts of types of waves and oscillations ,acoustics are highlighted
- The dielectric and magnetic response of materials are focussed.
- The importance of superconducting materials, nano and smart materials along with their engineering applications are well elucidated.
- Characterization of materials by advanced techniques, the important properties of crystals like the presence of long-range order and periodicity, structure determination using X-ray diffraction technique are focused.

**JNTUA College of Engineering (Autonomous), Ananthapuramu**

**II- Year B.Tech. I-Sem**

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**MATHEMATICAL METHODS (15A51301)**

**Objectives:**

- This course aims at providing the student with the concepts of Matrices, Numerical Techniques and Curve fitting.

**UNIT – I**

Elementary row transformations-Rank – Echelon form, normal form – Consistency of System of Linear equations. Linear transformations. Hermitian, Skew-Hermitian and Unitary matrices and their properties. Eigen Values, Eigen vectors for both real and complex matrices. Cayley – Hamilton Theorem and its applications – Diagonolization of matrix. Calculation of powers of matrix and inverse of a matrix. Quadratic forms – Reduction of quadratic form to canonical form and their nature.

**UNIT – II**

Solution of Algebraic and Transcendental Equations: The Bisection Method – The Method of False Position– Newton-Raphson Method, Solution of linear simultaneous equation: Crout's triangularisation method, Gauss - Seidal iteration method.

**UNIT – III**

**Interpolation:** Newton's forward and backward interpolation formulae – Lagrange's formulae. Gauss forward and backward formula, Stirling's formula, Bessel's formula.

**UNIT – IV**

Curve fitting: Fitting of a straight line – Second degree curve – Exponentional curve-Power curve by method of least squares. Numerical Differentiation for Newton's interpolation formula. Numerical Integration: Trapezoidal rule – Simpson's 1/3 Rule – Simpson's 3/8 Rule.

**UNIT – V**

Numerical solution of Ordinary Differential equations: Solution by Taylor's series-Picard's Method of successive Approximations-Euler's Method-Runge-Kutta Methods. Numerical solutions of Laplace equation using finite difference approximation.

**TEXT BOOKS:**

3. Higher Engineering Mathematics, B.S.Grewal, Khanna publishers.
4. Introductory Methods of Numerical Analysis, S.S. Sastry, PHI publisher.

**REFERENCES:**

2. Engineering Mathematics, Volume - II, E. Rukmangadachari Pearson Publisher.
3. Mathematical Methods by T.K.V. Iyengar, B.Krishna Gandhi, S.Ranganatham and M.V.S.S.N.Prasad, S. Chand publication.
3. Higher Engineering Mathematics, by B.V.Ramana, Mc Graw Hill publishers.
4. Advanced Engineering Mathematics, by Erwin Kreyszig, Wiley India.

**Outcomes:**The student will be able to analyze engineering problems using the concepts of Matrices and Numerical methods.

**JNTUA College of Engineering (Autonomous), Ananthapuramu**

| II Year B.Tech. I-Sem | L | P | C |
|---|---|---|---|
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## ELECTRICAL AND ELECTRONICS ENGINEERING (15A24301)
**(Common to Mech. Engg. & Chemical)**

**PART – A**

**ELECTRICAL ENGINEERING**

**OBJECTIVES:**

- To understand the basic concepts of different types of electrical machines and their performance.
- To understand the basic types of Circuits, DC generators & motors, Transformers, Induction motors and their performance aspects.
- To understand the concepts of semiconductors, various types of semiconductors, diodes rectifiers, transistors, amplifiers and number systems for digital electronics

**UNIT – I Introduction to DC & AC Circuits**

Ohm's Law, Basic Circuit Components, Kirchhoff's Laws, Types of Sources, Resistive Networks, Series Parallel Circuits, Star Delta and Delta Star Transformation. Principle of AC Voltages, Waveforms and Basic Definitions, Root Mean Square and Average Values of Alternating Currents and Voltage, Form Factor and Peak Factor, Phasor Representation of Alternating Quantities, The J Operator and Phasor Algebra, Analysis of Ac Circuits With Single Basic Network Element, Single Phase Series.

**UNIT-II DC Machines**

**D.C Generators:** Principle of Operation of Dc Machines, Types of D.C Generators, E.M.F Equation in D.C Generator, O.C.C. of a D.C. Shunt Generator

**D.C Motors**:Principle of Operation of Dc Motors, Types of D.C Motors, Torque Equation, Losses and Efficiency Calculation in D.C Motor- Swinburne's Test

**UNIT-III AC Machines**

**Transformers:** Principles of Operation, Constructional Details, Losses and Efficiency, Regulation of Transformer, Testing: OC & SC Tests.

**Three Phase Induction Motors**: Principle of Operation, Slip and Rotor Frequency, Torque (Simple Problems).

**Alternators:** Principle of Operation-Constructional Details-EMF Equation-Voltage Regulation by Synchronous Impedance Method.

**PART-B**

**ELECTRONICS ENGINEERING**

**UNIT I**

Semiconductor Devices-N-Type and P-Type Semiconductors, The p-n Junction Diode - Drift and Diffusion Currents, Volt-Ampere Characteristics- Diode Specifications, Applications of Diode,

Diode as a Switch. Diode as a Rectifier-types of Rectifier, Rectifiers with Filters, Zener Diode-Characteristics, Zener Diode as Voltage Regulator. Silicon Controlled Rectifier, DIAC, TRIAC.

**UNIT II**

Bipolar Junction Transistor (BJT) – Types of Transistors, Theory and Operations of Transistors, Input-Output Characteristics of BJT Configurations, Transistor Biasing- Fixed Bias, Voltage Divider Bias, Transistor Applications- Transistor as an Amplifier and Switch, Junction Field Effect Transistor (JFET)- (construction, principle of Operation, symbol), Characteristics - Input/output, Transfer Characteristics, Configurations of JFET, JFET Applications- JFET as an Amplifier and Switch, Comparison of BJT and JFET, MOSFET-The Enhancement and Depletion MOSFET, Characteristics and Applications of MOSFET

**UNIT III**

**Digital Electronics:** Number Systems-Decimal System, Binary System, Octal System, Hexadecimal System, Code Conversions, Binary Arithmetic- Binary Addition, Binary Subtraction, Logic Gates and Truth Tables-NOT, OR, AND, EX-OR, EX-NOR, Universal Gates-NAND, NOR Gates. Boolean algebra and De Morgan's Theorems,

**Text Books:**

**TEXT BOOKS:**

1. Basic Electrical Engineering - By M.S.Naidu and S. Kamakshiah – TMH.

2. Basic Electrical Engineering –By T.K.Nagasarkar and M.S. Sukhija Oxford University Press.

3. Electrical and Electronic Technology-By Hughes – Pearson Education.

4. Basic Electrical and Electronics Engineering, M.S.Sukhija, T.K.Nagsarkar, Oxford University Press, $1^{st}$ Edition, 2012.

5. Basic Electrical and Electronics Engineering, S.K Bhattacharya, Pearson Education, 2012.

**REFERENCES:**

1. Theory and Problems of Basic Electrical Engineering by D.P.Kothari & I.J. Nagrath PHI.

2. Principles of Electrical Engineering by V.K Mehta, S.Chand Publications.

3. Fundamentals of Electrical Electronics Engineering by T.Thyagarajan, SCITECH Publications $5^{th}$ Edition-2007

**Outcomes:**

1: Students shall gain knowledge on basics of Electrical Circuits, DC Machines, Transformers, Induction motors, Alternators.

2: Students shall gain knowledge on various types of semiconductor devices, transistors, amplifier and digital electronics.

3: Students shall be able to apply the knowledge of Electrical and Electronic systems real-world Chemical Engineering problems and applications.

**JNTUA College of Engineering (Autonomous), Ananthapuramu**

| II Year B.Tech. I-Sem | L | P | C |
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**ORGANIC CHEMISTRY (15A53301)**

**Objectives:**

- The Mechanism of organic chemical reaction is essential to synthesis new organic compounds in drug and pharmaceutical industries. In order to study their kinetics of reactions to regulate the process for optimization of production of drugs and pharmaceutical, the principles of organic chemistry are essential.
- For chemical engineer to carry out a processes industrially for the manufacture of drgus and pharmaceuticals, Comprehension on basic reactions, reagents and their applications is needed.
- He/She should know the electronic behavior of organic molecules, their special and geometrical arrangement of functional groups.
- He/She should have insight of reaction mechanisms for different types of reactions.
- He/She must have knowledge to conduct the most common reactions like addition, substitution, oxidation, reduction etc., on large scale.

**UNIT I:**

Polar effects – Inductive effect, electromeric effect, resonance, hyper conjugation, steric hindrens, and aromaticity – examples.

**UNIT II:**

Electrophilic reactions: a) Friedel-Craft reaction b) Riemer- Teimenn Reaction c) Backmann rearrangement.

Nucleophillic reactions : a) Aldol condensation b) Perkin Reaction c) Benzoin condensation.

**UNIT – III:**

Stereo isomerism; Optical isomerism; Symmetry and chirality; Optical isomerism in lactic acid and tartaric acid; Sequence rules; Enantiomers, diastereomers; Geometrical Isomerism; E-Z system of nomenclature, conformational analysis of ethane and Cyclohexane.

**UNIT.IV**

Some Reagents of Synthetic importance:

Preparation and applications of Aluminum Chloride, N-Bromosuccnamide (NBS), Diazomethane, Dicyclohexylcarbodiimide(DCC), Potassiumtertiarybutoxide and Grignard reagent

**UNIT.V:**

Some Useful Reactions in Organic Synthesis:

i). Protection of functional groups: Hydroxyl, Carbonyl and amino groups

ii). Oxidation: Oxidation of alcohols and carbonyl compounds with suitable examples

iii). Reduction: Reduction of double and triple bonds and carbonyl compounds with suitable examples.

**TEXTBOOKS**:

1. Text book of Organic Chemistry – Morrsion and Boyd.
2. Organic Reaction Mechanisms by VK Ahulwalia and RK Parashar

**REFERENCES:**

1. Reaction mechanism – Peter Skyes.
2. Text book of Organic Chemistry – P.L. Soni.
3. Organic Chemistry Vol- I-IL. Finar.
4. Reactions and Reagents – O.P. Agrawal.
5. A Text Books of Organic Chemistry- Bahl and Arun Bahl, S. Chand company, New Delhi
6. Polymer Science and Technology- Hema Singh, Acme Learning, New Delhi

**Outcomes:**

1. Will be able to understand the essentiality of organic chemical reaction to synthesis new organic compounds in drug and pharmaceutical industries.
2. To gain knowledge on basic reactions, reagents and their applications.
3. To gain knowledge on electronic behavior of organic molecules, their special and geometrical arrangement of functional groups.
4. To gain necessary knowledge to conduct the most common reactions like addition, substitution, oxidation, reduction etc., on large scale.

**JNTUA College of Engineering (Autonomous), Ananthapuramu**

**II- Year B.Tech. I-Sem** **L P C**
**4 0 4**

**MATERIALS SCIENCE FOR CHEMICAL ENGINEERS (15A08301)**

**UNIT- I**

**Introduction**:Engineering Materials – Classification – levels of structure.

**Crystal Geometry and Structure Determination**: Space lattice and Unit cell. Bravais lattices, crystal systems with examples. Lattice coordinates, Miller indices, Bravais indices for directions and places: crystalline and non crystalline solids; ionic, covalent and metallic solids; packing efficiency, coordination number; structure determination by Bragg's X-ray diffraction and powder methods.

**UNIT -II**

**Crystal Imperfection**: Point defects, line defects-edge and screw dislocation, Berger's circuit and Berger's vectors, dislocation reaction, dislocation motion, multiplication of dislocations during deformation , role of dislocation on crystal properties; surface defects, dislocation density and stress required to move dislocations.

**UNIT -III**

**Basic thermodynamic functions**: phase diagrams and phase transformation: Primary and binary systems-general types with examples; tie line& lever rule, non equilibrium cooling: phase diagrams of Fe-$Fe_3$-C, Pb-Sn, Cu-Ni systems.

Phase transformations in Fe-$Fe_3$-C steels, Time-Temperature-Transformation (TTT) curves for eutectoid steels and plain carbon steels; effect of alloying elements on properties of steels; types of steels, alloys and other metals used in chemical industry.

**UNIT -IV**

Elastic, an elastic and plastic deformations in solid materials; rubber like elasticity, visco elastic behavior (models); shear strength of real and perfect crystals, work hardening mechanisms, cold working, hot working; dynamic recovery, recrystallization, grain growth, grain size and yield stress, Brief description of heat treatment in steels.

**Magnetic materials**: Terminology and classification, magnetic moments due to electron spin, ferro-magnetism and related phenomena, domain structure, hysteresis loop, soft and hard magnetic materials.

**UNIT- V**

**Fracture in ductile and brittle materials, creep**: mechanism of creep and methods to reduce creeping in materials, creep rates and relations. Fatigue-mechanisms and methods to improve fatigue resistance in materials. Composite materials: types; stress-strain relations in composite materials, applications.

**Oxidation and Corrosion**: Mechanisms of oxidation, oxidation resistant materials, principles and types of corrosion, protection against corrosion.

**TEXT BOOK:**

1. Materials Science and Engineering, 5$^{th}$ed. V. Raghavan, PHI Learning Pvt. Ltd., New Delhi, 2009.

**REFERENCES:**

1. Elements of Materials Science, L.R. Van Vlack,
2. Science of Engineering Materials, vols. 1&2, ManasChanda, McMillan Company of India Ltd.

**Objective:** This course will help students to learn about the relationship between structure and properties of materials, application of various classes of materials including metals, ceramics, polymers.

**Outcome:** This course will enable the student to learn about proper selection of materials for designing various equipment in a chemical industry.

**JNTUA College of Engineering (Autonomous), Ananthapuramu**

**II- Year B.Tech. I-Sem** **L P C**
**4 0 4**

**MOMENTUM TRANSFER (15A08302)**

**UNIT- I**

Unit operations and unit processes, unit systems, basic concepts, nature of fluids, hydrostatic equilibrium, applications of fluid statics.

Fluid flow phenomena-Laminar flow, Shear rate, Shear stress, Rheological properties of fluids, Turbulence, Boundary layers.

**UNIT- II**

Basic equation of fluid flow –Mass balance in a flowing fluid; continuity equation, differential momentum balance; equations of motion, Macroscopic momentum balances, Bernoulli equation.

Incompressible Flow in pipes and channels- shear stress and skin friction in pipes, laminar flow in pipes and channels, turbulent flow in pipes and channels, friction from changes in velocity or direction.

**UNIT- III**

Dimensional analysis: Buckingham $\pi$ Theorem and Rayleigh's method.

Flow of compressible fluids- Definitions and basic equations, Processes of compressible flow, Isentropic flow through nozzles, adiabatic frictional flow, and isothermal frictional flow.

**UNIT -IV**

Flow past immersed bodies, Drag and Drag coefficient, friction in flow through beds of solids, Kozeny-Carman, Blake-Plummer and Ergun equations, and motion of particles through fluids.

Fluidization: Conditions for fluidization, Minimum fluidization velocity, Types of fluidization, Expansion of fluidized beds, Applications of fluidization, Continuous fluidization:Slurry and pneumatic transport.

**UNIT- V**

Transportation and Metering of fluids: Pipes, fittings and valves, Fluid- moving machinery, Fans, blowers, and compressors.

Measurement of flowing fluids:Variable head meters- Orifice meter, Venturi meter, Pitot tube; Area meter- Rota meter.

**TEXTBOOKS**

1. Unit Operations of Chemical Engineering by W.L.McCabe, J.C.Smith& Peter Harriot, McGraw-Hill, 7$^{th}$ed, 2007

**REFERENCES:**

1. Transport processes and unit operations by Christie J. Geankoplis, PHI
2. Unit operations, Vol-1 –Chattopadhya, Khanna publishers
3. Principles of Unit Operations, Foust *et al*, 2$^{nd}$ ed., John Wiley, 1999
4. Chemical Engineering, Vol-I, Coulson and Richardson, Pergamon Press.

**OBJECTIVE:** The behavior of fluids is important to process Engineering and constitutes foundations for the study of unit operations. An understanding of fluids is essential to students not only for accurately treating problems on the moment of fluids through pipes, pumps, but for dealing with all kinds of process equipment.

**OUTCOME:** To apply the concept of hydrostatic equilibrium and to have knowledge on fluid flow phenomena and to determine engineering design quantities for laminar and turbulent flow.

**JNTUA College of Engineering (Autonomous), Ananthapuramu**

**II- Year B.Tech. I-Sem** **L P C**
**4 0 4**

**CHEMICAL PROCESS CALCULATIONS (15A08303)**

**UNIT- I**

**Stoichiometric & Composition relations**: Stoichiometric relation, basis of calculations, methods of expressing compositions of mixtures and solutions, density and specific gravity, Baume and API gravity scales.

(For Assignments only: Use of Log-Log and Semi-Log graphs; Graph plotting using plotters like MS-Excel, Polymath, Minitab, Origin, etc..)

**Behavior of Ideal gases**: Kinetic theory of gases, application of ideal gas law, gaseous mixtures, gases in chemical reactions.

**UNIT -II**

**Vapor pressure**: Liquefaction and liquid state, vaporization, boiling point, effect of temperature on vapor pressure, Antoine equation, vapor pressure plots, estimation of critical properties, vapor pressure of immiscible liquids and ideal solutions, Raoult's law, Non volatile solutes.

**Humidity and Saturation**: Partial saturation, Humidity- Absolute Humidity, Vaporization process, Molal humidity, Relative and percentage saturation, dew point, humid heat, wet bulb and dry bulb temperatures, use of humidity charts, adiabatic vaporization.

**UNIT- III**

**Material balances**: Tie substance, Yield, conversion, limiting reactant, excess reactant, processes involving reactions, Material balances with the help of Stoichiometric equations, Material balances involving drying, dissolution, & crystallization. Material balance calculations for processes involving recycle, bypass and purge.

**UNIT -IV**

**Thermo physics**: Energy, energy balances, heat capacity of gases, liquid and mixture solutions. Kopp's rule, latent heats, heat of fusion and heat of vaporization, Trouton's rule, Kistyakowsky equation for non polar liquids enthalpy and its evaluation.

**Thermo chemistry**: Calculation and applications of heat of reaction, combustion, formation and neutralization, Kirchoff's equation, enthalpy concentration change,

**UNIT- V**

**Flame Temperature Calculations:** Calculation of theoretical and actual flame temperatures.

**Combustion Calculations**: Introduction, fuels, calorific value of fuels, coal, liquid fuels, gaseous fuels, air requirement and flue gases, combustion calculations, incomplete combustion, material and energy balances, thermal efficiency calculations.

**TEXTBOOKS**

**1.** Chemical process principles, Part -I, Material and Energy Balance, Hougen O A, Watson K.M. and Ragatz R.A. 2$^{nd}$ Edition,John Wiley and Sons, New York, 1963.

**REFERENCES:**

1. Basic principles and calculations in chemical engineering by D.H. Himmelblau, $7^{th}$ Ed. PHI, 2013

2. Stoichiometry by B.I. Bhatt and S.M. Vora (3rd Ed.) Tata McGraw Hill publishing company, Ltd. New Delhi (1996)

**Data Tables:**Use of Humidity Chart is permitted in the Examination hall

**OBJECTIVE:** To develop the basic knowledge in material and energy balance industry recycle streams.

**OUTCOME:** This course will enable students to evaluate the effeciency of a process in terms of yield, energy and provide guidance to improve upon them.

**JNTUA College of Engineering (Autonomous), Ananthapuramu**

| II- Year B.Tech. I-Sem | L | P | C |
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**HUMAN VALUES AND PROFESSIONAL ETHICS (15A54302)**
**(AUDIT COURSE)**

**Objectives:**

• To create an awareness on Engineering Ethics and Human Values.
• To instill Moral and Social Values and Loyalty
• To appreciate the rights of Others

**Students will be able to:**

- Identify and analyze an ethical issue in the subject matter under investigation or in a relevant field
- Identify the multiple ethical interests at stake in a real-world situation or practice
- Articulate what makes a particular course of action ethically defensible
- Assess their own ethical values and the social context of problems
- Identify ethical concerns in research and intellectual contexts, including academic integrity, use and citation of sources, the objective presentation of data, and the treatment of human subjects
- Demonstrate knowledge of ethical values in non-classroom activities, such as service learning, internships, and field work
- Integrate, synthesize, and apply knowledge of ethical dilemmas and resolutions in academic settings, including focused and interdisciplinary research

**Unit I: HUMAN VALUES**

Morals, Values and Ethics-Integrity-Work Ethic-Service learning – Civic Virtue – Respect for others – Living Peacefully – Caring – Sharing – Honesty - Courage- Co Operation – Commitment – Empathy –Self Confidence Character – Spirituality.

**Unit II: ENGINEERING ETHICS**

Senses of 'Engineering Ethics- Variety of moral issued – Types of inquiry – Moral dilemmas – Moral autonomy –Kohlberg's theory- Gilligan's theory- Consensus and controversy – Models of professional roles- Theories about right action- Self interest - Customs and religion –Uses of Ethical theories – Valuing time –Co operation – Commitment.

**Unit III :ENGINEERING AS SOCIAL EXPERIMENTATION**

Engineering As Social Experimentation – Framing the problem – Determining the facts – Codes of Ethics – Clarifying Concepts – Application issues – Common Ground - General Principles – Utilitarian thinking respect for persons.

**UNIT IV: ENGINEERS RESPONSIBILITY FOR SAFETY AND RISK**

Safety and risk – Assessment of safety and risk – Risk benefit analysis and reducing risk- Safety and the Engineer- Designing for the safety- Intellectual Property rights(IPR).

**UINIT V: GLOBAL ISSUES**

Globalization – Cross culture issues- Environmental Ethics – Computer Ethics – Computers as the instrument of Unethical behavior – Computers as the object of Unethical acts – Autonomous Computers- Computer codes of Ethics – Weapons Development - Ethics and Research – Analyzing Ethical Problems in research – Intellectual property Rights( IPR).

**Text Books:**

1. Engineering Ethics includes Human Values” by M.Govindarajan, S.Natarajan anad, V.S.SenthilKumar-PHI Learning Pvt. Ltd-2009
2. “Engineering Ethics” by Harris, Pritchard and Rabins, CENGAGE Learning, India Edition, 2009.
3. “Ethics in Engineering” by Mike W. Martin and Roland Schinzinger – Tata McGraw-Hill– 2003.
4. “Professional Ethics and Morals” by Prof.A.R.Aryasri, Dharanikota Suyodhana-Maruthi Publications.
5. “Professional Ethics and Human Values” by A.Alavudeen, R.Kalil Rahman and M.Jayakumaran- Laxmi Publications.
6. “Professional Ethics and Human Values” by Prof.D.R.Kiran-
7. Indian Culture, Values and Professional Ethics” by PSR Murthy-BS Publication

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**II- Year B.Tech. I-Sem** **L P C**
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**MOMENTUM TRANSFER LAB (15A08304)**

1. Identification of laminar and turbulent flows
   Major equipment - Reynolds apparatus
2. Measurement of point velocities
   Major equipment - Pitot tube setup
3. Verification of Bernoulli's equation
   Major equipment – Bernoulli's Apparatus
4. Calibration of Rotameter
   Major equipment – Rotameter Assembly
5. Variation of Orifice coefficient with Reynolds Number
   Major equipment - Orifice meter Assembly
6. Determination of Venturi coefficient
   Major equipment – Venturi meter Assembly
7. Friction losses in Fluid flow in pipes
   Major equipment - Pipe Assembly with provision for Pressure measurement
8. Pressure drop in a packed bed for different fluid velocities
   Major equipment - Packed bed with Pressure drop measurement
9. Pressure drop and void fraction in a fluidized bed
   Major equipment - Fluidized bed with Pressure drop measurement
10. Studying the coefficient of contraction for a given open orifice
    Major equipment - Open Orifice Assembly
11. Studying the coefficient of discharge in a V-notch
    Major equipment - V-notch Assembly
12. Studying the Characteristics of a centrifugal pump
    Major equipment - Centrifugal Pump

**Objective:**The lab provides knowledge on various flow patterns, flow measuring devices and pumps.

**Outcome:** Student will be able to understand the concept of fluid flow phenomena, different flow regimes, flow measuring devices like venturi, orifice and rotameter.

**JNTUA College of Engineering (Autonomous), Ananthapuramu**

**II- Year B.Tech. I-Sem** **L P C**
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**ORGANIC CHEMISTRY LAB (15A53302)**

**Course Objectives:**

To confirm the formation and nature of the product in a chemical processes, the knowledge of some physical, chemical and instrumental methods is essential for a chemical engineer.

**ORGANIC CHEMISTRY LAB:**

1. Criteria of Purity of Solid and Liquid, Determination of Melting Point & Boiling Point. Detecting Nitrogen, Sulphur, and Halogens in Organic Compounds.
2. Identification of an Unknown Substance from the following classes of Organic Compounds, Alcohols, Phenols, Aldehydes, Ketenes, Carbohydrates and Carboxylic acids.
3. Preparation of Aspririn
4. Preparation of Paracetamol
5. Preparation of Acetanilide
6. Preparation of Sulphonic acid
7. Preparation of derivatives for Aldehydes and Amines.
8. Beckman Rearrangement (Preparation of Benzanilide from Benzophenone oxime).
9. Determination of strength of a Glycine Solution.
10. Estimation of an Aldehyde.

**Course Outcome:**

Student will get the knowledge of methods to confirm the formation and the nature of the product.

**TEXT BOOKS:**

1. Vogels Text Book of Qualitative Organic Analysis.

**TEXTBOOKS**:

1. Text book of Organic Chemistry – Morrsion and Boyd.
2. Organic Reaction Mechanisms by VK Ahulwalia and RK Parashar

**REFERENCES:**

1. Reaction mechanism – Peter Skyes.
2. Text book of Organic Chemistry – P.L. Soni.
3. Organic Chemistry Vol- I-IL. Finar.
4. Reactions and Reagents – O.P. Agrawal.
5. A Text Books of Organic Chemistry- Bahl and Arun Bahl, S. Chand company, New Delhi
6. Polymer Science and Technology- Hema Singh, Acme Learning, New Delhi

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**II- Year B.Tech. II-Sem**

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**PROBABILITY AND STATISTICS (15A51401)**

**(Common for CE, ME, Chemical)**

**Objectives:** To help the students in getting a thorough understanding of the fundamentals of probability and usage of statistical techniques like testing of hypothesis, Statistical Quality Control and Queuing theory

**UNIT – I:** Basic concepts of Probability – Random variables – Expectation – Discrete and continuous Distributions – Distribution functions. Binomial and poison distributions Normal distribution – Related properties.

**UNIT – II:** Test of Hypothesis: Population and Sample - Confidence interval of mean from Normal distribution - Statistical hypothesis - Null and Alternative hypothesis - Level of significance. Test of significance - Test based on normal distribution - Z test for means and proportions.

**UNIT – III:** Small samples - t- test for one sample and two sample problem and paired t-test, F-test and Chi-square test (testing of goodness of fit and independence).

**UNIT – IV:** Statistical Quality Control: Concept of quality of a manufactured product -Defects and Defectives - Causes of variations - Random and assignable - The principle of Shewhart Control Chart-Charts for attribute and variable quality characteristics- Constructions and operation of $\overline{X}$ - Chart, R-Chart, p - Chart and C-Chart.

**UNIT – V:** Queuing Theory: Pure Birth and Death process, M/M/1 & M/M/S & their related simple problems.

**TEXT BOOKS:**

1. Probability & Statistics by E. Rukmangadachari & E. Keshava Reddy, Pearson Publisher.
2. Probability & Statistics for engineers by Dr. J. Ravichandran WILEY-INDIA publishers.

**REFERENCES:**

1. Probability & Statistics by T.K.V. Iyengar, B.Krishna Gandhi, S.Ranganatham and M.V.S.S.N.Prasad, S.Chand publications.
2. Statistical methods by S.P. Gupta, S.Chand publications.
3. Probability & Statistics for Science and Engineering by G.Shanker Rao, Universities Press.
4. Probability and Statistics for Engineering and Sciences by Jay L.Devore, CENGAGE.
5. Probability and Statistics by R.A. Jhonson and Gupta C.B.

**Outcomes:** The student will be able to analyze the problems of engineering & industry using the techniques of testing of hypothesis, Statistical Quality Control and Queuing theory and draw appropriate inferences.

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**II- Year B.Tech. II-Sem**

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**ANALYTICAL CHEMISTRY (15A53401)**

**Course Objectives:**

- To acquire basic principles of simple instrumental methods for estimation of organic/inorganic species.
- To acquire basic knowledge of industrial separations
- To acquire Knowledge in Characterization of the Materials synthesized by chemical industry
- To understand the Preparations, properties and reactions of materials

**UNIT-I: Basic Principles of Quantitative Analysis**
Limitations of analytical methods, Classification of errors, Accuracy, Precision, How to reduce systematic errors, Significant figures, Calculators and Computers, Mean and Standard deviation, Distribution of Random errors, Reliability of Results, Confidence interval , Comparison of results, Comparing the means of two samples, Paired T-test, Correlation and regression, Standard deviations.

**UNIT-II: Chromatographic Methods:**
Column chromatography-general principles, terminology: retention time, rotation volume, separation factor, resolution of peaks. Principles of gas chromatography, block diagram of gas chromatograph - detectors (FID, ECD), stationary phases for column, mobile phases, chromatogram, qualitative analysis, special plots, quantitative analysis, HPLC: Principles of High Performance Liquid Chromatography. Block diagram of HPLC Systems, function of each component, stationary phases, eluting solvents, pumps, detectors, quantitative applications of HPLC. Ion chromatography-seperation of anions and cations. Suppressed & non-suppressed ion chromatography. Numerical calculations.

**Unit-III: Thermal methods of Analysis:**
Introduction to Thermal methods, Thermogravimetric Analysis (TGA)-principles, and applications (determination of drying temperatures, kinetic methods, automatic thermo gravimetric Analysis) DTA: Differential thermal analysis-Principles and applications (exothermic and endothermic peaks, heat of reaction, catalysis, decompositions etc.,)
DSC: Differential scanning calorimettry, principles & applications (exothermic & endothermic peaks, compound purity determination, percentage crystallinity, glass transition temperature).

**Unit-IV: Electro-Analytical Techniques**
i). Polarography: Definition, advantage of dropping mercury electrode, factors affecting on limiting current, Half wave potentials and significance, Applications of Polarography
ii), Amperometric Titrations: Basic principle involved in the Amperometry, Amperometric Titrations and applications, Advantages and disadvantages of Amperometric Titrations.

**Unit-V: Spectrophotometric Methods:**
Introduction to Analysis: Qualitative & Quantitative Analysis; Conventional & Instrumental methods of analysis. Molecular spectrophotormetry-Beer’s law Block diagram of UV-Visible Spectrophotometer – quantitative analysis direct method for the determination metal ions: Chromium, Manganese, Iron, etc in alloys. Infrared spectrophotormetry-principle, instrumentation and Functional group analysis of organic compounds using infrared spectra.

Quantitative analysis of organic molecules. Atomic absorption spectrophotormetry(AAS) and flame photometry: principles, instrumentation and applications (Determination of Sodium, Potassium and Calcium.) (12h)

**Course Outcome:**

The student may acquire enough knowledge on industrial processes and Identification of Products using different analytical and instrumental techniques.

**BOOKS:**

1. Quantitative analysis, R.A.Day & A.L. Underwood , 5th edition, Printice- Hall of India Pvt. Ltd., 2000.
2. Vogel's Text Book of Qualitative chemical analysis, J. Mendham, R.C.Denney, J. Darnes, M.J.K. Thomas, Persar education 6th edition, 2002.
3. Elements of Physical Chemistry-Peter Atkins, Oxford Uni.Press, 3rd Edition, 2010.

**REFERENCES:**

1. Atkin's Physical Chemistry – P. Atkins and J. De Paula, Oxford Univ.Press, 9th Edition, 2012
2 Instrumental lMethods of Chemical Analysis, Gurdeep R.Chatwal, Sham K.Ananad, Himalayha publishing House,5th Edition, 2012.
3. Advanced physical chemistry – Gurudeepraj, Goel Publishing House, 2000
4. Essentials of Physical Chemistry- Arun Bahl, B.S.Bahl and G.D.Rulasi, S.Chand Publishers, New Delhi.

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**II- Year B.Tech. II-Sem**

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**PROCESS INSTRUMENTATION (15A08401)**

**UNIT I**

Elements of instruments, static and dynamic characteristics, basic concepts of response of first order type instruments, mercury in glass thermometer, bimetallic thermometer, pressure spring thermometer, static accuracy and response of thermometers.

**Unit II:**

**Thermo electricity:** Industrial thermocouples, thermocouple wires, thermo couple wells and response of thermocouples. Thermal coefficient of resistance, industrial resistance thermometer bulbs and circuits, radiation receiving elements, radiation, photoelectric and optical pyrometers.

**Unit III:**

Composition analysis, spectroscopic analysis by absorption, emission, mass and color measurement spectrometers, gas analysis by thermal conductivity, analysis of moisture, gas chromatography, refractometer.

**Unit IV:**

**Pressure vacuum and head:** liquid column manometers, measuring elements for gauge pressure and vacuum, indicating elements for pressure gauges, measurement of absolute pressure, measuring pressure in corrosive liquids, static accuracy and response of pressure gauges.

Head, density and specific gravity, direct measurement of liquid level, pressure measurement in open vessels, level measurements in pressure vessels, measurement of interface level, density measurement, and level of dry materials.

**Unit V:**

Head flow meters, area flow meters, open channel meters, viscosity meters, quantity meters, flow of dry materials, viscosity measurements.

Recording instruments, indicating and signaling instruments, transmission of instrument readings, control center, instrumentation diagram, process analysis.

**TEXT BOOK:**

1. Industrial instrumentation by Donald P.Eckman, Wiley eastern, 1950.

**REFERENCE:**

1. Principles of industrial instrumentation by PatraNabis, TMH.
2. Instruments for measurements and control by Holbrock W.C. Van Nostrand East West.
3. Hand book Instrumentation, Considine, McGraw Hill,

**OBJECTIVE:** The course will give an idea about different instruments for measuring T, P, flow rate, level and composition of various process streams in chemical industry.

**OUTCOME:** This course enables the student to select and design an instrument for measurement of flow, level, temperature, pressure and composition in chemical process industries.

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**II- Year B.Tech. II-Sem**

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**PROCESS HEAT TRANSFER (15A08402)**

**UNIT -I**

**Introduction:** Nature of heat flow, conduction, convection, natural and forced convection, radiation.

**Heat transfer by conduction in Solids:** Fourier's law, thermal conductivity, steady state conduction in plane wall & composite walls, compound resistances in series, heat flow through a cylinder, conduction in spheres.

**Unsteady state heat conduction:** Equation for one-dimensional conduction, Semi-infinite solid.

**UNIT- II**

**Principles of heat flow in fluids:** Typical heat exchange equipment, countercurrent and parallel current flows, energy balances, rate of heat transfer, overall heat transfer coefficient, electrical analogy, critical radius of insulation, logarithmic mean temperature difference, variable overall coefficient, multi-pass exchangers, individual heat transfer coefficients, resistance form of overall coefficient, fouling factors, classification of individual heat transfer coefficients, magnitudes of heat transfer coefficients, effective coefficients for unsteady-state heat transfer.

**UNIT- III**

**Heat Transfer to Fluids without Phase change:** Regimes of heat transfer in fluids, thermal boundary layer, heat transfer by forced convection in laminar flow, heat transfer by forced convection in turbulent flow, the transfer of heat by turbulent eddies and analogy between transfer of momentum and heat, heat transfer to liquid metals, heating and cooling of fluids in forced convection outside tubes.

**Natural convection:** Natural convection to air from vertical shapes and horizontal planes, effect of natural convection in laminar-flow heat transfer.

**UNIT -IV**

**Heat transfer to fluids with phase change:** Heat transfer from condensing vapors, heat transfer to boiling liquids.

**Radiation:** Introduction, properties and definitions, black body radiation, real surfaces and the gray body, absorption of radiation by opaque solids, radiation between surfaces, radiation shielding, radiation to semi transparent materials, combined heat transfer by conduction, convection and radiation.

**UNIT- V**

**Heat exchange equipment:** General design of heat exchange equipment, heat exchangers, condensers, boilers and calendrias, extended surface equipment, heat transfer in agitated vessels, scraped surface heat exchangers, heat transfer in packed beds, heat exchanger effectiveness (NTU method)

**Evaporators:** Evaporators, performance of tubular evaporators, capacity and economy, multiple effect evaporators, methods of feeding, vapor recompression.

**TEXT BOOK:**

1. Unit Operations of Chemical Engineering, 6$^{th}$ ed., W.L. McCabe, J.C. Smith and P. Harriot, McGraw-Hill, New York, 2001

**REFERENCES:**

1. Process Heat Transfer, D.Q. Kern, Tata McGraw-Hill, New Delhi, 1997.
2. Heat Transfer, 4$^{th}$ ed., J.P. Holman, McGraw-Hill, New York, 1976.
3. Chemical Engineering, Volume-I, J. Coulson and R.F. Richardson, Pergamon Press

**Objective:** To impart the students about knowledge on modes of heat transfer and design of heat transfer equipment evaporators etc.,

**Outcome:** Student will be able to use the heat transfer principles in selection and design of heat exchanger, evaporator, etc. for a chemical industry.

**JNTUA College of Engineering (Autonomous), Ananthapuramu**

**II- Year B.Tech. II-Sem** **L P C**
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**CHEMICAL ENGINEERING THERMODYNAMICS (15A08403)**

**UNIT -I**

**Introduction**: The scope of thermodynamics, temperature, defined quantities; volume, pressure, work, energy, heat, Joules Experiments.

**The first law and other basic concepts:** The first law of thermodynamics, thermodynamic state and state functions, enthalpy, the steady-state steady-flow process, equilibrium, the phase rule, the reversible process, constant-V and constant- P processes, heat capacity, isobaric, isochoric, isothermal, adiabatic and polytrophic processes.

**UNIT -II**

**Volumetric properties of pure fluids:** The PVT behavior of pure substances, virial equations, the ideal gas, the applications of the virial equations, second virial coefficients from potential functions. Cubic equations of state, generalized correlations for gases, generalized correlations for liquids, molecular theory of fluids.

**UNIT- III**

**The second law of thermodynamics:** Statements of the second law, heat engines, thermodynamic temperatures scales, thermodynamic temperature and the ideal gas scale

Entropy, Entropy changes of an ideal gas, mathematical statement of the second law, the third law of thermodynamics, entropy from the microscopic view point, calculation of ideal work and lost work.

**UNIT -IV**

**Power cycles:** Carnot cycle, Rankine cycle, Otto cycle, Diesel cycle.

**Refrigeration and liquefaction:** The Carnot refrigerator, the vapor compression cycle, the comparison of refrigeration cycles, the choice of refrigerant, absorption refrigeration, the heat pump, liquefaction processes.

**UNIT –V**

**Thermodynamic properties of fluids:** Property relations for homogeneous phases, residual properties, two phase systems, thermodynamic diagrams, tables of thermodynamic properties, generalized property correlation for gases.

**TEXT BOOKS**

1. J.M.Smith and HC Van Ness, Introduction to Chemical Engineering Thermodynamics, 6$^{th}$ed, McGraw Hill,2003.

**REFERENCE**

1. Y.V. C. Rao, Chemical Engineering Thermodynamics, University publications.
2. K. V. Narayanan, Chemical Engineering Thermodynamics, PHI,2001

**Objective:** To provide the students with the terminology of thermodynamics like system, properties, processes, reversibility, equilibrium, phases, components; the relationship between heat and work by understanding the significance of the thermodynamic laws.

**Outcome:** This course will enable the student to understand the spontaneity and energy efficiency of a process.

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**II- Year B.Tech. II-Sem**

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**MECHANICAL OPERATIONS (15A08404)**

**UNIT- I**

Properties, handling and mixing of particulate solids: Characterization of solid particles, properties of particulate masses, storage and mixing of solids, types of mixers, mixers for cohesive solids, mixers for free flowing solids.

**UNIT- II**

Size reduction: Principles of comminution, computer simulation of milling operations, size reduction equipment-crushers, grinders, ultra fine grinders, cutting machines, Equipment operation. Laws of crushing: Kick's law, Bond's law, Rittinger's law

Screening, Industrial screening equipments, Effectiveness of the screen, differential & cumulative analysis.

**UNIT -III**

Filtration, cake filters, centrifugal filters, cyclone separators, electro-static precipitators.

Principles of cake filtration, Clarifying filters, liquid clarification, gas cleaning, principles of clarification.

**UNIT- IV**

Separations based on motion of particles through fluids: gravity settling processes and centrifugal settling processes, float and sink method, differential settling, coagulation, Flotation-separation of ores, flotation agents

Transportation of solid particulate mass:Belt, screw, apron conveyers, bucket elevators, pneumatic conveying.

**UNIT- V**

Agitation and mixing of liquids: Agitation of liquids, circulation velocities, power consumption in agitated vessels. Blending and mixing of liquids, suspension of solid particles, dispersion operations.

**TEXT BOOK:**

1. Unit Operations in Chemical Engineering by W.L. McCabe and J.C. Smith and Peter Harriott, McGraw Hill 7$^{th}$ ed. 2001.

**REFERENCES:**

1. Chemical engineers hand book, J.H. Perry, 7th ed. McGraw Hill
2. Introduction to Chemical Engineering by J.T.Banchero& W.L. Badger., TMH, 1997.

**Objective:** This course deals with the different mechanical unit operations in chemical engineering. Specific attention is given on particle and separation techniques.

**Outcome:** Student will gain knowledge on various mechanical separation operations used in chemical industry.

**JNTUA College of Engineering (Autonomous), Ananthapuramu**

**II- Year B.Tech. II-Sem**

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**PROCESS HEAT TRANSFER LAB (15A08405)**

1. Determination of total thermal resistance and thermal conductivity of composite wall.
   Major equipment - Composite wall Assembly
2. Determination of thermal conductivity of a metal rod.
   Major equipment - Thermal Conductivity apparatus
3. Determination of natural convective heat transfer coefficient for a vertical tube.
   Major equipment - Natural convection heat transfer apparatus
4. Determination of critical heat flux point for pool boiling of water.
   Major equipment- Pool boiling apparatus
5. Determination of forced convective heat transfer coefficient for air flowing through a pipe
   Major equipment – Forced convection heat transfer apparatus
6. Determination of overall heat transfer coefficient in double pipe heat exchanger.
   Major equipment - Double pipe heat exchanger apparatus
7. Determination of heat transfer coefficient for a helical coil in an agitated vessel.
   Major equipment – Helical coil in a agitated vessel.
8. Study of the temperature distribution along the length of a pin-fin under natural and forced convection conditions
   Major equipment - Pin fin apparatus
9. Estimation of un-steady state film heat transfer coefficient between the medium in which the body is cooled.
   Major equipment - Heat transfer coefficient determination apparatus
10. Determination of Stefan – Boltzmann constant.
    Major equipment - Stefan Boltzmann apparatus
11. Determination of emissivity of a given plate at various temperatures.
    Major equipment - Emissivity determination apparatus

**Objective:** This lab will provide practical knowledge on various heat transfer process and equipment like heat exchangers and evaporators.

**Outcome:** The student will be able to understand the thermal conductivity measurement, heat transfer coefficient, calculation in natural and forced convection and some of the radiation aspects.

**JNTUA College of Engineering (Autonomous), Ananthapuramu**

**II Year B.Tech. II-Sem**

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**MECHANICAL OPERATIONS LAB (15A08406)**

1. To determine the time of grinding in a ball mill for producing a product with 80 % passing a given screen.
Major equipment - Ball mill Apparatus, Sieve shaker, Different sizes of sieves, weighing balance.
2. To verify the laws of crushing using any size reduction equipment like crushing rolls or vibrating mills and to find out the working index of the material.
Major equipment – Jaw Crusher, Sieve shaker, Different sizes of sieves, WeighingBalance, Energy meter.
3. To find the effectiveness of hand screening and vibrating screen of a given sample.
Major equipment - Vibrating Sieve shaker, Different sizes of sieves, WeighingBalance.
4. To achieve beneficiation of a ore using froth flotation technique.
Major equipment - Froth flotation cell
5. To obtain batch sedimentation data and to calculate the minimum thickner area under given conditions.
Major equipment- Sedimentation apparatus
6. To determine the specific cake resistance and filter medium resistance of a slurry in plate and frame filter press.
Major equipment - Plate and frame filter press.
7. To separate a mixture of particles by Jigging.
Major equipment - Jigging apparatus
8. To calculate separation efficiency of particles in a mixture using cyclone separator.
Major equipment - Cyclone separator
9. To determine reduction ratio of a given sample in a pulverizer.
Major equipment - Pulverizer
10. To Verify Stoke's law.
Major equipment – Stoke's law apparatus
11. To determine reduction ratio of a given sample in .a grinder Major equipment - Grinder

**Objective:** The course will equip students with the practical knowledge of different mechanical unit operations & operational conditions of different equipments.

**Outcome:** Student will be able to develop knowledge on various mechanical separation operations used in a chemical industry.

**JNTUA College of Engineering (Autonomous), Ananthapuramu**

| III Year B.Tech. I-Sem | L | P | C |
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**ENERGY ENGINEERING (15A08501)**

**OBJECTIVES:**

- To acquaint the student with the conventional energy sources and their utilization.
- To understand the importance of heat recovery and energy conservation methods and energy audit

**UNIT -I**

Sources of energy, types of fuels- energy and relative forms. Calorific value- gross and net value, calculation of calorific value from fuel analysis, experimental determination energy resources present and future energy demands with reference to India.

**Coal:** origin, occurrence, reserves, petrography, classification, ranking, analysis, testing, storage, coal carbonization and by product recovery, liquefaction of coal, gasification of coal, burning of coal and firing mechanism, burning of pulverized coal.

**UNIT- II**

**Liquid fuels:** petroleum: origin, occurrence, reserves, composition, classification, characteristics, fractionation, reforming, cracking, petroleum products, specification of petroleum products, burning of liquid fuels.

Natural gas, coke oven gas, producer gas, water gas, LPG, burning of gaseous fuels, hydrogen (from water) as future fuel, fuel cells, flue gas, analysis: orsat apparatus

**UNIT -III**

**Steam Plant:** Run time cycle, boiler plant, steam cost, steam distribution and utilization, combined heat and power systems, energy from biomass and biogas plants, gas purification, solar energy, wind energy, energy storage

**UNIT -IV**

Waste heat recovery, sources of waste heat and potential application, various types of heat recovery systems, regenerators, recuperators, waste heat boilers

**Energy conservation:** conservation methods in process industries, theoretical analysis, practical limitations.

**UNIT-V**

**Energy auditing:** short term, medium term, long term schemes, energy conversion, energy index, energy cost, representation of energy consumption, Sankey diagram, energy auditing.

**TEXT BOOKS:**

1. Fuels, Furnaces and Refractories, O.P.Gupta

2. Fuels and Combustion, 3rd ed., Samir Sarkar, Universities Press, 2009.

**REFERENCES:**

1. Non-conventional Energy Resources, G.D.Rai, Khanna Publishers

2. Fuel and Energy, Harker and Backhurst, Academic press London 1981

3. Fuel Science- Harker and Allen, Oliver and Boyd, 1972

**Outcomes:**

- Students would have a good knowledge about conventional energy sources and their audit.
- Ability to apply the fundamentals of energy conversion and applications.

**JNTUA College of Engineering (Autonomous), Ananthapuramu**

**III Year B.Tech. Chem. Engg. I-Sem**

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## PROCESS DYNAMICS AND CONTROL (15A08502)

**Objectives:**

- Develop mathematical and transfer function models for dynamic processes.
- Analyze process stability and dynamic responses.
- Empirically determine process dynamics for step response data.
- Development of block diagrams, reading block diagrams, process and instrumentation diagrams
- Familiarity with different types of PID feedback controllers..
- Ability to understand feed forward control, cascade control and Smith predictors and their applications
- Knowledge of real time applications of process control implementation.

**UNIT I**

**Introduction to process dynamics and control**: Laplace transforms, Inverse Laplace transform, Response of First Order Systems. Physical examples of first order systems- Liquid level, mixing process, R- C circuit. Linearization.

**UNIT II**

Response of first order systems in series- interacting and non- interacting systems, second order systems, transportation lag.

**Control system**: Components of a control system, Servo Vs regulator problem, development of block diagram.

**Controllers and final control elements**: Control valve and its construction,P, PD, PI, PID controllers.

**UNIT III**

**Stability**: Concept of Stability, Stability criterion, Routh test for stability

**Root locus**: concept of root locus, rules for plotting the root locus diagram.

**UNIT IV**

**Introduction to frequency response**: Substitution rule, Bode diagrams

**Control systems design by frequency response**: Bode stability criterion, Gain and Phase margins.

**Controller tuning**: Tuning of P, PD, PI, PID controllers, trial and error method, Ultimate gain and ultimate period, Ziegler- Nichols technique, Cohen and Coon rules.

**UNIT V**

**Advanced control strategies:** Cascade control, feed forward control, ratio control, Smith predictor, dead time compensation. Control valve sizing, valve characteristics.

**TEXT BOOK:**

1. Process Systems Analysis and Control, 2$^{nd}$ ed., D.R. Coughanowr, McGraw-Hill, 1991

**REFERENCES:**

1. Chemical Process Control, G. Stephanopoulos, PHI Learning Pvt. Ltd., New Delhi, 2010

2. Process Control, B.W. Bequette, PHI Learning Pvt. Ltd., New Delhi, 2010

**OUTCOME:** Ability to model the dynamic processes, to analyze the dynamic processes, to design feedback control system for chemical, mechanical & electrical engineering systems and to design advanced control system for complex and normal processes.

**JNTUA College of Engineering (Autonomous), Ananthapuramu**

**III Year B.Tech. Chem. Engg. I-Sem**

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**PHASE AND CHEMICAL EQUILIBRIA (15A08503)**

**OBJECTIVES:**

To introduce the concepts of chemical potential, partial properties, property relations for ideal gases, fugacity excess properties and to develop the theoretical foundation for applications of thermodynamics to gas mixtures and liquid solutions and to perform the phase equilibrium calculations using simple models for VLE, Gamma/Phi approach and equation of state approach.

**UNIT I**

**Solution Thermodynamics:** Theory, Fundamental property relation, chemical potential as a criterion for phase equilibrium, partial properties, ideal gas mixtures, fugacity and fugacity coefficient for pure species, fugacity and fugacity coefficient for species in solutions, generalized correlations for Fugacity coefficient, The ideal solutions, excess properties.

**UNIT II**

**Solution Thermodynamics:** Applications: The liquid phase properties from VLE data, models for the excess Gibbs energy, property changes of mixing

**VLE at low to moderate pressures:** The nature of equilibrium, the phase rule, Duhems theorem, VLE: Qualitative behavior, the gamma /Phi formulation of VLE, Dew point and bubble point calculations, flash calculations, solute (1)/solvent (2) systems

**UNIT III**

**Thermodynamic Properties and VLE from Equations of State:** properties of fluids from the virial equations of state, properties of fluids from cubic equations of state, fluid properties from correlations of the Pitzer type, VLE from cubic equations of state

**Topics in Phase Equilibria:** Equilibrium and stability, Liquid-Liquid Equilibrium (LLE), Vapor- Liquid–Liquid Equilibrium (VLLE), Solid-Liquid Equilibrium (SLE), Solid Vapor Equilibrium (SVE).

**UNIT IV**

**Chemical Reaction Equilibria:** The reaction coordinate, application equilibrium criterion to chemical reactions, The standard Gibb's energy change and the equilibrium constant, effect of temperature on equilibrium constants, relation of equilibrium constants to composition, equilibrium conversion for single reactions, Phase rule and Duhem's theorem for reacting systems.

**UNIT V**

**Introduction to Molecular Thermodynamics :** Molecular Theory of Fluids,Second Virial Coefficients from Potential Functions,Internal Energy of Ideal Gases: Microscopic view, Thermodynamic Properties and Statistical Mechanics ,Hydrogen Bonding and Charge-Transfer Complexing ,Behaviour of Excess Properties ,Molecular Basis for Mixture Behaviour,VLE by Molecular Simulation.

**TEXT BOOK:**

1. Introduction to Chemical Engineering Thermodynamics, 6th ed., J.M. Smith, H.C. Van Ness and M.M. Abbott, Tata McGraw-Hill, New Delhi, 2003.

**REFERENCE:**

1. Chemical Engineering Thermodynamics, Pradeep Ahuja, PHI Learning Pvt. Ltd., New Delhi, 2009
2. A Text Book of Chemical Engineering Thermodynamics, K.V. Narayanan, PHI Learning Pvt. Ltd., New Delhi, 2001.

**Outcome:**

1. Students will learn the concepts of chemical potential, partial properties, property relations for ideal gases, fugacity excess properties and to develop the theoretical foundation for applications of thermodynamics to gas mixtures and liquid solution.
2. Students will be able to understand the procedures for estimating the thermodynamic properties and perform thermodynamic calculations oriented to the analysis and design of chemical processes.

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## CHEMICAL REACTION ENGINEERING – I (15A08504)

**OBJECTIVES:**

- The emphasis of this course is on the fundamentals of chemical reaction kinetics and chemical reactor operation.
- The overall goal of this course is to develop a critical approach toward understanding complex reaction systems and elucidating chemical reactor design.
- Integrate concepts from science & engineering to constitute a basis for the design of chemical reactor, a key element in the design of chemical process.
- Provide a foundation on deriving rate expressions for series, parallel, reversible reactions and the knowledge about product distribution in multiple reactions, recycle reactors and auto catalytic reactions

**UNIT I**

Overview of chemical reaction engineering-classification of reactions, variables affecting the rate of reaction definition of reaction rate, kinetics of homogenous reactions- concentration dependent term of rate equation, Temperature dependent term of rate equation, searching for a mechanism, predictability of reaction rate from theory.

**Interpretation of batch reactor data- constant volume batch reactor**:- Analysis of total pressure data obtained in a constant-volume system, the conversion, Integral method of analysis of data– general procedure, irreversible unimolecular type first order reactions, irreversible bimolecular type second order reactions, irreversible trimolecular type third order reactions, empirical reactions of nth order, zero-order reactions, overall order of irreversible reactions from the half-life, fractional life method, irreversible reactions in parallel, homogenous catalyzed reactions, autocatalytic reactions, irreversible reactions in series.

**UNIT II**

**Constant volume batch reactor**– first order reversible reactions, second order reversible reactions, reversible reactions in general, reactions of shifting order, Differential method of analysis of data. Varying volume batch reactor–differential method of analysis, integral method of analysis, zero order, first order, second order, nth order reactions, temperature and reaction rate, the search for a rate equation.

**UNIT III**

**Introduction to reactor design**- general discussion, symbols and relationship between $C_A$ and $X_A$. Ideal reactors for a single reaction- Ideal batch reactor, Steady-state mixed flow reactor, Steady-state plug reactors.

**Design for single reactions**- Size comparison of single reactors, Multiple- reactor systems, Recycle reactor, Autocatalytic reactions.

**UNIT IV**

**Design for parallel reactions-** introduction to multiple reactions, qualitative discussion about product distribution, quantitative treatment of product distribution and of reactor size.

**Multiple reactions**-Irreversible first order reactions in series, quantitative discussion about product distribution, quantitative treatment, plug flow or batch reactor, quantitative treatment, mixed flow reactor, first-order followed by zero-order reaction, zero order followed by first order reaction.

**UNIT V**

**Temperature and Pressure effects-** single reactions- heats of reaction from thermodynamics, heats of reaction and temperature, equilibrium constants from thermodynamics, equilibrium conversion, general graphical design procedure, optimum temperature progression, heat effects, adiabatic operations, non adiabatic operations, comments and extensions. Exothermic reactions in mixed flow reactors-A special problem, multiple reactions.

**TEXT BOOK:**

1. Chemical Reaction Engineering, 3rd ed., O. Levenspiel, John Wiely & Sons, 1999.

**REFERENCES:**

1. Elements of Chemical Reaction Engineering, 2nd ed., H.S. Fogler, PHI Learning Pvt. Ltd., New Delhi, 2010.
2. Chemical Engineering Kinetics, 3rd ed., J.M. Smith, McGraw-Hill, New York, 1981.

**Outcome:**

- This course provides necessary knowledge for selection of the chemical reactors for a particular process.
- Analyze and interpret experimental data from batch reactors and determine the order of simple chemical reactions.
- Compare ideal reactor types (batch, CSTR and PFR) and apply quantitative methods to design and size reactors for simple chemical reaction schemes.
- Determine optimal ideal reactor design for multiple reactions for yield or selectivity.
- Predict reactor performance for reactors when the temperature is not uniform within the reactor

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**III Year B.Tech. Chem. Engg. I-Sem**

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**MASS TRANSFER OPERATIONS-I (15A08505)**

**OBJECTIVES:**

- To discuss the fundamental concepts of mass transfer principles and to apply those concepts to real engineering problems.
- To impart the basic concepts of molecular diffusion, mass transfer coefficients and analysis of different mass transfer processes
- Applies the concepts of diffusion mass transfer, mass transfer coefficients, convective mass transfer, inter-phase mass transfer, equipment for gas-liquid operations.

**UNIT- I**

The Mass Transfer Operations: Classification of the Mass-Transfer Operations, Choice of Separation Method, Methods of Conducting the Mass-Transfer Operations, Design Principles, Unit Systems

Molecular Diffusion In Fluids: Molecular Diffusion, Equation of Continuity, binary solutions, Steady State Molecular Diffusion in Fluids at Rest and in Laminar Flow, estimation of diffusivity of gases and liquids, Momentum and Heat Transfer in Laminar flow

Diffusion:Diffusion in Solids, Fick's Diffusion, Unsteady State Diffusion, Types of Solid Diffusion, diffusion through polymers, diffusion through crystalline solids, Diffusion through porous solids & hydrodynamic flow of gases.

**UNIT- II**

Mass Transfer Coefficients: Mass Transfer Coefficients, Mass Transfer Coefficients in Laminar Flow (Explanation of equations only and no derivation), Mass Transfer Coefficients in Turbulent Flow, eddy diffusion, Film Theory, Penetration theory, Surface-renewal Theory, Combination Film-Surface-renewal theory, Surface-Stretch Theory, Mass, Heat and Momentum Transfer Analogies, Turbulent Flow in Circular Pipes. Mass transfer data for simple situations.

Inter Phase Mass Transfer: Concept of Equilibrium, Diffusion between Phases, Material Balances in steady state co-current and counter current stage processes, Stages, Cascades, Kremser – Brown equation.

**UNIT-III**

Equipment For Gas-Liquid Operations: Gas Dispersed, Sparged vessels (Bubble Columns), Mechanical agitated equipments(Brief description),Tray towers, General characteristics, Sieve design for absorption and distillation (Qualitative Treatment), Different types of Tray Efficiencies, Liquid Dispersed venturi Scrubbers, Wetted-Wall Towers, Packed Towers, Counter current flow of Liquid & Gas through packing, Mass transfer coefficients for packed towers, End effects and Axial Mixing Tray tower vs Packed towers.

**UNIT-IV**

Absorption And Stripping: Absorption equilibrium, ideal and non ideal solutions selection of a solvent for absorption, one component transferred: material balances. Determination of number

of Plates (Graphical), Absorption Factor, estimation of number of plates by Kremser Brown equation, Continuous contact equipment; HETP, Absorption of one component,
Determination of number of Transfer Units and Height of the Continuous Absorber, overall coefficients and transfer units, dilute solutions, overall height of transfer units.

**UNIT-V**

Humidification Operations: Vapor-Pressure Curve, Definitions, Psychometric Charts, Enthalpy of gas-vapor Mixtures, Humidification and Dehumidification, Operating lines and Design of Packed Humidifiers, Dehumidifiers and Cooling towers, Spray Chambers

**TEXT BOOK:**

1. Mass transfer operations by R.E. Treybal, 3rd ed. Mc Graw Hill, 1980.
2. Separation process C.J King, Tata Mc Graw Hill
3. Principles of Mass Transfer and Separation Processes by B K Dutta, Printice Hall of India Pvt Limited, New Delhi

**REFERENCE:**

1. Diffusion mass transfer in fluid system by E. L. Cussler.
2. Transport processes and unit operations by Christie J. Geankoplis
3. Separation Process Principles, J D Seader and E. J. Henley, John Wiley & Sons, Inc,. New York

**Pre-requisite:---Nil---**

***Codes/Tables:*** *Psychometric Charts may be provided*

**Outcome:**

- Recognize the various modes of mass transfer, Determine mass transfer rates using Fick's Law.
- Fundamental knowledge on mass transfer mechanisms and operations like absorption, stripping, drying and humidification.
- Estimate diffusion coefficients, Solve unsteady state diffusion problems
- Determine convective mass transfer rates & mass transfer coefficients
- Determine the number of transfer units and height requirements for a packed column

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**CHEMICAL TECHNOLOGY (15A08506)**

**OBJECTIVES:**

- Unit operations unit processes involved in manufacture of important and widely employed organic and inorganic chemicals.
- Develop skills in preparing /presenting a neat Engineering drawing for Chemical Process Industries.
- Impart clear description of one latest process along with its Chemistry, Process parameters, Engineering Problems and Optimum Conditions.
- Demonstrate the importance of updating the latest technological developments in producing products economically and environment friendly.
- Appreciate the usage of other engineering principles such as Thermodynamics, Heat, mass and momentum transfer in operation and maintain the productivity

**UNIT – I**

Water and Air: Importance of water, sources, plant location factors related to water, water shortage problems, methods of treating fresh water, methods of obtaining fresh water from saline waters, waste water treatment and disposal, air as a chemical raw material.

Soda ash, caustic soda and chlorine, Glass: manufacture of special glasses

**UNIT – II**

Industrial gases: carbon dioxide, hydrogen and oxygen – products of water gas, producer gas. Nitrogen industries: synthetic ammonia, urea, nitric acid (ammonium nitrate), ammonium chloride, ammonium phosphate and complex fertilizers

Sulphur and sulphuric acid, manufacture of sulphuric acid, hydrochloric acid and some other chemicals –Aluminum sulphate and alum.

**UNIT – III**

Cement manufacture, special cements, miscellaneous calcium compounds, magnesium compounds.

Manufacture of phenols, formaldehyde, vinyl chloride and vinyl acetate, manufacture of phenol-formaldehyde resin and polyvinyl chloride polymer, SBR

**UNIT – IV**

Oils: Definition, constitution, extraction and expression of vegetable oils, refining and hydrogenation of oils.

Synthetic fibers: Classification, manufacture of Nylon 66, polyester fiber and viscose rayon fiber.

Soaps and detergents: Definitions, continuous process for the production of fatty acids, glycerin and soap, production of detergents.

**UNIT – V**

Pulp and paper industry: methods of pulping, production of sulphate and sulphite pulp, production of paper –wet process

Pharmaceutical Industries: Classification, Alkylation, Carboxylation and Acetylation, Condensation and Cyclization, Dehydration,Halogenation, Oxidation, Sulfonation, Amination, Radio isotopes in Medicine, Fermentation and Life processing for Antibiotics, Hormones, and Vitamines, Biologicals, Steroid hormones, isolates and Animals.

**Text books:**

1. Shreve’s Chemical Process Industries edited by Austin, Mc.graw-Hill.5$^{th}$ ed.1985.
2. Dryden’s Outlines of Chemical Technology edited by M. Gopal Rao and M. Sittig, 2$^{nd}$ ed. 1973.

**References:**

1. Industrial Chemistry by B.K. Sharma,
2. Hand book of industrial chemistry Vol 1& II K.H.Davis & F.S. Berner Edited by S.C. Bhatia, CBS publishers
3. Chemical Technology: G.N. Panday, Vol 1& Vol II.

**Pre-requisite:---Nil---**

**Outcomes:**

Upon successful completion of the course the students will be able to:

1. Make a neat and easy to understand the plant process flow sheet.
2. Keeps up the productivity while maintaining all safety norms stipulated, during their job.
3. Solve Engineering problems that are likely to come across during the operation of plants.
4. Suggest alternative manufacturing process in terms of Economic viability of the product.

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**ENERGY AND ENVIRONMENTAL ENGINEERING LAB (15A08507)**

**List of Experiments:**

1. Estimation of chemical and physical parameters of Ground and Surface water:
   $P^H$, TDS & Conductivity, Hardness, Turbidity, Fluoride, Color analysis.
   Pesticide Microbial analysis: e-coli/ total coli forms bacteria
2. Estimation of physical parameters of waste water:
   $P^H$, TDS, Hardness, Turbidity, Alkalinity etc.
3. Estimation of chemical parameters of waste water:
   COD, BOD, TSS
4. Water and waste water treatment:
   Small RO system for treatment of ground water.
   Same above system with UF membrane for turbidity removal and water disinfection.
5. Analysis of Air:
   Estimation of SPM, RSPM, Sox, Nox, CO and ozone in atmospheric air to study air pollution.

4. Fuel cell Test Kit [Energy]
   A small ½ watt to 1 watt fuel cell with water electrolysis kit ($H_2$ and $O_2$ Generation) plus small voltmeter and ammeter for measuring fuel cell performance.

7. Measurement of Flash point, fire point and calorific value of petroleum products.
8. Proximate Analysis of Coal – Moisture, Volatile Matter, Fixed Carbon and Ash. (Hot air Oven & Muffle Furnace)
9. Calorific value of Solid Fuels.
10. Energy auditing of your Department.

**List of Equipment**

$P^H$ meter, Colorimeter, TDS meter, Aerobic /Anaerobic reactor 25L capacity, BOD incubator, High accuracy analytical balance (5 digit), Desiccators, RO system with domestic 2”x12” Membrane module, $H_2S$ vial kit, Water analysis kit, UV-Vis spectrophotometer, High volume air sampler, Bomb calorimeter, Fuel cell test kit, Microscope.

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**PROCESS DYNAMICS AND CONTROL LAB (15A08508)**

**OBJECTIVES:**

- To evaluate response of fist and higher order characteristics.
- Study the installed characteristics of the valve.
- Study if there is a hysteresis in the control valve and sensor.
- Evaluate the tuning of a PID control via manual and automatic tuning.
- Evaluate the effect controller on the control system

1. Calibration and determination of time lag of various first and second order instruments
Major equipment - First order instrument like Mercury-in-Glass thermometer and
Overall second order instrument like Mercury-in-Glassthermometer in a thermal well

2.Experiments with single tank system.
Single tank - Step Response
Single tank - Impulse Response

3. Experiments with two tank systems with and without interaction.
Non Interacting Tanks – Step Response
Interacting Tanks – Step Response
Non Interacting Tanks – Impulse Response
Interacting Tanks – Impulse Response

4. Level control trainer
Major equipment - Level control trainer set up with computer

5. Temperature control trainer
Major equipment - Temperature control trainer with computer

6. Experiments on proportional, reset, rate mode of control etc.
Major equipment – PID control apparatus

7. Control valve characteristics
Major equipment – Control valve set up

8. Estimation of damping coefficient for U-tube manometer
Major equipment - U-tube manometer.

**Outcome:**

- Estimate the dynamic behavior of the control systems

- Understand the controllability, speed of response the control systems.
- Select proper control valve to meet process needs.
- Understand direct digital control systems handling and operation.
- Tuning of a PID control via manual and automatic tuning.
- Choose PID modes that effect controllability, speed of response the control systems

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**BIOCHEMICAL ENGINEERING (15A08601)**

**OBJECTIVES:**

- Study introduction to the application of chemical engineering principles in biochemical systems.
- Be enabled to understand the biological systems and kinetics of enzymatic reactions.
- Learn the kinetics of growth of microorganisms, hence be able to control the process.
- Be able to design equipments for handing biological processes.
- Study Operations utilized in the purification of biological products enable them to recommend, install and easily learn to operate the equipments.

**UNIT I**

Introduction to microbiology: Biophysics and the cell doctrine, the structure of cells, important cell types, from nucleotides to RNA and DNA, amino acids into proteins. Kinetics of enzyme catalyzed reaction: the enzyme substrate complex and enzyme action, simple enzyme kinetics with one and two substrates, other patterns of substrate concentration dependence, modulation and regulation of enzyme activity, other influences on enzyme activity.

**UNIT II**

Immobilized enzyme technology: enzyme immobilization, industrial processes, utilization and regeneration of cofactors.Immobilized enzyme kinetics: effect of external mass transfer resistance, analysis of intraparticle diffusion and reaction.

Kinetics of cellular growth in batch and continuous culture, models for cellular growth – unstructured, structured and cybernetic models. Thermal death kinetics of cells and spores

**UNIT III**

Introduction to metabolic pathways, biosynthesis, transport across cell membranes, end products of metabolism, stoichiometry of cell growth and product formation.

Design and analysis of biological reactors: batch reactors, fed-batch reactors, enzyme catalyzed reactions in CSTR, CSTR reactors with recycle and cell growth, ideal plug flow reactors, sterilization reactors, sterilization of gases, packed bed reactors using immobilized catalysts. Fermentation technology: medium formulation, design and operation of a typical aseptic, aerobic fermentation process.

**UNIT IV**

Transport phenomena in bioprocess systems: Gas-liquid mass transfer in cellular systems, determination of oxygen transfer rates, overall $k_L$a' estimates and power requirements for sparged and agitated vessels, scaling of mass transfer equipment, heat transfer.

**UNIT V**

Downstream processing: Strategies to recover and purify products; separation of insoluble products-filtration and centrifugation; cell disruption-mechanical and non-mechanical methods; separation of soluble products: liquid-liquid extractions, membrane separation (dialysis, ultra filtration and reverse osmosis), chromatographic separation-gel permeation chromatography, electrophoresis, final steps in purification – crystallization and drying.

**TEXT BOOKS:**

1. Biochemical Engineering Fundamentals, $2^{nd}$ ed., J.E. Bailey and D.F. Ollis, McGraw-Hill, New York, 1987.
2. Bioprocess Engineering, $2^{nd}$ ed., M. L. Shuler and F. Kargi, PHI Learning Pvt. Ltd, New Delhi, 2009.

**REFERENCES:**

1. Biochemical Engineering, J. M. Lee, Prentice-Hall, New Jersey 1992.
2. Bioprocess Engineering Principles, P. M. Doran, Elsevier, Gurgaon, 2005.

**Outcome:**

- This course will help the students to understand and apply the principles of biochemical engineering in analysis and design of industrial biochemical processes.
- Upon completion of this course, the students would develop the ability to design novel bioprocesses for their research in various areas. They will have the ability to find solutions to the problems which occur when materials and processes interact with the environment.
- Explain operations utilized in the purification of biological products are also studied by the students. This will enable them to recommend, install and easily learn to operate the equipment.

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**PROCESS MODELING AND SIMULATION (15A08602)**

**OBJECTIVES:**

- Learn to develop mathematical model for problems.
- To impart knowledge on modeling of various equipment and their simulation using different numerical techniques.
- Formulate a chemical engineering problem as a mathematical model, and select an appropriate solution method.
- Understand the computational requirements of various solution options and use this understanding in the selection of the solution method
- Formulate and solve process design problems, based on fundamental analysis and using mathematical models of chemical processes

**UNIT I**

**Introduction**: Uses of mathematical models, Principles of formulation,
**Fundamental laws:** Continuity equation, component Continuity equation, energy equation, Equation of motion.
**Classification of mathematical models**- steady state Vs dynamic models, lumped Vs distributed parameter models, deterministic Vs stochastic models.

**UNIT II**

**Examples of mathematical models of chemical engineering systems:** Series of isothermal constant hold-up CSTRs, CSTRs with variable hold-ups, two heated tanks, gas phase pressurized CSTR, Non-isothermal CSTR

**UNIT III**

**Examples of mathematical models of chemical engineering systems:** Single component vaporizer, batch reactor, reactor with mass transfer, ideal binary distillation column, batch distillation with hold-up.

**UNIT IV**

**Empirical model building**- method of least squares, linear, polynomial and multiple regression, non-Linear regression.
**Solution of non-linear algebraic equations**-bisection, false position, Newton- Raphson methods.
**Numerical solution of ordinary differential equations**-Euler's method, Modified Euler's method, Runge- Kutta method.

**UNIT V**

**Numerical solution of partial differential equations**- elliptic, parabolic and hyperbolic equations. Finite difference methods, Leibman's method and Crank Nicholson method.
**Process Simulation examples**: VLE dew point and bubble point calculations, binary distillation column, gravity flow tank, batch reactor, Non- isothermal CSTR, countercurrent heat exchanger.

**TEXTBOOKS:**

1. Process modeling, Simulation and Control for Chemical Engineers, 2nd ed., W. L. Luyben, McGraw-Hill, New York, 1990.
2. Numerical Methods for Engineers, S.K. Gupta, Wiley Eastern, New Delhi, 1995.

**REFERENCE:**

1. Introduction to Numerical Methods in Chemical Engineering, P. Ahuja, PHI learning Pvt. Ltd., New Delhi, 2010
2. Process Modeling and Simulation, Amiya K. Jana, 2012.

**Outcome:**

- Understand the stages involved in the development of a process model.
- Formulate a chemical engineering problem as a mathematical model from basic engineering principles.
- Identify the appropriate numerical solutions used in solving the models
- Apply various simulation tools for solving the chemical engineering models developed.
- Understand the solution techniques for solving ODEs.

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**MASS TRANSFER OPERATIONS-II (15A08603)**

**OBJECTIVES:**

- Study of the stage wise mass transfer operations, principles of various stage wise contact processes like distillation, extraction and leaching and drying
- Design aspects of the equipments utilized for above mentioned operations.
- Attain practical knowledge of separation processes, conduct experiments and submit the report.

**UNIT-I**
Distillation: Fields of applications, VLE for miscible liquids, immiscible liquids, steam distillation, Positive and negative deviations from ideality, enthalpy-concentration diagrams, flash vaporization and differential distillation for binary and multi component mixtures, Batch distillation with Reflux.

**UNIT-II**
Continuous rectification-binary systems, multistage tray towers –method of Mc Cabe and Thiele, enriching section, Stripping section, feed introduction, total reflux, minimum and optimum reflux ratios, use of open steam, types of condensers, partial condensers, effect of cold reflux, multiple feeds , tray efficiencies, continuous-contact equipment (packed towers)
Multistage (tray) towers –the method of Ponchon and Savarit, the enriching and stripping sections, feed tray location, total reflux, minimum and optimum reflux ratios, types of reboilers, use of open steam, condenser and reflux accumulators, Azeotropic distillation, extractive distillation, comparison of Azeotropic and extractive distillation.

**UNIT- III**
Liquid-Liquid operations: fields of usefulness, liquid-liquid equilibrium, equilateral triangular co-ordinates, choice of solvent, stage wise contact, multistage cross-current extraction, Multi stage counter current without reflux
Multi stage counter current with reflux, Differential (continuous contact) extractors, spray towers, packed towers, mechanically agitated counter-current extractors, centrifugal extractors, dilute solutions, super critical fluid extraction, fractional extraction.

**UNIT-IV**
Drying: Equilibrium, Definitions, Drying Conditions- Rate of Batch Drying under constant drying conditions, Mechanisms of batch drying, Drying time Through Circulation Drying.
Classification Of Drying Operations: Batch and Continuous Drying Equipment, Material and Energy Balances of Continuous Driers, rate of drying for continuous direct heat driers.

**UNIT-V**
Leaching: Fields of applications, preparation of solid for leaching, types of leaching, leaching equilibrium, single stage and multi stage leaching calculations, constant under flow conditions, equipment for leaching operation.

**TEXT BOOK:**

1. Mass transfer operations by R.E. Treybal, 3rd ed. Mc Graw Hill, 1980.

**REFERENCE:**

1. Principles of Mass Transfer and Separation Processes by B K Dutta, Printice Hall of India Pvt Limited, New Delhi
2. Transport processes and unit operations by Christie J. Geankoplis
3. Separation Process Principles, J D Seader and E. J. Henley, John Wiley & Sons, Inc,. New York

**Pre-requisite:---**Mass Transfer Operations-I

**Outcome:**

- Have complete insight of stage wise contact processes absorption; distillation, extraction and leaching that are used in separation processes in industries.
- Explain the underlying principles and apply them for related separation processes in industries.
- Suggest and design equipment for various mass transfer operations mentioned above.
- Apply these separation processes for specific purposes by using the experience obtained while conducting experiments in laboratory.
- Can operate, design and debug any problems emanating in equipment used in industries for the above operations.
- Be able to operate and debug any problems emanating in equipments used in industries for the above operations.

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## CHEMICAL REACTION ENGINEERING – II (15A08604)

**OBJECTIVES:**

- Learn the importance of RTD and the compartmental models for modeling of Non-ideal flow reacting vessels.
- Calculate the conversions based on segregated flow model, dispersion model and tanks-in-series models.
- Knowledge of rate law given the rate controlling step in catalytic reactions, internal and external diffusion effects.
- Learn the factors influencing catalyst decay, the role of pore diffusion on catalyst activity rate.
- Shrinking core model for spherical particles of unchanging size and design the fluid-solid reactors.

### UNIT I

**Basics of non-ideal flow**: E, the exit age distribution function of fluid, the RTD, conversion in non-ideal flow reactors, diagnosing reactors (qualitative discussion only).

**The dispersion model**: axial dispersion, correlations for axial dispersion, chemical reaction and dispersion.

### UNIT II

**The tanks in series model**: pulse response experiments and the RTD, chemical conversion. The convection model for laminar flow- the convective model and its RTD, chemical conversion in laminar flow reactors

**Earliness of mixing, segregation and RTD**: self-mixing of a single fluid, mixing of two miscible fluids.

### UNIT III

**Catalysis and Catalytic reactors**: catalysts, steps in catalytic reactions, synthesizing a rate law, mechanism and rate limiting step. (From chapter 10, Fogler)

**Heterogeneous reactions**: Introduction to Solid catalyzed reactions: The rate equation for Surface Kinetics- Pore diffusion resistance combined with surface kinetics, Porous catalyst particles, heat effects during reaction, Performance equations for reactors containing porous catalyst particles.

### UNIT IV

Solid catalyzed reactions- Experimental methods for finding rates. Deactivating catalysts- mechanisms of catalyst deactivation, the rate and performance equations.

### UNIT–V

**Fluid-fluid reactions**: kinetics- the rate equation.

**Fluid-particle reactions**: kinetics- selection of a model, shrinking core model for spherical particles of unchanging size, rate of reaction for shrinking spherical particles, extensions, determination of rate controlling step.

## TEXT BOOKS:

1. Chemical Reaction Engineering, 3rd ed., O. Levenspiel, John Wiley & Sons, 1999.
2. Elements of Chemical Reaction Engineering, 4th ed., H.S. Fogler, PHI Learning Pvt. Ltd., New Delhi, 2010.

## REFERENCES:

1. Chemical Engineering Kinetics, 3rd ed., J.M. Smith, McGraw-Hill, New York, 1981.
2. The Engineering of Chemical Reactions, 2nd ed., L.D. Schmidt, Oxford University Press, New Delhi, 2010

**Outcome:**

- Modeling of compartmental models for Non-ideal flow reacting vessels.
- Calculation of conversions based on variousmodels
- Students can design the fluid-solid reactors.

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## CHEMICAL PLANT DESIGN AND ECONOMICS (15A08605)

**OBJECTIVES:**

- To familiarize the students about various economic aspects of chemical processes
- Learn basics of Cost estimation, Working Capital and Capital Investment and understand the time value of money
- Learn the importance of Cash flow diagrams and Break-even analysis.
- Study depreciation methods and methods of estimation of profitability of an industry
- Study the procedures adopted for Replacement and Selection from Alternatives.

**UNIT I**

Introduction, Process Design development.General design considerations, Cost and asset accounting.Cash flow for industrial operations, factors effecting investment and production cost, capital investments, estimation of capital investments, cost indices, cost factors in capital investment

**UNIT II**

Organizations for presenting capital investments, estimates by compartmentalization, estimation of total product of cost direction, production costs, fixed charges, plant overhead costs, financing.

Interest and investment cost, type interest, nominal and effective interest rates, continuous interest, present worth and discount annuities, cost due interest on investment, source of capital.

**UNIT III**

Taxes and insurances, type of taxes: federal income taxes, insurance-types of insurance, self insurance.

Depreciation : types of depreciation, services life, salvage value, present value, methods for determining depreciation, single unit and group depreciation.

**UNIT IV**

Profitability: alternative investments and replacements, profitability standards, discounted cash flow, capitalized cost, pay out period ,alternative investments, analysis with small investments, increments and replacements.

**UNIT V**

Optimum design and design strategy, incremental cost, general procedure for determining optimum condition, comparison of graphical and analytical methods, optimum production rates, semi continuous cyclic operation, fluid dynamics, mass transfer strategy of linearization

**TEXT BOOK:**

1. Plant Design and Economics for Chemical Engineering, 4th ed., M.S. Peters and K.D. Timmerhaus, McGraw-Hill,1991

**REFERENCE:**

1. Process Engineering Economics, Schweyer

**Outcome:**

- Estimate various costs involved in a process industry and evaluate the tax burden of an establishment
- They will be ready with tools to estimate profitability of a company
- Find the replacement costs of an equipment and select best one from different alternatives
- Compute break even period for an investment and rate of return

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**BASICS OF NANOTECHNOLOGY (OPEN ELECTIVE) (15A08606a)**

**OBJECTIVES:**

- Basic knowledge of nanotechnology, classification and properties of nanomaterials
- Various methods of synthesis of nanomaterials
- Applications of nanomaterials

**Unit I**

**Introduction:** History and Scope, Can Small Things Make a Big Difference? Classification of Nanostructured Materials, Fascinating Nanostructures, Applications of Nanomaterials, Nature: The Best of Nanotechnologist, Challenges and Future Prospects.

**Unit II**

**Unique Properties of Nanomaterials: Microstructure and Defects in Nanocrystalline Materials**: Dislocations, Twins, stacking faults and voids, Grain Boundaries, triple and disclinations. **Effect of Nano-dimensions on Materials Behavior:** Elastic properties, Melting Point, Diffusivity, Grain growth characteristics, Enhanced solid solubility.

**Unit III**

**Magnetic Properties**: Soft magnetic nanocrystalline alloy, Permanent magnetic nanocrystalline materials, Giant Magnetic Resonance, Electrical Properties, Optical Properties, Thermal Properties and Mechanical Properties.

**Unit IV**

**Synthesis Routes: Bottom up approaches:** Physical Vapor Deposition, Inert Gas Condensation, Laser Ablation, Chemical Vapor Deposition, Molecular Beam Epitaxy, Sol-gel method ,Self assembly

**Unit V**

**Top down approaches:** Mechanical alloying, Nano-lithography.

**Consolidation of Nanopowders**: Shock wave consolidation, Hot isostatic pressing and Cold isostatic pressing Spark plasma sintering.

**Applications of Nanomaterials:** Nano-electronics, Nanosensors, Nanocatalysts, Structure and Engineering, Automotive Industry, Water- Treatment and the environment, Nano-medical applications, Textiles, Paints, Energy, Defence and Space Applications

**TEXT BOOKS**

1. Text Book of Nano Science and Nano Technology – B.S. Murthy, P. Shankar, Baldev Raj, B.B. Rath and James Munday, University Press-IIM.
2. Introduction to Nanotechnology – Charles P. Poole, Jr., and Frank J. Owens, Wley India Edition, 2012.

**REFERENCES:**

1. Nano: The Essentials by T.Pradeep, Mc Graw- Hill Education.
2. Nanomaterials, Nanotechnologies and Design by Michael F. Ashby, Paulo J. Ferreira and Daniel L.Schodek
3. Transport in Nano structures- David Ferry, Cambridge University press 2000
4. Nanofabrication towards biomedical application: Techniques, tools, Application and impact – Ed. Challa S.,S. R. Kumar, J. H. Carola.
5. Carbon Nanotubes: Properties and Applications- Michael J. O'Connell.
6. Electron Transport in Mesoscopic systems - S. Dutta, Cambridge University press.

**Outcomes:**

- Understand the importance of nanotechnology and its interdisciplinary nature.
- Understand the methods of fabrications and applications of nanomaterials
- Understand the Unique properties of nanomaterials.

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**GREEN TECHNOLOGY (OPEN ELECTIVE) (15A08606b)**

**Unit I**

**An introduction to environmental issues**: Role of chemical processes and chemical products, Global environmental issues, Air and water quality issues, Ecology.

**Risk concept**: Description of risk, Risk assessment concept, Dose-response, Exposure assessment.

**Unit II**

**Evaluating exposures:** Occupational exposures: recognition, evaluation, control,

Exposure assessment for chemicals in the ambient environment, Designing safer chemicals.

**Green chemistry**: Green chemistry methodologies, Optimization based frameworks for the design of green chemical synthesis pathway.

**Unit III**

**Evaluating environmental fate:** Chemical and physical property estimation, Estimating environmental persistence, Estimating ecosystem risk, Classifying environmental risk based on chemical structure.

**Unit IV**

**Life-cycle concepts**: Life-cycle assessment, Life-cycle impact assessment

**Unit V**

Material flows in chemical manufacturing, Assessing opportunities for waste exchanges and byproduct synergies.

**TEXT BOOKS**

SHONNARD, D.ALLEN, D. Green Egineering: Environmentally Conscious Design of Chemical Processes.

**Outcomes:**

- To present approaches and methodologies for evaluating and improving the environmental performance of chemical processes and chemical products.
- To understand the basic knowledge of environmental issues and environmental regulations.
- To discuss the type of wastes and emissions that drive the environmental impacts.

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**NUCLEAR ENGINEERING (OPEN ELECTIVE) (15A08606c)**

**UNIT-1**

**Introduction:** Motivation for Nuclear Energy, India's Nuclear Power Program

**Nuclear Physics:** Nuclear model of the atom - Equivalence of mass and energy - Binding - Radio activity - Half life - Neutron interactions - Cross sections.

**UNIT-II**

**Nuclear Reactions and Reactor Materials**

Mechanism of nuclear fission and fusion - Radio activity - Chain reactions - Critical mass and composition - Nuclear fuel cycles and its characteristics - Uranium production and purification - Zirconium, thorium, beryllium.

**UNIT-III**

**Reprocessing**

Nuclear fuel cycles - spent fuel characteristics - Role of solvent extraction in reprocessing - Solvent extraction equipment.

**UNIT-IV**

**Nuclear Reactors**

Reactors - Types of fast breeding reactors - Design and construction of fast breeding reactors - heat transfer techniques in nuclear reactors - reactor shielding.

**UNIT-V**

**Safety, Disposal and Proliferation**

Nuclear plant safety- Safety systems - Changes and consequences of an accident - Criteria for safety - Nuclear waste - Type of waste and its disposal - Radiation hazards and their prevention - Weapons proliferation.

**Text Book**s:

1. Thomas J.Cannoly, " Fundamentals of Nuclear Engineering ", John Wiley (1978).
2. G,Vaidyanathan," Nuclear Reactor Engineering", Chand Publishers, 2013

**References**:

1. Collier J.G., and G.F.Hewitt, " Introduction to Nuclear Power ", (1987), Hemisphere Publishing, New York.
2. Lamarsh U.R. " Introduction to Nuclear Engineering Second Edition ", (1983), Addison Wesley M.A.
3. Lipschutz R.D. " Radioactive Waste - Politics, Technology and Risk ", (1980), Ballingor, Cambridge. M.A.

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**SOLID WASTE MANAGEMENT (OPEN ELECTIVE) (15A08606d)**

**OBJECTIVES:**

- Material flow in society and generation of solid waste source
- Clarification of solid waste on characterization of the same
- Understand the sense of onsite handling storage and collection systems including transportation
- Understand processing technologies with mechanical volume reduction and thermal volume reduction corporate land filling, deep well injections.
- Learn to estimate material recovery a energy recovery from a given waste data using case standing

**Unit I**

**Introduction:** Definition, characteristics and perspectives of solid waste. Types of solid waste.Physical and chemical characteristics.Variation of composition and characteristics.Municipal, industrial, special and hazardous wastes.

**General aspects:** Overview of material flow in society. Reduction in raw material usage.Reduction in solid waste generation.Reuse and material recovery.General effects on health and environment.Legislations.

**Unit II**

**Engineered systems:** Typical generation rates.Estimation and factors effecting generation rates.On site handling.Storage and processing.Collection systems and devices.Transfer and transport.

**Unit III**

**Processing Techniques:** Mechanical volume reduction.Thermal volume reduction.Component separation.Land filling and land forming.Deep well injection.

**Unit IV**

**Material recovery:** Mechanical size alteration. Electromagnetic separation. Drying and dewatering. Other material recovery systems.Recovery of biological conversion products.Recovery of thermal conversion products.

**Energy recovery:** Energy recovery systems and efficiency factors. Determination of output and efficiency.Details of energy recovery systems.Combustion incineration and heat recovery.Gasification and pyrolysis. Refuse derived fuels (RDF).

**Unit V**

**Case studies:** Major industries and management methods used in typical industries – Coal fired power stations, textile industry, oil refinery, distillery, sugar industry, and radioactive waste generation units.

**Text Books:**

1. Howard S. Peavy, Environmental Engineering, McGraw Hill International Edition, 1986.
2. Dutta, Industrial Solid Water Management and Land Filling Practice, Narose Publishing House, 1999.

**Reference Books:**

1. Sastry C.A., Waste Treatment Plants, Narose Publishing House, 1995.
2. Lagrega, Hazardous Waste Management, McGraw Hill, 1994.

**Outcomes:**

The student should be able to

- Apply his knowledge of characterization of waste and develop a suitable management plan
- Assess the cost of transportation laboratory processing of solid waste
- Identify hazardous nature of waste if any and can suggest suitable dumping methods.
- Suggest processing waste for material for energy recovery.
- Develop a management plan for land filling composting deep well injection for non-recoverable waste.

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**CHEMICAL REACTION ENGINEERING LAB (15A08607)**

**OBJECTIVES:**

- Operate lab equipments like CSTR, Batch, PFR reactors.
- Analyze the concentration versus time data and determine the specific rate constant and the order of the reaction.
- Compare theoretical and experimental conversions in a CSTR and PFR.
- Estimate RTD and model parameters in a CSTR, PFR, packed bed and CSTRin-series.

1. Determination of the order of a reaction using a batch reactor and analyzing the data by (a) differential method (b) integral method.
2. Determination of the activation energy of a reaction using a batch reactor .
3. To determine the effect of residence time on conversion and to determine the rate constant using a CSTR.
4. To determine the specific reaction rate constant of a reaction of a known order using a batch reactor.
5. To determine the order of the reaction and the rate constant using a tubular reactor.
6. CSTRs in series- comparison of experimental and theoretical values for space times and volumes of reactors.
7. Mass transfer with chemical reaction (solid-liquid system) – determination of mass transfer coefficient.
8. Mass transfer with chemical reaction (liquid-liquid system) – determination of mass transfer coefficient
9. Axial mixing in a packed bed. Determination of RTD and dispersion number for a packed-bed using tracer
10. Determination of RTD and dispersion number in a tubular reactor using a tracer.

**Outcomes:**

- Skills of deriving the kinetic expressions by performing the experiments on batch and continuous flow reactors.
- Understand the effects of non ideal flow.
- Proficient to estimate RTD and model parameters in a CSTR, PFR, packed bed and CSTRin-series

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**MASS TRANSFER OPERATIONS LAB (15A08608)**

**OBJECTIVES:**This lab gives an overall idea of various mass transfer operations used in the industry.

1. Estimation of diffusivity coefficients for vapor in gas
2. Estimation of solid diffusion coefficient in air
3. Steam distillation
4. Simple distillation
5. Evaluation of HETP in packed towers
6. Vapor Liquid Equilibria
7. Batch Drying
8. Evaluation of Mass transfer coefficients for Surface Evaporation
9. Evaluation of Mass transfer coefficients for Wetted wall column
10. Liquid- Liquid Equilibria (Tie line data)
11. Ternary Liquid Equilibria (binodal curve)
12. Leaching
13. Adsorption studies

**Outcomes:**

1: The student will be able to perform VLE, LLE related experiments and can estimate diffusivity coefficients.

2: The student will be able to learn about the calculation of different parameters in distillation, absorption, drying and evaporation.

3: The student will be able to design distillation units, drying and evaporation units.

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**ADVANCED ENGLISH LANGUAGE COMMUNICATION SKILLS LAB (AUDIT Lab) (15A55601)**

## Objectives:

This lab focuses on using computer-aided multimedia instruction for language development to meet the following targets:

- To expose the students to a variety of self instructional, learner-friendly modes of language learning.
- To enable the students to learn better pronunciation and accent through listening and reading exercises.
- To train students to use language appropriately for interviews, group discussion and public speaking.
- To initiate them to greater use of the computer in resume preparation, format-making etc.
- To help the students to cultivate the habit of reading passages from the computer monitor, thus providing them with the required facility to face computer based competitive exams such as GRE, TOFEL, and GMAT etc.
- To enable the students to acquire good communication skills as well as soft skills to meet global demands.

**Syllabus:**

**Unit I:**

**Reading &Listening Comprehension:** Skimming –scanning- Extensive and Intensive reading. Reading for making inferences. Active VS passive listening.Listening and Note taking, -Listening for making inferences.

**Unit II:**

Writing Skills: Formal and informal writing-Resume Writing-E-Correspondence.

**Unit III:**

**Technical Presentations (Oral) :** Planning-Preparation-Presentation . Art of Persuasion-Audience analysis- Handling questions.

**Unit IV:**

**Interview Skills:** Types of Interviews - pre-interview planning- answering strategies. Analysis of One to one –interviews – group interviews - Mock interviews.

**Unit V:**

**Soft Skills**: Inter Personal Skills- Goal setting – Etiquettes and good manners – Team Working – Work Ethics--Time management – Problem Solving.

**Minimum Requirements**

The English Language Lab shall have two parts:

The Computer Aided Language Lab for 60 students with 60 systems, one master console, LAN facility and English language software for self-study by learners.

The Communication Skills Lab with movable chairs and audio-visual aids with a PA System, a TV, a digital stereo-audio and video system, a Camcorder, etc

System Requirement (Hardware Component):

Computer network with LAN with a minimum of 60 multimedia systems with the following specifications:

P-IV Processor

Speed-2.8 GHZ

RAM_512 MB minimum

Hard Disk-80 GB

Headphones

**Prescribed Software:**

9. K-Van Advanced Communication Skills
10. Walden Infotech Advanced Communication Skills.

**Books Suggested for English Language Lab Library (to be located within the lab in addition to the CDs of the text book which are loaded on the systems):**

1. **Technical Writing and Professional Communication, Huckin and Olsen** Tata Mc Graw-Hil 2009.
2. **Technical Communication** by Meenakshi Raman & Sangeeta Sharma, Oxford University Press 2009.
3. **Cambridge English for Job-Hunting** by Colm Downes, Cambridge University Press, 2008
4. **Resume's and Interviews** by M.Ashraf Rizvi, Tata Mc Graw-Hill, 2008

**5.**. **English Language Communication : A Reader cum Lab Manual** Dr A Ramakrishna Rao, Dr G Natanam & Prof SA Sankaranarayanan, Anuradha Publications, Chennai 2008.

**6. Managing Soft Skills** by K R Lakshminarayan and T.Muruguvel, Sci-Tech Publications, 2010

**7. The ACE of Soft Skills** by Gopal Ramesh and Mahadevan Ramesh, Pearson Education, 2010

8. **Soft Skills** by Dr. K. Alex, S.Chand

9. **Study Skills for Professional Students in Higher Education** by Dr. M. Adithan, S.Chand.

10. **Personality Development and Soft Skills by Barun** K. Mitra, Oxford Higher Education.

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**TRANSPORT PHENOMENA (15A08701)**

**OBJECTIVES:**

- Different types of fluids, their flow characteristics and different mathematical models applied to actual situations
- Mechanism of fluids in motion under different conditions.

**UNIT-I**

Viscosity and the mechanisms of momentum transfer: Newton's law of viscosity (molecular momentum transport), generalization of Newton's law of viscosity, pressure and temperature dependence of viscosity, molecular theory of the viscosity of gases at low density, molecular theory of the viscosity of liquids. Thermal conductivity and the mechanisms of energy transport: Fourier's law of heat conduction (molecular energy transport), temperature and pressure dependence of thermal conductivity, and theory of thermal conductivity of gases at low density. Diffusivity and the mechanisms of mass transport: Fick's law of binary diffusion (molecular mass transport), temperature and pressure dependence of diffusivities, theory of diffusion in gases at low density.

**UNIT -II**

Shell momentum balances and velocity distributions in laminar flow: shell momentum balances and boundary conditions, flow of a falling film, flow through a circular tube, flow through annulus, flow of two adjacent immiscible fluids, creeping flow around a sphere.

**UNIT -III**

Shell energy balances and temperature distributions in solids and laminar flow: shell energy balances; boundary conditions, heat conduction with an electrical heat source, heat conduction with a nuclear heat source, heat conduction with a viscous heat source, heat conduction with a chemical heat source, heat conduction through composite walls, heat conduction in a cooling fin, forced convection, free convection.

**UNIT -IV**

Concentration distributions in solids and laminar flow: shell mass balances; boundary conditions, diffusion through a stagnant gas film, diffusion with a heterogeneous chemical reaction, diffusion with a homogeneous chemical reaction, diffusion into a falling liquid film (gas absorption), diffusion into a falling liquid film (solid dissolution), diffusion and chemical reaction inside a porous catalyst.

**UNIT -V**

The equations of change: Derivation of the equation of continuity in Rectangular and Polar coordinates, the equation of motion, the equation of energy, the equation of continuity of a component in multi component mixture (in rectangular coordinates only) the equations of change in terms of the substantial derivative. Use of equations of change to solve one dimensional steady state problems of momentum, heat and component transfer, Introduction to Turbulent transport, Time smoothing of equation change.

**TEXT BOOK:**

1. Transport Phenomena by Bird R.B., Stewart W.C., Lightfoot F.N., 2$^{nd}$ ed. John Wiley &Sons Inc,U.S.A,1960.

**Reference:**

1. Transport phenomena for engineers by L. Theodore, International text book company, U.S.A.1971.
2. Transport processes and unit operations by C.J. Geankoplis, PHI, 3$^{rd}$ed. 1997.
3. Fundamental of heat, momentum and mass transfer, Welty, Wicks and Wilson, John Wiley.

**Pre-requisite:** Fluid Mechanics for Chemical Engineers, Process heat transfer, Mass Transfer operations- I & II and Chemical Reaction Engineering I and II

**Codes / Tables:** 1. Leonard – Jones potential parameters and critical properties.
2. Equations of change (from Bird)

**Outcomes:**

1. Ability to understand the chemical and physical transport processes and their mechanism.
2. Ability to do heat, mass and momentum transfer analysis.
3. Ability to analyze industrial problems along with appropriate approximations and boundary conditions.
4. Ability to develop steady and time dependent solutions along with their limitations.

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**CHEMICAL PROCESS EQUIPMENT DESIGN (15A08702)**

**OBJECTIVES:**

- Study design safe process and design appropriate equipment like reactors, mass transfer heat transfer equipment, pipelines storage tanks etc.
- Study relevant codes for design of chemical plant equipment as per the standard procedures specified by design code books.
- Learn the fabrication techniques and testing methods.
- Learn design and engineering skills directly applied in design, installation and commissioning of equipments.

**UNIT-I**

**Basic Considerations in Process Equipment Design:** Introduction, general design procedure, fabrication techniques, equipment classification, power for rotational motion, drives for process equipment

**Materials of Construction:** Mechanical properties, materials, corrosion, corrosion prevention, choice of material.

**UNIT-II**

**Design Considerations:** Introduction, stress created due to static and dynamic loads, design stress, combined stresses and theories of failure, fatigue, brittle fracture, creep, effects of temperature, radiation and fabrication methods.

**Process Hazards and Safety Mechanisms in Equipment Design:** Introduction, hazards in process industries, safety measures, safety measures in equipment design, pressure relief devices.

**UNIT-III**

**Material Handling Equipment Design:** Piping in fluid transportation process-selection of piping material, design of piping system, pumping of fluids: selection of pumps, design procedures for pumps, compression and expansion of fluids: selection of compressors, fans and blowers, vacuum system equipment, turbines and expanders, design procedures for compressors, turbines and expanders

**Heat Transfer Equipment Design:**Selection of heat exchangers types- key heat exchanger types available, preliminary selection of heat exchanger types,Design of key heat exchanger types- Double pipe and multiple double pipe exchangers, shell and tube heat exchangers, plate exchangers, compact exchangers, air cooled exchangers.

**UNIT-IV**

**Seperation Equipment Design:** Distillation design procedures for columns with sieve trays, with random packing, with structural packing, Absorption and Stripping design procedures for trayed columns, packed columns separating dilute solutions

**Equipment Selection for liquid-liquid extraction:** Design procedure for liquid liquid extraction, selection of sorbent for separation by adsorption, basic adsorption cycles, selection of appropriate adsorption cycles, general design for separation by adsorption

**UNIT-V**

**Pressure Vessels:** Introduction, operating condition, pressure vessel codes, selection of materials, vessels operating at low temperatures and elevated temperatures, Design conditions and stresses.

Design of shell and its components, Fabrication, Inspection and Tests.

**TEXT BOOKS:**

1. Joshi's Process Equipment Design, Fourth Edition by V. V. Mahajani and S. B. Umarji, Macmillan Publishers India Ltd., 2009.
2. Plant Design and Economics for Chemical Engineers, Fifth Edition by Max. S. Peters, Klans Timmerhaus and Ronald E. West, McGrawHill International Edition, 2004.

**REFERENCE BOOKS:**

1. Coulson J.M. and Richardson J.F., Chemical Engineering Vol.VI (An introduction to Chemical Engineering Design), Pergamon Press, 1993.

**Outcome:**

The student will be able to do

1. Mechanical design of pressure vessels
2. Process design of separation equipments for distillation, absorption, stripping, liquid-liquid extraction, adsorption
3. Selection of piping materials, pumps, compressors, compressors, fans and blowers, vacuum system equipment, turbines and expanders
4. Design of material handling equipment like piping system, pumps, compressors, turbines and expanders.

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| L | P | C |
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**OPTIMIZATION OF CHEMICAL PROCESSES (15A08703)**

**OBJECTIVES:**

- To learn problem formulation of optimization.
- To realize the numerical methods of un-constrained optimization.
- To learn linear programming and its applications
- To understand the use of genetic algorithms in optimization
- To know the applications of numerical optimization.

**UNIT I**

**Nature and organization of optimization problems**: Introduction to optimization, scope and hierarchy of optimization, examples of applications of optimization, essential features of optimization problems, general procedure for solving optimization problems, Optimization of a manufacturing problem with a stepwise procedure, obstacles of optimization, constraints in optimization, examples and formulation of constrained optimization problems.

**Basic concepts of optimization**: Continuity of functions, unimodal versus Multimodel functions. Convex and Concave functions, Convex region, Necessary and sufficient conditions for an extremum of an unconstrained function.

**UNIT II**

**Optimization of unconstrained single variable functions:** Region elimination methods: Fibonacci search, Golden section search. Polynomial approximation methods- Sequential search

**Methods specifying optimum by a point:** Newton's method, Secant method, Quadratic interpolation, Cubic interpolation. Applications of one- dimensional search methods to chemical engineering problems.

**UNIT III**

**Unconstrained multivariable optimization:** Random search methods, grid search, uni-variate search, multivariable Newton's method, steepest descent method, Conjugate search directions, Conjugate gradient method

.

**UNIT IV**

**Optimization of Unit operations:** Optimal pipe diameter, optimizing recovery of waste heat, optimization of multiple effect evaporator, Determination of optimal reflux ratio for staged distillation column, shell and tube heat exchanger.

**UNIT V**

**Linear programming and applications:** Basic concepts in linear programming, graphical solution, artificial variable technique, exceptional cases in LPP, non-existing feasible solution, degeneracy, duality in linear programming, dual simplex method, revised simplex method.

**TEXT BOOKS:**

1. Optimization of Chemical Processes, T.F. Edgar and D.M. Himmelblau, McGraw-Hill, New York, 2001.
2. Optimization for Engineering Design, Kalyan Moy Deb, PHI Pvt. Ltd., New Delhi, 2000

**Outcome:**

- Knowledge of optimization to formulate the problems and analyze the optimization criterion for solving problems
- Apply different methods of optimization and to suggest a technique for specific problem
- Advanced optimization techniques like Genetic algorithms and other optimization techniques can be used to solve the industrial problems of relevance to the chemical industry

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**SEPARATION TECHNIQUES FOR BIOPROCESSING (15A08704)**

**OBJECTIVES:**

- Learn the fundamentals of adsorptive separations and modeling
- Study the Pressure swing & thermal swing adsorption, Counter current separations.
- Study the basic concepts and design procedures of chromatographic columns.
- Learn different membrane separation technological processes and their design

**UNIT -I**

Crystallization: crystal geometry, principles of crystallization equilibria and yields, nucleation, crystal growth, adsorption and mass transfer theories, precipitation, crystallization from melts. (Textbook 3)

**UNIT -II**

Adsorption: Adsorption, types of adsorption, nature of adsorbents, adsorption equilibrium, single gases and vapors, Adsorption Hysteresis, effect of temperature, Heat of adsorption, vapor and gas mixtures: One component adsorbed, Effect of change of temperature or pressure. Liquids, Adsorption of solute from dilute solution, The Freundlich equation, Adsorption from concentrated solutions, adsorption operations, stage wise operation, application of Freundlich equation to single and Multistage adsorption (cross current & counter current).

Fluidized and teeter beds, adsorption of vapor from a gas, fluidized bed, continuous contact, steady state moving bed adsorbers, unsteady state–fixed bed adsorbers, adsorption wave, elution, adsorption-desorption operations- thermal desorption of gases, activated carbon solvent recovery, pressure swing and vacuum swing adsorption (qualitative treatment), regeneration with purge and desorbent, ion-exchange: principles of ion exchange, techniques and applications. (Textbook 2)

**UNIT –III (qualitative treatment only)**

Chromatography: Types of chromatography: Gas and liquid chromatography, paper and thin layer chromatography, polarization chromatography, and continues chromatography, large-scale chromatography. Electrophoretic separations: Theory of electrophoresis, basic concepts of electrophoresis, forces in electrophoresis, complicating factors in electrophoresis, methods of electrophoresis: Moving boundary electrophoresis, gel membrane and paper electrophoresis, zone spreading in zonal electrophoresis, affinity electrophoresis, free solution and capillary electrophoresis. (Textbook 1)

**UNIT-IV (qualitative treatment only)**

Pressure driven membrane separation processes, reverse osmosis, ultrafiltration, micro filtration, nano filtration, governing equations, effect of operating parameters on flux and rejection, applications. Concentration and electrical driven membrane processes(Text book 1)

**UNIT –V (qualitative treatment only)**

Gas separation in porous and non-porous membrane, pervaporation, dialysis, liquid membranes, governing equations, effect of operating parameters on flux and selectivity, applications, concentration polarization, approximate analysis for concentration polarization, mass transfer correlations, gel formation and fouling, membrane modules. (Textbook 1)

**Text Book:**

1. Rate controlled separation by Phillip C. Wankat, Springer international, 2005
2. Mass transfer operations by R.E. Tryebal, Mc Graw Hill, 3rd ed. 1980.
3. Unit operations of Chemical Engineering by Mc.Cabe & Smith, McGraw-Hill, 5th edition 1993

**References:**

1. Separation processes, C. J. King, Tata McGraw Hill.
2. Transport processes and unit operations, C.J. Geankoplis, Prentice-Hall India, 3rd edition, 2000

**Pre-requisite:** Mass Transfer operations-I, II, Phase and Chemical Equilibria, Chemical Process Calculations.

**Outcome:**

- The students would fully understand key concepts of separation processes including equilibrium stages, reflux, countercurrent contacting, limiting cases, efficiency and mass transport effects.
- The student will know about handling of separations using solid- fluid and separation techniques for the low-temperature, heat sensitive materials.
- Facilitate the students with the novel techniques that are required in downstream processing of biotechnology based industries.

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**INDUSTRIAL ENGINEERING AND MANAGEMENT (15A08705)**

**OBJECTIVES:**The objective of the course, is to equip the Engineering students about the fundamental knowledge of general management, management of materials, human resource management, marketing management, inspection and quality control and will be exposed to the latest and contemporary issues of industrial management.

**UNIT I**

**Introduction to Management:**

Management-Concept and meaning-Nature-Functions-Management as a science and art and both- Schools of management thought-Taylor's Scientific Theory-Henry Fayol's Principles-Weber's Ideal Bureaucracy –Eltan Mayo's Human relations– Systems theory- Situational or Contingency theory- Social responsibilities of management. **Organizational structure and design**: Features of organizational structure- Work specialization-Departmentation-Span of control-Centralization and Decentralization **Organisational designs**-Line Organization-Line & Staff Organization-Functional Organization- Matrix Organization-Project Organization-Committee form of Organisation

**UNIT II**

**Plant Location and Material Management:**

Definition- Factors affecting the plant location- comparison of rural and urban sites-methods for selection of plant-Types of Plant Layout-Methods of production (Job, batch and Mass Production)- Work Study. **Materials Management:**Inventory-functions-Inventory classification techniques-EOQ, ABC and VED analysis- Inventory Control System- Purchase- Procedure - Stores Management.**Marketing Mangement:** Definition-Functions of Marketing- Marketing Mix-Marketing strategies based on Product Life Cycle- Channels of distribution.

**UNIT III**

**Human Resources Management (HRM):**

HRM- Definition and meaning – Nature-Managerial and Operative functions-Evolution of HRM-Human Resource Planning(HRP)-Employee Recruitment-Sources of Recruitment - Employee Selection- Process and tests in employee selection- Employee training and development-On- the- job and Off –the- job training methods-Performance Appraisal systems-Concept-methods of Performance Appraisal-Placement-Employee Induction-Wage and Salary Administration-Objectives-Essentials of Wage and Salary Administration-Job Analysis-Process - Job Evaluation-Employee Grievances-Techniques of handling Grievances.

**UNIT IV**

**Inspection and Quality Control**: Types of inspections - Difference between Inspection & Quality Control- Statistical Quality Control techniques-Variables and Attributes- Variable control charts - R charts-Attributes control charts-P charts - C charts. Acceptance sampling plan-Single sampling - Double sampling plans-OC curves-Introduction to TQM-Quality Circles-ISO 9000 series procedures.

**UNIT V**
**Contemporary Issues in Management:**
The concept of MIS- Materials Requirement Planning (MRP)- Just-In-Time (JIT) System- Total Quality Management (TQM)- Six Sigma Concept- Supply Chain Management- Enterprise Resource Planning (ERP)- Performance Management- Business Process Outsourcing (BPO)- Business Process Re-engineering and Bench Marking- Balanced Score Card-Knowledge Management.

***The students are required to submit any one of the following - two assignments/ a mini project/submission of any two case studies in the subject.***

**Outcome**: After completion of this course, the prospective engineering technocrats will be able to understand various fundamentals of functional areas such general management, plant and materials management, marketing management,human resource management, statistical quality control techniques, strategic management and also aware of the latest and contemporary issues of industrial management.

**Text Books:**

1. GuptaA.K.EngineeringManagement,SChand&CompanyLimitedNewDelhi-2014(Reprint)
2. Khanna O.P and Dhanpat Rai Industrial Engineering &Management.

**Reference Books:**

1. A.R Aryasri: Management Science, TMH, 2013.
2. Stoner. Freeman. Gilbert. Managemem. 6th Ed, Pearson Education. New Delhi, .
3. Fanner Selvam, Production and Operations Management, PHI.
4. Dr. C. Nadha Muni Reddy and Dr. K. Vijaya Kumar Reddy, Reliability Engineering &Quality Engineering. Galgotia Publications, Pvt Limited.
5. Ralph M Barnes. Motion and Time Studies. John Wiley and Sons. 2004.
6. Chase. Jacobs. Aquilano. Operations Management. TM Ii 10th Edition. 2013.

**JNTUA College of Engineering (Autonomous), Ananthapuramu**

**IV Year B.Tech. Chem. Engg. I-Sem**

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**ELECTIVE – I (Through Mooc) (15A08706)**

**JNTUA College of Engineering (Autonomous), Ananthapuramu**

**IV Year B.Tech. Chem. Engg. I-Sem** **L P C**
**0 3 2**

**PROCESS EQUIPMENT DESIGN AND DRAWING LAB (15A08707)**

**OBJECTIVES:**To make the student familiar with design and drawing aspects of chemical processes equipments.

1. Drawing of flow sheet symbols.
2. Drawing of instrumentation symbols.
3. Drawing of instrumentation diagrams.
4. Mechanical aspects chemical equipment design and drawing of following equipment.
   a) Double pipe heat exchanger
   b) Shell and tube heat exchanger
   c) Evaporator
   d) Distillation column
   e) Batch reactor.

**Text Book:**
1. Process Equipment Design by M. V. Joshi
2. Chemical Process Equipment Design and Drawing, S.C. Maidargi, PHI, 2013

**Reference**:
1. Process Equipment Design by Brownell and Young
2. Chemical Process Equipment Design by Bhattacharya
3. Process Equipment Design by Wallas

**Pre-requisite:** Chemical Process equipment design

**Outcome:**

- Students would gain knowledge to develop key concepts and techniques to design the process equipment in a process plant. These key concepts would be utilized to make design and operating decisions.

**JNTUA College of Engineering (Autonomous), Ananthapuramu**

**IV Year B.Tech. Chem. Engg. I-Sem**

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## SIMULATION LAB (15A08708)

**Objective**: To make the student familiar with software's and simulation of chemical processes equipments.

The following experiments have to be conducted using C and MATLAB

1. General introduction to MATLAB
2. Functions (log, exp, conv, roots).
3. Matlab Scripts and function files
4. Gravity Flow tank.
5. Three CSTRs in series – open loop
6. Three CSTRs in series – Closed loop
7. Non isothermal CSTR
8. Binary Distillation column
9. Batch Reactor isothermal; Batch reactor non isothermal – closed loop
10. Isothermal batch reactor – open loop
11. Heat Exchanger
12. Interacting System- two tank liquid level
13. Non interacting system-two tank liquid level
14. Plug flow reactor
15. Bubble point calculations
16. Dew point calculations

**TEXT BOOKS**:

1. A Guide to MATLAB for Chemical Engineering Problem Solving, Kip D. Hauch
2. Understanding MATLAB A Textbook for Beginners by S.N. Alam

**Pre-requisite**: Fluid mechanics for chemical Engineers, Process Heat transfer, Mass transfer operation- 1 & 2, Chemical Reaction Engineering.

**Outcomes:**

1. Helps to interconnect knowledge of mathematics, science, and engineering to real world problems.
2. Helps to identify, formulate, and solve engineering problems
   (for ex: most of chemical engineering problems are based on transport equations consisting broader areas of kinetics, thermodynamics and mass transfer which can be thoroughly solved using MATLAB inbuilt functions)
   - The complex multi component distillation column design can be modeled and simulated
   - System of ordinary and partial differential equations obtained in multiple reactors in series/parallel can be solved
   - Process control and optimization of reactors can be handled easily
3. "Genetic algorithms" can be implemented at a more pronounced way via MATLAB to solve various linear and non linear models of chemical engineering systems.
4. Most fascinating approach of Artificial Neural Networks (ANN) for electrical related concepts of chemical engineering systems can also be well handled in MATLAB
5. Steady state and unsteady state problems of chemical engineering and allied fields can be modeled and solved using MATLAB

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**Project Work Part - A (15A08709)**

**JNTUA College of Engineering (Autonomous), Ananthapuramu**

**IV Year B.Tech. Chem. Engg. II-Sem**

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**DESIGN AND ANALYSIS OF EXPERIMENTS (15A08801a)**

**Elective – II**

## Objectives:

- Which factors affect a given experiment?
- Find the most significant factor for an experiment.
- Calculate the factor levels that optimize the outcome of an experiment.
- Factorial Design of experiments.

**UNIT- I**

Introduction to probability, probability laws, Baye's theorem.Probability distributions, parameters and statistics.Normal and t-distributions, central limit theorem, random sampling and declaration of independence significance tests

**UNIT- II**

Randomization and blocking with paired comparisons significance tests and confidence interval for means, variances, proportions and frequencies.

**UNIT-III**

Analysis of variance, experiments to compare k-treatment means, Two-way factorial designs, blocking, Yate's algorithm

**UNIT- IV**

Fractional factorial designs at two levels, concept of design resolution, Simple modeling with least squares (regression analysis), Matrix versions of normal equations

**UNIT- V**

Mechanistic model building, Empirical and mechanistic models, model building process, model testing with diagnostic parameters.

**Text Book:**

1. Statistics for experimenters by G.E.P. Box, William G. Hunter and J.S. Hunter, John Wiley & Sons.

**Reference:**

1. "Design and analysis of experiments" by D.C. Montgomery, 2nd edition John Wiley and sons, NewYork (1984).

**<u>Outcome</u>:**

- Predict how many numbers of experiments are to be carried out, given the number of important factor
- Design an experiment and calculate the factor levels that optimize a given objective.
- Use response surface methodology to optimize the process, by considering curvature effects.
- Understand strategy in planning and conducting experiments
- Choose an appropriate experiment to evaluate a new product design or process improvement

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**IV Year B.Tech. Chem. Engg. II-Sem**

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**INDUSTRIAL SAFETY AND HAZARD MANAGEMENT (15A08801b)**
**ELECTIVE-II**

**OBJECTIVES:**
- Have awareness of different hazards in process industries
- Classification of hazards and their identifications
- Precautions in chemical storage and handling
- Learn risk analysis techniques and quantify them
- Learn emergency management plans

**Unit – I**
Introduction, Factors Contributing to the Costs of Accidents, List of some Notable accidents in the process industry/selected case histories, some common features of high cost accidents, reasons for high priority towards safety.

**Unit – II**
Material hazards1: Introduction Hazardous substances-categories, Toxicity, Radiation, Flammability, Ignition, Fires and explosions.

**Unit – III**
Material hazards 2: Fire balls, Fire damage, run away chemical reaction, incompatible materials, material safety and data sheets
Process and plant Hazards: Hazards of pressure, causes of over pressures, flow deviations, effects of leakages/releases, hazards of temperatures.

**Unit – IV**
Hazard analysis: process safety management, process hazards analysis, hazards analysis methods, check list, preliminary hazard analysis, what-if / check list, hazard and operability analysis, FMEA, Fault tree analysis, cause and consequence analysis.

**Unit – V**
Preventive and protective measures: Safety options, process safety approaches, inherent safety and design, plant layout, inherent security, explosion prevention and protection, personal protective systems, plant modifications and management change, relief valves and rupture discs, breather vents for storage tanks, explosions vents, flame arresters, flare systems

**TEXT BOOK:**
1. Chemical process industry safety by K S N Raju, Mc-Graw Hill education (India) Pvt.Ltd,2014

2. Chemical process Safety by Crowl

**REFERENCES:**

1. Chemical process safety by sanders

**<u>Outcome</u>:**

- The student will be equipped with the knowledge by which thorough safety is ensured in the organization.
- Classify and identify hazards in chemical industries
- Take precautions in chemical storage and handling
- Perform fault tree and event tree risk analysis and quantify them
- Suggest and make others in the plant about emergency management plans

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**IV Year B.Tech. Chem. Engg. II-Sem** **L P C**
**3+1* 0 4**

**CHEMICAL PLANT UTILITIES (15A08801c)**
**ELECTIVE – II**

**UNIT- I**
STEAM, COMPRESSORS AND VACUUM PUMPS
Steam generation and its application in chemical process plants, steam distribution including appropriate mechanical valves and instrumentation, steam utilization, design of efficient steam heating systems, steam nozzles. Compressed air, process pumps, compressors, vacuum pumps, pressurized air distribution systems. Types of compressors and vacuum pumps.

**UNIT- II**
REFRIGERATION SYSTEMS AND INSULATION
Refrigeration system and their characteristics, load calculation and load calculation and humidification and de humidification equipments, drying and cooling tower, air blending, exhaust, ventilation, cryogenics, their characteristics and production of liquid N2 and O2 Importance of insulation for meeting for the process equipment, insulation material and the air effect on various materials of equipment piping, fitting and valves, insulation for high, intermediate, low and sub zero temperatures including cryogenic insulation, determination of optimum insulation thickness.

**UNIT –III**
WATER
Water Resources, process water, boiler feed water, storage and distribution of water, reuse and conservation of water.

**UNIT- IV**
PIPING
Piping: Role & scope of piping, line diagram, Process flow diagram and piping and instrumentation diagram

**UNIT- V**
PINCH ANALYSIS
Problem representation, temperature enthalpy diagram, simple match matrix. Heat content diagram, Temperature interval diagram. Heat Exchanger Network Synthesis using Pinch technology

**TEXT BOOK**
1.Jack Broughton,Process Utility Systems:Introduction to Design, Operation and Maintenance ,IChemE, 1994

**REFERENCES**
1.Mahesh Rathore,“Thermal Engineering,”Tata McGraw Hill India, New Delhi,2010
.
2.Robin M. Smith,“Chemical Process: Design and Integration”,John Wiley &Sons Ltd., 2005

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**INDUSTRIAL POLLUTION & CONTROL ENGINEERING (15A08802a)**
**ELECTIVE-III**

**OBJECTIVES:** The aim of this course is that the students will learn the essential principles used in industrial pollution abatement and understand important issues in industrial pollution abatement and pertinent environmental legislations.

**UNIT I**

Types of emissions from chemical industries and effects of environment, environment legislation, Type of pollution, sources of wastewater, Effluent guidelines and standards.
Characterization of effluent streams, oxygen demands and their determination (BOD, COD, and TOC), Oxygen sag curve, BOD curve mathematical, controlling of BOD curve, self purification of running streams, sources and characteristics of pollutants in fertilizer, paper and pulp industry, petroleum and petroleum industry.

**UNITII**

General methods of control and removal of sulfur dioxide, oxides of nitrogen and organic vapors from gaseous effluent, treatment of liquid and gaseous effluent in fertilizer industry.
Air pollution sampling and measurement: Types of pollutant and sampling and measurement, ambient air sampling: collection of gaseous air pollutants, collection of particulate air pollutants. Stack sampling: sampling system, particulate sampling, and gaseous sampling. Analysis of air pollutants: Sulphur dioxide, nitrogen oxides, carbon monoxide, oxidants and Ozones, hydrocarbons, particulate matter.

**UNIT III**

Air pollution control methods and equipments: Source collection methods: raw material changes, process changes, and equipment modification. Cleaning of gaseous equipments particulate emission control: collection efficiency, control equipment like gravitational settling chambers, Cyclone separators, fabric filters, ESP and their constructional details and design aspects. Scrubbers: wet scrubbers, spray towers, centrifugal scrubbers, packed beds and plate columns, venturi scrubbers, their design aspects. Control of gaseous emissions: absorption by liquids, absorption equipments, adsorption by solids, equipment and the design aspects.

**UNIT IV**

Introduction to waste water treatment, biological treatment of wastewater, bacterial and bacterial growth curve, aerobic processes, suspended growth processes, activated aerated lagoons and stabilization ponds,
Attached growth processes, trickling filters, rotary drum filters, anaerobic processes.

**UNIT V**

Methods of primary treatments: screening, sedimentation, flotation, neutralization, and methods of tertiary treatment. A brief study of carbon absorption, ion exchange, reverse osmosis, ultra filtration, chlorination, ozonation, treatment and disposal.

Hazardous waste management: Nuclear wastes: health and environment effects, sources and disposal methods. Chemical wastes: health and environmental effects, treatment and disposal:treatment and disposal by industry, off site treatment and disposal, treatment practices in various countries. Biomedical wastes: types of wastes and their control.

**TEXT BOOKS:**

1. Environmental Pollution and Control Engineering, C. S. Rao – Wiley Eastern Limited, India, New Delhi, 1993.
2. Pollution Control in Process Industries, S.P. Mahajan, Tata McGraw-Hill, New Delhi, 1985.

**REFERENCES:**

1. Wastewater Treatment, M. Narayana Rao and A.K.Datta, Oxford and IHB publ. New Delhi.

**OUTCOMES:**

2. Understand the different types of wastes generated in an industry, their effects on living and non-living things.
3. Understand environmental regulatory legislations and standards and climate changes.
4. Understand about the quantification and analysis of wastewater and treatment.
5. Understand the different unit operations and unit processes involved in conversion of highly polluted water to potable standards.
6. Understand the atmospheric dispersion of air pollutants, and operating principles, design calculations of particulate control devices.

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## COMPUTATIONAL FLUID DYNAMICS (15A08802b)
## ELECTIVE-III

**UNIT I - CONSERVATION LAWS OF FLUID MOTION**
Governing equations of fluid flow and heat transfer - Equation of state – Navier Stokes equations for a Newtonian fluid – Governing equations of the flow of compressible Newtonian fluid – Differential and integral forms of the general transport equations.

**UNIT II - FINITE VOLUME METHOD FOR DIFFUSION PROBLEMS**
One-dimensional, two dimensional and three dimensional steady state diffusion problems – One dimensional unsteady heat conduction.

**UNIT III - THE FINITE VOLUME METHOD FOR CONVECTIVE-DIFFUSION PROBLEMS**
Steady one-dimensional convective and diffusion – Assessment of the central differencing scheme for convective diffusion problems – The upwind differencing scheme – The hybrid differencing scheme – Higher order differencing schemes for convective diffusion – Discretisation of transient convection-diffusion equation

**UNIT IV - SOLUTION ALGORITHMS FOR PRESSURE-VELOCITY COUPLING IN STEADY FLOWS**
Introduction – The staggered grid – The momentum equations – The SIMPLE algorithm – The SIMPLER algorithm – The SIMPLEC algorithm – The PISO algorithm – Transient SIMPLE algorithm

**UNIT V - SOLUTION OF DISCRETISED EQUATIONS**
Introduction – The tri-diagonal matrix algorithm – Application of TDMA to two dimensional problems – Application of the TDMA method to three-dimensional problems

**TEXT BOOK**

1. Versteeg. H. K and Malalasekera. W. "*An introduction to computational fluid dynamics – The finite volume method*", Longman Group Ltd 1995

**REFERENCES**

1. Ferziger. J.H, and Peric. M. "*Computational Methods for Fluid Dynamics*," Springer, 2002

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**IV Year B.Tech. Chem. Engg. II-Sem**

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**INTRODUCTION TO STATISTICAL THERMODYNAMICS (15A08802C)**
**ELECTIVE-III**

**UNIT I - CASCADES**
Typical cascade configurations, Solid-liquid cascades, Single-section Liquid-Liquid extraction cascades, Degrees of freedom and specifications for countercurrent cascades.

**UNIT II - APPROXIMATE METHODS FOR MULTICOMPONENT, MULTISTAGE SEPARATIONS**
Fenske-Underwood – Gilliland Method, Kremser Group Method.

**UNIT III - EQUILIBRIUM – BASED METHODS FOR MULTICOMPONENT ABSORPTION, STRIPPING AND EXTRACTION**
Theoretical Model for an Equilibrium Stage, General Strategy of Mathematical Solution, Equation – Tearing Procedures – Tridiagonal Matrix Algorithm, Bubble Point Method for Distillation.

**UNIT IV - ENHANCED DISTILLATION**
Use of triangular graphs – Extractive Distillation, Azeotropic Distillation, Reactive Distillation.

**UNIT V - ADSORPTION**
Equilibrium Consideration – Liquid adsorption, Kinetic and Transport Considerations.

**TEXT BOOK**
1. Treybal. R .E, "*Mass Transfer Operations*", 3rd Edition, McGraw Hill, 1980.

**REFERENCES**
1. Seader. J D, & E J Henley, "*Separation Process Principles*", John Wiley & Sons Inc., 1998.

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**IV Year B.Tech. Chem. Engg. II-Sem** **L P C**
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**FLUIDIZATION ENGINEERING (15A08803a)**
**ELECTIVE –IV**

**UNIT I**

**Introduction:** The phenomenon of fluidization; liquid like behavior of a fluidized bed; Comparison with other contacting methods; Advantages and disadvantages of fluidized beds

**Industrial applications of fluidized beds:** Coal gasification; gasoline from other petroleum fractions; Gasoline from natural and synthesis gases; Heat exchange; Coating of metal objects with plastics; Drying of solids; Synthesis of phthalic anhydride; Acrylonitrile; Polymerization of olefins; FCCU; Fluidized combustion of coal; incineration of solid waste; Activation of carbon; gasification of waste; bio-fluidization.

**UNIT II**

**Fluidization and mapping of regimes:** Minimum fluidization velocity; Pressure drop vs. velocity diagram; effect of temperature and pressure on fluidization; Geldart classification of particles; terminal velocity of particles, Transport disengaging height; turbulent fluidization; pneumatic transport of solids; fast fluidization; solid circulation systems; Voidage diagram; Mapping of regimes of fluidization.

**UNIT III**

**Bubbles in dense bed:** Single rising bubbles; Davidson model for gas flow at bubbles; Evaluation of models for gas flow at bubbles.

**Bubbling Fluidized beds:** Experimental findings; Estimation of bed Voidages; Physical models: simple two phase model; K-L model.

**UNIT IV**

**High velocity Fluidization:** Turbulent fluidized bed; Fast fluidization pressure drop in turbulent and fast fluidization.

**Solids Movement, Mixing, Segregation and staging:** Vertical movement of solids; Horizontal movement of solids; Staging of fluidized beds.

**UNIT V**

**Gas Dispersion and Gas interchange in Bubbling Beds:** Dispersion of gas in beds; Gas interchange between bubble and emulsion; Estimation of gas interchange coefficients.

**Particle to Gas Mass Transfer:** Experimental interpolation of mass transfer coefficients; Heat transfer; Experimental heat transfer from the bubbling bed model.

**TEXT BOOKS**

1. Fluidization Engineering by Kunil, Diazo and Octave Levenspiel, John Weiley& Sons Inc, Newyork, 1969.

2. Fluidization Engineering by J.R. Howard, Adam Heilgar

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**INTERFACIAL ENGINEERING (15A08803b)**

**Elective- IV**

**(Qualitative Treatment only)**

## Objectives:

1. Importance of various components of interfacial science in different chemical engineering industries viz. food, paint and pharmaceutical industries are emphasized.
2. The properties and functioning of surfactants and detergency are made familiarized. Interfacial and vander Waals forces play important role in the nano particles

**UNIT-I:**

Basic concepts of Colloids and Interfaces: Introduction, Examples of Interfacial Phenomena, Solid-Fluid Interfaces, Colloids.Properties of Colloid Dispersions: Introduction, Sedimentation under Gravity, Sedimentation in a Centrifugal Field, Brownian Motion, Osmotic pressure, Optical properties, Electrical Properties, Rheological Properties of Colloid Dispersions.

**UNIT-II:**

Surfactants and their properties: Introduction, Surfactants and their Properties, Emulsions and Microemulsions, foams.

**UNIT-III:**

Surface and Interfacial Tension: Introduction, Surface tension, Interfacial Tension, Contact Angle and Wetting, Shape of the Surfaces and interfaces.Measurement of Surface and Interfacial Tension, Measurement of Contact Angle;

**UNIT-IV:**

Intermolecular and Surface Forces: Introduction, Vanderwalls Forces.Intermolecular and Surface Forces: Electrostatic double layer force, The DLVO theory, Non-DLVO forces.

**UNIT-V:**

Adsorption at interfaces: Introduction, The Gibbs Dividing surface, Gibbs Adsorption Equation, Langmuir and Frumkin Adsorption Isotherms, Surface Equation of state(EOS), Effect of Salt on Adsorption of Surfactants.Adsorption Isotherms incorporating the Electrostatic Effects, Calculation of Free energy of Adsorption.

**TEXT BOOKS:**

1. **Foundations of Colloid Science by** R. J. Hunter, 2nd edition, Oxford University Press, USA, 2001.
2. **Principles of Colloid and Surface Chemistry**, Third edition, Revised and Expanded, Paul C. Hiemenz and Raj Rajagopalan.

3. **Physical Chemistry of Sciences**, 6th edition, A. Adamson, 1997.
4. **Interfacial Science: An Introduction by** G.Barnes, I.Gentle, Oxford University Press, USA, 2006.
5. **Coloid and Interface Science by** Pallab Ghosh, PHI, NEWDELHI.

**Outcomes:**

1. Realize the factors influencing stability of dispersions & emulsions.
2. Get the knowledge to measure surface tension & contact angle and apply them for practical problems.
3. Comprehend about detergency, surfactants and their applications.

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**IV Year B.Tech. Chem. Engg. II-Sem**

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**POLYMER TECHNOLOGY (15A08803c)**

**Elective- IV**

**OBJECTIVES:**

To enable the students to compute molecular weight averages from the molecular weight distribution, Condensation polymerization and transition in polymers

**Unit I**

Introduction; definitions: polymer& macro molecule, monomer, functionality, average functionality, co-polymer, polymer blend., plastic and resin. Classification of polymers: based on source, structure, applications, thermal behavior, mode of polymerization. Concept of average molecular weight of polymers, molecular weight distribution, poly disparity index. Determination of average molecular weights: End group analysis, osmometry, light scattering techniques, viscometer, Gel permeation chromatography.

**Unit II**

Natural polymers: brief study of i) Natural rubber ii) shellac iii) rosin iv) cellulose v) proteins.

Mechanism and kinetics of: Addition or chain polymerization

a) Free radical addition polymerization b) Ionic addition polymerizations

c) Coordination polymerization d) Coordination or step growth or condensation polymerization.

**Unit III**

Methods of polymerization: mass or bulk polymerization process, solution polymerization process, suspension polymerization process and emulsion polymerization method comparison of merits and demerits of these methods. Properties of polymers: crystalline and amorphous status, melting and glass transition temperatures and their determination, effect of polymer structure on mechanical, physical, chemical and thermal properties.

**Unit IV**

Degradation of polymers, Role of the following additives in the polymers: i) Fillers and reinforcing fillers ii) Plasticizers iii) Lubricants iv)Antioxidants and UV stabilizers v) Blowing agents vi)Coupling agents vii)Flame retardants viii) Inhibitors

Brief description of manufacture, properties and uses of: i) Polyethylene (HDPE&LDPE), ii) Poly propylene iii) Polyvinylchloride iv) Polystyrene v) Polytetra fluoroethylene vi) Polymethyl mehacrylate vii) Polyvinylacetate & Polyvinylalcohol.

**Unit V**

Brief description of manufacture, properties and uses of: i) Polyesters (Polyethylene terephthalate polycarbonate and unsaturated polyesters) ii) Nylon(Nylon 66) iii) Phenol-Formaldehyde resins iv) Epoxy resins v) Polyurethane vi) Silicones

Compounding of polymer resins, brief description of: i) Compression and transfer moulding ii) Injection moulding iii) Extrusion iv) Blow moulding v) Calendaring vi) Laminating and pultrusion

**TEXT BOOKS:**

1. Polymer Science & Technology, 2nd ed., J.R. Fried, PHI Learning Pvt. Ltd., New Delhi, 2009
2. Plastic materials, J.A. Brydson, Newnes-Butterworth (London) 1989.

**REFERENCES:**

1. Text book of polymer science, F.W.Jr. Bill Meyer, (3rd ed.) John Wiely&sons 1984
2. Introduction to Plastics, J.H. Brison and C.C. Gosselin, Newnes-Butterworth, London 1968.

**Outcome:**

- Classify the polymers and also able to identify the structural configurations of any polymer.
- Distinguish the modification of a polymer and also in a position to examine the mechanism of a polymerization.
- Synthesize any elastomer and optimize their deformation properties on applying force.
- Explain the processing of polymer, identify the mode of deformation of a polymer and test the mechanical strength of a polymer.

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**IV Year B.Tech. Chem. Engg. II-Sem L P C**
**3+1* 0 4**

**PETROLEUM REFINING AND PETROCHEMICALS (15A08804a)**
**ELECTIVE –V**

**OBJECTIVES:**

- Learn the formation, refining of crude oil and products of refinery.
- Understand the means of processing data including thermal properties, important products characteristics.
- Develop skills in drawing neat flow diagrams of different petroleum refining processes
- (cracking/reforming/alkylation/isomerization / hydrocracking etc.,) that are aimed at producing high value/demand products.
- Identify important testing methods for important petroleum products.
- Have idea on Indian standards for major petroleum products

**UNIT-I:**

Origin, formation and composition of petroleum: Origin and formation of petroleum, Reserves and deposits of world, Indian Petroleum Industry. Petroleum processing data: Evaluation of petroleum, thermal properties of petroleum fractions, important products, properties and test methods.

**UNIT-II:**

Fractionation of petroleum: Dehydration and desalting of crudes, heating of crude pipe still heaters, distillation of petroleum, blending of gasoline. Treatment techniques: fraction-impurities, treatment of gasoline, treatment of kerosene, treatment of lubes.

**UNIT-III:**

Thermal and catalytic processes: Cracking, catalytic cracking, catalytic reforming, Naphtha cracking, coking, Hydrogenation processes, Alkylation processes, Isomerization process.

**UNIT-IV:**

Petrochemical Industry – Feed stocks Chemicals from methane: Introduction, production of Methanol, Formaldehyde, Ethylene glycol, PTFE, Methylamines.

**UNIT-V:**

Chemicals from Ethane-Ethylene-Acetylene: Oxidation of ethane, production of Ethylene, Manufacture of Vinyl Chloride monomer, vinyl Acetate manufacture, Ethanol from Ethylene, Acetylene manufacture, Acetaldehyde from Acetylene.

**TEXT BOOKS:**

1. Nelson. W.L. "Petroleum refining Engineering", 4 Edition, Mc Graw Hill, New York, 1969.

2. Rao, B.K.B. "Modern Petroleum Refining Processes", 4 Edition, Oxford and IBH Publishing, 2002.

**REFERENCES:**

1. Goldstine. R.F. "The Petroleum Chemicals Industry", Taylor and Francis, London, 1967.

2. Gruese. W.S.and Stevens, D.R. "Chemical Technology of Petroleum", McGraw Hill, 1980.

3 Chauvel. A. and Lefevrev, "Petro Chemicals", Volume 1 and 2, Gulf Publishing company 1989.

**Outcomes:**

- Describe the formation of crude oil, its refining techniques.
- Describe the chemical composition and physical properties of crude oil
- Understand various processes employed in petroleum refinery such that we can meet customer demand in terms of quality & quantity.
- Demonstrate the different methods available for removal of impurities from crude and products manufacture
- Understand, draw and describe the process flow diagrams of various refinery processes like distillation, cracking and reforming etc.,
- Understand the difference between thermal and catalytic cracking.

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**FOOD PROCESSING TECHNOLOGY ( 15A08804b)**

**Elective – V**

**Objectives:** To impart knowledge to the students about food processing and various unit operations involved in it, packaging, storing and preservation.

**UNIT I**

**Food process engineering - Fundamentals**: Fundamentals of food process engineering, application of quantitative methods of material and energy balances in food engineering practices.

**UNIT II**

**Unit Operations in food industries**: Fluid flow, thermal process calculations, refrigeration, evaporation and dehydration operations in food processing.

**UNIT III**

**Microwave heating:** Theory of microwave heating, microwave properties of foods, comparison of microwave and conventional heating, benefits of microwave heating, applications in food processing, microwave heating equipment, hazards of microwave heating.

**UNIT IV**

**Mechanical Operations in food processing**: Conversion operations, Size reduction and screening of solids, mixing and emulsification, filtration and membrane separation, centrifugation, crystallization, extraction.

**UNIT V**

**Preservation operations:** Preservation methods & Strategies, Thermal Methods, Nabla Factor Sterilization Types Pasteurization Dehydro freezing Irradiation Dosimetry Transport of food & Preservation strategies Cheap and applicable everywhere.

**TEXT BOOKS**

1. R. T. Toledo, "Fundamentals of Food Process Engineering", AVI Publishing Co., 1980.
2. R. Angold,G.Beech and J.Taggart, " Food Biotechnology", Cambridge University Press, 1989.
3. Fundamentals of Food Engineering, D G Rao, PHI, New Delhi, 2012.

**REFERENCES**

1. J. M. Jackson and B. M. Shinn, "Fundamentals of Food Canning Technology", AVI Publishing Co., 1978.
2. J. G. Bernnan, J. R. Butters, N. D. Cowell and A.E.V.Lilley, "Food Engineering Operations", $2^{nd}$Edn., Applied Science, 1976.

**Outcomes:**

1. Understanding the various causes of food deterioration and food poisoning.
2. Identification of appropriate processing, preservation, and packaging method.
3. Analyze product quality and effect of processing technique on it.

**JNTUA College of Engineering (Autonomous), Ananthapuramu**

**IV Year B.Tech. Chem. Engg. II-Sem** **L P C**
**3+1* 0 4**

**RHEOLOGY OF POLYMERS (15A08804c)**
**Elective – V**

**Unit I**

Stress tensor, principal stress and invariants, polar decomposition theorem, finger tensor, strain tensor, inverse deformation tensors, principal strains, uniaxial extension and simple shear in neo-hookean solid, rate of deformation tensor, Newton's law in three dimensions, uniaxial extension, viscosity models for general viscous fluids and visco-plastic models.

**Unit II**

General linear viscoelastic model, stress relaxation and creep, non-linear viscoelasticity - normal stress difference in shear, shear thinning, interrelations between shear functions, extensional thickening, differential-type constitutive equations - single mode differential constitutive equations and multimode constitutive equations for viscoelastic fluids, integral type constitutive equations, rate-type constitutive equations for viscoelastic fluids.

**Unit III**

Shear rheometer: sliding plates, falling ball rheometer, concentric cylinder rheometer, cone and plate rheometer, parallel disks, capillary rheometer, slit rheometer and squeezing flow behavior.

**Unit IV**

Rheology of polymeric liquids: polymer chain conformation, zero shear viscosity, rheology of dilute polymer solutions, entanglement, Reptation Model, effect of long chain branching, effect of molecular weight distribution, temperature dependence.

**Unit V**

Rheology in polymer processing operations: Calendaring and two roll mill, Twin screw extruders, Blow molding, Wire coating, Thermoforming, Sheet extrusion, Internal mixers, Rubber extrusion

**Reference books:**

1. Rheology, Principles, Measurements and Applications, Christopher W. Macasko, WileyVCH,1994
2. Rheology and Processing of Polymeric Materials, Vol. 1, Oxford University Press, 2007
3. Rheology: Concepts, Methods, and Applications, Prof. Dr. Alexander Ya. Malkin, Prof. Dr. Avraam I Isayev, ChemTec Publishing, 2006

4. Dynamics of Polymeric Liquid, Volume I, R. Byron Bird, Robert C Armstrong, Ole Hassager, John Wiley and Sons, 1976
5. Polymer Processing Fundamentals, Tim A Osswald, Hanser Publishers, Munich, 1998.
6. Melt Rheology and its Role in Plastic Processing: Theory and applications, John M. Dealy, Kurt F. Wissbrun, Reprinted by Chapman and Hall,1999.

**JNTUA College of Engineering (Autonomous), Ananthapuramu**

**IV Year B.Tech. Chem. Engg. II-Sem**

| L | P | C |
|---|---|---|
| 3+1* | 0 | 4 |

**CORROSION ENGINEERING (15A08804d)**

**Elective – V**

**OBJECTIVES:**

The course will enable the students to:

1. Be introduced to the principles of electrochemistry as well as the essential elements of electrochemical corrosion.
2. Lay a foundation for understanding the forms of corrosion, the mechanisms of corrosion, electrochemical methods.
3. Develop the thermodynamic and kinetic aspects of electrochemistry, including potential-pH (Pourbaix) diagrams, mixed potential theory, and the theory and application of polarization.
4. Design methods for combating corrosion, the principles and methods leading to mitigation of corrosion problems that might occur in engineering practice.

**UNIT- I:**

**Introduction**

Definitions of Corrosion - Overall classification of types of corrosion-Basic electrochemistry – Galvanic and electrolytic cells – Potential measurements - EMF and Galvanic series – Galvanic corrosion and bimetallic contacts – Eh – pH diagrams, Cost of Corrosion, Metallurgical properties influencing corrosion.

**UNIT-II:**

**Forms of Corrosion**

Uniform attack, galvanic, crevice, pitting, Inter granular, selective leaching, erosion and stress corrosion – Mechanisms, testing procedures and their protection.

**UNIT- III:**

**Electrode kinetics and polarization phenomena**

Electrode – solution interface – Electrode kinetics and polarization phenomena – Exchange current density – Polarization techniques to measure corrosion rates – Mixed potential theory – Activation and diffusion controlled mixed electrodes.

**UNIT IV:**

**Methods of corrosion prevention and control**

Design, coatings and inhibition – Cathodic protection – Stray current corrosion – Passivity phenomena and development of corrosion resistant alloys – Anodic control.

**UNIT-V:**

**Industry Approach**

Selection for a given Chemical Engineering Service Environment- Materials for Chemical Engineering Industry to resist the given chemical Environment.-Ferritic, Austenitic steels and stainless steels- Copper and its alloys-Brasses, bronzes, Nickel and its alloys- Monel alloys-materials for a petroleum refinery industry.

**TEXT BOOKS:**

1. M. G. Fontana, Corrosion Engineering (Third Edition) McGraw-Hill Book Company.
2. Denny A Jones, Principles and Prevention of Corrosion (second edition), Prentice-Hall, N. J. (1996).

**REFERENCE:**

1. H. H. Uhlig and R. W. Revie, Corrosion and Corrosion Control, Wiley (NY) (1985).

**Outcomes:**

At the end of the course, the students will be able to:
1. Understand the electrochemical and metallurgical behavior of corroding systems.
2. Apply the electrochemical and metallurgical aspects of combating eight forms of corrosion.
3. Select or choose the testing procedures for corroding systems.
4. Evaluate the polarization behavior of corroding systems.
5. Design of suitable materials, methods to combat corrosion.
6. Predict the function of corrosion inhibitors.

**JNTUA College of Engineering (Autonomous), Ananthapuramu**

**IV Year B.Tech. Chem. Engg. II-Sem**

| L | P | C |
|---|---|---|
| 0 | 4 | 2 |

## SEMINAR (15A08805)

**JNTUA College of Engineering (Autonomous), Ananthapuramu**

| IV Year B.Tech. Chem. Engg. II-Sem | L | P | C |
|---|---|---|---|
| | 0 | 20 | 10 |

**PROJECT WORK (15A08806)**

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR**
**COLLEGE OF ENGINEERING (Autonomous), ANANTHAPURAMU**
**B.Tech (Chemical Engineering) :2017-18**
**COURSE STRUCTURE**

**I YEAR I Semester**

| S.No | Subject code | Subject | L | T | P | C |
|---|---|---|---|---|---|---|
| 1 | 17A15501 | English | 3 | - | - | 3 |
| 2 | 17A15101 | Mathematics -I | 2 | 2 | - | 3 |
| 3 | 17A15302 | Physical Chemistry | 2 | 2 | - | 3 |
| 4 | 17A10101 | Environmental Studies | 3 | - | - | 3 |
| 5 | 17A10103 | Engineering Mechanics& Strength of Materials | 2 | 2 | - | 3 |
| 6 | 17A10501 | Problem Solving & Computer Programming | 3 | - | - | 3 |
| 7 | 17A15304 | Physical Chemistry Lab | - | 1 | 3 | 2 |
| 8 | 17A13501 | Engineering Workshop & IT Workshop | - | 1 | 3 | 2 |
| 9 | 17A15502 | English Language Communication Skills Lab. | - | 1 | 3 | 2 |
| 10 | 17A10801 | Comprehensive Objective type Examination | - | - | - | 1 |
| | | Total | 15 | 8 | 9 | 25 |

**I YEAR II Semester**

| S.No | Subject code | Subject | L | T | P | C |
|---|---|---|---|---|---|---|
| 1 | 17A25501 | Technical Communication and Presentation Skills | 3 | - | - | 3 |
| 2 | 17A25101 | Mathematics -II | 2 | 2 | - | 3 |
| 3 | 17A25201 | Engineering Physics | 2 | 2 | - | 3 |
| 4 | 17A20303 | Engineering Drawing | 1 | 1 | 3 | 3 |
| 5 | 17A22401 | Elements of Electrical and Electronics Engineering | 3 | - | - | 3 |
| 6 | 17A20801 | Introduction to Chemical Engineering | 3 | - | - | 3 |
| 7 | 17A25202 | Engineering Physics Lab | - | 1 | 3 | 2 |
| 8 | 17A20504 | Computer Programing Lab | - | 1 | 3 | 2 |
| 9 | 17A22402 | Electrical and Electronics Engineering Lab | - | 1 | 3 | 2 |
| 10 | 17A29901 | Community Service (Audit) | - | - | 2 | - |
| 11 | 17A20304 | Comprehensive Objective type Examination | - | - | - | 1 |
| | | Total | 14 | 08 | 14 | 25 |

**JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS):: ANANTAPURAMU**

**CHEMICAL ENGINEERING DEPARTMENT**

**II YEAR I SEMESTER**

| S.No. | Subject code | Subject | L | T | P | C |
|---|---|---|---|---|---|---|
| 1 | 17A35102 | **Mathematical Methods** | 2 | 2 | - | 3 |
| 2 | 17A35301 | Organic Chemistry | 2 | 2 | - | 3 |
| 3 | 17A30801 | Chemical Process Calculations | 2 | 2 | - | 3 |
| 4 | 17A30802 | Momentum Transfer | 2 | 2 | - | 3 |
| 5 | 17A30803 | Material science for Chemical Engineers | 2 | 2 | - | 3 |
| 6 | 17A30804 | Process instrumentation | 2 | 2 | - | 3 |
| 7 | 17A39901 | **Human Values & Professional Ethics(Audit)** | 2 | - | - | - |
| 8 | 17A30104 | Organic Chemistry Lab | - | - | 2 | 1 |
| 9 | 17A30805 | Momentum Transfer Lab | - | - | 2 | 1 |
| 10 | 17A35104 | Exploratory Data Analysis | - | - | 2 | 1 |
| 11 | 17A30806 | **Comprehensive Objective type Examination** | - | - | - | 1 |
| | | **Total** | **14** | **12** | **6** | **22** |

**II YEAR II SEMESTER**

| S.No. | Subject code | Subject | L | T | P | C |
|---|---|---|---|---|---|---|
| 1 | 17A45402 | **Management Science** | 3 | - | - | 3 |
| 2 | 17A45102 | **Probability and Statistics** | 2 | 2 | - | 3 |
| 3 | 17A40801 | Analytical Chemistry | 2 | - | - | 2 |
| 4 | 17A40802 | Process Heat Transfer | 2 | 2 | - | 3 |
| 5 | 17A40803 | Mechanical Operations | 2 | 2 | - | 3 |
| 6 | 17A40804 | Chemical Engineering Thermodynamics | 2 | 2 | - | 3 |
| 7 | 17A40805 | **Mechanical Operations Lab** | - | 1 | 2 | 1 |
| 8 | 17A40806 | Process Heat Transfer Lab | - | 1 | 2 | 1 |
| 9 | 17A40807 | **Comprehensive Objective type Examination** | - | - | - | 1 |
| | | **Total** | **13** | **10** | **4** | **20** |

**III YEAR I SEMESTER**

| S.No | Subject code | Subject | L | T | P | C |
|---|---|---|---|---|---|---|
| 1 | 17A50801 | Process Dynamics & Control | 3 | - | - | 3 |
| 2 | 17A50802 | Phase and Chemical Equilibria | 3 | - | - | 3 |
| 3 | 17A50803 | Chemical Reaction Engineering-I | 2 | 2 | - | 3 |
| 4 | 17A50804 | Mass Transfer Operations-I | 2 | 2 | - | 3 |
| 5 | 17A50805 | Chemical Technology | 2 | 2 | - | 3 |
| 6 | 17A50806 | Process Modelling & Simulation | 3 | - | - | 3 |
| 7 | 17A59901 | **Foreign Language (Audit)** | 2 | - | - | - |
| 8 | 17A50807 | Process Dynamics & ControlLab | - | - | 4 | 2 |
| 9 | 17A50808 | Energy & Environmental Engineering Lab | - | - | 2 | 1 |
| 10 | 17A59902 | **Internship / Skill Development (Audit)** | - | - | - | - |
| 11 | 17A50809 | **Comprehensive Objective type Examination** | - | - | - | 1 |
| | | **Total** | **17** | **6** | **8** | **23** |

**III YEAR II SEMESTER**

| S.No. | Subject code | Subject | L | T | P | C |
|---|---|---|---|---|---|---|
| 1 | 17A60801 | Mass Transfer Operations-II | 3 | - | - | 3 |
| 2 | 17A60802 | Chemical Reaction Engineering-II | 2 | 2 | - | 3 |
| 3 | 17A60803 | Chemical Plant Design and Economics | 3 | - | - | 3 |
| | 17A60804 | Chemical Process Equipment Design | 3 | - | - | 3 |
| 4 | 17A60805 | Industrial Pollution Control Engineering | 3 | - | - | 3 |
| 5 | 17A60806 | **Open Elective I** | 2 | 2 | - | 3 |
| 6 | 17A65501 | **Advanced Communication Skills Lab** | - | 1 | 3 | 2 |
| 7 | 17A60807 | Mass Transfer Operation Lab | - | - | 2 | 1 |
| 10 | 17A60808 | Chemical Reaction Engineering Lab | - | - | 2 | 1 |
| 11 | 17A60809 | **Comprehensive Objective type Examination** | - | - | - | 1 |
| | | **Total** | **16** | **5** | **7** | **23** |

**Open Elective:**
1. **Basics of Nanotechnology**
2. **Green Technology**
3. **Nuclear Engineering**
4. **Solid Waste management**

**IV YEAR I SEMESTER**

| S.No. | Subject code | Subject | L | T | P | C |
|---|---|---|---|---|---|---|
| 1 | 17A70801 | Transport Phenomena | 4 | - | - | 4 |
| 2 | 17A70802 | Optimization of Chemical Processes | 4 | - | - | 4 |
| 3 | 17A70803 | Separation Processes | 3 | - | - | 3 |
| 4 | 17A70804 | Industrial Safety & Hazard Management | 3 | - | - | 3 |
| 5 | 17A70805 | **Open Elective-II** | 3 | - | - | 3 |
| 6 | 17A70806 | **Elective – I** | 3 | - | - | 3 |
| 7 | 17A79906 | **MOOC-I (Audit)** | - | - | - | - |
| 8 | 17A70807 | Process Equipment Design & Drawing Lab | - | 1 | 3 | 2 |
| 9 | 17A70808 | Process Simulation Lab | - | 1 | 3 | 2 |
| 10 | 17A70809 | **Comprehensive Objective type Examination** | - | - | - | 1 |
| | | **Total** | **20** | **2** | **6** | **25** |

**Open Elective-II:**
**1.Applied Numerical Methods**
**2. Computational Fluid Dynamics**
**3. Design & Analysis of Experiments**

**Elective I:**
**1. Energy Engineering**
**2. Non-Conventional Sources of Energy**
**3. Waste to Energy Conversion Technologies**

**Note: Project Work shall initiate in IV-I Semester with a target of submission of Abstract and finalization of topic, and the evaluation of project work shall be done in IV-II Semester**

*** The student should select the subject in the open elective which is not studied in previous semesters.**
**** The student can select the subject of any discipline for MOOC-I. However the agency will decide by the BoS Chair persons.**

**IV YEAR II SEMESTER**

| S.No. | Subject code | Subject | L | T | P | C |
|---|---|---|---|---|---|---|
| 1 | 17A80801 | **Elective – II** | 3 | - | - | 3 |
| 2 | 17A80802 | **Elective – III** | 3 | - | - | 3 |
| 3 | 17A80803 | **Elective – IV** | 3 | - | - | 3 |
| 4 | 17A80804 | **Elective – V** | 3 | - | - | 3 |
| 5 | 17A89906 | **MOOC-II(Audit)** | - | - | - | - |
| 6 | 17A80805 | **Seminar** | - | - | 2 | 1 |
| 7 | 17A80806 | **Project Work** | - | - | 16 | 8 |
| 8 | 17A80807 | **Comprehensive Objective type Examination** | - | - | - | 1 |
| | | **Total** | **12** | **-** | **18** | **22** |

***** The student should select the subject of discipline centric for MOOC-II. However the agency will decide by the BoS Chair persons.**

**Note:** All End Examinations (Theory and Practical) are of three hours duration.

**L – Lectures T- Tutorial P – Practical/Drawing C – Credits**

**Elective II:**
1. **Bio-Chemical Engineering**
2. **Industrial Biotechnology**
3. **Enzyme Engineering**

**Elective III:**
1. **Fluidization Engineering**
2. **Interfacial Engineering**
3. **Polymer Technology**

**Elective IV:**
1. **Technology of Pharmaceuticals & Fine Chemicals**
2. **Food Processing Technology**
3. **Corrosion Engineering**

**Elective V:**
1. **Petroleum Refining & Petrochemicals**
2. **Rheology of Polymers**
3. **Process Intensification**

**JNTUA College of Engineering (Autonomous),**

**Ananthapuramu**

**I Year B.Tech - I Semester**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**ENGLISH(17A15501)**
**(Common to all Branches)**

**OBJECTIVES:**

1. To enable the students to communicate in English for academic and social purpose
2. To enable the students to acquire structure and written expressions required for their profession.
3. To develop the listening skills of the students
4. To inculcate the habit of reading for pleasure
5. To enhance the study skills of the students with emphasis on LSRW skills

**SYLLABUS:**

**UNIT –I**

**Chapter entitled *Humour* from "Using English"**
**Chapter entitled '*Homi Jehangir Bhabha'* from "New Horizons"**

L- Listening -Techniques - Importance of phonetics
L- Meet & Greet and Leave taking, Introducing Oneself and Others (Formal and Informal situations)
R- -Reading Strategies -Skimming and Scanning
W- Writing strategies- sentence structures
G-Parts of Speech –Noun-number, pronoun-personal pronoun, verb- analysis
V-Affixes-prefix and suffix, root words, derivatives

**UNIT –II**

**Chapter entitled *Inspiration* from "Using English"**
**Chapter entitled 'My Struggle for an Education' from "New Horizons"**

L- Listening to details
S- Apologizing, Interrupting, Requesting and Making polite conversations
R-note making strategies
W- Paragraph-types- topic sentences, unity, coherence, length , linking devices
G-Auxiliary verbs and question tags
V- synonyms-antonyms, homonyms , homophones, homographs, words often confused

**UNIT –III**

**Chapter entitled *Sustainable Development* from "Using English"**
**Chapter entitled 'The Autobiography of Abraham Lincoln' from "New Horizons"**

L- Listening to themes and note taking

S- Giving instructions and Directions, making suggestions, Accepting ideas, fixing a time and Advising

R- Reading for details -1

W- Resume and cover letter

G- Tenses – Present tense, Past tense and Future tense

V-Word formation and One-Word Substitutes

## UNIT –IV

**Chapter entitled *Relationships* from "Using English"**

**Chapter entitled ' T*he Happy Prince* from "New Horizons"**

L- Listening to news

S- Narrating stories, Expressing ideas and opinions and telephone skills

R- Reading for specific details and Information

W- Technical Report writing-strategies, formats-types-technical report writing

G- Voice and Subject – Verb Agreement

V- Idioms and prepositional Phrases

## UNIT –V

**Chapter entitled Science and Humanism from "Using English"**

**Chapter entitled 'If'from "New Horizons"**

L- Listening to speeches

S- Making Presentations and Group Discussions

R- Reading for Information

W- E-mail drafting

G- Conditional clauses and conjunctions

V- Collocations and Technical Vocabulary and using words appropriately

**EXPECTED OUTCOME:**

The students will get the required training in LSRW skills through the prescribed texts and develop communicative competence

**Prescribed Books:**

1. **Using English (for detailed study)** published by Orient Black Swan, 2013
2. **New Horizons** published by Pearson, 2013

**Suggested Reading:**

1. **Raymond Murphy's English Grammar with CD,** Murphy, Cambridge University Press, 2012.
2. **English Conversation Practice –**Grant Taylor, Tata McGraw Hill,2009.
3. **Communication Skills, Sanjay Kumar & Pushpalatha** Oxford University Press, 2012.
4. **A Course in Communication Skills**- Kiranmai Dutt & co. Foundation Books, 2012.
5. **Current English grammar and usage-**S M Guptha, PHI, 2013.
6. **Modern English Grammar-**Krishna SWAMI .McMillan, 2009.
7. **Powerful Vocabulary Builder**- Anjana Agarwal New Age International Publishers, 2011.
8. **Writing with a Purpose, Tickoo and Sasi Kumar, OUP, 2011**
9. **Strengthen Your Writing, Orient Blackswan**

**JNTUA College of Engineering (Autonomous),**

**Ananthapuramu**

**I Year B.Tech - I Semester**

| L | T | P | C |
|---|---|---|---|
| 2 | 2 | 0 | 3 |

**MATHEMATICS – I(17A15101)**

(Common to All Branches)

**Objectives**

- To train the students thoroughly in Mathematical concepts of ordinary differential equations and their applications.
- To prepare students for lifelong learning and successful careers using mathematical concepts of differential and Integral calculus, ordinary differential equations and vector calculus.
- To develop the skill pertinent to the practice of the mathematical concepts including the students abilities to formulate and modeling the problems, to think creatively and to synthesize information.

**UNIT – I**

Exact, linear and Bernoulli equations, Applications to first order equations.

Non-homogeneous linear differential equations of second and higher order with constant coefficients with RHS term of the type $e^{ax}$, sin ax, cos ax, polynomials in x, $e^{ax}$ V(x), xV(x), method of variation of parameters, linear equations with variable coefficients: Euler-Cauchy Equations, Legendre's linear equation. Applications of linear differential equations- Mechanical and Electrical oscillatory circuits and Deflection of Beams.

**UNIT – II**

Taylor's and Maclaurin's Series - Functions of several variables – Jacobian – Maxima and Minima of functions of two variables, Lagrange's method of undetermined Multipliers with three variables only. Radius of curvature, center of curvature, Involutes, evolutes and envelopes..

**UNIT – III**

Curve tracing – Cartesian, polar and parametric curves. Length of curves, surface area of solid of revolution (single integrals)

**UNIT – IV**

Multiple integral – Double and triple integrals – Change of Variables – Change of order of integration. Applications to areas and volumes in Cartesian and polar coordinates using double and triple integral.

**UNIT – V**

Vector Calculus: Gradient – Divergence – Curl and their properties; Vector integration – Line integral - Potential function – Area – Surface and volume integrals. Vector integral theorems: Green's theorem – Stoke's and Gauss's Divergence Theorem (Without proof). Application of Green's, Stoke's and Gauss's Theorems.

**TEXT BOOKS:**

1. Engineering Mathematics-I, E. Rukmangadachari & E. Keshava Reddy, Pearson Publisher
2. Higher Engineering Mathematics, B.S.Grewal, Khanna publishers.

**REFERENCES:**

1. Engineering Mathematics Volume-I, by T.K.V. Iyengar, B.Krishna Gandhi, S.Ranganatham and M.V.S.S.N.Prasad, S.Chand publication.
2. Advanced Engineering Mathematics, by Erwin Kreyszig, Wiley India.
3. Higher Engineering Mathematics, by B.V.Ramana, Mc Graw Hill publishers.
4. Advanced Engineering Mathematics, by Alan Jeffrey, Elsevier.

**Outcomes:**

- The students become familiar with the application of differential and integral calculus, ordinary differential equations and vector calculus to engineering problems.
- The students attain the abilities to use mathematical knowledge to analyze, formulate and solve problems in engineering applications.

**JNTUA College of Engineering (Autonomous),**

**Ananthapuramu**

**I Year B.Tech - I Semester**

| L | T | P | C |
|---|---|---|---|
| 2 | 2 | 0 | 3 |

**PHYSICAL CHEMISTRY(17A15302)**

**Course Objectives:**

- To acquire basic knowledge of basic types of reactions
- To acquire knowledge about the mechanisms through which the chemical reactions proceed.
- To understand the impact of nature on metals.

**Unit-I: Kinetics**

Introduction to chemical kinetics-theories of reaction rates-Collision theories-Modified collision theory – Absolute reaction rate theory (Transition state theory)-reaction between ions, Chain reactions-Hydrogen and bromine, hydrogen and oxygen (Steady state treatment)-.explosion limits.

**UNIT-II: Colloids**

Definition of colloids, classification of colloids, solids in liquids (Sols) – properties, kinetics, optical and electrical, stability of colloids, protective action, Hardy-Schultze Law, Gold Number. Liquids in liquids (Emulsions) -Types of Emulsions, preparation, Emulsifier. Liquids in solids (Gels) – Classification, preparation & properties, Inhibition, General, applications of colloids.

**UNIT-III: Catalysis**

Definition-Homogeneous and heterogeneous Catalysis- Characteristics of a good catalyst-Theories of Catalysis: Intermediate compound formation theory and adsorption theory, relevant examples- Types of catalysis: Acid-base catalysis and enzymatic catalysis (10h)

**Unit-IV: Surface Chemistry**

Adsorption, characteristics of adsorption, physical & chemical adsorption, Langumuir adsorption isotherm, B.E.T. equation, BET plot, surface area determination of solids. Numerical calculations of surface area, Heterogenous catalysis, Mechanism of catalysis-Langmuir-Hinsel Wood mechanism of surface catalyzed reactions, Eley-Rideal mechanism surface catalysed reactions. Applications of catalysis in industry. (12h)

**UNIT-V: Electrochemistry**

i)Review of electrochemical cells, Numerical calculations, Batteries: Rechargeable batteries (Lead acid, Ni-Cd, Lithium Ion Batteries),Fuels cells: (Hydrogen-Oxygen and Methanol-Oxygen)

ii)Electrochemical sensors: Potentiometric Sensors and Voltammetric sensors. Examples : analysis of Glucose and urea iii)Corrosion: Electrochemical Theory of corrosion, Factors affecting the corrosion. Prevention: Anodic and cathodic protection and electro and electroless plating. (12h)

**Course Outcome:**

The student may acquire enough knowledge on industrial processes and Products

**BOOKS:**

1. Quantitative analysis, R.A.Day & A.L. Underwood , $5^{th}$ edition, Printice- Hall of India Pvt. Ltd., 2000.
2. Vogel's Text Book of Qualitative chemical analysis, J. Mendham, R.C.Denney, J. Darnes, M.J.K. Thomas, Persar education $6^{th}$ edition, 2002.
3. Elements of Physical Chemistry-Peter Atkins, Oxford Uni.Press, $3^{rd}$ Edition, 2010.

**REFERENCES:**

1. Atkin's Physical Chemistry – P. Atkins and J. De Paula, Oxford Univ.Press, $9^{th}$ Edition, 2012
2 Instrumental lMethods of Chemical Analysis, Gurdeep R.Chatwal, Sham K.Ananad, Himalayha publishing House,$5^{th}$ Edition, 2012.
3. Advanced physical chemistry – Gurudeepraj, Goel Publishing House, 2000
4. Essentials of Physical Chemistry- Arun Bahl, B.S.Bahl and G.D.Tuli, S.Chand Publishers, New Delhi.

**JNTUA College of Engineering (Autonomous),**

**Ananthapuramu**

**I Year B.Tech - I Semester**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**ENVIRONMENTAL STUDIES(17A10101)**
**(Common to all Branches)**

**OBJECTIVE:** To make the students to get awareness on environment, to understand the importance of protecting natural resources, ecosystems for future generations and pollution causes due to the day to day activities of human life to save earth from the inventions by the engineers.

**UNIT – I**

**MULTIDISCIPLINARY NATURE OF ENVIRONMENTAL STUDIES: –** Definition, Scope and Importance – Need for Public Awareness.

**NATURAL RESOURCES :** Renewable and non-renewable resources – Natural resources and associated problems – Forest resources – Use and over – exploitation, deforestation, case studies – Timber extraction – Mining, dams and other effects on forest and tribal people – Water resources – Use and over utilization of surface and ground water – Floods, drought, conflicts over water, dams – benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. – Energy resources:

**UNIT – II**

**ECOSYSTEMS:** Concept of an ecosystem. – Structure and function of an ecosystem – Producers, consumers and decomposers – Energy flow in the ecosystem – Ecological succession – Food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the following ecosystem:

a. Forest ecosystem.
b. Grassland ecosystem
c. Desert ecosystem
d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

**BIODIVERSITY AND ITS CONSERVATION :** Introduction 0 Definition: genetic, species and ecosystem diversity – Bio-geographical classification of India – Value of biodiversity: consumptive use, Productive use, social, ethical, aesthetic and option values – Biodiversity at global, National and local levels – India as a mega-diversity nation – Hot-sports of biodiversity –

Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – Endangered and endemic species of India – Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

**UNIT – III**

**ENVIRONMENTAL POLLUTION:** Definition, Cause, effects and control measures of :

a. Air Pollution.
b. Water pollution
c. Soil pollution
d. Marine pollution
e. Noise pollution
f. Thermal pollution
g. Nuclear hazards

**SOLID WASTE MANAGEMENT :**Causes**,** effects and control measures of urban and industrial wastes – Role of an individual in prevention of pollution – Pollution case studies – Disaster management: floods, earthquake, cyclone and landslides.

**UNIT – IV**

**SOCIAL ISSUES AND THE ENVIRONMENT:** From Unsustainable to Sustainable development – Urban problems related to energy – Water conservation, rain water harvesting, watershed management – Resettlement and rehabilitation of people; its problems and concerns. Case studies – Environmental ethics: Issues and possible solutions – Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies – Wasteland reclamation. – Consumerism and waste products. – Environment Protection Act. – Air (Prevention and Control of Pollution) Act. – Water (Prevention and control of Pollution) Act – Wildlife Protection Act – Forest Conservation Act – Issues involved in enforcement of environmental legislation – Public awareness.

**UNIT – V**

**HUMAN POPULATION AND THE ENVIRONMENT:** Population growth, variation among nations. Population explosion – Family Welfare Programmed. – Environment and human health – Human Rights – Value Education – HIV/AIDS – Women and Child Welfare – Role of information Technology in Environment and human health – Case studies.

**FIELD WORK :** Visit to a local area to document environmental assets River/forest grassland/hill/mountain – Visit to a local polluted site-Urban/Rural/Industrial/Agricultural Study of common plants, insects, and birds – river, hill slopes, etc..

**TEXT BOOKS** :

(1) Text book of Environmental Studies for Undergraduate Courses by Erach Bharucha for University Grants Commission, Universities Press.
(2) Environmental Studies by Palaniswamy – Pearson education
(3) Environmental Studies by Dr.S.Azeem Unnisa, Academic Publishing Company

**REFERENCES :**

(1) Textbook of Environmental Science by Deeksha Dave and E.Sai Baba Reddy, Cengage Pubilications.
(2) Text book of Environmental Sciences and Technology by M.Anji Reddy, BS Publication.

(3) Comprehensive Environmental studies by J.P.Sharma, Laxmi publications.
(4) Environmental sciences and engineering – J. Glynn Henry and Gary W. Heinke – Printice hall of India Private limited.
(5) A Text Book of Environmental Studies by G.R.Chatwal, Himalaya Pubilishing House
(6) Introduction to Environmental engineering and science by Gilbert M. Masters and Wendell P. Ela - Printice hall of India Private limited.

**Outcomes:**

- Gain a higher level of personal involvement and interest in understanding and solving environmental problems.
- Comprehend environmental problems from multiple perspectives with emphasis on human modern lifestyles and developmental activities.
- Demonstrate knowledge relating to the biological systems involved in the major global environmental problems of the 21st century
- Recognize the interconnectedness of — human dependence — on the earth's ecosystems
- Influence their society in proper utilization of goods and services.
- Learn the management of environmental hazards and to mitigate disasters and have a clear understanding of environmental concerns and follow sustainable development practices.

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**ENGINEERING MECHANICS & STRENGTH OF MATERIALS (17A10103)**

**Objective:** This course will serve as a basic course by introducing the concepts of basic mechanics which will help as a foundation to various courses.

**UNIT – I**

**Introduction of Engineering Mechanics** – Basic concepts – System of Forces – Momentum of forces and its applications – Couples and Resultant of Force system – Equilibrium of System of Forces – Degree of Freedom – Free body diagrams – Types of Supports –Support reaction for beams with different types of loading – Concentrated, uniformly distributed and uniformly varying loading.

**UNIT – II**

**Friction –** Types of friction – laws of friction – limiting friction –Cone of limiting friction – Static and Dynamic frictions – Motion of bodies – Wedge, Screw jack and differential screw jack.

**Centroid and Center of Gravity:**Centroid of simple figures – Centroids of Composite figures – Centre of Gravity of bodies – Area moment of Inertia – parallel axis and perpendicular axis theorems – Moment of Inertia of Composite figures.

**Mass Moment of Inertia**: Moment of inertia of simple solids – Moment of Inertia of composite masses (Simple problems only)

**UNIT – III**

**Simple Stresses and Strains:**Deformable bodies – Elasticity and plasticity – Types of stresses and strains – Hooke's law – Stress – strain diagram for mild steel – working stress – Factor of safety – lateral strain, Poisson's ratio and volumetric strain –

Elastic moduli and the relationship between them – Bars of Varying section – Composite bars – Temperature stresses. Strain energy – Resilence – Gradual, Sudden, impact and shock loadings – simple applications.

**UNIT – IV**

**Shear Force and Bending Moment:** Definition of beam – types of beams – Concept of Shear force and bending moment – S.F and B.M diagrams for cantilever, simply supported and over changing beams subjected to point loads, uniformly distributed load, uniformly varying loads and combination of these loads – point of contra flexure – Relation between S.F, B.M and rate of loading at section of a beam.

**UNIT – V**

**Flexural Stresses:** Theory of simple bending – Assumptions – Derivation of bending equation: M/I = f/Y = E/R – Neutral axis – Determination of bending stresses – Section modulus of rectangular and circular sections (Solid and Hallow), I, T, Angle and Channel Sections – Design of simple beam sections.

**Shear Stresses**: Derivation of formula – Shear stress distribution across various beam sections like rectangular, circular, triangular, I, T and angle sections.

**TEXT BOOKS:**

(1) Engineering Mechanics by Shames & Rao – Pearson Education
(2) Engineering Mechanics by Dr. R.K Bansal, Lakshmi Publications
(3) Strength of Materials by Ghosh & Datta, New Age Publishers
(4) Strength of Materials by B.C Punmia – laxmi publications

**REFERENCES**:

(1) Engineering Mechanics by Fedrinand L.Singer – Harper Collings publishers
(2) Engineering Mechanics by Shesigiri Rao, Universities Press, Hyderabad
(3) Engineering Mechanics by B.Bhattacharya, Oxford University Publications
(4) Engineering Mechanics by Rjasekharan , Vikas Publications
(5) Engineering Mechanics by S.Timoshenko, D.H Young and J.V Rao, Tata McGraw-Hill Company
(6) A Text book of strength of materials by R.K Bansal – Laxmi publications (p) Ltd, New Delhi
(7) Strength of Materials by R.Subramanian, Oxford University Press

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## PROBLEM SOLVING USING C(17A10501)

**Course Objectives:**

- To understand the various steps in Program development.
- To understand the basic concepts in C Programming Language.
- To learn how to write modular and readable C Programs
- To understand the basic concepts such as Abstract Data Types, Linear and Non Linear Data structures.
- To understand the notations used to analyze the Performance of algorithms.
- To understand and analyze various searching and sorting algorithms.

**UNIT - I**

**Introduction:** Programs and Programming, Programming Languages, Compiler, Interpreter, Loader and Linker, Program Execution, Classification of Programming, Structured Programming Concept, Algorithms, Flowcharts, System Developments.

**Fundamentals Algorithms:** Exchange the Values between two variables, Counting, Summation of set of numbers, Factorial Computation, Generation of the Fibonacci sequence, Reversing the digits of a integer.

**Basics Of C:** Introduction**,** Developing Programs in C, A Simple C program, Parts of C Program Revisited.

**UNIT – II**

**Structure of C:** Structure of a C Program, Concept of a Variable, Data Types in C, Program Statements, Declaration, Tokens, Operators and Expressions, Type conversion in C.

**Input and Output:** Introduction, Basic Screen and Keyboard I/O in C, Non-Formatted Input and Output, Formatted Input and Output Function.

**Control Statements:** Introduction, Specifying Test Condition for Selection and Iteration, Writing Test Expression, Conditional Execution and Selection, Iteration and Repetitive Execution. Nested Loops.

**UNIT – III**

**Arrays and Strings:** Introduction, One-Dimensional Array, Strings, Multidimensional Arrays, Arrays of Strings.

**Function:** Introduction, Concept of Functions, Using Functions, Call by Value Mechanism, Working with Functions, Passing Arrays to Functions, Scope and Extent, Inline Function, Recursion.

**UNIT - IV**

**Factoring Methods:** Finding Square root of a Number, The Smallest Deviser of an Interger, The GCD of Two Integers, Generating Prime Numbers.

**Pointers** – Introduction, Understanding Memory, Address Operator, Pointer, Void Pointer, Null Pointer, Use of pointer, Arrays and Pointers, Pointers and string, Pointers and string, Pointers to pointers, Array of pointers, Pointers to Function, Dynamic Memory Allocation,.

**UNIT – V**

**User-Defined Data Types and Variables:** Introduction, User-defined Data Types, Structures, Union, Enumeration Types.

**Files in C:** Introduction, Using Files in C, Working with text Files, Working with Binary Fields, Direct File Input and Output, Files of Records, Random Access to Files of Records.

**TEXT BOOKS:**

1. Programming in C, Pradip Dey, Manas Ghosh, Second Edition, OXFORD,
2. How to Slove it by Computer by R.G. Dromey, Pearson.

**REFERENCES:**

1. Programming in C and Data Structures, Jeri R. Hanly, Elliot B. Koffman, Ashok Kamthane and A.Ananda Rao, Pearson Education.
2. C Programming with problem solving, J.A. Jones & K. Harrow, dreamtech Press
3. Programming In C, Remma Teraja, Second Edition OXFORD.
3 Programming in C – Stephen G. Kochan, III Edition, Pearson Eductaion.
3. C for Engineers and Scientists, H.Cheng, Mc.Graw-Hill International Edition
4. Education / PHI
5. C Programming & Data Structures,E.Balagurusamy,TMH.

**Outcomes:**

- Able to design the flowchart and algorithm for real world problems
- Able to learn and understand new programming languages
- Able to construct modular and readable programs
- Able to write C programs for real world problems using simple and compound data types
- Adapt programming experience and language knowledge to other programming language contexts
- Employee good programming style, standards and practices during program development

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**PHYSICAL CHEMISTRY LAB(17A15304)**

**Course Objectives:**
To confirm the formation and nature of the product in a chemical processes, the knowledge of some physical, chemical and instrumental methods is essential for a chemical engineer.

**I. PHYSICAL CHEMISTRY LAB:**
1. Determination of Specific rotation of substance by Polarimeter.
2. Study of inversion of Sucrose by Polarimetry.
3. Conductometric titration of Strong acid Vs Strong base.
4. Conductometric titration of Weak acid Vs Strong base.
5. Potentiometric titration between Potassium Dichromate and Ferrous iron.
6. Potentiometric Titration of Strong acid Vs Strong base
7. a)Determination of the specific rate (first order kinetics) of the hydrolysis of Methyl acetate by volumetric method.
   b) Study of first order kinetics(hydrolysis of methylacetat by raising 10$^{o}$C
8. Study of Adsorption characteristics of acetic acid on Charcoal.
9. Estimation of critical solution temperature of Phenol-Water System.
10. Determination of Molecular weight of a given Polymer from Visicocity measurements.

(Any 10 experiments from the above list)

**Course Outcomes**

- Would be confident in handling energy storage systems and would be able combat chemical corrosion
- Would have acquired the practical skill to handle the analytical methods with confidence.
- Would feel comfortable to think of design materials with the requisite properties
- Would be in a postion to technically address the water related problems.

**TEXT BOOKS:**

1. Vogel's Text book of Quantitative Chemical Analysis, Sixth Edition – J. Mendham et al, Pearson Education.
2. Chemistry Practical – Lab Manual by Chandra Sekhar, GV Subba Reddy and Jayaveera.

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**Engineering & IT Workshop(17A13501)**

**(Common to All Branches)**

**Part – A: Engineering Workshop Lab**

**Objectives:**

- Make the students correctly use measuring and marking tools
- Practice the correct use of hand tools
- Apply safe workshop practices when performing basic fitting, carpentry, tin smithy and electrical wiring skills
- Develop the fabrication skills among the students
- Read and interpret the component drawings
- Gain practical skills to apply student's knowledge of theory concepts in real time practice

**1. TRADES FOR EXERCISES:**

**At least 2 exercise In each:**

1. Carpentry
2. Fitting
3. House-wiring
4. Black Smithy
5. Tin smithy
6. Power Tools Demonstration

**TEXT BOOK:**

1. Work shop Manual / P.Kannaiah/ K.L.Narayana/ Scitech Publishers.

**Objective**: The objective of this subject is to provide the basic concepts about different manufacturing processes and use of various workshop tools the exposer to the Power tools used in the inclusion

Question Paper pattern: Test in any two out of 6 trades.

**Outcomes:**

- Expected to improve practical skills
- Able to develop and fabricate the experimental setups for academic and research purposes.
- Able to assemble components for making various systems

**PART – B: IT Workshop**

**Objectives:**

- To provide Technical training to the students on Productivity tools like Word processors, Spreadsheets, Presentations
- To make the students know about the internal parts of a computer, assembling a computer from the parts, preparing a computer for use by installing the operating system
- Disassemble and Assemble a Personal Computer and prepare the computer ready to use
- Prepare the Documents using Word processors
- Prepare Slide presentations using the presentation tool
- Install single or dual operating systems on computer

**Preparing your Computer (4 weeks)**

**Task 1:** Identify the internal parts of a computer of a computer, and its peripherals. Represent the same in the form of diagrams including Block diagram.

**Task 2:** Disassemble and assemble the PC back to working condition. Students should be able to trouble shoot the computer and identify working and non-working parts. Student should identify the problem correctly by various methods available. Students should record the process of assembling and trouble shooting a computer.

**Task 3: S**tudent should install Linux on the computer. Student may install another operating system (including proprietary software) and make the system dual boot or multi boot. Students should record the entire installation process.

**Task 4**: Students should record the various features that are supported by the operating system installed and submit it.

**Productivity tools (3 weeks)**

**Task 5: Word Processor:** Students should be able to create documents using the word processor tool. Some of the tasks that are to be performed are inserting and deleting the characters, words and lines, Alignment of the lines, Inserting header and Footer, changing the font, changing the colour, including images and tables in the word file, making page setup, copy and paste block of text, images, tables etc, linking the images which are present in other directory, formatting paragraphs, spell checking, etc. Students should be able to prepare project cover pages etc at the end of the task. Students should submit a user manual of the word processor considered.

**Task 6: Spreadsheet:** Students should be able to create, open, save the application documents and format them as per the requirement.Some of the tasks that may be practiced are Managing the worksheet environment, creating cell data, inserting and deleting cell data, format cells, adjust the cell size, applying formulas and functions, preparing charts, sorting cells. Students should submit a user manual of the Spreadsheet application considered.

**Task 7: Presentations :** creating, opening, saving and running the presentations; Selecting the style for slides, formatting the slides with different fonts, colours; creating charts and tables, inserting and deleting text, graphics and animations; bulleting and numbering; hyperlinking, running the slide show, setting the timing for slide show. Students should submit a user manual of the Presentation tool considered.

**References:**

1. "Introduction to Computers", Peter Norton, Mc Graw Hill
2. "LaTeX Companion" – Leslie Lamport, PHI/Pearson.
3. "MOS study guide for word, Excel, Powerpoint & Outlook Exams", Joan Lambert, Joyce Cox, PHI.
4. "Introduction to Information Technology", ITL Education Solutions limited, Pearson Education.
5. "Networking your computers and devices", Rusen, PHI "Trouble shooting, Maintaining & Repairing PCs", Bigelows, TMH.

**Outcomes:**

- Students attain complete knowledge of a computer i.e. hardware as well as operating systems.
- Students will be technically strong in using Word processors, Spreadsheets.
- Prepare Slide presentations that helps them in their career

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**ENGLISH LANGUAGE COMMUNICATION SKILLS (ELCS) LAB (17A15502)**

The **Language Lab** focuses on the production and practice of sounds of language and familiarizes the students with the use of English in everyday situations and contexts.

**OBJECTIVES:**

1.To train students to use language effectively in everyday conversations, to participate in group discussions, to help them face interviews, and sharpen public speaking skills

2.To expose the students to a varied blend of self-instructional learner-friendly modes of language learning through computer-aided multi-media instruction.

3.To enable them to learn better pronunciation through stress on word accent, intonation, and rhythm.

4.To help the second language learners to acquire fluency in spoken English and neutralize mother tongue influence

5.To train students to use language appropriately for interviews, group discussion and public speaking

**SYLLABUS:**

**UNIT- I**

Phonetics – Introduction to Sounds of Speech – Vowels – Consonants – Phonetic Transcription & Orthographic Transcription

**UNIT – II**

Syllabification – Word Stress – Rules of word stress – Intonation – Falling tone and Rising tone

**UNIT – III**

Situational Dialogues – Role-play – Expressions in various situations – Self Introduction – Introducing others – Greetings – Apologies – Requests – Social and Professional etiquettes – Telephone Etiquettes

**UNIT – IV**

JAM – Describing object/person/place/situation – Giving directions

**UNIT – V**

Debates and Group Discussions

**OUTCOMES** :

- Develop linguistic and communicative competence through the development of the language skills.
- Becoming active participants in the learning process and acquiring proficiency in spoken English of the students
- Speaking with clarity and confidence thereby enhancing employability skills of the students

**MINIMUM REQUIREMENT FOR ELCS LAB:**

The English Language Lab shall have two parts:

1. Computer Assisted Language Learning (CALL) Lab:
   The Computer aided Language Lab for 60 students with 60 systems, one master console, LAN facility and English language software for self- study by learners.
2. The Communication Skills Lab with movable chairs and audio-visual aids with a P.A. system, Projector, a digital stereo-audio & video system and camcorder etc.

System Requirement (Hardware component):

Computer network with LAN with minimum 60 multimedia systems with the following specifications:

- i) P – IV Processor
  - a) Speed – 2.8 GHZ
  - b) RAM – 512 MB Minimum
  - c) Hard Disk – 80 GB
- ii) Headphones of High quality

**Suggested software:**

1. Clarity Pronunciation Power – Part I (Sky Pronunciation)
2. Clarity Pronunciation Power – part II
3. K-Van Advanced Communication Skills
4. TOEFL & GRE (KAPLAN, AARCO & BARRONS, USA, Cracking GRE by CLIFFS)
5. *DELTA's key to the Next Generation TOEFL Test: Advanced Skills Practice.*
6. Lingua TOEFL CBT Insider, by Dreamtech
7. English Pronunciation in Use (Elementary, Intermediate, Advanced) CUP
8. Cambridge Advanced Learners' English Dictionary with CD.

**Reference books:**

1. **A Textbook of English Phonetics for Indian Students** 2nd Ed T. Balasubramanian. (Macmillian),2012.
2. **A Course in Phonetics and Spoken English**, Dhamija Sethi, Prentice-Hall of India Pvt.Ltd
3. **Speaking English Effectively**, 2nd Edition Krishna Mohan & NP Singh, 2011. (Mcmillan).
4. **A Hand book for English Laboratories**, E.Suresh kumar, P.Sreehari, Foundation Books,2011
5. **English Pronunciation in Use. Intermediate &Advanced** ,Hancock, M. 2009. CUP
6. **Basics of Communication in English** ,Soundararaj, Francis. 2012.. *New Delhi: Macmillan*
7. **Spoken English** (CIEFL) in 3 volumes with 6 cassettes, OUP.
8. **English Pronouncing Dictionary**, Daniel Jones Current Edition with CD.Cambridge, 17th edition, 2011.

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**Comprehensive Objective Type Examination (17A10801)**

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## TECHNICAL COMMUNICATION &PRESENTATION SKILLS (17A25501)

**Preamble:**

In the increasingly globalized world, technical communication and presentation skills are assuming great importance. Industries and employers constantly complain that young engineers have adequate technical knowledge, but no communication and presentation skills. Success is defined these days in terms of possessing these skills. The syllabus has been designed to develop communicative competencies of the students.

**Objectives:**

1. To develop awareness in students of the relevance and importance of technical communication and presentation skills.
2. To prepare the students for placements
3. To provide students with interactive practice sessions to make them internalize these skills

**UNIT 1:**

Basics of Technical Communication – Introduction – Objectives & Characteristics of Technical Communication – Importance and need for Technical communication - LSRW Skills – Barriers to effective communication

**UNIT II**

Informal and Formal Conversation - Verbal and Non-verbal communication –Kinesics, Proxemics, Chronemics, Haptics, Paralanguage

**UNIT III**

Written communication – Differences between spoken and written communication – Features of effective writing –Advantages and disadvantages of spoken and written communication

**UNIT IV**

Presentation Skills – Nature and importance of oral presentation – Defining the purpose – Analyzing the audience - Planning and preparing the presentation, organizing and rehearsing the presentation –Individual and group presentations - Handling stage fright

**UNIT V**

Interview Skills – The Interview process –Characteristics of the job interview – Pre-interview preparation techniques – Projecting the positive image – Answering Strategies

**Prescribed Books**

1. Effective Technical Communication, Ashrif Rizvi, TataMcGrahill, 2011
2. Technical Communication by Meenakshi Raman & Sangeeta Sharma, O U Press 2009

**Reference Books**

1. Communication Skills by Pushpalatha & Sanjay Kumar, Oxford Univsesity Press

2. Books on TOEFL/GRE/GMAT/CAT/ IELTS by Barron's/DELTA/Cambridge University Press.2012.

3. Soft Skills for Everyone, Butterfield Jeff, Cengage Publications, 2011.

4. Management Shapers Series by Universities Press (India) Pvt Ltd., Himayatnagar, Hyderabad 2008.

5. Handbook for Technical Writing by David A McMurrey & Joanne Buckely CENGAGE Learning 2008.

6. English for Technical Communication for Engineering Students, Aysha Vishwamohan, Tata Mc Graw-Hill 2009.

**Outcomes:**

- Turning out the students with a clear concept of communication like speaking convincingly, express their opinions clearly, initiate a discussion, negotiate, and argue using appropriate communicative strategies
- Read different genres of texts, infer implied meanings and critically analyse and evaluate them for ideas as well as for method of presentation
- Getting them ready for placements and equipping them with readiness to implement their communication and Presentation skills at work place.

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**MATHEMATICS – II(17A25101)**
**(Common to All Branches)**

**Objectives:**Our emphasis will be more on conceptual understanding and application of Fourier series, Fourier, Z and Laplace transforms and solution of partial differential equations.

**UNIT – I**

Laplace transform of standard functions – Inverse transform – First shifting Theorem, Transforms of derivatives and integrals – Unit step function – Second shifting theorem – Dirac's delta function – Convolution theorem – Laplace transform of Periodic function.

Differentiation and integration of transform – Application of Laplace transforms to ordinary differential equations of first and second order.

**UNIT – II**

Fourier Series: Determination of Fourier coefficients – Fourier series – Even and odd functions – Fourier series in an arbitrary interval – Even and odd periodic continuation – Half-range Fourier sine and cosine expansions- Parseval's formula- Complex form of Fourier series.

**UNIT – III**

Fourier integral theorem (only statement) – Fourier sine and cosine integrals. Fourier transform – Fourier sine and cosine transforms – Properties – Inverse transforms – Finite Fourier transforms.

**UNIT – IV**

Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions – Method of separation of variables – Solutions of one dimensional wave equation, heat equation and two-dimensional Laplace's equation under initial and boundary conditions.s

**UNIT – V**

z-transform – Inverse z-transform – Properties – Damping rule – Shifting rule – Initial and final value theorems. Convolution theorem – Solution of difference equations by z-transforms.

**TEXT BOOKS:**

1. Higher Engineering Mathematics, B.S.Grewal, Khanna publishers.
2. Engineering Mathematics, Volume - II, E. Rukmangadachari Pearson Publisher.

**REFERENCES:**

1. Mathematical Methods by T.K.V. Iyengar, B.Krishna Gandhi, S.Ranganatham and M.V.S.S.N.Prasad S. Chand publication.
2. Higher Engineering Mathematics, by B.V.Ramana, Mc Graw Hill publishers.
3. Advanced Engineering Mathematics, by Erwin Kreyszig, Wiley India.

**Outcomes:**The student gains the knowledge to tackle the engineering problems using the concepts of Fourier series, various transforms and partial differential equations.

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## ENGINEERING PHYSICS(17A25201)

(Common to Civil, Mechanical & Chemical Engg.)

**Objectives:**

- To evoke interest on applications of superposition effects like interference and diffraction, the mechanisms of emission of light, achieving amplification of electromagnetic radiation through stimulated emission, study of propagation of light through transparent dielectric waveguides along with engineering applications.
- To understand and employ the concepts of waves & oscillations and acoustics to engineering applications.
- To open new avenues of knowledge in dielectric and magnetic materials which find potential in the emerging micro device applications.
- To give an impetus on the subtle mechanism of superconductors using the concept of BCS theory and their fascinating applications.Considering the significance of microminiaturization of electronic devices and significance of low dimensional materials, the basic concepts of nano and smart materials, their properties and applications in modern emerging technologies are elicited.

- To enlighten the characterization of materials by different techniques, the periodic arrangement of atoms in crystals, Bragg's law and X-Ray diffraction technique.

**UNIT 1:PHYSICALOPTICS, LASERS AND FIBRE OPTICS**

***PhysicalOptics:*** Introduction to interference – Colours in thin films – Newton's Rings – Michelson interferometer - Fraunhoffer diffraction due to single slit, double slit – Diffraction grating.

***Lasers:*** Introduction – Characteristics of laser – Spontaneous and stimulated emission of radiation –- Einstein's coefficients –– Population inversion – Pumping mechanisms - Ruby laser – He-Ne laser – Applications of lasers.

**Fiberoptics**: Introduction– working principle of optical fiber –Numerical aperture and acceptance angle – Types of optical fibers –Optical fiber communication system –Attenuation and losses in optical fibers – Applications of optical fibers.

**UNIT 2: WAVES&OSCILLATIONS AND ACOUSTICS**

***Waves&Oscillations:*** Categories of waves: Mechanical, electromagnetic, matter and gravitational – Reflection and transmission of waves at a boundary – Free oscillations – Damped Oscillations – Forced oscillations – Resonance – Coupled oscillations.

***Acoustics:*** Sound absorption – Absorption coefficient and its measurement – Reverberation time – Sabine's formula – Eyring's formula.

**UNIT 3: DIELECTRICSAND MAGNETIC MATERIALS**

***Dielectrics:*** Introduction – Dielectric Polarization – Types of Polarization – Lorentz field – Clausius- Mosotti equation – Dielectric strength, loss, breakdown.

***Magneticmaterials:*** Introduction – Basic definitions – Origin of magnetic moment – Classification of magnetic materials into dia, para, ferro, antiferro and ferri magnetic materials – Hysteresis – Soft and hard magnetic materials – Applications of magnetic materials.

**UNIT 4: ADVANCED MATERIALS**

***Superconductors:*** Introduction – Properties of superconductors – Meissner effect– Type I and Type II superconductors – ac and dc Josephson effects – BCS theory (qualitative treatment) – High $T_c$ superconductors – Applications of superconductors.

***Nanomaterials***: Introduction – Significance of nanoscale – Surface area and quantum confinement – Physical properties: optical, thermal, mechanical and magnetic – Carbon nanotubes & their properties – Applications of nanomaterials.

***SmartMaterials***: Shape Memory Alloys: Definition – Two phases – One way and two way memory effect – Pseudo elasticity – Applications
of shape memory alloys.

**UNIT 5:MATERIAL CHARACTERIZATION AND CRYSTALLOGRAPHY**

***Material Characterization:***Electron microscopy:SEM, TEM, AFM – UV-Visible and IR Spectroscopy – Non-destructive testing: objectives – Methods: Pulse-echo method.

***Crystallography****:* Introduction – Space lattice –Unit cell – Lattice parameters –Bravias lattice – Crystal systems – Packing fractions of SC, BCC and FCC - Miller indices – Interplanar spacing in cubic crystals – X-ray diffraction – Bragg's law – Laue method.

**Prescribed Text books:**

1. Engineering Physics – Dr.M.N.Avadhanulu & Dr.P.G.Kshirsagar, S.Chand and Company
2. Engineering physics – S. ManiNaidu, Pearson Education
3. Instrumental methods of analysis - Willard and Meritt

**Reference Books:**

1. Introduction to modern optics – Grant R Fowles
2. A text book on Optics – Brijlal & Subramanyam
3. Laser Fundamentals – William T. Silfvast, Cambridge University Press
4. Fundamentals of Physics – Halliday, Resnick and Walker, John Wiley &Sons
5. Introduction to Nanotechnology – C P Poole and F J Owens, Wiley
6. Shape Memory Alloys-Modeling and Engg. Applications – C Lagoudas, Springer
7. Hand Book of Non-destructive evaluation, C.J.Hellier, McGraw-Hill
8. Engineering Physics – V. Rajendran, K.Thyagarajan Tata MacGraw Hill Publishers
9. Engineering Physics – M.R.Srinivasan, New Age Publications
10. Engineering Physics – D K Pandey, S. Chaturvedi, Cengage Learning
11. Engineering Physics - Sanjay D. Jain, D. Sahasrambudhe and Girish, University Press
12. Engineering Physics – M. Arumugam, Anuradha Publications

**Outcomes:**

- The different realms of physics and their applications in both scientific and technological systems are achieved through the study of physical optics, lasers and fiber optics.
- The concepts of types of waves and oscillations ,acoustics are highlighted
- The dielectric and magnetic response of materials are focussed.
- The importance of superconducting materials, nano and smart materials along with their engineering applications are well elucidated.
- Characterization of materials by advanced techniques, the important properties of crystals like the presence of long-range order and periodicity, structure determination using X-ray diffraction technique are focused.

**JNTUA College of Engineering (Autonomous),**

**Ananthapuramu**

**I- Year B.Tech. II-Sem**

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**ENGINEERINGDRAWING (17A20303)**

**Unit-I**

Introduction to Engineering Drawing: Principles of Engineering Graphics and their significance Drawing Instruments and their Use – BIS Conventions in drawing and Lettering.

Curves used in practice:

a) Conic sections including the Rectangular Hyperbola
b) Cycloid, Epicycloid and Hypocycloid –Normals and Tangents
c) Involute of a circle –Normals and Tangents

Principles of orthographic projection, I and III angle projections –Conventions –Projections of points.

**Unit –II**

Projection of lines inclined to both planes –traces, Projection of plane figures inclined to both planes.

**Unit –III**

Projection of simple solids inclined to both planes.

**Unit –IV**

Sections and Developments: Sections and Sectional views of Regular solids –Prism, Cylinder, Pyramid, Cone – True shapes.

**Unit –V**

Isometric projections: Principles of pictorial representations-Isometric projection- Isometric scale-Isometric views- conventions- Isometric views of plane figures, solids-Isometric projection of objects with non isometric lines-Isometric projection of spherical parts.

**TEXT BOOKS:**

1. Engineering Drawing, N.D. Bhat, Charotar Publishers
2. Engineering Drawing, K.L. Narayana& P. Kannaih, Scitech Publishers, Chennai.

**REFERENCES:**

1. Engineering Drawing, Johle, Tata McGraw-Hill Publishers.
2. Engineering Drawing, Shah and Rana,2/e, Pearson Education
3. Engineering Drawing and Graphics, Venugopal/New age Publishers
4. Engineering Graphics, John&john.

***Suggestions:***

*Student is expected to buy a book mentioned under 'Text books' for better understanding.*

*Student should prepare rough sketches for all the problems given at the end of each chapter to improve his / her imaginations.*

*Student should also practice Auto CAD or any other drawing software to help understanding better.*

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**ELECTRICAL AND ELECTRONICS ENGINEERING (15A24301)**

**(Common to Mech. Engg. & Chemical)**

**PART – A**

**ELECTRICAL ENGINEERING (17A22401)**

**OBJECTIVES:**

- To understand the basic concepts of different types of electrical machines and their

performance.
- To understand the basic types of Circuits, DC generators & motors, Transformers, Induction motors and their performance aspects.
- To understand the concepts of semiconductors, various types of semiconductors, diodes rectifiers, transistors, amplifiers and number systems for digital electronics

**UNIT – I Introduction to DC & AC Circuits**

Ohm's Law, Basic Circuit Components, Kirchhoff's Laws, Types of Sources, Resistive Networks, Series Parallel Circuits, Star Delta and Delta Star Transformation. Principle of AC Voltages, Waveforms and Basic Definitions, Root Mean Square and Average Values of Alternating Currents and Voltage, Form Factor and Peak Factor, Phasor Representation of Alternating Quantities, The J Operator and Phasor Algebra, Analysis of Ac Circuits With Single Basic Network Element, Single Phase Series.

**UNIT-II DC Machines**

**D.C Generators:** Principle of Operation of Dc Machines, Types of D.C Generators, E.M.F Equation in D.C Generator, O.C.C. of a D.C. Shunt Generator

**D.C Motors**:Principle of Operation of Dc Motors, Types of D.C Motors, Torque Equation, Losses and Efficiency Calculation in D.C Motor- Swinburne's Test

**UNIT-III AC Machines**

**Transformers:** Principles of Operation, Constructional Details, Losses and Efficiency, Regulation of Transformer, Testing: OC & SC Tests.

**Three Phase Induction Motors**: Principle of Operation, Slip and Rotor Frequency, Torque (Simple Problems).

**Alternators:** Principle of Operation-Constructional Details-EMF Equation-Voltage Regulation by Synchronous Impedance Method.

## PART-B
## ELECTRONICS ENGINEERING

**UNIT I**

Semiconductor Devices-N-Type and P-Type Semiconductors, The p-n Junction Diode - Drift and Diffusion Currents, Volt-Ampere Characteristics- Diode Specifications, Applications of Diode, Diode as a Switch. Diode as a Rectifier-types of Rectifier, Rectifiers with Filters, Zener Diode-Characteristics, Zener Diode as Voltage Regulator. Silicon Controlled Rectifier, DIAC, TRIAC.

**UNIT II**

Bipolar Junction Transistor (BJT) – Types of Transistors, Theory and Operations of Transistors, Input-Output Characteristics of BJT Configurations, Transistor Biasing- Fixed Bias, Voltage Divider Bias, Transistor Applications- Transistor as an Amplifier and Switch, Junction Field Effect Transistor (JFET)- (construction, principle of Operation, symbol), Characteristics -

Input/output, Transfer Characteristics, Configurations of JFET, JFET Applications- JFET as an Amplifier and Switch, Comparison of BJT and JFET, MOSFET-The Enhancement and Depletion MOSFET, Characteristics and Applications of MOSFET

**UNIT III**

**Digital Electronics:** Number Systems-Decimal System, Binary System, Octal System, Hexadecimal System, Code Conversions, Binary Arithmetic- Binary Addition, Binary Subtraction, Logic Gates and Truth Tables-NOT, OR, AND, EX-OR, EX-NOR, Universal Gates-NAND, NOR Gates. Boolean algebra and De Morgan's Theorems,

**Text Books:**

**TEXT BOOKS:**

1. Basic Electrical Engineering - By M.S.Naidu and S. Kamakshiah – TMH.
2. Basic Electrical Engineering –By T.K.Nagasarkar and M.S. Sukhija Oxford University Press.
3. Electrical and Electronic Technology-By Hughes – Pearson Education.
4. Basic Electrical and Electronics Engineering, M.S.Sukhija, T.K.Nagsarkar, Oxford University Press, 1$^{st}$ Edition, 2012.
5. Basic Electrical and Electronics Engineering, S.K Bhattacharya, Pearson Education, 2012.

**REFERENCES:**

1. Theory and Problems of Basic Electrical Engineering by D.P.Kothari & I.J. Nagrath PHI.
2. Principles of Electrical Engineering by V.K Mehta, S.Chand Publications.
3. Fundamentals of Electrical Electronics Engineering by T.Thyagarajan, SCITECH Publications 5$^{th}$ Edition-2007

**Outcomes:**

1: Students shall gain knowledge on basics of Electrical Circuits, DC Machines, Transformers, Induction motors, Alternators.

2: Students shall gain knowledge on various types of semiconductor devices, transistors, amplifier and digital electronics.

3: Students shall be able to apply the knowledge of Electrical and Electronic systems real-world Chemical Engineering problems and applications.

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**INTRODUCTION TO CHEMICAL ENGINEERING(17A20801)**

**Unit-I**

Introduction, Chemical Engineering in everyday life, Scaling up or down, Engineering applications of portable devices, challenges in petroleum sector, versatility of a Chemical

Engineer, role of Chemical Engineers in Biomedical Engineering, similarities in dissimilar applications.

Batch Processing, paint manufacture, transition from batch to continuous processing, Case study: Manufacture of Sulphuric acid, role of basic sciences in Chemical Engineering (Introduction) (Text Book 1)

**Unit-II**

Introduction, Unit operations, basic laws, units and dimensions, partial pressure, vapor pressure.

Solutions, concentration measurements,humidityand saturation. Material and Energy balances.

Flow of fluids: Introduction, nature of fluid, viscosity, velocity profile, flow field, types of fluid motion, laminarand turbulent flow, flow of a fluid past a solid surface, Reciprocating, rotary, and centrifugal pumps(Text Book 2)

**Unit-III**

Heat transfer: Conduction, convection (omit correlations for calculation of heat transfer coefficients, heattransfer with change in phase) and radiation. Flow arrangement in heat exchangers, variation of fluidtemperatures in heat exchangers, heat transfer equipment (double pipe & Shell and tube heat exchanger),evaporation, long tube vertical type and forced circulation type evaporators, multiple effect evaporation,methods of feeding(Text Book 2)

**Unit-IV**

Mass transfer: Introduction - Diffusion, mass transfer operation, equipment for gas-liquid operations, contact patterns, classification of separation processes and applications, basic definitions of separation processes, VLE, LLE, boiling point diagram.(Text Book 2)

**Unit-V:**

Introduction to mechanical operations: Size reduction, filtration, basic differences between agitation and mixing.

Types of reactions and reactors.

Introduction to environmental pollution: types and their effect.

Safety in chemical process industries (case study on DDT, environmental hazards of a green project)(Text Book 1&2)

**TEXT BOOK:**

1. Introduction to chemical engineering by S. Pushpavanam, PHI, 2012.
2. Introduction to chemical engineering by S. K. Ghosal, S. K. Sanyal and S. Dutta, TMH publications, 1993.

**REFERENCE:**

1. Unit operations in chemical engineering by W.L. McCabe and J.C. Smith and Peter Harriott, McGraw Hill5th ed. 1993.

**Objectives:**

1. To impart the role of Chemical Engineers in everyday life and the importance of

Chemical Engineering.

2. To learn the role of various Unit Operations and Unit Processes in Chemical industries.
3. To learn the role of Chemical Engineers in environmental and safety aspects in process industries.

**Outcomes:**

The student will be able to explain:

1. The role of Chemical Engineers in everyday life and the importance of Chemical Engineering.
2. The role of various Unit Operations and Unit Processes in Chemical industries.
3. The role of Chemical Engineers in environmental and safety aspects in process industries.

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**ENGINEERING PHYSICS LABORATORY (17A25202)**

**Objectives:**

- To evoke interest on applications of superposition effects like interference and diffraction, the mechanisms of emission of light, achieving amplification of electromagnetic radiation through stimulated emission, study of propagation of light through transparent dielectric waveguides along with engineering applications.
- To understand and employ the concepts of waves & oscillations and acoustics to engineering applications.
- To open new avenues of knowledge in dielectric and magnetic materials which find potential in the emerging micro device applications.
- To give an impetus on the subtle mechanism of superconductors using the concept of BCS theory and their fascinating applications. Considering the significance of micro miniaturization of electronic devices and significance of low dimensional materials, the basic concepts of nano and smart materials, their properties and applications in modern emerging technologies are elicited.
- To enlighten the characterization of materials by different techniques, the periodic arrangement of atoms in crystals, Bragg's law and X-Ray diffraction technique

**Any EIGHT of the following experiments has to be performed during the SEMESTER**

1. Determination of wavelengths of various colours of mercury spectrum using diffraction grating in normal incidence method
2. Determination of dispersive power of prism
3. Determination of thickness of thin object by wedge method
4. Determination of radius of curvature of lens by Newton's rings
5. Laser : Diffraction due to single slit
6. Laser : Diffraction due to double slit
7. Laser: Determination of wavelength using diffraction grating
8. Determination of Numerical aperture of an optical fiber
9. Meldes experiment: Determination of the frequency of tuning fork
10. Sonometer: Verification of the three laws of stretched strings
11. Energy gap of a material using p-n junction diode
12. Electrical conductivity by four probe method
13. Hall effect: Determination of mobility of charge carriers in semiconductor
14. B-H curve
15. Magnetic field along the axis of a current carrying coil – Stewart and Gee's method
16. Determination of dielectric constant and Curie temperature of a ferroelectric material

**Outcomes:**

- The different realms of physics and their applications in both scientific and technological systems are achieved through the study of physical optics, lasers and fiber optics.

- The concepts of types of waves and oscillations ,acoustics are highlighted
- The dielectric and magnetic response of materials are focussed.
- The importance of superconducting materials, nano and smart materials along with their engineering applications are well elucidated.
- Characterization of materials by advanced techniques, the important properties of crystals like the presence of long-range order and periodicity, structure determination using X-ray diffraction technique are focused.

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**ELECTRICAL & ELECTRONICS ENGINEERING LABORATORY ((17A22402)**

**PART-A**

The following experiments are required to be conducted as compulsory experiments:

1. Swinburne's Test on DC Shunt Machine (Predetermination of Efficiency of a Given DC Shunt Machine Working as Motor and Generator).
2. OC & SC Tests on Single-Phase Transformer (Predetermination of Efficiency and Regulation at Given Power Factors and Determination of Equivalent Circuit).
3. Brake Test on 3-Phase Induction Motor ( Determination of Performance Characteristics )
4. Regulation of Alternator by Synchronous Impedance Methods.
5. Speed Control of D.C.Shunt Motor by

   a) Armature Voltage Control B) Field Flux Control Method
6. Brake Test on D.C Shunt Motor

**PART-B**

**LIST OF EXPERIMENTS:**

1. PN Junction diode characteristics A) Forward bias B) Reverse bias.
2. Zener diode characteristics and Zener as voltage Regulator
3. Full Wave Rectifier with & without filter
4. Wave Shaping Circuits (Clippers & Clampers)
5. Input & Output characteristics of Transistor in CB / CE configuration
6. Frequency response of CE amplifier.
7. Inverting and Non-inverting Amplifiers using Op Amps
8. Verification of Truth Table of AND, OR, NOT, NAND, NOR, Ex-OR, Ex-NOR gates using ICs
9. Verification of Truth Tables of RS, JK, T & D flip flops using respective ICs

**LAB REQUIREMENTS:**

Cathode Ray Oscilloscopes (30MHz)
Signal Generator /Function Generators (3 MHz)
Dual Regulated Power Supplies ( 0 – 30V)
IC Trainer Kit
Bread Boards
Electronic Components

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**COMPUTER PROGRAMMING LAB(17A20504)**
**(Common to Civil, EEE, ME, CSE, Chemical)**

**Objectives:**

- To work with the compound data types
- To explore dynamic memory allocation concepts
- Able to design the flowchart and algorithm for real world problems
- Able to write C programs for real world problems using simple and compound data types
- Employee good programming style, standards and practices during program development

**Week-1**

1) Write an algorithm and draw a flowchart to make the following exchange between the variables a-> b -> c->d - > a
2) Write an algorithm and draw a flowchart to generate the first n terms of the sequence. A Fibonacci sequence is defined as follows: the first and second terms in the sequence are 0 and 1. Subsequent terms are found by adding the preceding two terms in the sequence.
3) Write a algorithm and draw a flowchart to carry out the arithmetic operations addition, subtraction, multiplication, and division between two variables
4) Write a algorithm and draw a flowchart for printing prime numbers between 1 and n.

**Week-2**

1) Write a C program to construct a multiplication table for a given number.
2) Write a program to reverse the digit of a given integer.
1) Write a C program to calculate the factorial of a given number

**Week-3**

Write a program to calculate tax, given the following conditions:

a) If income is less than 1,50,000 then no tax.
b) If taxable income is in the range 1,50,001 – 300,000 then charge 10% tax
c) If taxable income is in the range 3,00,001 – 500,000 then charge 20% tax
d) If taxable income is above 5,00,001 then charge 30% tax

**Week-4**

1) Write a program to print the calendar for a month given the first Week- day of the month.

Input the first day of the month (Sun=0,Mon=1,Tue=2,Wed=3,.....) :: 3

Total number of days in the month : 31

Expected output

| *Sun* | *Mon* | *Tue* | *Wed* | *Thu* | *Fri* | *Sat* |
|---|---|---|---|---|---|---|
| - | - | - | *1* | *2* | *3* | *4* |
| *5* | *6* | *7* | *8* | *9* | *10* | *11* |
| *12* | *13* | *14* | *15* | *16* | *17* | *18* |
| *19* | *20* | *21* | *22* | *23* | *24* | *25* |
| *25* | *26* | *27* | *28* | *29* | *30* | *31* |

**Week-5**

1) Write a program to print the Pascal triangle for a given number
2) Write a program to calculate the following expression for given x value

$$f(x) = a_0 + \sum_{n=1}^{\infty}\left(a_n \cos\frac{n\pi x}{L} + b_n \sin\frac{n\pi x}{L}\right)$$

**Week-6**

1) Write C code to define a function cash_dispense, which takes an amount as its input, and returns the number of 1000, 500, 100, 50, 20, 10, 5, 2, 1 rupee denomination that make up the given amount.
2) Write C code to reverse the contents of the array. For example, [1,2,3,4,5] should become [5,4,3,2,1]
3) Write a program that will search and find out the position where the given key element exist in a user chosen array and print it as output.

**Week-7**

1) Write C code to compute the frequency table of survey responses given by 20 users. The survey responses range from 1 to 5 and are stored in an array. For example, 10 responses are stored in the array [1,1,5,2,3,3,5,5,2,2]. The frequency table will be as shown below:
    a. 1 = 2
    b. 2 = 3
    c. 3 = 2
    d. 4 = 0
    e. 5 = 3
2) Write a program to define a function to sort an array of integers in ascending order by using exchange sort.

**Week-8**

1) Write a C program to check whether a given string is a palindrome or not, without using any built-in functions
2) Write a function that accepts a string and delete the first character.
3) Write a function that accepts a string and delete all the leading spaces.

**Week-9**

Write a program to accept a string from user and display number of vowels, consonants, digits and special characters present in each of the words of the given string.

**Week-10**

1) Write a C program to define a union and structure both having exactly the same numbers using the sizeof operators print the sizeof structure variables as well as union variable
2) Declare a structure *time* that has three fields *hr*, *min*, *secs*. Create two variables, *start_time* and *end_time*. Input there values from the user. Then while *start_time* is not equal to *end_time* display GOOD DAY on screen.

**Week-11**

1) Write a program to read in an array of names and to sort them in alphabetical order. Use sort function that receives pointers to the functions strcmp, and swap, sort in turn should call these functions via the pointers.
2) Write a program to read and display values of an integer array. Allocate space dynamically for the array using the *malloc()*.

3) Write a program to calculate area of a triangle using function that has the input parameters as pointers as sides of the triangle.

**Week-12**

1) Two text files are given with the names text1 and text2. These files have several lines of text. Write a program to merge (first line of text1 followed by first line of text2 and so on until both the files reach the end of the file) the lines of text1 and text2 and write the merged text to a new file text3.
2) Write a program to split a given text file into n parts. Name each part as the name of the original file followed by .part<**n**> where n is the sequence number of the part file.

**Reference Books:**

1. Computer Science, A Structured Programming Approach Using C by Behrouz A. Forouzan & Richard F. Gilberg, Third Edition, Cengage Learning
2. C Programming A Problem-Solving Approach, Behrouz A. Forouzan & E.V. Prasad, F. Gilberg, Third Edition, Cengage Learning
3. Programming with C Rema Theraja, Oxford
4. "C Test Your Skills", Kamthane, Pearson Education
5. Programming in C: A Practical Approach, Ajay Mittal, Pearson
6. Problem solving with C, M.T.Somasekhara, PHI
7. C Programming with problem solving, J.A. Jones & K. Harrow,Dreamtech Press
8. Programming with C, Byron S Gottfried, Jitender Kumar Chhabra, TMH, 2011

**Outcomes:**

- Able to have fundamental concept.
- Able to write, compile and debug programs in C language.
- Able to formulate problems and implement algorithms in C.
- Able to effectively choose programming components that efficiently solve computing problems in real-world.
- Able to use different data types in a computer program.
- Able to design programs involving decision structures, loops and functions.

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# COMMUNITY SERVICE (AUDIT) (17A29901)

**JNTUA College of Engineering (Autonomous), Ananthapuramu**

**I- Year B.Tech. II-Sem**

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**Comprehensive Objective Type Examination (17A20802)**

**JNTUA College of Engineering (Autonomous),**

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**II- Year B.Tech. I-Sem**

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## MATHEMATICAL METHODS (17A35102)

**Objectives:**

- This course aims at providing the student with the concepts of Matrices, Numerical Techniques and Curve fitting.

**UNIT – I**

Elementary row transformations-Rank – Echelon form, normal form – Consistency of System of Linear equations. Linear transformations. Hermitian, Skew-Hermitian and Unitary matrices and their properties. Eigen Values, Eigen vectors for both real and complex matrices. Cayley – Hamilton Theorem and its applications – Diagonolization of matrix. Calculation of powers of matrix and inverse of a matrix. Quadratic forms – Reduction of quadratic form to canonical form and their nature.

**UNIT – II**

Solution of Algebraic and Transcendental Equations: The Bisection Method – The Method of False Position– Newton-Raphson Method, Solution of linear simultaneous equation: Crout's triangularisation method, Gauss - Seidal iteration method.

**UNIT – III**

**Interpolation:** Newton's forward and backward interpolation formulae – Lagrange's formulae. Gauss forward and backward formula, Stirling's formula, Bessel's formula.

**UNIT – IV**

Curve fitting: Fitting of a straight line – Second degree curve – Exponentional curve-Power curve by method of least squares. Numerical Differentiation for Newton's interpolation formula. Numerical Integration: Trapezoidal rule – Simpson's 1/3 Rule – Simpson's 3/8 Rule.

**UNIT – V**

Numerical solution of Ordinary Differential equations: Solution by Taylor's series-Picard's Method of successive Approximations-Euler's Method-Runge-Kutta Methods. Numerical solutions of Laplace equation using finite difference approximation.

**TEXT BOOKS:**

3. Higher Engineering Mathematics, B.S.Grewal, Khanna publishers.
4. Introductory Methods of Numerical Analysis, S.S. Sastry, PHI publisher.

**REFERENCES:**


2. Engineering Mathematics, Volume - II, E. Rukmangadachari Pearson Publisher.
3. Mathematical Methods by T.K.V. Iyengar, B.Krishna Gandhi, S.Ranganatham and M.V.S.S.N.Prasad, S. Chand publication.
3. Higher Engineering Mathematics, by B.V.Ramana, Mc Graw Hill publishers.
4. Advanced Engineering Mathematics, by Erwin Kreyszig, Wiley India.

**Outcomes:**The student will be able to analyze engineering problems using the concepts of Matrices and Numerical methods.

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**II Year B.Tech. I-Sem**

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**ORGANIC CHEMISTRY(17A35301)**

**Objectives:**

- The Mechanism of organic chemical reaction is essential to synthesis new organic compounds in drug and pharmaceutical industries. In order to study their kinetics of reactions to regulate the process for optimization of production of drugs and pharmaceutical, the principles of organic chemistry are essential.
- For chemical engineer to carry out a processes industrially for the manufacture of drgus and pharmaceuticals, Comprehension on basic reactions, reagents and their applications is needed.
- He/She should know the electronic behavior of organic molecules, their special and geometrical arrangement of functional groups.
- He/She should have insight of reaction mechanisms for different types of reactions.
- He/She must have knowledge to conduct the most common reactions like addition, substitution, oxidation, reduction etc., on large scale.

**UNIT I:**

Polar effects – Inductive effect, electromeric effect, resonance, hyper conjugation, steric hindrens, and aromaticity – examples.

**UNIT II:**

Electrophilic reactions: a) Friedel-Craft reaction b) Riemer- Teimenn Reaction c) Backmann rearrangement.

Nucleophillic reactions : a) Aldol condensation b) Perkin Reaction c) Benzoin condensation.

**UNIT – III:**

Stereo isomerism; Optical isomerism; Symmetry and chirality; Optical isomerism in lactic acid and tartaric acid; Sequence rules; Enantiomers, diastereomers; Geometrical Isomerism; E-Z system of nomenclature, conformational analysis of ethane and Cyclohexane.

**UNIT.IV**

Some Reagents of Synthetic importance:

Preparation and applications of Aluminum Chloride, N-Bromosuccnamide (NBS), Diazomethane, Dicyclohexylcarbodiimide(DCC), Potassiumtertiarybutoxide and Grignard reagent

**UNIT.V:**

Some Useful Reactions in Organic Synthesis:

i). Protection of functional groups: Hydroxyl, Carbonyl and amino groups

ii). Oxidation: Oxidation of alcohols and carbonyl compounds with suitable examples

iii). Reduction: Reduction of double and triple bonds and carbonyl compounds with suitable examples.

**TEXTBOOKS**:

1. Text book of Organic Chemistry – Morrsion and Boyd.
2. Organic Reaction Mechanisms by VK Ahulwalia and RK Parashar

**REFERENCES:**

1. Reaction mechanism – Peter Skyes.
2. Text book of Organic Chemistry – P.L. Soni.
3. Organic Chemistry Vol- I-IL. Finar.
4. Reactions and Reagents – O.P. Agrawal.
5.A Text Books of Organic Chemistry- Bahl and Arun Bahl, S. Chand company, New Delhi
6. Polymer Science and Technology- Hema Singh, Acme Learning, New Delhi

**Outcomes:**

1. Will be able to understand the essentiality of organic chemical reaction to synthesis new organic compounds in drug and pharmaceutical industries.
2. To gain knowledge on basic reactions, reagents and their applications.
3. To gain knowledge on electronic behavior of organic molecules, their special and geometrical arrangement of functional groups.
4. To gain necessary knowledge to conduct the most common reactions like addition, substitution, oxidation, reduction etc., on large scale.

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**Ananthapuramu**

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## CHEMICAL PROCESS CALCULATIONS(17A30801)

**UNIT- I**

**Stoichiometric & Composition relations**: Stoichiometric relation, basis of calculations, methods of expressing compositions of mixtures and solutions, density and specific gravity, Baume and API gravity scales.

(For Assignments only: Use of Log-Log and Semi-Log graphs; Graph plotting using plotters like MS-Excel, Polymath, Minitab, Origin, etc..)

**Behavior of Ideal gases**: Kinetic theory of gases, application of ideal gas law, gaseous mixtures, gases in chemical reactions.

**UNIT -II**

**Vapor pressure**: Liquefaction and liquid state, vaporization, boiling point, effect of temperature on vapor pressure, Antoine equation, vapor pressure plots, estimation of critical properties, vapor pressure of immiscible liquids and ideal solutions, Raoult's law, Non volatile solutes.

**Humidity and Saturation**: Partial saturation, Humidity- Absolute Humidity, Vaporization process, Molal humidity, Relative and percentage saturation, dew point, humid heat, wet bulb and dry bulb temperatures, use of humidity charts, adiabatic vaporization.

**UNIT- III**

**Material balances**: Tie substance, Yield, conversion, limiting reactant, excess reactant, processes involving reactions, Material balances with the help of Stoichiometric equations, Material balances involving drying, dissolution, & crystallization. Material balance calculations for processes involving recycle, bypass and purge.

**UNIT -IV**

**Thermo physics**: Energy, energy balances, heat capacity of gases, liquid and mixture solutions. Kopp's rule, latent heats, heat of fusion and heat of vaporization, Trouton's rule, Kistyakowsky equation for non polar liquids enthalpy and its evaluation.

**Thermo chemistry**: Calculation and applications of heat of reaction, combustion, formation and neutralization, Kirchoff's equation, enthalpy concentration change,

**UNIT- V**

**Flame Temperature Calculations:** Calculation of theoretical and actual flame temperatures.

**Combustion Calculations**: Introduction, fuels, calorific value of fuels, coal, liquid fuels, gaseous fuels, air requirement and flue gases, combustion calculations, incomplete combustion, material and energy balances, thermal efficiency calculations.

**TEXTBOOKS**

**1.** Chemical process principles, Part -I, Material and Energy Balance, Hougen O A, Watson K.M. and Ragatz R.A. 2$^{nd}$ Edition,John Wiley and Sons, New York, 1963.

**REFERENCES:**

1. Basic principles and calculations in chemical engineering by D.H. Himmelblau, 7$^{th}$ Ed. PHI, 2013
2. Stoichiometry by B.I. Bhatt and S.M. Vora (3rd Ed.) Tata McGraw Hill publishing company, Ltd. New Delhi (1996)

**Data Tables:**Use of Humidity Chart is permitted in the Examination hall

**OBJECTIVE:** To develop the basic knowledge in material and energy balance industry recycle streams.

**OUTCOME:** This course will enable students to evaluate the effeciency of a process in terms of yield, energy and provide guidance to improve upon them

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## MOMENTUM TRANSFER (17A30802)

**UNIT- I**

Unit operations and unit processes, unit systems, basic concepts, nature of fluids, hydrostatic equilibrium, applications of fluid statics.

Fluid flow phenomena-Laminar flow, Shear rate, Shear stress, Rheological properties of fluids, Turbulence, Boundary layers.

**UNIT- II**

Basic equation of fluid flow –Mass balance in a flowing fluid; continuity equation, differential momentum balance; equations of motion, Macroscopic momentum balances, Bernoulli equation.

Incompressible Flow in pipes and channels- shear stress and skin friction in pipes, laminar flow in pipes and channels, turbulent flow in pipes and channels, friction from changes in velocity or direction.

**UNIT- III**

Dimensional analysis: Buckingham $\pi$ Theorem and Rayleigh's method.

Flow of compressible fluids- Definitions and basic equations, Processes of compressible flow, Isentropic flow through nozzles, adiabatic frictional flow, and isothermal frictional flow.

**UNIT -IV**

Flow past immersed bodies, Drag and Drag coefficient, friction in flow through beds of solids, Kozeny-Carman, Blake-Plummer and Ergun equations, and motion of particles through fluids.

Fluidization: Conditions for fluidization, Minimum fluidization velocity, Types of fluidization, Expansion of fluidized beds, Applications of fluidization, Continuous fluidization:Slurry and pneumatic transport.

**UNIT- V**

Transportation and Metering of fluids: Pipes, fittings and valves, Fluid- moving machinery, Fans, blowers, and compressors.

Measurement of flowing fluids:Variable head meters- Orifice meter, Venturi meter, Pitot tube; Area meter- Rota meter.

**TEXTBOOKS**

1. Unit Operations of Chemical Engineering by W.L.McCabe, J.C.Smith& Peter Harriot, McGraw-Hill, 7$^{th}$ed, 2007

**REFERENCES:**

1. Transport processes and unit operations by Christie J. Geankoplis, PHI

2. Unit operations, Vol-1 –Chattopadhya, Khanna publishers
3. Principles of Unit Operations, Foust *et al*, 2nd ed., John Wiley, 1999
4. Chemical Engineering, Vol-I, Coulson and Richardson, Pergamon Press.

**OBJECTIVE:** The behavior of fluids is important to process Engineering and constitutes foundations for the study of unit operations. An understanding of fluids is essential to students not only for accurately treating problems on the moment of fluids through pipes, pumps, but for dealing with all kinds of process equipment.

**OUTCOME:** To apply the concept of hydrostatic equilibrium and to have knowledge on fluid flow phenomena and to determine engineering design quantities for laminar and turbulent flow.

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**MATERIALS SCIENCE FOR CHEMICAL ENGINEERS(17A30803)**

**UNIT- I**

**Introduction**:Engineering Materials – Classification – levels of structure.

**Crystal Geometry and Structure Determination**: Space lattice and Unit cell. Bravais lattices, crystal systems with examples. Lattice coordinates, Miller indices, Bravais indices for directions and places: crystalline and non crystalline solids; ionic, covalent and metallic solids; packing efficiency, coordination number; structure determination by Bragg's X-ray diffraction and powder methods.

**UNIT -II**

**Crystal Imperfection**: Point defects, line defects-edge and screw dislocation, Berger's circuit and Berger's vectors, dislocation reaction, dislocation motion, multiplication of dislocations during deformation , role of dislocation on crystal properties; surface defects, dislocation density and stress required to move dislocations.

**UNIT -III**

**Basic thermodynamic functions**: phase diagrams and phase transformation: Primary and binary systems-general types with examples; tie line& lever rule, non equilibrium cooling: phase diagrams of Fe-$Fe_3$-C, Pb-Sn, Cu-Ni systems.

Phase transformations in Fe-$Fe_3$-C steels, Time-Temperature-Transformation (TTT) curves for eutectoid steels and plain carbon steels; effect of alloying elements on properties of steels; types of steels, alloys and other metals used in chemical industry.

**UNIT -IV**

Elastic, an elastic and plastic deformations in solid materials; rubber like elasticity, visco elastic behavior (models); shear strength of real and perfect crystals, work hardening mechanisms, cold working, hot working; dynamic recovery, recrystallization, grain growth, grain size and yield stress, Brief description of heat treatment in steels.

**Magnetic materials**: Terminology and classification, magnetic moments due to electron spin, ferro-magnetism and related phenomena, domain structure, hysteresis loop, soft and hard magnetic materials.

**UNIT- V**

**Fracture in ductile and brittle materials, creep**: mechanism of creep and methods to reduce creeping in materials, creep rates and relations. Fatigue-mechanisms and methods to improve fatigue resistance in materials. Composite materials: types; stress-strain relations in composite materials, applications.

**Oxidation and Corrosion**: Mechanisms of oxidation, oxidation resistant materials, principles and types of corrosion, protection against corrosion.

**TEXT BOOK:**

1. Materials Science and Engineering, 5$^{th}$ed. V. Raghavan, PHI Learning Pvt. Ltd., New Delhi, 2009.

**REFERENCES:**

1. Elements of Materials Science, L.R. Van Vlack,
2. Science of Engineering Materials, vols. 1&2, ManasChanda, McMillan Company of India Ltd.

**Objective:** This course will help students to learn about the relationship between structure and properties of materials, application of various classes of materials including metals, ceramics, polymers.

**Outcome:** This course will enable the student to learn about proper selection of materials for designing various equipment in a chemical industry.

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**PROCESS INSTRUMENTATION(17A30804)**

**UNIT I**

Elements of instruments, static and dynamic characteristics, basic concepts of response of first order type instruments, mercury in glass thermometer, bimetallic thermometer, pressure spring thermometer, static accuracy and response of thermometers.

**Unit II:**

**Thermo electricity:** Industrial thermocouples, thermocouple wires, thermo couple wells and response of thermocouples. Thermal coefficient of resistance, industrial resistance thermometer bulbs and circuits, radiation receiving elements, radiation, photoelectric and optical pyrometers.

**Unit III:**

Composition analysis, spectroscopic analysis by absorption, emission, mass and color measurement spectrometers, gas analysis by thermal conductivity, analysis of moisture, gas chromatography, refractometer.

**Unit IV:**

**Pressure vacuum and head:** liquid column manometers, measuring elements for gauge pressure and vacuum, indicating elements for pressure gauges, measurement of absolute pressure, measuring pressure in corrosive liquids, static accuracy and response of pressure gauges.

Head, density and specific gravity, direct measurement of liquid level, pressure measurement in open vessels, level measurements in pressure vessels, measurement of interface level, density measurement, and level of dry materials.

**Unit V:**

Head flow meters, area flow meters, open channel meters, viscosity meters, quantity meters, flow of dry materials, viscosity measurements.

Recording instruments, indicating and signaling instruments, transmission of instrument readings, control center, instrumentation diagram, process analysis.

**TEXT BOOK:**

1. Industrial instrumentation by Donald P.Eckman, Wiley eastern, 1950.

**REFERENCE:**

1. Principles of industrial instrumentation by PatraNabis, TMH.
2. Instruments for measurements and control by Holbrock W.C. Van Nostrand East West.
3. Hand book Instrumentation, Considine, McGraw Hill,

**OBJECTIVE:** The course will give an idea about different instruments for measuring T, P, flow rate, level and composition of various process streams in chemical industry.

**OUTCOME:** This course enables the student to select and design an instrument for measurement of flow, level, temperature, pressure and composition in chemical process industries.

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## HUMAN VALUES AND PROFESSIONAL ETHICS (AUDIT COURSE) (17A39901)

**Objectives:**

• To create an awareness on Engineering Ethics and Human Values.
• To instill Moral and Social Values and Loyalty
• To appreciate the rights of Others

**Students will be able to:**

- Identify and analyze an ethical issue in the subject matter under investigation or in a relevant field
- Identify the multiple ethical interests at stake in a real-world situation or practice
- Articulate what makes a particular course of action ethically defensible
- Assess their own ethical values and the social context of problems
- Identify ethical concerns in research and intellectual contexts, including academic integrity, use and citation of sources, the objective presentation of data, and the treatment of human subjects
- Demonstrate knowledge of ethical values in non-classroom activities, such as service learning, internships, and field work
- Integrate, synthesize, and apply knowledge of ethical dilemmas and resolutions in academic settings, including focused and interdisciplinary research

**Unit I: HUMAN VALUES**

Morals, Values and Ethics-Integrity-Work Ethic-Service learning – Civic Virtue – Respect for others – Living Peacefully – Caring – Sharing – Honesty - Courage- Co Operation – Commitment – Empathy –Self Confidence Character – Spirituality.

**Unit II: ENGINEERING ETHICS**

Senses of 'Engineering Ethics- Variety of moral issued – Types of inquiry – Moral dilemmas – Moral autonomy –Kohlberg's theory- Gilligan's theory- Consensus and controversy – Models of professional roles- Theories about right action- Self interest - Customs and religion –Uses of Ethical theories – Valuing time –Co operation – Commitment.

**Unit III :ENGINEERING AS SOCIAL EXPERIMENTATION**

Engineering As Social Experimentation – Framing the problem – Determining the facts – Codes of Ethics – Clarifying Concepts – Application issues – Common Ground - General Principles – Utilitarian thinking respect for persons.

**UNIT IV: ENGINEERS RESPONSIBILITY FOR SAFETY AND RISK**

Safety and risk – Assessment of safety and risk – Risk benefit analysis and reducing risk- Safety and the Engineer- Designing for the safety- Intellectual Property rights(IPR).

**UINIT V: GLOBAL ISSUES**

Globalization – Cross culture issues- Environmental Ethics – Computer Ethics – Computers as the instrument of Unethical behavior – Computers as the object of Unethical acts – Autonomous Computers- Computer codes of Ethics – Weapons Development - Ethics and Research – Analyzing Ethical Problems in research – Intellectual property Rights( IPR).

**Text Books:**

1. Engineering Ethics includes Human Values" by M.Govindarajan, S.Natarajan anad, V.S.SenthilKumar-PHI Learning Pvt. Ltd-2009
2. "Engineering Ethics" by Harris, Pritchard and Rabins, CENGAGE Learning, India Edition, 2009.
3. "Ethics in Engineering" by Mike W. Martin and Roland Schinzinger – Tata McGraw-Hill– 2003.
4. "Professional Ethics and Morals" by Prof.A.R.Aryasri, Dharanikota Suyodhana-Maruthi Publications.
5. "Professional Ethics and Human Values" by A.Alavudeen, R.Kalil Rahman and M.Jayakumaran- LaxmiPublications.
6. "Professional Ethics and Human Values" by Prof.D.R.Kiran-
7. Indian Culture, Values and Professional Ethics" by PSR Murthy-BS Publication

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**ORGANIC CHEMISTRY LAB(17A35104)**

**Course Objectives:**

To confirm the formation and nature of the product in a chemical processes, the knowledge of some physical, chemical and instrumental methods is essential for a chemical engineer.

**ORGANIC CHEMISTRY LAB:**

1. Criteria of Purity of Solid and Liquid, Determination of Melting Point & Boiling Point. Detecting Nitrogen, Sulphur, and Halogens in Organic Compounds.
2. Identification of an Unknown Substance from the following classes of Organic Compounds, Alcohols, Phenols, Aldehydes, Ketenes, Carbohydrates and Carboxylic acids.
3. Preparation of Aspririn
4. Preparation of Paracetamol
5. Preparation of Acetanilide
6. Preparation of Sulphonic acid
7. Preparation of derivatives for Aldehydes and Amines.
8. Beckman Rearrangement (Preparation of Benzanilide from Benzophenone oxime).
9. Determination of strength of a Glycine Solution.
10. Estimation of an Aldehyde.

**Course Outcome:**

Student will get the knowledge of methods to confirm the formation and the nature of the product.

**TEXT BOOKS:**

1. Vogels Text Book of Qualitative Organic Analysis.

**TEXTBOOKS**:

1. Text book of Organic Chemistry – Morrsion and Boyd.

2. Organic Reaction Mechanisms by VK Ahulwalia and RK Parashar

**REFERENCES:**

1. Reaction mechanism – Peter Skyes.
2. Text book of Organic Chemistry – P.L. Soni.
3. Organic Chemistry Vol- I-IL. Finar.
4. Reactions and Reagents – O.P. Agrawal.
5. A Text Books of Organic Chemistry- Bahl and Arun Bahl, S. Chand company, New Delhi
6. Polymer Science and Technology- Hema Singh, Acme Learning, New Delhi

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**MOMENTUM TRANSFER LAB(17A30805)**

1. Identification of laminar and turbulent flows
   Major equipment - Reynolds apparatus
2. Measurement of point velocities
   Major equipment - Pitot tube setup
3. Verification of Bernoulli's equation
   Major equipment – Bernoulli's Apparatus
4. Calibration of Rotameter
   Major equipment – Rotameter Assembly
5. Variation of Orifice coefficient with Reynolds Number
   Major equipment - Orifice meter Assembly
6. Determination of Venturi coefficient
   Major equipment – Venturi meter Assembly
7. Friction losses in Fluid flow in pipes
   Major equipment - Pipe Assembly with provision for Pressure measurement
8. Pressure drop in a packed bed for different fluid velocities
   Major equipment - Packed bed with Pressure drop measurement
9. Pressure drop and void fraction in a fluidized bed
   Major equipment - Fluidized bed with Pressure drop measurement
10. Studying the coefficient of contraction for a given open orifice
    Major equipment - Open Orifice Assembly
11. Studying the coefficient of discharge in a V-notch

Major equipment - V-notch Assembly

12. Studying the Characteristics of a centrifugal pump
    Major equipment - Centrifugal Pump
13. Drag studies using two different fluids

**Objective:**The lab provides knowledge on various flow patterns, flow measuring devices and pumps.

**Outcome:** Student will be able to understand the concept of fluid flow phenomena, different flow regimes, flow measuring devices like venturi, orifice and rotameter.

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**EXPLORATORY DATA ANALYSIS LAB (17A35104)**

**COURSE DESCRIPTION:** Statistical and Numerical Techniques – Measures of central tendency/dispersion, Curve fitting by method of least squares, linear regression and correlation, ANOVA; Data analysis using R, Numerical Solution of algebraic, transcendental and ordinary differential equations, Inverse and Eigen values of a matrix – Numerical method.

**LIST OF EXPERIMENTS**

**Required softwares: ORIGIN, MATLAB, R-LAB.**

**I. Statistical and Fourier series Techniques:**

To a given set of data:

1. Determine measures of central tendency/dispersion - Mean, Median, Mode, Range and Variance; Box plot representation using Origin Software.
2. Fit a straight line, parabola, exponential curve.
3. Determine the coefficient of correlation and regression.
4. Analysis of variance (ANOVA) for one variable.
5. Determine R function and give interpretation.
6. Transforming signal in time domain into frequency domain.
7. Represent in contour plot using matlab.

**II. Numerical Techniques:**

8. Solving algebraic and transcendental equations using Regula - Falsi and Newton - Raphson methods.
9. Determine the inverse of a matrix; solving system of algebraic equations using Gauss-Siedal method.
10. Determine the Eigen values of a matrix and dominant Eigen value by power method.
11. Numerical differentiation and integration.
12. Numerical solution of Ordinary differential equations - Modified Euler method & R-K fourth order method.

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**Comprehensive Objective Type Examination (17A30806)**

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## MANAGEMENT SCIENCE (17A45402)

**COURSE OBJECTIVES :**

To provide fundamental knowledge on Management, Administration, Organization & its concepts.
To understand the role of management in Production
To study Materials/Purchases/Stores/Inventory/Marketing Management and Quality control
To study HRM in order to have an idea on Recruitment, Selection, Training &Development, job evaluation and Merit rating concepts.
To identify Strategic Management areas & to Study the PERT/CPM for better Project Management.

**UNIT I:INTRODUCTION TO MANAGEMENT:**

Management-Concept and meaning-Nature-Functions-Management as a Science and Art and both. Schools of Management Thought-Taylor's Scientific Theory-Henry Fayol's principles-Eltan Mayo's Human relations-Systems Theory- **Organizational Structure and Design**: Features of Organizational Structure-Work Specialization-Departmentation-Span of Control-Centralization and Decentralization. **Organisational Designs**-Line organization-Line & Staff Organization-Functional Organization-Matrix Organization-Project Organization-Committee form of Organization-Social responsibilities of Management.

**UNIT II:OPERATIONS MANAGEMENT:**

Principles and Types of Plant Layout-Methods of Production (Job, batch and Mass Production), Work Study- Statistical Quality Control**:***C* chart, *P* chart, (simple Problems) Deming's contribution to Quality.

**Material Management:** Objectives-Inventory-Functions, Types, Inventory Techniques-EOQ-ABC Analysis-Purchase Procedure and Stores Management-Just-In-Time (JIT). **Marketing Management:** Concept- Meaning - Nature-Functions of Marketing- Marketing Mix- Channels of Distribution - Advertisement and Sales Promotion- Marketing Strategies based on Product Life Cycle.

**UNIT III:HUMAN RESOURCES MANAGEMENT (HRM):**

HRM- Definition and Meaning – Nature-Managerial and Operative functions-Evolution of HRM-Job Analysis -Human Resource Planning(HRP)-Employee Recruitment-Sources of Recruitment-Employee Selection- Process and Tests in Employee Selection- Employee Training and Development-On- the- job & Off- the- job training methods-Performance Appraisal Concept-Methods of Performance Appraisal-Placement-Employee Induction-Wage and Salary Administration-Objectives-Essentials of Wage and Salary Administration-Job Evaluation-Employee Grievances-Techniques of handling Grievances.

**UNIT IV:STRATEGIC & PROJECT MANAGEMENT:**

Definition& Meaning-Setting of Vision- Mission- Goals- Corporate Planning Process- Environmental Scanning-Steps in Strategy Formulation and Implementation-SWOT Analysis. **Project Management:**Network Analysis- Programme Evaluation and Review Technique (PERT), Critical Path Method (CPM), Identifying Critical Path, Probability of Completing the project within given time, Project Cost Analysis, Project Crashing. (Simple problems).

**UNIT V:CONTEMPORARY ISSUES IN MANAGEMENT:**

The concept of Management Information System(MIS)- Materials Requirement Planning (MRP)- Customer Relations Management(CRM)- Total Quality Management (TQM)- Six Sigma Concept- Supply Chain Management(SCM)- Enterprise Resource Planning (ERP)- Performance Management- Business Process Outsourcing (BPO), Business Process Re-engineering and Bench Marking -Balanced Score Card-Knowledge Management.

**<u>Text Books:</u>**

1. A.R Aryasri: Management Science, TMH, 2013
2. Stoner, Freeman, Gilbert, Management, Pearson Education,New Delhi, 2012.

**COURSE OUTCOMES:**

1. To apply the concepts & principles of management & designs of organization in a practical world.

To design good plant layout and apply Work-study principles, Quality Control techniques, in real life industry & To maintain & control the Inventory & students can able to identify the importance of marketing in emerging world.

To apply the concepts of HRM in Recruitment, Selection, Training & Development.

To develop PERT/CPM Charts for projects of an enterprise and estimate time & cost of project & to analyse the business through SWOT .

They can aware of the latest and contemporary issues of management science.

**<u>References:</u>**

1. Koontz & Weihrich: Essentials of Management, 6/e, TMH, 2005.
2. Thomas N.Duening & John M.Ivancevich ManagementPrinciples and Guidelines,Biztantra.

3. Kanishka Bedi, Production and Operations Management, Oxford University Press, 2004.
4. Memoria & S.V.Gauker, Personnel Management, Himalaya, 25/e, 2005
5. Samuel C.Certo: Modern Management, 9/e, PHI, 2005
6. Schermerhorn, Capling, Poole & Wiesner: Management, Wiley, 2002.
7. Parnell: Strategic Management, Biztantra, 2003.
8. Lawrence R Jauch, R.Gupta &William F.Glueck: Business Policy and Strategic Management, Frank Bros., 2005.

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**PROBABILITY AND STATISTICS(17A45101)**
**(Common for CE, ME, Chemical)**

**Objectives:**To help the students in getting a thorough understanding of the fundamentals of probability and usage of statistical techniques like testing of hypothesis, Statistical Quality Control and Queuing theory

**UNIT – I:** Basic concepts of Probability – Random variables – Expectation – Discrete and continuous Distributions – Distribution functions. Binomial and poison distributions Normal distribution – Related properties.

**UNIT – II:** Test of Hypothesis: Population and Sample - Confidence interval of mean from Normal distribution - Statistical hypothesis - Null and Alternative hypothesis - Level of significance. Test of significance - Test based on normal distribution - Z test for means and proportions.

**UNIT – III:** Small samples - t- test for one sample and two sample problem and paired t-test, F-test and Chi-square test (testing of goodness of fit and independence).

**UNIT – IV:** Statistical Quality Control: Concept of quality of a manufactured product -Defects and Defectives - Causes of variations - Random and assignable - The principle of Shewhart Control Chart-Charts for attribute and variable quality characteristics- Constructions and operation of $\overline{X}$ - Chart, R-Chart, p - Chart and C-Chart.

**UNIT – V:** Queuing Theory: Pure Birth and Death process, M/M/1 & M/M/S & their related simple problems.

**TEXT BOOKS:**

1. Probability & Statistics by E. Rukmangadachari & E. Keshava Reddy, Pearson Publisher.
2. Probability & Statistics for engineers by Dr. J. Ravichandran WILEY-INDIA publishers.

**REFERENCES:**

1. Probability & Statistics by T.K.V. Iyengar, B.Krishna Gandhi, S.Ranganatham and M.V.S.S.N.Prasad, S.Chand publications.
2. Statistical methods by S.P. Gupta, S.Chand publications.
3. Probability & Statistics for Science and Engineering by G.Shanker Rao, Universities Press.
4. Probability and Statistics for Engineering and Sciences by Jay L.Devore, CENGAGE.
5. Probability and Statistics by R.A. Jhonson and Gupta C.B.

**Outcomes:** The student will be able to analyze the problems of engineering & industry using the techniques of testing of hypothesis, Statistical Quality Control and Queuing theory and draw appropriate inferences.

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**ANALYTICAL CHEMISTRY(17A40801)**

**Course Objectives:**

- To acquire basic principles of simple instrumental methods for estimation of organic/inorganic species.
- To acquire basic knowledge of industrial separations
- To acquire Knowledge in Characterization of the Materials synthesized by chemical industry
- To understand the Preparations, properties and reactions of materials

**UNIT-I: Basic Principles of Quantitative Analysis**

Limitations of analytical methods, Classification of errors, Accuracy, Precision, How to reduce systematic errors, Significant figures, Calculators and Computers, Mean and Standard deviation, Distribution of Random errors, Reliability of Results, Confidence interval , Comparison of results, Comparing the means of two samples, Paired T-test, Correlation and regression, Standard deviations.

**UNIT-II: Chromatographic Methods:**

Column chromatography-general principles, terminology: retention time, rotation volume, separation factor, resolution of peaks. Principles of gas chromatography, block diagram of gas chromatograph - detectors (FID, ECD), stationary phases for column, mobile phases, chromatogram, qualitative analysis, special plots, quantitative analysis, HPLC: Principles of High Performance Liquid Chromatography. Block diagram of HPLC Systems, function of each component, stationary phases, eluting solvents, pumps, detectors, quantitative applications of HPLC. Ion chromatography-seperation of anions and cations. Suppressed & non-suppressed ion chromatography. Numerical calculations.

**Unit-III: Thermal methods of Analysis:**

Introduction to Thermal methods, Thermogravimetric Analysis (TGA)-principles, and applications (determination of drying temperatures, kinetic methods, automatic thermo gravimetric Analysis) DTA: Differential thermal analysis-Principles and applications (exothermic and endothermic peaks, heat of reaction, catalysis, decompositions etc.,)

DSC: Differential scanning calorimettry, principles & applications (exothermic & endothermic peaks, compound purity determination, percentage crystallinity, glass transition temperature).

**Unit-IV: Electro-Analytical Techniques**

i). Polarography: Definition, advantage of dropping mercury electrode, factors affecting on limiting current, Half wave potentials and significance, Applications of Polarography

ii), Amperometric Titrations: Basic principle involved in the Amperometry, Amperometric Titrations and applications, Advantages and disadvantages of Amperometric Titrations.

**Unit-V: Spectrophotometric Methods:**

Introduction to Analysis: Qualitative & Quantitative Analysis; Conventional & Instrumental methods of analysis. Molecular spectrophotormetry-Beer's law Block diagram of UV-Visible Spectrophotometer – quantitative analysis direct method for the determination metal ions: Chromium, Manganese, Iron, etc in alloys. Infrared spectrophotormetry-principle, instrumentation and Functional group analysis of organic compounds using infrared spectra. Quantitative analysis of organic molecules. Atomic absorption spectrophotormetry(AAS) and flame photometry: principles, instrumentation and applications (Determination of Sodium, Potassium and Calcium.) (12h)

**Course Outcome:**

The student may acquire enough knowledge on industrial processes and Identification of Products using different analytical and instrumental techniques.

**BOOKS:**

1. Quantitative analysis, R.A.Day & A.L. Underwood , 5th edition, Printice- Hall of India Pvt. Ltd., 2000.
2. Vogel's Text Book of Qualitative chemical analysis, J. Mendham, R.C.Denney, J. Darnes, M.J.K. Thomas, Persar education 6th edition, 2002.
3. Elements of Physical Chemistry-Peter Atkins, Oxford Uni.Press, 3rd Edition, 2010.

**REFERENCES:**

1. Atkin's Physical Chemistry – P. Atkins and J. De Paula, Oxford Univ.Press, 9th Edition, 2012
2 Instrumental lMethods of Chemical Analysis, Gurdeep R.Chatwal, Sham K.Ananad, Himalayha publishing House,5th Edition, 2012.
3. Advanced physical chemistry – Gurudeepraj, Goel Publishing House, 2000
4. Essentials of Physical Chemistry- Arun Bahl, B.S.Bahl and G.D.Rulasi, S.Chand Publishers, New Delhi.

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**PROCESS HEAT TRANSFER (17A40802)**

**UNIT -I**

**Introduction:** Nature of heat flow, conduction, convection, natural and forced convection, radiation.

**Heat transfer by conduction in Solids:** Fourier's law, thermal conductivity, steady state conduction in plane wall & composite walls, compound resistances in series, heat flow through a cylinder, conduction in spheres.

**Unsteady state heat conduction:** Equation for one-dimensional conduction, Semi-infinite solid.

**UNIT- II**

**Principles of heat flow in fluids:** Typical heat exchange equipment, countercurrent and parallel current flows, energy balances, rate of heat transfer, overall heat transfer coefficient, electrical analogy, critical radius of insulation, logarithmic mean temperature difference, variable overall coefficient, multi-pass exchangers, individual heat transfer coefficients, resistance form of overall coefficient, fouling factors, classification of individual heat transfer coefficients, magnitudes of heat transfer coefficients, effective coefficients for unsteady-state heat transfer.

**UNIT- III**

**Heat Transfer to Fluids without Phase change:** Regimes of heat transfer in fluids, thermal boundary layer, heat transfer by forced convection in laminar flow, heat transfer by forced convection in turbulent flow, the transfer of heat by turbulent eddies and analogy between transfer of momentum and heat, heat transfer to liquid metals, heating and cooling of fluids in forced convection outside tubes.

**Natural convection:** Natural convection to air from vertical shapes and horizontal planes, effect of natural convection in laminar-flow heat transfer.

**UNIT -IV**

**Heat transfer to fluids with phase change:** Heat transfer from condensing vapors, heat transfer to boiling liquids.

**Radiation:** Introduction, properties and definitions, black body radiation, real surfaces and the gray body, absorption of radiation by opaque solids, radiation between surfaces, radiation shielding, radiation to semi transparent materials, combined heat transfer by conduction, convection and radiation.

**UNIT- V**

**Heat exchange equipment:** General design of heat exchange equipment, heat exchangers, condensers, boilers and calendrias, extended surface equipment, heat transfer in agitated vessels, scraped surface heat exchangers, heat transfer in packed beds, heat exchanger effectiveness (NTU method)

**Evaporators:** Evaporators, performance of tubular evaporators, capacity and economy, multiple effect evaporators, methods of feeding, vapor recompression.

**TEXT BOOK:**

1. Unit Operations of Chemical Engineering, 6$^{th}$ ed., W.L. McCabe, J.C. Smith and P. Harriot, McGraw-Hill, New York, 2001

**REFERENCES:**

1. Process Heat Transfer, D.Q. Kern, Tata McGraw-Hill, New Delhi, 1997.
2. Heat Transfer, 4$^{th}$ ed., J.P. Holman, McGraw-Hill, New York, 1976.
3. Chemical Engineering, Volume-I, J. Coulson and R.F. Richardson, Pergamon Press

**Objective:** To impart the students about knowledge on modes of heat transfer and design of heat transfer equipment evaporators etc.,

**Outcome:** Student will be able to use the heat transfer principles in selection and design of heat exchanger, evaporator, etc. for a chemical industry.

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## MECHANICAL OPERATIONS (17A40803)

**UNIT- I**

Properties, handling and mixing of particulate solids: Characterization of solid particles, properties of particulate masses, storage and mixing of solids, types of mixers, mixers for cohesive solids, mixers for free flowing solids.

**UNIT- II**

Size reduction: Principles of comminution, computer simulation of milling operations, size reduction equipment-crushers, grinders, ultra fine grinders, cutting machines, Equipment operation. Laws of crushing: Kick's law, Bond's law, Rittinger's law

Screening, Industrial screening equipments, Effectiveness of the screen, differential & cumulative analysis.

**UNIT -III**

Filtration, cake filters, centrifugal filters, cyclone separators, electro-static precipitators.

Principles of cake filtration, Clarifying filters, liquid clarification, gas cleaning, principles of clarification.

**UNIT- IV**

Separations based on motion of particles through fluids: gravity settling processes and centrifugal settling processes, float and sink method, differential settling, coagulation, Flotation-separation of ores, flotation agents

Transportation of solid particulate mass:Belt, screw, apron conveyers, bucket elevators, pneumatic conveying.

**UNIT- V**

Agitation and mixing of liquids: Agitation of liquids, circulation velocities, power consumption in agitated vessels. Blending and mixing of liquids, suspension of solid particles, dispersion operations.

**TEXT BOOK:**

1. Unit Operations in Chemical Engineering by W.L. McCabe and J.C. Smith and Peter Harriott, McGraw Hill 7th ed. 2001.

**REFERENCES:**

1. Chemical engineers hand book, J.H. Perry, 7th ed. McGraw Hill
2. Introduction to Chemical Engineering by J.T.Banchero& W.L. Badger., TMH, 1997.

**Objective:** This course deals with the different mechanical unit operations in chemical engineering. Specific attention is given on particle and separation techniques.

**Outcome:** Student will gain knowledge on various mechanical separation operations used in chemical industry.

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**II- Year B.Tech. II-Sem**

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## CHEMICAL ENGINEERING THERMODYNAMICS (17A40804)

**UNIT -I**

**Introduction**: The scope of thermodynamics, temperature, defined quantities; volume, pressure, work, energy, heat, Joules Experiments.

**The first law and other basic concepts:** The first law of thermodynamics, thermodynamic state and state functions, enthalpy, the steady-state steady-flow process, equilibrium, the phase rule, the reversible process, constant-V and constant- P processes, heat capacity, isobaric, isochoric, isothermal, adiabatic and polytrophic processes.

**UNIT -II**

**Volumetric properties of pure fluids:** The PVT behavior of pure substances, virial equations, the ideal gas, the applications of the virial equations, second virial coefficients from potential functions. Cubic equations of state, generalized correlations for gases, generalized correlations for liquids, molecular theory of fluids.

**UNIT- III**

**The second law of thermodynamics:** Statements of the second law, heat engines, thermodynamic temperatures scales, thermodynamic temperature and the ideal gas scale

Entropy, Entropy changes of an ideal gas, mathematical statement of the second law, the third law of thermodynamics, entropy from the microscopic view point, calculation of ideal work and lost work.

**UNIT -IV**

**Power cycles:** Carnot cycle, Rankine cycle, Otto cycle, Diesel cycle.

**Refrigeration and liquefaction:** The Carnot refrigerator, the vapor compression cycle, the comparison of refrigeration cycles, the choice of refrigerant, absorption refrigeration, the heat pump, liquefaction processes.

**UNIT –V**

**Thermodynamic properties of fluids:** Property relations for homogeneous phases, residual properties, two phase systems, thermodynamic diagrams, tables of thermodynamic properties, generalized property correlation for gases.

**TEXT BOOKS**

1. J.M.Smith and HC Van Ness, Introduction to Chemical Engineering Thermodynamics, $6^{th}$ed, McGraw Hill,2003.

**REFERENCE**

1. Y.V. C. Rao, Chemical Engineering Thermodynamics, University publications.
2. K. V. Narayanan, Chemical Engineering Thermodynamics, PHI,2001

**Objective:** To provide the students with the terminology of thermodynamics like system, properties, processes, reversibility, equilibrium, phases, components; the relationship between heat and work by understanding the significance of the thermodynamic laws.

**Outcome:** This course will enable the student to understand the spontaneity and energy efficiency of a process.

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**MECHANICAL OPERATIONS LAB (17A40805)**

1. To determine the time of grinding in a ball mill for producing a product with 80 % passing a given screen.
Major equipment - Ball mill Apparatus, Sieve shaker, Different sizes of sieves, weighing balance.
2. To verify the laws of crushing using any size reduction equipment like crushing rolls or vibrating mills and to find out the working index of the material.

Major equipment – Jaw Crusher, Sieve shaker, Different sizes of sieves, WeighingBalance, Energy meter.

3. To find the effectiveness of hand screening and vibrating screen of a given sample.
   Major equipment - Vibrating Sieve shaker, Different sizes of sieves, WeighingBalance.
4. To achieve beneficiation of a ore using froth flotation technique.
   Major equipment - Froth flotation cell
5. To obtain batch sedimentation data and to calculate the minimum thickner area under given conditions.
   Major equipment- Sedimentation apparatus
6. To determine the specific cake resistance and filter medium resistance of a slurry in plate and frame filter press.
   Major equipment - Plate and frame filter press.
7. To separate a mixture of particles by Jigging.
   Major equipment - Jigging apparatus
8. To calculate separation efficiency of particles in a mixture using cyclone separator.
   Major equipment - Cyclone separator
9. To determine reduction ratio of a given sample in a pulverizer.
   Major equipment - Pulverizer
10. Filtration Studies using
    a. Plate and Frame Filter Press
    b. Rotary Drum Filter
    c. Batch Centrifuge
11. To Perform mixing studies using Ribbon Mixer.
12. To determine reduction ratio of a given sample in .a grinder Major equipment - Grinder

**Objective:**The course will equip students with the practical knowledge of different mechanical unit operations & operational conditions of different equipments.

**Outcome:** Student will be able to develop knowledge on various mechanical separation operations used in a chemical industry.

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## PROCESS HEAT TRANSFER LAB(17A40806)

1. Determination of total thermal resistance and thermal conductivity of composite wall.
   Major equipment - Composite wall Assembly

2. Determination of thermal conductivity of a metal rod.
   Major equipment - Thermal Conductivity apparatus
3. Determination of natural convective heat transfer coefficient for a vertical tube.
   Major equipment - Natural convection heat transfer apparatus
4. Determination of critical heat flux point for pool boiling of water.
   Major equipment- Pool boiling apparatus
5. Determination of forced convective heat transfer coefficient for air flowing through a pipe
   Major equipment – Forced convection heat transfer apparatus
6. Determination of overall heat transfer coefficient in double pipe heat exchanger.
   Major equipment - Double pipe heat exchanger apparatus
7. Determination of heat transfer coefficient for a helical coil in an agitated vessel.
   Major equipment – Helical coil in a agitated vessel.
8. Study of the temperature distribution along the length of a pin-fin under natural and forced convection conditions
   Major equipment - Pin fin apparatus
9. Estimation of un-steady state film heat transfer coefficient between the medium in which the body is cooled.
   Major equipment - Heat transfer coefficient determination apparatus
10. Determination of Stefan – Boltzmann constant.
    Major equipment - Stefan Boltzmann apparatus
11. Determination of emissivity of a given plate at various temperatures.
    Major equipment - Emissivity determination apparatus

**Objective:** This lab will provide practical knowledge on various heat transfer process and equipment like heat exchangers and evaporators.

**Outcome:** The student will be able to understand the thermal conductivity measurement, heat transfer coefficient, calculation in natural and forced convection and some of the radiation aspects.

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**COMPREHENSIVE OBJECTIVE TYPE EXAMINATION (17A40807)**

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**PROCESS DYNAMICS AND CONTROL (17A50801)**

**Objectives:**

- Develop mathematical and transfer function models for dynamic processes.

- Analyze process stability and dynamic responses.
- Empirically determine process dynamics for step response data.
- Development of block diagrams, reading block diagrams, process and instrumentation diagrams
- Familiarity with different types of PID feedback controllers..
- Ability to understand feed forward control, cascade control and Smith predictors and their applications
- Knowledge of real time applications of process control implementation.

**UNIT I**

**Introduction to process dynamics and control**: Laplace transforms, Inverse Laplace transform, Response of First Order Systems. Physical examples of first order systems- Liquid level, mixing process, R- C circuit. Linearization.

**UNIT II**

Response of first order systems in series- interacting and non- interacting systems, second order systems, transportation lag.

**Control system**: Components of a control system, Servo Vs regulator problem, development of block diagram.

**Controllers and final control elements**: Control valve and its construction,P, PD, PI, PID controllers.

**UNIT III**

**Stability**: Concept of Stability, Stability criterion, Routh test for stability

**Root locus**: concept of root locus, rules for plotting the root locus diagram.

**UNIT IV**

**Introduction to frequency response**: Substitution rule, Bode diagrams

**Control systems design by frequency response**: Bode stability criterion, Gain and Phase margins.

**Controller tuning**: Tuning of P, PD, PI, PID controllers, trial and error method, Ultimate gain and ultimate period, Ziegler- Nichols technique, Cohen and Coon rules.

**UNIT V**

**Advanced control strategies:** Cascade control, feed forward control, ratio control, Smith predictor, dead time compensation. Control valve sizing, valve characteristics.

**TEXT BOOK:**

1. Process Systems Analysis and Control, 2nd ed., D.R. Coughanowr, McGraw-Hill, 1991

**REFERENCES:**

1. Chemical Process Control, G. Stephanopoulos, PHI Learning Pvt. Ltd., New Delhi, 2010
2. Process Control, B.W. Bequette, PHI Learning Pvt. Ltd., New Delhi, 2010

**OUTCOME:** Ability to model the dynamic processes, to analyze the dynamic processes, to design feedback control system for chemical, mechanical & electrical engineering systems and to design advanced control system for complex and normal processes.

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## PHASE AND CHEMICAL EQUILIBRIA(17A50802)

**OBJECTIVES:**

To introduce the concepts of chemical potential, partial properties, property relations for ideal gases, fugacity excess properties and to develop the theoretical foundation for applications of thermodynamics to gas mixtures and liquid solutions and to perform the phase equilibrium calculations using simple models for VLE, Gamma/Phi approach and equation of state approach.

**UNIT I**

**Solution Thermodynamics:** Theory, Fundamental property relation, chemical potential as a criterion for phase equilibrium, partial properties, ideal gas mixtures, fugacity and fugacity coefficient for pure species, fugacity and fugacity coefficient for species in solutions, generalized correlations for Fugacity coefficient, The ideal solutions, excess properties.

**UNIT II**

**Solution Thermodynamics:** Applications: The liquid phase properties from VLE data, models for the excess Gibbs energy, property changes of mixing

**VLE at low to moderate pressures:** The nature of equilibrium, the phase rule, Duhems theorem, VLE: Qualitative behavior, the gamma /Phi formulation of VLE, Dew point and bubble point calculations, flash calculations, solute (1)/solvent (2) systems

**UNIT III**

**Thermodynamic Properties and VLE from Equations of State:** properties of fluids from the virial equations of state, properties of fluids from cubic equations of state, fluid properties from correlations of the Pitzer type, VLE from cubic equations of state

**Topics in Phase Equilibria:** Equilibrium and stability, Liquid-Liquid Equilibrium (LLE), Vapor- Liquid–Liquid Equilibrium (VLLE), Solid-Liquid Equilibrium (SLE), Solid Vapor Equilibrium (SVE).

**UNIT IV**

**Chemical Reaction Equilibria:** The reaction coordinate, application equilibrium criterion to chemical reactions, The standard Gibb’s energy change and the equilibrium constant, effect of temperature on equilibrium constants, relation of equilibrium constants to composition, equilibrium conversion for single reactions, Phase rule and Duhem’s theorem for reacting systems.

**UNIT V**

**Introduction to Molecular Thermodynamics :** Molecular Theory of Fluids,Second Virial Coefficients from Potential Functions,Internal Energy of Ideal Gases: Microscopic view, Thermodynamic Properties and Statistical Mechanics ,Hydrogen Bonding and Charge-Transfer Complexing ,Behavior of Excess Properties ,Molecular Basis for Mixture Behavior,VLE by Molecular Simulation.

**TEXT BOOK:**

1. Introduction to Chemical Engineering Thermodynamics, 6$^{th}$ ed., J.M. Smith, H.C. Van Ness and M.M. Abbott, Tata McGraw-Hill, New Delhi, 2003.

**REFERENCE:**

1. Chemical Engineering Thermodynamics, Pradeep Ahuja, PHI Learning Pvt. Ltd., New Delhi, 2009
2. A Text Book of Chemical Engineering Thermodynamics, K.V. Narayanan, PHI Learning Pvt. Ltd., New Delhi, 2001.

**Outcome:**

1. Students will learn the concepts of chemical potential, partial properties, property relations for ideal gases, fugacity excess properties and to develop the theoretical foundation for applications of thermodynamics to gas mixtures and liquid solution.
2. Students will be able to understand the procedures for estimating the thermodynamic properties and perform thermodynamic calculations oriented to the analysis and design of chemical processes.

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**CHEMICAL REACTION ENGINEERING – I(17A50803)**

**OBJECTIVES:**

- The emphasis of this course is on the fundamentals of chemical reaction kinetics and chemical reactor operation.
- The overall goal of this course is to develop a critical approach toward understanding complex reaction systems and elucidating chemical reactor design.
- Integrate concepts from science & engineering to constitute a basis for the design of chemical reactor, a key element in the design of chemical process.
- Provide a foundation on deriving rate expressions for series, parallel, reversible reactions and the knowledge about product distribution in multiple reactions, recycle reactors and auto catalytic reactions

**UNIT I**

Overview of chemical reaction engineering-classification of reactions, variables affecting the rate of reaction definition of reaction rate, kinetics of homogenous reactions- concentration dependent term of rate equation, Temperature dependent term of rate equation, searching for a mechanism, predictability of reaction rate from theory.

**Interpretation of batch reactor data- constant volume batch reactor**:- Analysis of total pressure data obtained in a constant-volume system, the conversion, Integral method of analysis of data– general procedure, irreversible unimolecular type first order reactions, irreversible bimolecular type second order reactions, irreversible trimolecular type third order reactions, empirical reactions of nth order, zero-order reactions, overall order of irreversible reactions from the half-life, fractional life method, irreversible reactions in parallel, homogenous catalyzed reactions, autocatalytic reactions, irreversible reactions in series.

**UNIT II**

**Constant volume batch reactor**– first order reversible reactions, second order reversible reactions, reversible reactions in general, reactions of shifting order, Differential method of analysis of data. Varying volume batch reactor–differential method of analysis, integral method of analysis, zero order, first order, second order, nth order reactions, temperature and reaction rate, the search for a rate equation.

**UNIT III**

**Introduction to reactor design**- general discussion, symbols and relationship between $C_A$ and $X_A$. Ideal reactors for a single reaction- Ideal batch reactor, Steady-state mixed flow reactor, Steady-state plug reactors.

**Design for single reactions**- Size comparison of single reactors, Multiple- reactor systems, Recycle reactor, Autocatalytic reactions.

**UNIT IV**

**Design for parallel reactions**- introduction to multiple reactions, qualitative discussion about product distribution, quantitative treatment of product distribution and of reactor size.

**Multiple reactions**-Irreversible first order reactions in series, quantitative discussion about product distribution, quantitative treatment, plug flow or batch reactor, quantitative treatment, mixed flow reactor, first-order followed by zero-order reaction, zero order followed by first order reaction.

**UNIT V**

**Temperature and Pressure effects**- single reactions- heats of reaction from thermodynamics, heats of reaction and temperature, equilibrium constants from thermodynamics, equilibrium conversion, general graphical design procedure, optimum temperature progression, heat effects, adiabatic operations, non adiabatic operations, comments and extensions. Exothermic reactions in mixed flow reactors-A special problem, multiple reactions.

**TEXT BOOK:**

1. Chemical Reaction Engineering, 3rd ed., O. Levenspiel, John Wiely & Sons, 1999.

**REFERENCES:**

1. Elements of Chemical Reaction Engineering, 2nd ed., H.S. Fogler, PHI Learning Pvt. Ltd., New Delhi, 2010.
2. Chemical Engineering Kinetics, 3rd ed., J.M. Smith, McGraw-Hill, New York, 1981.

**Outcome:**

- This course provides necessary knowledge for selection of the chemical reactors for a particular process.
- Analyze and interpret experimental data from batch reactors and determine the order of simple chemical reactions.
- Compare ideal reactor types (batch, CSTR and PFR) and apply quantitative methods to design and size reactors for simple chemical reaction schemes.
- Determine optimal ideal reactor design for multiple reactions for yield or selectivity.
- Predict reactor performance for reactors when the temperature is not uniform within the reactor

**III Year B.Tech. Chem. Engg. I-Sem**

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**MASS TRANSFER OPERATIONS-I (17A50804)**

**OBJECTIVES:**

- To discuss the fundamental concepts of mass transfer principles and to apply those concepts to real engineering problems.
- To impart the basic concepts of molecular diffusion, mass transfer coefficients and analysis of different mass transfer processes
- Applies the concepts of diffusion mass transfer, mass transfer coefficients, convective mass transfer, inter-phase mass transfer, equipment for gas-liquid operations.

**UNIT- I**

The Mass Transfer Operations: Classification of the Mass-Transfer Operations, Choice of Separation Method, Methods of Conducting the Mass-Transfer Operations, Design Principles, Unit Systems

Molecular Diffusion In Fluids: Molecular Diffusion, Equation of Continuity, binary solutions, Steady State Molecular Diffusion in Fluids at Rest and in Laminar Flow, estimation of diffusivity of gases and liquids, Momentum and Heat Transfer in Laminar flow

Diffusion:Diffusion in Solids, Fick's Diffusion, Unsteady State Diffusion, Types of Solid Diffusion, diffusion through polymers, diffusion through crystalline solids, Diffusion through porous solids & hydrodynamic flow of gases.

**UNIT- II**

Mass Transfer Coefficients: Mass Transfer Coefficients, Mass Transfer Coefficients in Laminar Flow (Explanation of equations only and no derivation), Mass Transfer Coefficients in Turbulent Flow, eddy diffusion, Film Theory, Penetration theory, Surface-renewal Theory, Combination Film-Surface-renewal theory, Surface-Stretch Theory, Mass, Heat and Momentum Transfer Analogies, Turbulent Flow in Circular Pipes. Mass transfer data for simple situations.

Inter Phase Mass Transfer: Concept of Equilibrium, Diffusion between Phases, Material Balances in steady state co-current and counter current stage processes, Stages, Cascades, Kremser – Brown equation.

**UNIT-III**

Equipment For Gas-Liquid Operations: Gas Dispersed, Sparged vessels (Bubble Columns), Mechanical agitated equipments(Brief description),Tray towers, General characteristics, Sieve design for absorption and distillation (Qualitative Treatment), Different types of Tray Efficiencies, Liquid Dispersed venturi Scrubbers, Wetted-Wall Towers, Packed Towers, Counter current flow of Liquid & Gas through packing, Mass transfer coefficients for packed towers, End effects and Axial Mixing Tray tower vs Packed towers.

**UNIT-IV**

Absorption And Stripping: Absorption equilibrium, ideal and non ideal solutions selection of a solvent for absorption, one component transferred: material balances. Determination of number of Plates (Graphical), Absorption Factor, estimation of number of plates by Kremser Brown equation, Continuous contact equipment; HETP, Absorption of one component, Determination of number of Transfer Units and Height of the Continuous Absorber, overall coefficients and transfer units, dilute solutions, overall height of transfer units.

**UNIT-V**

Humidification Operations: Vapor-Pressure Curve, Definitions, Psychometric Charts, Enthalpy of gas-vapor Mixtures, Humidification and Dehumidification, Operating lines and Design of Packed Humidifiers, Dehumidifiers and Cooling towers, Spray Chambers

**TEXT BOOK:**

1. Mass transfer operations by R.E. Treybal, 3rd ed. Mc Graw Hill, 1980.
2. Separation process C.J King, Tata Mc Graw Hill
3. Principles of Mass Transfer and Separation Processes by B K Dutta, Printice Hall of India Pvt Limited, New Delhi

**REFERENCE:**

1. Diffusion mass transfer in fluid system by E. L. Cussler.
2. Transport processes and unit operations by Christie J. Geankoplis
3. Separation Process Principles, J D Seader and E. J. Henley, John Wiley & Sons, Inc,. New York

**Pre-requisite:---Nil---**

***Codes/Tables:*** *Psychometric Charts may be provided*

**Outcome:**

- Recognize the various modes of mass transfer, Determine mass transfer rates using Fick's Law.
- Fundamental knowledge on mass transfer mechanisms and operations like absorption, stripping, drying and humidification.
- Estimate diffusion coefficients, Solve unsteady state diffusion problems
- Determine convective mass transfer rates & mass transfer coefficients
- Determine the number of transfer units and height requirements for a packed column

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**CHEMICAL TECHNOLOGY(17A50805)**

**OBJECTIVES:**

- Unit operations unit processes involved in manufacture of important and widely employed organic and inorganic chemicals.
- Develop skills in preparing /presenting a neat Engineering drawing for Chemical Process Industries.
- Impart clear description of one latest process along with its Chemistry, Process parameters, Engineering Problems and Optimum Conditions.
- Demonstrate the importance of updating the latest technological developments in producing products economically and environment friendly.
- Appreciate the usage of other engineering principles such as Thermodynamics, Heat, mass and momentum transfer in operation and maintain the productivity

**UNIT – I**

Water and Air: Importance of water, sources, plant location factors related to water, water shortage problems, methods of treating fresh water, methods of obtaining fresh water from saline waters, waste water treatment and disposal, air as a chemical raw material.

Soda ash, caustic soda and chlorine, Glass: manufacture of special glasses

**UNIT – II**

Industrial gases: carbon dioxide, hydrogen and oxygen – products of water gas, producer gas. Nitrogen industries: synthetic ammonia, urea, nitric acid (ammonium nitrate), ammonium chloride, ammonium phosphate and complex fertilizers

Sulphur and sulphuric acid, manufacture of sulphuric acid, hydrochloric acid and some other chemicals –Aluminum sulphate and alum.

**UNIT – III**

Cement manufacture, special cements, miscellaneous calcium compounds, magnesium compounds.

Manufacture of phenols, formaldehyde, vinyl chloride and vinyl acetate, manufacture of phenol-formaldehyde resin and polyvinyl chloride polymer, SBR

**UNIT – IV**

Oils: Definition, constitution, extraction and expression of vegetable oils, refining and hydrogenation of oils.

Synthetic fibers: Classification, manufacture of Nylon 66, polyester fiber and viscose rayon fiber.

Soaps and detergents: Definitions, continuous process for the production of fatty acids, glycerin and soap, production of detergents.

**UNIT – V**

Pulp and paper industry: methods of pulping, production of sulphate and sulphite pulp, production of paper –wet process

Pharmaceutical Industries: Classification, Alkylation, Carboxylation and Acetylation, Condensation and Cyclization, Dehydration,Halogenation, Oxidation, Sulfonation, Amination, Radio isotopes in Medicine, Fermentation and Life processing for Antibiotics, Hormones, and Vitamines, Biologicals, Steroid hormones, isolates and Animals.

**Text books:**

1. Shreve's Chemical Process Industries edited by Austin, Mc.graw-Hill.5$^{th}$ ed.1985.
2. Dryden's Outlines of Chemical Technology edited by M. Gopal Rao and M. Sittig, 2$^{nd}$ ed. 1973.

**References:**

1. Industrial Chemistry by B.K. Sharma,
2. Hand book of industrial chemistry Vol 1& II K.H.Davis & F.S. Berner Edited by S.C. Bhatia, CBS publishers
3. Chemical Technology: G.N. Panday, Vol 1& Vol II.

**Pre-requisite:---Nil---**

**Outcomes:**

Upon successful completion of the course the students will be able to:

1. Make a neat and easy to understand the plant process flow sheet.
2. Keeps up the productivity while maintaining all safety norms stipulated, during their job.
3. Solve Engineering problems that are likely to come across during the operation of plants.
4. Suggest alternative manufacturing process in terms of Economic viability of the product.

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## PROCESS MODELING AND SIMULATION(17A50806)

**OBJECTIVES:**

- Learn to develop mathematical model for problems.
- To impart knowledge on modeling of various equipment and their simulation using different numerical techniques.
- Formulate a chemical engineering problem as a mathematical model, and select an appropriate solution method.
- Understand the computational requirements of various solution options and use this understanding in the selection of the solution method
- Formulate and solve process design problems, based on fundamental analysis and using mathematical models of chemical processes

**UNIT I**

**Mathematical models for chemical engineering systems**: classification of mathematical models- steady state vs dynamic models, lumped vs distributed parameter models, deterministic vs stochastic models. **Examples of mathematical models-** Two heated tanks, batch reactor, constant volume CSTRs, non-isothermal CSTR, reactor with mass transfer, ideal binary distillation column, batch distillation with holdup.

**UNIT II**

**Empirical model building**- method of least squares, linear, polynomial and multiple regression, non-Linear regression. **Solution of Non- Linear Algebraic equations-** bisection, false position, Quasi Newton and Newton- Raphson methods.

**UNIT III**

**Numerical integration-** Trapezoidal rule, Simpson's rule and Newton– Cotes formula. **Numerical solution of differential equations-** Euler's method, Runge- Kutta methods, predictor corrector methods.

**UNIT IV**

**Numerical solution of partial differential equations-** elliptic, parabolic and hyperbolic equations.finite difference methods, Leibman's method, Crank Nicholson method. Apllications to steady state and Unsteady state heat conduction and temperature distribution problems.

**UNIT V**

**Process Simulation examples**: VLE dew point and bubble point calculations, binary distillation column, gravity flow tank, batch reactor, Non- isothermal CSTR, countercurrent heat exchanger.

**Process simulation using modular and equation based solving approaches**: Developing a simulation model, a simple flow sheet, Sequential modular approach, Simultaneous modular approach, Equation solving approach.

**TEXTBOOKS:**

1. Process modeling, Simulation and Control for Chemical Engineers, 2nd ed., W. L. Luyben, McGraw-Hill, New York, 1990.
2. Numerical Methods for Engineers, S.K. Gupta, Wiley Eastern, New Delhi, 1995.

**REFERENCE:**

1. Numerical Methods for Engineers and Scientists, S.S. Rao
2. Introduction to Numerical Methods in Chemical Engineering, P. Ahuja, PHI learning Pvt. Ltd., New Delhi, 2010
3. Process Modeling and Simulation, Amiya K. Jana, 2012.

**Outcome:**

- Understand the stages involved in the development of a process model.
- Formulate a chemical engineering problem as a mathematical model from basic engineering principles.
- Identify the appropriate numerical solutions used in solving the models
- Apply various simulation tools for solving the chemical engineering models developed.
- Understand the solution techniques for solving ODEs.

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## Foreign Language (Audit)(17A59901)

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## PROCESS DYNAMICS AND CONTROL LAB (17A50807)

**OBJECTIVES:**

- To evaluate response of fist and higher order characteristics.
- Study the installed characteristics of the valve.
- Study if there is a hysteresis in the control valve and sensor.
- Evaluate the tuning of a PID control via manual and automatic tuning.
- Evaluate the effect controller on the control system

1. Calibration and determination of time lag of various first and second order instruments
Major equipment - First order instrument like Mercury-in-Glass thermometer and
Overall second order instrument like Mercury-in-Glassthermometer in a thermal well

2.Experiments with single tank system.
Single tank - Step Response
Single tank - Impulse Response

3. Experiments with two tank systems with and without interaction.
Non Interacting Tanks – Step Response
Interacting Tanks – Step Response
Non Interacting Tanks – Impulse Response
Interacting Tanks – Impulse Response

4. Level control trainer
Major equipment - Level control trainer set up with computer

5. Temperature control trainer
Major equipment - Temperature control trainer with computer

6. Experiments on proportional, reset, rate mode of control etc.
Major equipment – PID control apparatus

7. Control valve characteristics
Major equipment – Control valve set up

8. Estimation of damping coefficient for U-tube manometer
   Major equipment - U-tube manometer.

**Outcome:**

- Estimate the dynamic behavior of the control systems
- Understand the controllability, speed of response the control systems.
- Select proper control valve to meet process needs.
- Understand direct digital control systems handling and operation.
- Tuning of a PID control via manual and automatic tuning.
- Choose PID modes that effect controllability, speed of response the control systems

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**ENERGY AND ENVIRONMENTAL ENGINEERING LAB (17A50808)**

**List of Experiments:**

1. Estimation of chemical and physical parameters of Ground and Surface water:
   $P^H$, TDS & Conductivity, Hardness, Turbidity, Fluoride, Color analysis.
   Pesticide Microbial analysis: e-coli/ total coli forms bacteria
2. Estimation of physical parameters of waste water:
   $P^H$, TDS, Hardness, Turbidity, Alkalinity etc.
3. Estimation of chemical parameters of waste water:
   COD, BOD, TSS
4. Water and waste water treatment:
   Small RO system for treatment of ground water.
   Same above system with UF membrane for turbidity removal and water disinfection.
5. Analysis of Air:
   Estimation of SPM, RSPM, Sox, Nox, CO and ozone in atmospheric air to study air pollution.
4. Fuel cell Test Kit [Energy]
   A small ½ watt to 1 watt fuel cell with water electrolysis kit ($H_2$ and $O_2$ Generation) plus small voltmeter and ammeter for measuring fuel cell performance.
7. Measurement of Flash point, fire point and calorific value of petroleum products.
8. Proximate Analysis of Coal – Moisture, Volatile Matter, Fixed Carbon and Ash. (Hot air Oven & Muffle Furnace)
9. Calorific value of Solid Fuels.
10. Energy auditing of your Department.

**List of Equipment**

$P^H$ meter, Colorimeter, TDS meter, Aerobic /Anaerobic reactor 25L capacity, BOD incubator, High accuracy analytical balance (5 digit), Desiccators, RO system with domestic 2”x12” Membrane module, $H_2S$ vial kit, Water analysis kit, UV-Vis spectrophotometer, High volume air sampler, Bomb calorimeter, Fuel cell test kit, Microscope.

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## COMPREHENSIVE OBJECTIVE TYPE EXAMINATION(17A50809)

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**MASS TRANSFER OPERATIONS-II(17A60801)**

**OBJECTIVES:**

- Study of the stage wise mass transfer operations, principles of various stage wise contact processes like distillation, extraction and leaching and drying
- Design aspects of the equipments utilized for above mentioned operations.
- Attain practical knowledge of separation processes, conduct experiments and submit the report.

**UNIT-I**

Distillation: Fields of applications, VLE for miscible liquids, immiscible liquids, steam distillation, Positive and negative deviations from ideality, enthalpy-concentration diagrams, flash vaporization and differential distillation for binary and multi component mixtures, Batch distillation with Reflux.

**UNIT-II**

Continuous rectification-binary systems, multistage tray towers –method of Mc Cabe and Thiele, enriching section, Stripping section, feed introduction, total reflux, minimum and optimum reflux ratios, use of open steam, types of condensers, partial condensers, effect of cold reflux, multiple feeds , tray efficiencies, continuous-contact equipment (packed towers)

Multistage (tray) towers –the method of Ponchon and Savarit, the enriching and stripping sections, feed tray location, total reflux, minimum and optimum reflux ratios, types of reboilers, use of open steam, condenser and reflux accumulators, Azeotropic distillation, extractive distillation, comparison of Azeotropic and extractive distillation.

**UNIT- III**

Liquid-Liquid operations: fields of usefulness, liquid-liquid equilibrium, equilateral triangular co-ordinates, choice of solvent, stage wise contact, multistage cross-current extraction, Multi stage counter current without reflux

Multi stage counter current with reflux, Differential (continuous contact) extractors, spray towers, packed towers, mechanically agitated counter-current extractors, centrifugal extractors, dilute solutions, super critical fluid extraction, fractional extraction.

**UNIT-IV**

Drying: Equilibrium, Definitions, Drying Conditions- Rate of Batch Drying under constant drying conditions, Mechanisms of batch drying, Drying time Through Circulation Drying.
Classification Of Drying Operations: Batch and Continuous Drying Equipment, Material and Energy Balances of Continuous Driers, rate of drying for continuous direct heat driers.

**UNIT-V**
Leaching: Fields of applications, preparation of solid for leaching, types of leaching, leaching equilibrium, single stage and multi stage leaching calculations, constant under flow conditions, equipment for leaching operation.

**TEXT BOOK:**

1. Mass transfer operations by R.E. Treybal, 3rd ed. Mc Graw Hill, 1980.

**REFERENCE:**

1. Principles of Mass Transfer and Separation Processes by B K Dutta, Printice Hall of India Pvt Limited, New Delhi
2. Transport processes and unit operations by Christie J. Geankoplis
3. Separation Process Principles, J D Seader and E. J. Henley, John Wiley & Sons, Inc,. New York

**Pre-requisite:---**Mass Transfer Operations-I
**<u>Outcome</u>:**

- Have complete insight of stage wise contact processes absorption; distillation, extraction and leaching that are used in separation processes in industries.
- Explain the underlying principles and apply them for related separation processes in industries.
- Suggest and design equipment for various mass transfer operations mentioned above.
- Apply these separation processes for specific purposes by using the experience obtained while conducting experiments in laboratory.
- Can operate, design and debug any problems emanating in equipment used in industries for the above operations.
- Be able to operate and debug any problems emanating in equipments used in industries for the above operations.

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**CHEMICAL REACTION ENGINEERING – II(17A60802)**

**OBJECTIVES:**

- Learn the importance of RTD and the compartmental models for modeling of Non-ideal flow reacting vessels.
- Calculate the conversions based on segregated flow model, dispersion model and tanks-in-series models.
- Knowledge of rate law given the rate controlling step in catalytic reactions, internal and external diffusion effects.
- Learn the factors influencing catalyst decay, the role of pore diffusion on catalyst activity rate.
- Shrinking core model for spherical particles of unchanging size and design the fluid-solid reactors.

**UNIT I**

**Basics of non-ideal flow**: E, the exit age distribution function of fluid, the RTD, conversion in non-ideal flow reactors, diagnosing reactors (qualitative discussion only).

**The dispersion model**: axial dispersion, correlations for axial dispersion, chemical reaction and dispersion.

**UNIT II**

**The tanks in series model**: pulse response experiments and the RTD, chemical conversion. The convection model for laminar flow- the convective model and its RTD, chemical conversion in laminar flow reactors

**Earliness of mixing, segregation and RTD**: self-mixing of a single fluid, mixing of two miscible fluids.

**UNIT III**

**Catalysis and Catalytic reactors**: catalysts, steps in catalytic reactions, synthesizing a rate law, mechanism and rate limiting step. (From chapter 10, Fogler)

**Heterogeneous reactions**: Introduction to Solid catalyzed reactions: The rate equation for Surface Kinetics- Pore diffusion resistance combined with surface kinetics, Porous catalyst particles, heat effects during reaction, Performance equations for reactors containing porous catalyst particles.

**UNIT IV**

Solid catalyzed reactions- Experimental methods for finding rates. Deactivating catalysts- mechanisms of catalyst deactivation, the rate and performance equations.

**UNIT–V**

**Fluid-fluid reactions**: kinetics- the rate equation.

**Fluid-particle reactions**: kinetics- selection of a model, shrinking core model for spherical particles of unchanging size, rate of reaction for shrinking spherical particles, extensions, determination of rate controlling step.

**TEXT BOOKS:**

1. Chemical Reaction Engineering, 3rd ed., O. Levenspiel, John Wiley & Sons, 1999.
2. Elements of Chemical Reaction Engineering, 4th ed., H.S. Fogler, PHI Learning Pvt. Ltd., New Delhi, 2010.

**REFERENCES:**

1. Chemical Engineering Kinetics, 3rd ed., J.M. Smith, McGraw-Hill, New York, 1981.
2. The Engineering of Chemical Reactions, 2nd ed., L.D. Schmidt, Oxford University Press, New Delhi, 2010

**Outcome**:

- Modeling of compartmental models for Non-ideal flow reacting vessels.
- Calculation of conversions based on variousmodels
- Students can design the fluid-solid reactors.

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## CHEMICAL PLANT DESIGN AND ECONOMICS(17A60803)

**OBJECTIVES:**

- To familiarize the students about various economic aspects of chemical processes
- Learn basics of Cost estimation, Working Capital and Capital Investment and understand the time value of money
- Learn the importance of Cash flow diagrams and Break-even analysis.
- Study depreciation methods and methods of estimation of profitability of an industry
- Study the procedures adopted for Replacement and Selection from Alternatives.

**UNIT I**

Introduction, Process Design development.General design considerations, Cost and asset accounting.Cash flow for industrial operations, factors effecting investment and production cost, capital investments, estimation of capital investments, cost indices, cost factors in capital investment

**UNIT II**

Organizations for presenting capital investments, estimates by compartmentalization, estimation of total product of cost direction, production costs, fixed charges, plant overhead costs, financing.

Interest and investment cost, type interest, nominal and effective interest rates, continuous interest, present worth and discount annuities, cost due interest on investment, source of capital.

**UNIT III**

Taxes and insurances, type of taxes: federal income taxes, insurance-types of insurance, self insurance.

Depreciation : types of depreciation, services life, salvage value, present value, methods for determining depreciation, single unit and group depreciation.

**UNIT IV**

Profitability: alternative investments and replacements, profitability standards, discounted cash flow, capitalized cost, pay out period ,alternative investments, analysis with small investments, increments and replacements.

**UNIT V**

Optimum design and design strategy, incremental cost, general procedure for determining optimum condition, comparison of graphical and analytical methods, optimum production rates, semi continuous cyclic operation, fluid dynamics, mass transfer strategy of linearization

**TEXT BOOK:**

1. Plant Design and Economics for Chemical Engineering, 4th ed., M.S. Peters and K.D. Timmerhaus, McGraw-Hill,1991

**REFERENCE:**

1. Process Engineering Economics, Schweyer

**Outcome:**

- Estimate various costs involved in a process industry and evaluate the tax burden of an establishment
- They will be ready with tools to estimate profitability of a company
- Find the replacement costs of an equipment and select best one from different alternatives
- Compute break even period for an investment and rate of return

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# CHEMICAL PROCESS EQUIPMENT DESIGN (17A60804)

**OBJECTIVES:**

- Study design safe process and design appropriate equipment like reactors, mass transfer heat transfer equipment, pipelines storage tanks etc.
- Study relevant codes for design of chemical plant equipment as per the standard procedures specified by design code books.
- Learn the fabrication techniques and testing methods.
- Learn design and engineering skills directly applied in design, installation and commissioning of equipments.

**UNIT-I**

**Basic Considerations in Process Equipment Design:** Introduction, general design procedure, fabrication techniques, equipment classification, power for rotational motion, drives for process equipment

**Materials of Construction:** Mechanical properties, materials, corrosion, corrosion prevention, choice of material.

**UNIT-II**

**Design Considerations:** Introduction, stress created due to static and dynamic loads, design stress, combined stresses and theories of failure, fatigue, brittle fracture, creep, effects of temperature, radiation and fabrication methods.

**Process Hazards and Safety Mechanisms in Equipment Design:** Introduction, hazards in process industries, safety measures, safety measures in equipment design, pressure relief devices.

**UNIT-III**

**Material Handling Equipment Design:** Piping in fluid transportation process-selection of piping material, design of piping system, pumping of fluids: selection of pumps, design procedures for pumps, compression and expansion of fluids: selection of compressors, fans and blowers, vacuum system equipment, turbines and expanders, design procedures for compressors, turbines and expanders

**Heat Transfer Equipment Design:**Selection of heat exchangers types- key heat exchanger types available, preliminary selection of heat exchanger types,Design of key heat exchanger types- Double pipe and multiple double pipe exchangers, shell and tube heat exchangers, plate exchangers, compact exchangers, air cooled exchangers.

**UNIT-IV**

**Seperation Equipment Design:** Distillation design procedures for columns with sieve trays, with random packing, with structural packing, Absorption and Stripping design procedures for trayed columns, packed columns separating dilute solutions

**Equipment Selection for liquid-liquid extraction:** Design procedure for liquid liquid extraction, selection of sorbent for separation by adsorption, basic adsorption cycles, selection of appropriate adsorption cycles, general design for separation by adsorption

**UNIT-V**

**Pressure Vessels:** Introduction, operating condition, pressure vessel codes, selection of materials, vessels operating at low temperatures and elevated temperatures, Design conditions and stresses.

Design of shell and its components, Fabrication, Inspection and Tests.

**TEXT BOOKS:**

1. Joshi's Process Equipment Design, Fourth Edition by V. V. Mahajani and S. B. Umarji, Macmillan Publishers India Ltd., 2009.
2. Plant Design and Economics for Chemical Engineers, Fifth Edition by Max. S. Peters, Klans Timmerhaus and Ronald E. West, McGrawHill International Edition, 2004.

**REFERENCE BOOKS:**

1. Coulson J.M. and Richardson J.F., Chemical Engineering Vol.VI (An introduction to Chemical Engineering Design), Pergamon Press, 1993.

**Outcome:**

The student will be able to do

1. Mechanical design of pressure vessels
2. Process design of separation equipments for distillation, absorption, stripping, liquid-liquid extraction, adsorption
3. Selection of piping materials, pumps, compressors, compressors, fans and blowers, vacuum system equipment, turbines and expanders
4. Design of material handling equipment like piping system, pumps, compressors, turbines and expanders.

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**INDUSTRIAL POLLUTION & CONTROL ENGINEERING(17A60805)**

**OBJECTIVES:** The aim of this course is that the students will learn the essential principles used in industrial pollution abatement and understand important issues in industrial pollution abatement and pertinent environmental legislations.

**UNIT I :** Types of emissions from chemical industries and effects of environment, environment legislation, Type of pollution, sources of wastewater, Effluent guidelines and standards.
Characterization of effluent streams, oxygen demands and their determination (BOD, COD, and TOC), Oxygen sag curve, BOD curve mathematical, controlling of BOD curve, self purification of running streams, sources and characteristics of pollutants in fertilizer, paper and pulp industry, petroleum and petroleum industry.

**UNITII:** General methods of control and removal of sulfur dioxide, oxides of nitrogen and organic vapors from gaseous effluent, treatment of liquid and gaseous effluent in fertilizer industry.
Air pollution sampling and measurement: Types of pollutant and sampling and measurement, ambient air sampling: collection of gaseous air pollutants, collection of particulate air pollutants. Stack sampling: sampling system, particulate sampling, and gaseous sampling. Analysis of air pollutants: Sulphur dioxide, nitrogen oxides, carbon monoxide, oxidants and Ozones, hydrocarbons, particulate matter.

**UNIT III :** Air pollution control methods and equipments: Source collection methods: raw material changes, process changes, and equipment modification. Cleaning of gaseous equipments particulate emission control: collection efficiency, control equipment like gravitational settling chambers, Cyclone separators, fabric filters, ESP and their constructional details and design aspects. Scrubbers: wet scrubbers, spray towers, centrifugal scrubbers, packed beds and plate columns, venturi scrubbers, their design aspects. Control of gaseous emissions: absorption by liquids, absorption equipments, adsorption by solids, equipment and the design aspects.

**UNIT IV :** Introduction to waste water treatment, biological treatment of wastewater, bacterial and bacterial growth curve, aerobic processes, suspended growth processes, activated aerated lagoons and stabilization ponds,

Attached growth processes, trickling filters, rotary drum filters, anaerobic processes.

**UNIT V :** Methods of primary treatments: screening, sedimentation, flotation, neutralization, and methods of tertiary treatment. A brief study of carbon absorption, ion exchange, reverse osmosis, ultra filtration, chlorination, ozonation, treatment and disposal.

Hazardous waste management: Nuclear wastes: health and environment effects, sources and disposal methods. Chemical wastes: health and environmental effects, treatment and disposal:treatment and disposal by industry, off site treatment and disposal, treatment practices in various countries. Biomedical wastes: types of wastes and their control.

**TEXT BOOKS:**

1. Environmental Pollution and Control Engineering, C. S. Rao – Wiley Eastern Limited, India, New Delhi, 1993.

2. Pollution Control in Process Industries, S.P. Mahajan, Tata McGraw-Hill, New Delhi, 1985.

**REFERENCES:**

1. Wastewater Treatment, M. Narayana Rao and A.K.Datta, Oxford and IHB publ. New Delhi.

**OUTCOMES:**

2. Understand the different types of wastes generated in an industry, their effects on living and non-living things.
3. Understand environmental regulatory legislations and standards and climate changes.
4. Understand about the quantification and analysis of wastewater and treatment.
5. Understand the different unit operations and unit processes involved in conversion of highly polluted water to potable standards.
6. Understand the atmospheric dispersion of air pollutants, and operating principles, design calculations of particulate control devices.

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**(OPEN ELECTIVE-I)**

**1. BASICS OF NANOTECHNOLOGY (17A60806)**

**OBJECTIVES:**

- Basic knowledge of nanotechnology, classification and properties of nanomaterials
- Various methods of synthesis of nanomaterials
- Applications of nanomaterials

**Unit I**

**Introduction:** History and Scope, Can Small Things Make a Big Difference? Classification of Nanostructured Materials, Fascinating Nanostructures, Applications of Nanomaterials, Nature: The Best of Nanotechnologist, Challenges and Future Prospects.

**Unit II**

**Unique Properties of Nanomaterials: Microstructure and Defects in Nanocrystalline Materials**: Dislocations, Twins, stacking faults and voids, Grain Boundaries, triple and disclinations. **Effect of Nano-dimensions on Materials Behavior:** Elastic properties, Melting Point, Diffusivity, Grain growth characteristics, Enhanced solid solubility.

**Unit III**

**Magnetic Properties**: Soft magnetic nanocrystalline alloy, Permanent magnetic nanocrystalline materials, Giant Magnetic Resonance, Electrical Properties, Optical Properties, Thermal Properties and Mechanical Properties.

**Unit IV**

**Synthesis Routes: Bottom up approaches:** Physical Vapor Deposition, Inert Gas Condensation, Laser Ablation, Chemical Vapor Deposition, Molecular Beam Epitaxy, Sol-gel method ,Self assembly

**Unit V**

**Top down approaches:** Mechanical alloying, Nano-lithography.

**Consolidation of Nanopowders**: Shock wave consolidation, Hot isostatic pressing and Cold isostatic pressing    Spark plasma sintering.

**Applications of Nanomaterials:** Nano-electronics, Nanosensors, Nanocatalysts, Structure and Engineering, Automotive Industry, Water- Treatment and the environment, Nano-medical applications, Textiles, Paints, Energy, Defence and Space Applications

**TEXT BOOKS**

1. Text Book of Nano Science and Nano Technology – B.S. Murthy, P. Shankar, Baldev Raj, B.B. Rath and James Munday, University Press-IIM.
2. Introduction to Nanotechnology – Charles P. Poole, Jr., and Frank J. Owens, Wley India Edition, 2012.

**REFERENCES:**

1. Nano: The Essentials by T.Pradeep, Mc Graw- Hill Education.
2. Nanomaterials, Nanotechnologies and Design by Michael F. Ashby, Paulo J. Ferreira and Daniel L.Schodek
3. Transport in Nano structures- David Ferry, Cambridge University press 2000
4. Nanofabrication towards biomedical application: Techniques, tools, Application and impact – Ed. Challa S.,S. R. Kumar, J. H. Carola.
5. Carbon Nanotubes: Properties and Applications- Michael J. O'Connell.
6. Electron Transport in Mesoscopic systems - S. Dutta, Cambridge University press.

**Outcomes:**

- Understand the importance of nanotechnology and its interdisciplinary nature.
- Understand the methods of fabrications and applications of nanomaterials
- Understand the Unique properties of nanomaterials.

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**(OPEN ELECTIVE -I)**

**2. GREEN TECHNOLOGY (17A60806)**

**Unit I: An introduction to environmental issues**: Role of chemical processes and chemical products, Global environmental issues, Air and water quality issues, Ecology.

**Risk concept**: Description of risk, Risk assessment concept, Dose-response, Exposure assessment.

**Unit II : Evaluating exposures:** Occupational exposures: recognition, evaluation, control, Exposure assessment for chemicals in the ambient environment, Designing safer chemicals.

**Green chemistry**: Green chemistry methodologies, Optimization based frameworks for the design of green chemical synthesis pathway.

**Unit III : Evaluating environmental fate:** Chemical and physical property estimation, Estimating environmental persistence, Estimating ecosystem risk, Classifying environmental risk based on chemical structure.

**Unit IV : Life-cycle concepts**: Life-cycle assessment, Life-cycle impact assessment

**Unit V :** Material flows in chemical manufacturing, Assessing opportunities for waste exchanges and byproduct synergies.

**TEXT BOOKS**

SHONNARD, D.ALLEN, D. Green Egineering: Environmentally Conscious Design of Chemical Processes.

**Outcomes:**

- To present approaches and methodologies for evaluating and improving the environmental performance of chemical processes and chemical products.
- To understand the basic knowledge of environmental issues and environmental regulations.
- To discuss the type of wastes and emissions that drive the environmental impacts.

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**(OPEN ELECTIVE -I)**

**3. NUCLEAR ENGINEERING (17A60806)**

**UNIT-1**

**Introduction:** Motivation for Nuclear Energy, India's Nuclear Power Program

**Nuclear Physics:** Nuclear model of the atom - Equivalence of mass and energy - Binding - Radio activity - Half life - Neutron interactions - Cross sections.

**UNIT-II**

**Nuclear Reactions and Reactor Materials**

Mechanism of nuclear fission and fusion - Radio activity - Chain reactions - Critical mass and composition - Nuclear fuel cycles and its characteristics - Uranium production and purification - Zirconium, thorium, beryllium.

**UNIT-III**

**Reprocessing**

Nuclear fuel cycles - spent fuel characteristics - Role of solvent extraction in reprocessing - Solvent extraction equipment.

**UNIT-IV**

**Nuclear Reactors**

Reactors - Types of fast breeding reactors - Design and construction of fast breeding reactors - heat transfer techniques in nuclear reactors - reactor shielding.

**UNIT-V**

**Safety, Disposal and Proliferation**

Nuclear plant safety- Safety systems - Changes and consequences of an accident - Criteria for safety - Nuclear waste - Type of waste and its disposal - Radiation hazards and their prevention - Weapons proliferation.

**Text Book**s:

1. Thomas J.Cannoly, " Fundamentals of Nuclear Engineering ", John Wiley (1978).
2. G,Vaidyanathan," Nuclear Reactor Engineering", Chand Publishers, 2013

**References**:

1. Collier J.G., and G.F.Hewitt, " Introduction to Nuclear Power ", (1987), Hemisphere Publishing, New York.
2. Lamarsh U.R. " Introduction to Nuclear Engineering Second Edition ", (1983), Addison Wesley M.A.
3. Lipschutz R.D. " Radioactive Waste - Politics, Technology and Risk ", (1980), Ballingor, Cambridge. M.A.

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**(OPEN ELECTIVE -I)**

## 4. SOLID WASTE MANAGEMENT (17A60806)

**OBJECTIVES:**

- Material flow in society and generation of solid waste source
- Clarification of solid waste on characterization of the same
- Understand the sense of onsite handling storage and collection systems including transportation
- Understand processing technologies with mechanical volume reduction and thermal volume reduction corporate land filling, deep well injections.
- Learn to estimate material recovery a energy recovery from a given waste data using case standing

**Unit I: Introduction:** Definition, characteristics and perspectives of solid waste. Types of solid waste.Physical and chemical characteristics.Variation of composition and characteristics.Municipal, industrial, special and hazardous wastes. **General aspects:** Overview of material flow in society. Reduction in raw material usage.Reduction in solid waste generation.Reuse and material recovery.General effects on health and environment.Legislations.

**Unit II: Engineered systems:** Typical generation rates.Estimation and factors effecting generation rates.On site handling.Storage and processing.Collection systems and devices.Transfer and transport.

**Unit III: Processing Techniques:** Mechanical volume reduction.Thermal volume reduction.Component separation.Land filling and land forming.Deep well injection.

**Unit IV: Material recovery:** Mechanical size alteration. Electromagnetic separation. Drying and dewatering. Other material recovery systems.Recovery of biological conversion products.Recovery of thermal conversion products.
**Energy recovery:** Energy recovery systems and efficiency factors. Determination of output and efficiency.Details of energy recovery systems.Combustion incineration and heat recovery.Gasification and pyrolysis. Refuse derived fuels (RDF).

**Unit V: Case studies:** Major industries and management methods used in typical industries – Coal fired power stations, textile industry, oil refinery, distillery, sugar industry, and radioactive waste generation units.

**Text Books:**
1. Howard S. Peavy, Environmental Engineering, McGraw Hill International Edition, 1986.
2. Dutta, Industrial Solid Water Management and Land Filling Practice, Narose Publishing House, 1999.

**Reference Books:**
1. Sastry C.A., Waste Treatment Plants, Narose Publishing House, 1995.
2. Lagrega, Hazardous Waste Management, McGraw Hill, 1994.

**Outcomes:**
The student should be able to
- Apply his knowledge of characterization of waste and develop a suitable management plan
- Assess the cost of transportation laboratory processing of solid waste
- Identify hazardous nature of waste if any and can suggest suitable dumping methods.
- Suggest processing waste for material for energy recovery.
- Develop a management plan for land filling composting deep well injection for non-recoverable waste.

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**ADVANCED ENGLISH LANGUAGE COMMUNICATION SKILLS LAB (17A65501)**

## Objectives:

This lab focuses on using computer-aided multimedia instruction for language development to meet the following targets:

- To expose the students to a variety of self instructional, learner-friendly modes of language learning.
- To enable the students to learn better pronunciation and accent through listening and reading exercises.
- To train students to use language appropriately for interviews, group discussion and public speaking.
- To initiate them to greater use of the computer in resume preparation, format-making etc.
- To help the students to cultivate the habit of reading passages from the computer monitor, thus providing them with the required facility to face computer based competitive exams such as GRE, TOFEL, and GMAT etc.
- To enable the students to acquire good communication skills as well as soft skills to meet global demands.

**Syllabus:**

**Unit I:Reading &Listening Comprehension:** Skimming –scanning- Extensive and Intensive reading. Reading for making inferences. Active VS passive listening.Listening and Note taking, - Listening for making inferences.

**Unit II:**Writing Skills: Formal and informal writing-Resume Writing-E-Correspondence.

**Unit III:Technical Presentations (Oral) :** Planning-Preparation-Presentation . Art of Persuasion- Audience analysis- Handling questions.

**Unit IV:Interview Skills:** Types of Interviews - pre-interview planning- answering strategies. Analysis of One to one –interviews – group interviews - Mock interviews.

**Unit V:Soft Skills**: Inter Personal Skills- Goal setting – Etiquettes and good manners – Team Working – Work Ethics--Time management – Problem Solving.

**Minimum Requirements**

The English Language Lab shall have two parts:

The Computer Aided Language Lab for 60 students with 60 systems, one master console, LAN facility and English language software for self-study by learners.

The Communication Skills Lab with movable chairs and audio-visual aids with a PA System, a TV, a digital stereo-audio and video system, a Camcorder, etc

System Requirement (Hardware Component):

Computer network with LAN with a minimum of 60 multimedia systems with the following specifications:

P-IV Processor

Speed-2.8 GHZ

RAM_512 MB minimum

Hard Disk-80 GB

Headphones

**Prescribed Software:**

9. K-Van Advanced Communication Skills
10. Walden Infotech Advanced Communication Skills.

**Books Suggested for English Language Lab Library (to be located within the lab in addition to the CDs of the text book which are loaded on the systems):**

1. **Technical Writing and Professional Communication, Huckin and Olsen** Tata Mc Graw-Hil 2009.
2. **Technical Communication** by Meenakshi Raman & Sangeeta Sharma, Oxford University Press 2009.
3. **Cambridge English for Job-Hunting** by Colm Downes, Cambridge University Press, 2008
4. **Resume's and Interviews** by M.Ashraf Rizvi, Tata Mc Graw-Hill, 2008

**5.**. **English Language Communication : A Reader cum Lab Manual** Dr A Ramakrishna Rao, Dr G Natanam & Prof SA Sankaranarayanan, Anuradha Publications, Chennai 2008.

**6. Managing Soft Skills** by K R Lakshminarayan and T.Muruguvel, Sci-Tech Publications, 2010

**7. The ACE of Soft Skills** by Gopal Ramesh and Mahadevan Ramesh, Pearson Education, 2010
8. **Soft Skills** by Dr. K. Alex, S.Chand
9. **Study Skills for Professional Students in Higher Education** by Dr. M. Adithan, S.Chand.
10. **Personality Development and Soft Skills by Barun** K. Mitra, Oxford Higher Education.

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**MASS TRANSFER OPERATIONS LAB(17A60807)**

**OBJECTIVES:**This lab gives an overall idea of various mass transfer operations used in the industry.

1. Estimation of diffusivity coefficients for vapor in gas
2. Estimation of solid diffusion coefficient in air
3. Steam distillation
4. Simple distillation
5. Evaluation of HETP in packed towers
6. Vapor Liquid Equilibria
7. Batch Drying
8. Evaluation of Mass transfer coefficients for Surface Evaporation
9. Evaluation of Mass transfer coefficients for Wetted wall column
10. Liquid- Liquid Equilibria (Tie line data)
11. Ternary Liquid Equilibria (binodal curve)

12. Leaching
13. Adsorption studies

**Outcomes**:

1: The student will be able to perform VLE, LLE related experiments and can estimate diffusivity coefficients.

2: The student will be able to learn about the calculation of different parameters in distillation, absorption, drying and evaporation.

3: The student will be able to design distillation units, drying and evaporation units.

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## CHEMICAL REACTION ENGINEERING LAB(17A60808)

**OBJECTIVES:**

- Operate lab equipments like CSTR, Batch, PFR reactors.
- Analyze the concentration versus time data and determine the specific rate constant and the order of the reaction.
- Compare theoretical and experimental conversions in a CSTR and PFR.
- Estimate RTD and model parameters in a CSTR, PFR, packed bed and CSTRin-series.

1. Determination of the order of a reaction using a batch reactor and analyzing the data by (a) differential method (b) integral method.
2. Determination of the activation energy of a reaction using a batch reactor .
3. To determine the effect of residence time on conversion and to determine the rate constant using a CSTR.

4. To determine the specific reaction rate constant of a reaction of a known order using a batch reactor.
5. To determine the order of the reaction and the rate constant using a tubular reactor.
6. CSTRs in series- comparison of experimental and theoretical values for space times and volumes of reactors.
7. Mass transfer with chemical reaction (solid-liquid system) – determination of mass transfer coefficient.
8. Mass transfer with chemical reaction (liquid-liquid system) – determination of mass transfer coefficient
9. Axial mixing in a packed bed. Determination of RTD and dispersion number for a packed-bed using tracer
10. Determination of RTD and dispersion number in a tubular reactor using a tracer.

**Outcomes:**

- Skills of deriving the kinetic expressions by performing the experiments on batch and continuous flow reactors.
- Understand the effects of non ideal flow.
- Proficient to estimate RTD and model parameters in a CSTR, PFR, packed bed and CSTRin-series

**JNTUA College of Engineering (Autonomous), Ananthapuramu**

**III Year B.Tech. Chem. Engg. II-Sem**

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**COMPREHENSIVE OBJECTIVE TYPE EXAMINATION(17A60809)**

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**IV Year B.Tech. Chem. Engg. I-Sem**

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**TRANSPORT PHENOMENA(17A70801)**

**OBJECTIVES:**

- Different types of fluids, their flow characteristics and different mathematical models applied to actual situations
- Mechanism of fluids in motion under different conditions.

**UNIT-I**

Viscosity and the mechanisms of momentum transfer: Newton's law of viscosity (molecular momentum transport), generalization of Newton's law of viscosity, pressure and temperature dependence of viscosity, molecular theory of the viscosity of gases at low density, molecular theory of the viscosity of liquids. Thermal conductivity and the mechanisms of energy transport: Fourier's law of heat conduction (molecular energy transport), temperature and pressure dependence of thermal conductivity, and theory of thermal conductivity of gases at low density. Diffusivity and the mechanisms of mass transport: Fick's law of binary diffusion (molecular mass transport), temperature and pressure dependence of diffusivities, theory of diffusion in gases at low density.

**UNIT -II**

Shell momentum balances and velocity distributions in laminar flow: shell momentum balances and boundary conditions, flow of a falling film, flow through a circular tube, flow through annulus, flow of two adjacent immiscible fluids, creeping flow around a sphere.

**UNIT -III**

Shell energy balances and temperature distributions in solids and laminar flow: shell energy balances; boundary conditions, heat conduction with an electrical heat source, heat conduction with a nuclear heat source, heat conduction with a viscous heat source, heat conduction with a chemical heat source, heat conduction through composite walls, heat conduction in a cooling fin, forced convection, free convection.

**UNIT -IV**

Concentration distributions in solids and laminar flow: shell mass balances; boundary conditions, diffusion through a stagnant gas film, diffusion with a heterogeneous chemical reaction, diffusion with a homogeneous chemical reaction, diffusion into a falling liquid film (gas absorption), diffusion into a falling liquid film (solid dissolution), diffusion and chemical reaction inside a porous catalyst.

**UNIT -V**

The equations of change: Derivation of the equation of continuity in Rectangular and Polar coordinates, the equation of motion, the equation of energy, the equation of continuity of a component in multi component mixture (in rectangular coordinates only) the equations of change in terms of the substantial derivative. Use of equations of change to solve one dimensional steady state problems of momentum, heat and component transfer, Introduction to Turbulent transport, Time smoothing of equation change.

**TEXT BOOK:**

1. Transport Phenomena by Bird R.B., Stewart W.C., Lightfoot F.N., 2$^{nd}$ ed. John Wiley &Sons Inc,U.S.A,1960.

**Reference:**

1. Transport phenomena for engineers by L. Theodore, International text book company, U.S.A.1971.
2. Transport processes and unit operations by C.J. Geankoplis, PHI, 3$^{rd}$ed. 1997.
3. Fundamental of heat, momentum and mass transfer, Welty, Wicks and Wilson, John Wiley.

**Pre-requisite:** Fluid Mechanics for Chemical Engineers, Process heat transfer, Mass Transfer operations- I & II and Chemical Reaction Engineering I and II

**Codes / Tables:** 1. Leonard – Jones potential parameters and critical properties.
2. Equations of change (from Bird)

**Outcomes:**

1. Ability to understand the chemical and physical transport processes and their mechanism.
2. Ability to do heat, mass and momentum transfer analysis.
3. Ability to analyze industrial problems along with appropriate approximations and boundary conditions.
4. Ability to develop steady and time dependent solutions along with their limitations.

**JNTUA College of Engineering (Autonomous), Ananthapuramu**

**IV Year B.Tech. Chem. Engg. I-Sem**

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**OPTIMIZATION OF CHEMICAL PROCESSES(17A70802)**

**OBJECTIVES:**

- To learn problem formulation of optimization.
- To realize the numerical methods of un-constrained optimization.
- To learn linear programming and its applications
- To understand the use of genetic algorithms in optimization
- To know the applications of numerical optimization.

**UNIT I**

**Nature and organization of optimization problems**: Introduction to optimization, scope and hierarchy of optimization, examples of applications of optimization, essential features of optimization problems, general procedure for solving optimization problems, Optimization of a manufacturing problem with a stepwise procedure, obstacles of optimization, constraints in optimization, examples and formulation of constrained optimization problems.

**Basic concepts of optimization**: Continuity of functions, unimodal versus Multimodel functions. Convex and Concave functions, Convex region, Necessary and sufficient conditions for an extremum of an unconstrained function.

**UNIT II**

**Optimization of unconstrained single variable functions:** Region elimination methods: Fibonacci search, Golden section search. Polynomial approximation methods- Sequential search

**Methods specifying optimum by a point:** Newton's method, Secant method, Quadratic interpolation, Cubic interpolation. Applications of one- dimensional search methods to chemical engineering problems.

**UNIT III**

**Unconstrained multivariable optimization:** Random search methods, grid search, uni-variate search, multivariable Newton's method, steepest descent method, Conjugate search directions, Conjugate gradient method

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**UNIT IV**

**Optimization of Unit operations:** Optimal pipe diameter, optimizing recovery of waste heat, optimization of multiple effect evaporator, Determination of optimal reflux ratio for staged distillation column, shell and tube heat exchanger.

**UNIT V**

**Linear programming and applications:** Basic concepts in linear programming, graphical solution, artificial variable technique, exceptional cases in LPP, non-existing feasible solution, degeneracy, duality in linear programming, dual simplex method, revised simplex method.

**TEXT BOOKS:**

1. Optimization of Chemical Processes, T.F. Edgar and D.M. Himmelblau, McGraw-Hill, New York, 2001.

2. Optimization for Engineering Design, Kalyan Moy Deb, PHI Pvt. Ltd., New Delhi, 2000

**<u>Outcome</u>:**

- Knowledge of optimization to formulate the problems and analyze the optimization criterion for solving problems
- Apply different methods of optimization and to suggest a technique for specific problem
- Advanced optimization techniques like Genetic algorithms and other optimization techniques can be used to solve the industrial problems of relevance to the chemical industry

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**IV Year B.Tech. Chem. Engg. I-Sem**

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**SEPARATION TECHNIQUES FOR BIOPROCESSING (17A70803)**

**OBJECTIVES:**

- Learn the fundamentals of adsorptive separations and modeling
- Study the Pressure swing & thermal swing adsorption, Counter current separations.
- Study the basic concepts and design procedures of chromatographic columns.
- Learn different membrane separation technological processes and their design

**UNIT -I**

Crystallization: crystal geometry, principles of crystallization equilibria and yields, nucleation, crystal growth, adsorption and mass transfer theories, precipitation, crystallization from melts. (Textbook 3)

**UNIT -II**

Adsorption: Adsorption, types of adsorption, nature of adsorbents, adsorption equilibrium, single gases and vapors, Adsorption Hysteresis, effect of temperature, Heat of adsorption, vapor and gas mixtures: One component adsorbed, Effect of change of temperature or pressure. Liquids, Adsorption of solute from dilute solution, The Freundlich equation, Adsorption from concentrated solutions, adsorption operations, stage wise operation, application of Freundlich equation to single and Multistage adsorption (cross current & counter current).

Fluidized and teeter beds, adsorption of vapor from a gas, fluidized bed, continuous contact, steady state moving bed adsorbers, unsteady state–fixed bed adsorbers, adsorption wave, elution, adsorption-desorption operations- thermal desorption of gases, activated carbon solvent recovery, pressure swing and vacuum swing adsorption (qualitative treatment), regeneration with purge and desorbent, ion-exchange: principles of ion exchange, techniques and applications. (Textbook 2)

**UNIT –III (qualitative treatment only)**

Chromatography: Types of chromatography: Gas and liquid chromatography, paper and thin layer chromatography, polarization chromatography, and continues chromatography, large-scale chromatography. Electrophoretic separations: Theory of electrophoresis, basic concepts of electrophoresis, forces in electrophoresis, complicating factors in electrophoresis, methods of electrophoresis: Moving boundary electrophoresis, gel membrane and paper electrophoresis, zone spreading in zonal electrophoresis, affinity electrophoresis, free solution and capillary electrophoresis. (Textbook 1)

**UNIT-IV (qualitative treatment only)**

Pressure driven membrane separation processes, reverse osmosis, ultrafiltration, micro filtration, nano filtration, governing equations, effect of operating parameters on flux and rejection, applications. Concentration and electrical driven membrane processes(Text book 1)

**UNIT –V(qualitative treatment only)**

Gas separation in porous and non-porous membrane, pervaporation, dialysis, liquid membranes, governing equations, effect of operating parameters on flux and selectivity, applications, concentration polarization, approximate analysis for concentration polarization, mass transfer correlations, gel formation and fouling, membrane modules. (Textbook 1)

**Text Book:**

1. Rate controlled separation by Phillip C. Wankat, Springer international, 2005

2. Mass transfer operations by R.E. Tryebal, Mc Graw Hill, 3rd ed. 1980.
3. Unit operations of Chemical Engineering by Mc.Cabe & Smith, McGraw-Hill, 5th edition 1993

**References:**

1. Separation processes, C. J. King, Tata McGraw Hill.
2. Transport processes and unit operations, C.J. Geankoplis, Prentice-Hall India, 3rd edition, 2000

**Pre-requisite:** Mass Transfer operations-I, II, Phase and Chemical Equilibria, Chemical Process Calculations.

**Outcome:**

- The students would fully understand key concepts of separation processes including equilibrium stages, reflux, countercurrent contacting, limiting cases, efficiency and mass transport effects.
- The student will know about handling of separations using solid- fluid and separation techniques for the low-temperature, heat sensitive materials.
- Facilitate the students with the novel techniques that are required in downstream processing of biotechnology based industries.

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**IV Year B.Tech. Chem. Engg. I-Sem**

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## INDUSTRIAL SAFETY AND HAZARD MANAGEMENT (17A70804)

**OBJECTIVES:**

- Have awareness of different hazards in process industries
- Classification of hazards and their identifications
- Precautions in chemical storage and handling

- Learn risk analysis techniques and quantify them
- Learn emergency management plans

**Unit – I**

Introduction, Factors Contributing to the Costs of Accidents, List of some Notable accidents in the process industry/selected case histories, some common features of high cost accidents, reasons for high priority towards safety.

**Unit – II**

Material hazards1: Introduction Hazardous substances-categories, Toxicity, Radiation, Flammability, Ignition, Fires and explosions.

**Unit – III**

Material hazards 2: Fire balls, Fire damage, run away chemical reaction, incompatible materials, material safety and data sheets

Process and plant Hazards: Hazards of pressure, causes of over pressures, flow deviations, effects of leakages/releases, hazards of temperatures.

**Unit – IV**

Hazard analysis: process safety management, process hazards analysis, hazards analysis methods, check list, preliminary hazard analysis, what-if / check list, hazard and operability analysis, FMEA, Fault tree analysis, cause and consequence analysis.

**Unit – V**

Preventive and protective measures: Safety options, process safety approaches, inherent safety and design, plant layout, inherent security, explosion prevention and protection, personal protective systems, plant modifications and management change, relief valves and rupture discs, breather vents for storage tanks, explosions vents, flame arresters, flare systems

**TEXT BOOK:**

1. Chemical process industry safety by K S N Raju, Mc-Graw Hill education (India) Pvt.Ltd,2014
2. Chemical process Safety by Crowl

**REFERENCES:**

1. Chemical process safety by sanders

**Outcome:**

- The student will be equipped with the knowledge by which thorough safety is ensured in the organization.
- Classify and identify hazards in chemical industries

- Take precautions in chemical storage and handling
- Perform fault tree and event tree risk analysis and quantify them
- Suggest and make others in the plant about emergency management plans

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**IV Year B.Tech. Chem. Engg. I-Sem**

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**OPEN ELECTIVE-II**

**APPLIED NUMERICAL METHODS (17A70805a)**

**UNIT I : Eigen values and Eigen vectors**: Introduction, Calculation of Largest and smallest Eigen Values and Corresponding Eigen vectors using power method.

**Linear Algebraic Equations**: Introduction, Gauss- Elimination, LU Decomposition, Gauss-Jordan Elimination, Gauss- Siedel methods.

**UNIT II : Nonlinear Algebraic Equations**: Introduction, single variable successive substitutions (Fixed point method), single variable Newton-Raphson Technique, Multivariable Newton-Raphson Technique.

**UNIT III : Regression Analysis**: Introduction, least squares curve-fitting methods, Newton's forward formulae, Newton's backward formulae. Interpolation Polynomial, Lagrangian Interpolation (Unequal Intervals),Pade' approximations,(upto second order both in numerator and denominator)

**UNIT IV: Ordinary Differential Equations-Initial Value Problems (ODE-IVPs):** Introduction, explicit and implicit Euler's method, Runge- Kutta fourth order method. **Ordinary Differential Equations- Boundary Value Problems (ODE-BVPs):** Introduction, Galerkin Finite Element (GFE) Technique, Shooting Techniques.

**UNIT V: Advanced methods for Differential Equations**: Introduction, the finite difference technique (method of lines), Orthogonal Collocation, Finite Volume Method.

**TEXT BOOKS:**

1.Numerical Methods in Engineering, S.K. Gupta., Tata Mc-Graw Hill.,1998,1$^{st}$Edition.

**REFERENCE BOOKS:**

1. Numerical Methods in Engineering &Science, B.S.Grewal, Khanna Publisher, 6$^{th}$ Ed. 2005.

**Objective:** This course trains the students in learning and applying the numerical techniques to solve the chemical engineering problems.

**Outcome:** The student will learn different techniques to solve linear algebra equations, ODES, difference equitation.

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**IV Year B.Tech. Chem. Engg. I-Sem**

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**OPEN ELECTIVE-II**

**COMPUTATIONAL FLUID DYNAMICS (17A70805b)**

**Prerequisite:** Fluid mechanics for chemical engineers, process heat transfer, mass transfer operations, chemical reaction engineering, process modeling & simulation

**OBJECTIVE:** This subject deals with different mathematical methods like finite difference techniques to solve Navier - Stokes equations & other fluid flow problems

**UNIT I**

Introduction - Finite difference methods- finite element method - finite volume method- Treatment of boundary conditions- Governing differential equations. Finite difference methods - Taylor's series - Errors associated with FDE- FDE formulation for steady state heat transfer problems.

**UNIT II**

Cartesian, cylindrical and spherical coordinate systems- boundary conditions- Un steady state heat conduction Explicit Method - Stability criteria - Implicit Method - Crank Nickolson method - 2-D FDE formulation ADI- ADE. Finite volume method - Generalized differential equation, Basic rules for control volume approach, Source term linearization, boundary conditions. Un-steady state one, two, three dimensional heat conduction.

**UNIT III**

Convection and diffusion, different methods i.e., upwind scheme, Exponential scheme, Hybrid scheme, power law scheme, calculation of flow field, staggered grid method, pressure and velocity corrections, SIMPLE Algorithms & SIMPLER (revised algorithm). Solution methods of elliptical, parabolic and hyperbolic partial differential equations in fluid mechanics - Burgers equation.

**UNIT IV**

Formulations for incompressible viscous flows - vortex methods -pressure correction methods.

**UNIT V**

Treatment of compressible flows- potential equation, Navier - Stokes equation - flow field dependent variation methods, boundary conditions. Linear fluid flow problems, 2-I) and 3- 1) fluid flow problems.

**TEXT BOOKS:**

1. Numerical heat transfer and fluid flow - S.V. Patankar
2. Computational Fluid Dynamics, T.J. Chung, Cambridge University
3. Text Book of Fluid Dynamics, Frank Chorlton, CBS Publishers

**OUTCOME:** The student will apply the principles of fluid dynamics to solve different problems of the industry

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**OPEN ELECTIVE- II**

**DESIGN AND ANALYSIS OF EXPERIMENTS (17A70805c)**

## Objectives:

- Which factors affect a given experiment?

- Find the most significant factor for an experiment.
- Calculate the factor levels that optimize the outcome of an experiment.
- Factorial Design of experiments.

**UNIT- I**

Introduction to probability, probability laws, Baye's theorem.Probability distributions, parameters and statistics.Normal and t-distributions, central limit theorem, random sampling and declaration of independence significance tests

**UNIT- II**

Randomization and blocking with paired comparisons significance tests and confidence interval for means, variances, proportions and frequencies.

**UNIT-III**

Analysis of variance, experiments to compare k-treatment means, Two-way factorial designs, blocking, Yate's algorithm

**UNIT- IV**

Fractional factorial designs at two levels, concept of design resolution, Simple modeling with least squares (regression analysis), Matrix versions of normal equations

**UNIT- V**

Mechanistic model building, Empirical and mechanistic models, model building process, model testing with diagnostic parameters.

**Text Book:**

1. Statistics for experimenters by G.E.P. Box, William G. Hunter and J.S. Hunter, John Wiley & Sons.

**Reference:**

1. "Design and analysis of experiments" by D.C. Montgomery, 2$^{nd}$ edition John Wiley and sons, NewYork (1984).

**<u>Outcome</u>:**

- Predict how many numbers of experiments are to be carried out, given the number of important factor
- Design an experiment and calculate the factor levels that optimize a given objective.
- Use response surface methodology to optimize the process, by considering curvature effects.
- Understand strategy in planning and conducting experiments
- Choose an appropriate experiment to evaluate a new product design or process improvement

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**ELECTIVE-I**

**ENERGY ENGINEERING (17A70806a)**

**OBJECTIVES:**

- To acquaint the student with the conventional energy sources and their utilization.
- To understand the importance of heat recovery and energy conservation methods and energy audit

**UNIT -I**

Sources of energy, types of fuels- energy and relative forms. Calorific value- gross and net value, calculation of calorific value from fuel analysis, experimental determination energy resources present and future energy demands with reference to India.

**Coal:** origin, occurrence, reserves, petrography, classification, ranking, analysis, testing, storage, coal carbonization and byproduct recovery, liquefaction of coal, gasification of coal, burning of coal and firing mechanism, burning of pulverized coal.

**UNIT- II**

**Liquid fuels:** petroleum: origin, occurrence, reserves, composition, classification, characteristics, fractionation, reforming, cracking, petroleum products, specification of petroleum products, burning of liquid fuels.

Natural gas, coke oven gas, producer gas, water gas, LPG, burning of gaseous fuels, hydrogen (from water) as future fuel, fuel cells, flue gas, analysis: orsat apparatus.

**UNIT -III**

**Steam Plant:** Run time cycle, boiler plant, steam cost, steam distribution and utilization, combined heat and power systems, energy from biomass and biogas plants, gas purification, solar energy, wind energy, energy storage.

**UNIT -IV**

Waste heat recovery, sources of waste heat and potential application, various types of heat recovery systems, regenerators, recuperators, waste heat boilers

**Energy conservation:** conservation methods in process industries, theoretical analysis, practical limitations.

**UNIT-V**

**Energy auditing:** short term, medium term, long term schemes, energy conversion, energy index, energy cost, representation of energy consumption, Sankey diagram, energy auditing.

**TEXT BOOKS:**

1. Fuels, Furnaces and Refractories, O.P.Gupta

2. Fuels and Combustion, 3rd ed., Samir Sarkar, Universities Press, 2009.

**REFERENCES:**

1. Non-conventional Energy Resources, G.D.Rai, Khanna Publishers

2. Fuel and Energy, Harker and Backhurst, Academic press London 1981

3. Fuel Science- Harker and Allen, Oliver and Boyd, 1972

**Outcomes:**

- Students would have a good knowledge about conventional energy sources and their audit.
  Ability to apply the fundamentals of energy conversion and applications

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**IV Year B.Tech. I-Sem**

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**ELECTIVE-I**

**NON-CONVENTIONAL SOURCES OF ENERGY (17A70806b)**

**Objective:**

It introduces solar energy its radiation, collection, storage and application. It also introduces the Windenergy, Biomass energy, Geothermal energy and ocean energy as alternative energy sources.

**UNIT – I**: PRINCIPLES OF SOLAR RADIATION: Role and potential of new and renewable source, the solar energyoption, Environmental impact of solar power, physics of the sun, the solar constant, extraterrestrial andterrestrial solar radiation, solar radiation on titled surface, instruments for measuring solar radiation andsun shine, solar radiation data.

**UNIT-II**: SOLAR ENERGY COLLECTION: Flat plate and concentrating collectors, classification of concentratingcollectors, orientation and thermal analysis, advanced collectors.SOLAR ENERGY STORAGE AND APPLICATIONS: Different methods, Sensible, latent heat andstratified storage, solar ponds. Solar Applications- solar heating/cooling technique, solar distillation anddrying, photovoltaic energy conversion.

**UNIT-III**: WIND ENERGY: Sources and potentials, horizontal and vertical axis windmills, performancecharacteristics, Betz criteria .BIO-MASS: Principles of Bio-Conversion, Anaerobic/aerobic digestion, types of Bio-gas digesters, gasyield, combustion characteristics of bio-gas, utilization for cooking, I.C.Engine operation and economicaspects.

**UNIT-IV**: GEOTHERMAL ENERGY: Resources, types of wells, methods of harnessing the energy, potential inIndia.OCEAN ENERGY: OTEC, Principles utilization, setting of OTEC plants, thermodynamic cycles. Tidal andwave energy: Potential and conversion techniques, mini-hydel power plants, and their economics.

**UNIT-IV**: DIRECT ENERGY CONVERSION: Need for DEC, Carnot cycle, limitations, principles of DEC. Thermoelectricgenerators, seebeck, peltier and joul Thomson effects, Figure of merit, materials, applications,MHD generators, principles, dissociation and ionization, hall effect, magnetic flux, MHD accelerator, MHDEngine, power generation systems, electron gas Dynamicconversion,economicaspects.Fuelcells,principles, faraday's law's, thermodynamic aspects, selection of fuels and operating conditions.

**References:**

1. Non-Conventional Energy Sources /G.D. Rai

2. Renewable Energy Technologies /Ramesh & Kumar /Narosa

REFERENCE BOOKS:

1. Renewable energy resources/ Tiwari and Ghosal/ Narosa.

2. Non-Conventional Energy / Ashok V Desai /Wiley Eastern.

3. Non-Conventional Energy Systems / K Mittal /Wheeler

4. Solar Energy /Sukhame

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**ELECTIVE-I**

**WASTE TO ENERGY CONVERSION TECHNOLOGIES (17A70806c)**

**Unit I:** Solid Waste -Definitions: Sources, types, compositions; Properties of Solid Waste; Municipal Solid Waste: Physical, chemical and biological property; Collection, transfer stations; Waste minimization and recycling of municipal waste Landfill method of solid waste disposal; Landfill classification; Types, methods & siting consideration; Layout & preliminary design of landfills: Composition, characteristics, generation; Design of Sanitary Land fill - Movement and control of landfill leachate &gases; Environmental monitoring system for landfill gases.- Gas Recovery – Applications .

**Unit II:** Waste Treatment & Disposal Size Reduction: incineration; Furnace type& design; Types of Incinerators – Fuel Economy - Medical / Pharmaceutical waste / Hazardous waste / Nuclear Waste incineration.; Environmental impacts; Measures of mitigate environmental effects due to incineration;

**Unit III** : Energy Generation From Waste Types: Biochemical Conversion: Sources of energy generation, Industrial waste, agro residues; Anaerobic Digestion: Biogas production; Determination of BOD, DO, COD, TOC, & Organic loading, Aerobic & Anaerobic treatments – types of digester – factors affecting biodigestion - Activated sludge process. Methods of treatment and recovery from the in industrial waste water – Case Studies in sugar, distillery, dairy, pulp and paper mill, fertilizer, tanning, steel industry, textile, petroleum refining, chemical and power plant.

**Unit IV**: Rural applications of biomass –Combustion - Chulas - improved Chulas- Biomass – Physical - Chemical composition – properties of biomass – TGA – DSC characterization – Ash Characterization - Preparation of biomass – Size reduction – Briquetting of loose biomass Briequtting machine.

**Unit V** : Thermochemical Conversion -Basic aspects of biomass combustion - heat of combustion - different types of grates - Co combustion of biomass – Gasification - Fixed and Fluidized bed gasifier - Gasification technologies for the selected waste like Rice Husk, Coir pith, Bagasse, Poultry litter etc., - Pyrolysis.

References:

1. Parker, Colin, & Roberts, Energy from Waste - An Evaluation of Conversion Technologies, Elsevier Applied Science, London, 1985.

2. Shah, Kanti L., Basics of Solid & Hazardous Waste Management Technology, Prentice Hall, 2000.

3. Manoj Datta, Waste Disposal in Engineered Landfills, Narosa Publishing House, 1997.

4. Rich, Gerald et.al., Hazardous Waste Management Technology, Podvan Publishers, 1987

5. Bhide AD., Sundaresan BB, Solid Waste Management in Developing Countries, INSDOC, New Delhi,1983.

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**MOOC-I (AUDIT) (17A79906a)**

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**MOOC-I (AUDIT) (17A79906b)**

**JNTUA College of Engineering (Autonomous), Ananthapuramu**

**IV Year B.Tech. I-Sem**

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**MOOC-I (AUDIT) (17A79906c)**

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**IV Year B.Tech. Chem. Engg. I-Sem**

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**PROCESS EQUIPMENT DESIGN AND DRAWING LAB(17A70807)**

**OBJECTIVES:**To make the student familiar with design and drawing aspects of chemical processes equipments.

1. Drawing of flow sheet symbols.
2. Drawing of instrumentation symbols.
3. Drawing of instrumentation diagrams.
4. Mechanical aspects chemical equipment design and drawing of following equipment.
    a) Double pipe heat exchanger
    b) Shell and tube heat exchanger
    c) Evaporator
    d) Distillation column
    e) Batch reactor.

**Text Book:**

1. Process Equipment Design by M. V. Joshi
2. Chemical Process Equipment Design and Drawing, S.C. Maidargi, PHI, 2013

**Reference**:

1. Process Equipment Design by Brownell and Young
2. Chemical Process Equipment Design by Bhattacharya
3. Process Equipment Design by Wallas

**Pre-requisite:** Chemical Process equipment design

**Outcome:**

- Students would gain knowledge to develop key concepts and techniques to design the process equipment in a process plant. These key concepts would be utilized to make design and operating decisions.

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**SIMULATION LAB((17A70808)**

**Objective**: To make the student familiar with software's and simulation of chemical processes equipments.

The following experiments have to be conducted using C and MATLAB

1. General introduction to MATLAB
2. Functions (log, exp, conv, roots).
3. Matlab Scripts and function files
4. Gravity Flow tank.
5. Three CSTRs in series – open loop
6. Three CSTRs in series – Closed loop
7. Non isothermal CSTR
8. Binary Distillation column
9. Batch Reactor isothermal; Batch reactor non isothermal – closed loop
10. Isothermal batch reactor – open loop
11. Heat Exchanger
12. Interacting System- two tank liquid level
13. Non interacting system-two tank liquid level
14. Plug flow reactor
15. Bubble point calculations
16. Dew point calculations

**TEXT BOOKS**:

1. A Guide to MATLAB for Chemical Engineering Problem Solving, Kip D. Hauch
2. Understanding MATLAB A Textbook for Beginners by S.N. Alam

**Pre-requisite**: Fluid mechanics for chemical Engineers, Process Heat transfer, Mass transfer operation- 1 & 2, Chemical Reaction Engineering.

**Outcomes:**

1. Helps to interconnect knowledge of mathematics, science, and engineering to real world problems.
2. Helps to identify, formulate, and solve engineering problems
   (for ex: most of chemical engineering problems are based on transport equations consisting broader areas of kinetics, thermodynamics and mass transfer which can be

thoroughly solved using MATLAB inbuilt functions)

- The complex multi component distillation column design can be modeled and simulated
- System of ordinary and partial differential equations obtained in multiple reactors in series/parallel can be solved
- Process control and optimization of reactors can be handled easily

3. "Genetic algorithms" can be implemented at a more pronounced way via MATLAB to solve various linear and non linear models of chemical engineering systems.
4. Most fascinating approach of Artificial Neural Networks (ANN) for electrical related concepts of chemical engineering systems can also be well handled in MATLAB
5. Steady state and unsteady state problems of chemical engineering and allied fields can be modeled and solved using MATLAB

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**COMPREHENSIVE OBJECTIVE TYPE EXAMINATION (17A70809)**

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**Elective - II**

**BIOCHEMICAL ENGINEERING (17A80801a)**

**OBJECTIVES:**

- Study introduction to the application of chemical engineering principles in biochemical systems.
- Be enabled to understand the biological systems and kinetics of enzymatic reactions.
- Learn the kinetics of growth of microorganisms, hence be able to control the process.
- Be able to design equipments for handing biological processes.
- Study Operations utilized in the purification of biological products enable them to recommend, install and easily learn to operate the equipments.

**UNIT I**

Introduction to microbiology: Biophysics and the cell doctrine, the structure of cells, important cell types, from nucleotides to RNA and DNA, amino acids into proteins. Kinetics of enzyme catalyzed reaction: the enzyme substrate complex and enzyme action, simple enzyme kinetics with one and two substrates, other patterns of substrate concentration dependence, modulation and regulation of enzyme activity, other influences on enzyme activity.

**UNIT II**

Immobilized enzyme technology: enzyme immobilization, industrial processes, utilization and regeneration of cofactors.Immobilized enzyme kinetics: effect of external mass transfer resistance, analysis of intraparticle diffusion and reaction.

Kinetics of cellular growth in batch and continuous culture, models for cellular growth – unstructured, structured and cybernetic models. Thermal death kinetics of cells and spores

**UNIT III**

Introduction to metabolic pathways, biosynthesis, transport across cell membranes, end products of metabolism, stoichiometry of cell growth and product formation.

Design and analysis of biological reactors: batch reactors, fed-batch reactors, enzyme catalyzed reactions in CSTR, CSTR reactors with recycle and cell growth, ideal plug flow reactors, sterilization reactors, sterilization of gases, packed bed reactors using immobilized catalysts. Fermentation technology: medium formulation, design and operation of a typical aseptic, aerobic fermentation process.

**UNIT IV**

Transport phenomena in bioprocess systems: Gas-liquid mass transfer in cellular systems, determination of oxygen transfer rates, overall $k_La$’ estimates and power requirements for sparged and agitated vessels, scaling of mass transfer equipment, heat transfer.

**UNIT V**

Downstream processing: Strategies to recover and purify products; separation of insoluble products-filtration and centrifugation; cell disruption-mechanical and non-mechanical methods; separation of soluble products: liquid-liquid extractions, membrane separation (dialysis, ultra filtration and reverse osmosis), chromatographic separation-gel permeation chromatography, electrophoresis, final steps in purification – crystallization and drying.

**TEXT BOOKS:**

1. Biochemical Engineering Fundamentals, 2nd ed., J.E. Bailey and D.F. Ollis, McGraw-Hill, New York, 1987.

2. Bioprocess Engineering, 2nd ed., M. L. Shuler and F. Kargi, PHI Learning Pvt. Ltd, New Delhi, 2009.

**REFERENCES:**

1. Biochemical Engineering, J. M. Lee, Prentice-Hall, New Jersey 1992.

2. Bioprocess Engineering Principles, P. M. Doran, Elsevier, Gurgaon, 2005.

**Outcome:**

- This course will help the students to understand and apply the principles of biochemical engineering in analysis and design of industrial biochemical processes.
- Upon completion of this course, the students would develop the ability to design novel bioprocesses for their research in various areas. They will have the ability to find solutions to the problems which occur when materials and processes interact with the environment.
- Explain operations utilized in the purification of biological products are also studied by the students. This will enable them to recommend, install and easily learn to operate the equipment.

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**ELECTIVE - II**

## INDUSTRIAL BIOTECHNOLOGY (17A80801b)

**UNIT-I**

Fundamentals of biochemical engineering sciences; Biotechnology – ancient and modern. Exploitation of microbes – Large-scale process, commercial exploitation, micro-gravity biotechnology (space biotechnology);

**UNIT -II**

Animal biotechnology – application of animal cell culture, monoclonal antibodies, transgenic animal and gene therapy;Plant biotechnology – plant cell, tissue and organ culture processes – engineering perspectives

**UNIT -III**

Industrial production of Antibiotics, Alcoholic beverages, Citric Acid, Vitamins, vaccines and industrial enzymes

**UNIT -IV**

Large-scale separation processes- ATPS, gradient elution and affinity interaction. Techno economics of biotechnology industries

**UNIT -V**

Legal, social and ethical aspects of biotechnology. Fermentation Economics, Isolation of Micro-organisms of potential industrial interest, Market potential, Recovery costs.

**TEXT BOOKS:**

1. Text book of Biotechnology; HK Das, Wiley Dremtechs Publications

2. Industrial Biotechnology, Casida, New Age Publication

3. Industrial Microbiology, Presscott and Dunn.

**REFERENCES:**

1. Concepts in Biotechnology by Balasubramayam, University Press, 2$^{nd}$ ed.,2004

**Pre-requisite:** Biochemical Engineering

**Objective:** The objective of the courses to impart the basic knowledge on process biotechnology plant biotechnology and animal biotechnology.

**Codes / Tables:---Nil---**

**Question paper Pattern:** 5 Question to be answered out of 8 questions.

Each question should not have more than 3 bits.

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**ELECTIVE-II**

**ENZYME ENGINEERING (17A80801c)**

**Course Objectives:**

- To impart the basic concepts of enzymes and the reactors involved in free and immobilized enzyme system •To understand the kinetics and physicochemical characteristics of enzymes

**UNIT I:** Classification of enzymes, commercial application of enzymes in food, pharmaceutical and other industries. Enzymes for analytical and diagnostic applications. Production and purification of crude enzymes. Extracts from plant, animal and microbial sources

UNIT II: Mechanism of Enzyme action, Concept of active site, enzyme-substrate complex and enzyme action, Simple enzyme kinetics with one substrate. Michaelis - Menten kinetics. Evaluation of parameters in the Michaelis - Menten kinetics Equation. Types of inhibition. Influences of pH, temperature, fluid forces, chemical agents and irradiation on enzyme activity.

UNIT III: Enzyme immobilization. Physical and chemical techniques for enzyme immobilization adsorption, matrix entrapment, encapsulation, cross – linking, covalent binding. Advantages and disadvantages of different immobilization techniques. Application of immobilized enzyme systems.

UNIT IV: Mass transfer effects in immobilized enzyme systems. Analysis of film and pore diffusion effects on kinetics of immobilized enzyme reactions.

UNIT V: Batch Operation of a stirred reactor Time course for batch enzyme reaction. continuous operation in a stirred tank reactor. Immobilized enzyme reaction in a CSTR and plug flow reactor.Enzyme biosensors, application of enzymes in analysis, design of enzyme electrodes and their application in industry, health care and environment

**References:**

1. Gerharts, W, Enzymes in industry – Production and application.

2. James E Bailey & David F Ollis "Biochemical Engineering Fundamentals" McGraw Hill

3. Pauline M Doran "BiopriocessEngg. Principles" – Academic press

4. Taylor, R.F.(Ed.) "Protein Immobilization – Fundamentals and applications". Wiley online Library.

5. Zubay G, Biochemistry, Maxwell Macmillan International Education

**Expected Outcome:**Students will be able to: i. Classify enzymes along with their applications in different fields ii. Analyse the kinetics of enzymes and apply the same in the design of reactors iii. Outline the types and methods of immobilization of enzymes iv. Summarize the various types of enzyme reaction systems and reactors.

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## ELECTIVE-III

### FLUIDIZATION ENGINEERING (17A80802a)

**UNIT I**

**Introduction:** The phenomenon of fluidization; liquid like behavior of a fluidized bed; Comparison with other contacting methods; Advantages and disadvantages of fluidized beds.

**Industrial applications of fluidized beds:** Coal gasification; gasoline from other petroleum fractions; Gasoline from natural and synthesis gases; Heat exchange; Coating of metal objects with plastics; Drying of solids; Synthesis of phthalic anhydride; Acrylonitrile; Polymerization of olefins; FCCU; Fluidized combustion of coal; incineration of solid waste; Activation of carbon; gasification of waste; bio-fluidization.

**UNIT II**

**Fluidization and mapping of regimes:** Minimum fluidization velocity; Pressure drop vs. velocity diagram; effect of temperature and pressure on fluidization; Geldart classification of particles; terminal velocity of particles, Transport disengaging height; turbulent fluidization; pneumatic transport of solids; fast fluidization; solid circulation systems; Voidage diagram; Mapping of regimes of fluidization.

**UNIT III**

**Bubbles in dense bed:** Single rising bubbles; Davidson model for gas flow at bubbles; Evaluation of models for gas flow at bubbles.

**Bubbling Fluidized beds:** Experimental findings; Estimation of bed Voidages; Physical models: simple two phase model; K-L model.

**UNIT IV**

**High velocity Fluidization:** Turbulent fluidized bed; Fast fluidization pressure drop in turbulent and fast fluidization.

**Solids Movement, Mixing, Segregation and staging:** Vertical movement of solids; Horizontal movement of solids; Staging of fluidized beds.

**UNIT V**

**Gas Dispersion and Gas interchange in Bubbling Beds:** Dispersion of gas in beds; Gas interchange between bubble and emulsion; Estimation of gas interchange coefficients.

**Particle to Gas Mass Transfer:** Experimental interpolation of mass transfer coefficients; Heat transfer; Experimental heat transfer from the bubbling bed model.

**TEXT BOOKS**

1. Fluidization Engineering by Kunil, Diazo and Octave Levenspiel, John Weiley & Sons Inc, Newyork, 1969.

2. Fluidization Engineering by J.R. Howard, Adam Heilgar.

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**ELECTIVE-III**

**INTERFACIAL ENGINEERING (17A80802b)**

## Objectives:

1. Importance of various components of interfacial science in different chemical engineering industries viz. food, paint and pharmaceutical industries are emphasized.
2. The properties and functioning of surfactants and detergency are made familiarized. Interfacial and vander Waals forces play important role in the nano particles

**UNIT-I:**

Basic concepts of Colloids and Interfaces: Introduction, Examples of Interfacial Phenomena, Solid-Fluid Interfaces, Colloids. Properties of Colloid Dispersions: Introduction, Sedimentation under Gravity, Sedimentation in a Centrifugal Field, Brownian Motion, Osmotic pressure, Optical properties, Electrical Properties, Rheological Properties of Colloid Dispersions.

**UNIT-II:**

Surfactants and their properties: Introduction, Surfactants and their Properties, Emulsions and Microemulsions, foams.

**UNIT-III:**

Surface and Interfacial Tension: Introduction, Surface tension, Interfacial Tension, Contact Angle and Wetting, Shape of the Surfaces and interfaces.Measurement of Surface and Interfacial Tension, Measurement of Contact Angle;

**UNIT-IV:**

Intermolecular and Surface Forces: Introduction, Vanderwalls Forces.Intermolecular and Surface Forces: Electrostatic double layer force, The DLVO theory, Non-DLVO forces.

**UNIT-V:**

Adsorption at interfaces: Introduction, The Gibbs Dividing surface, Gibbs Adsorption Equation, Langmuir and Frumkin Adsorption Isotherms, Surface Equation of state(EOS), Effect of Salt on Adsorption of Surfactants.Adsorption Isotherms incorporating the Electrostatic Effects, Calculation of Free energy of Adsorption.

**TEXT BOOKS:**

1. **Foundations of Colloid Science by** R. J. Hunter, 2nd edition, Oxford University Press, USA, 2001.
2. **Principles of Colloid and Surface Chemistry**, Third edition, Revised and Expanded, Paul C. Hiemenz and Raj Rajagopalan.
3. **Physical Chemistry of Sciences**, 6th edition, A. Adamson, 1997.

4. **Interfacial Science: An Introduction by** G.Barnes, I.Gentle, Oxford University Press, USA, 2006.
5. **Coloid and Interface Science by** Pallab Ghosh, PHI, NEWDELHI.

**Outcomes:**

1. Realize the factors influencing stability of dispersions & emulsions.
2. Get the knowledge to measure surface tension & contact angle and apply them for practical problems.
3. Comprehend about detergency, surfactants and their applications.

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**ELECTIVE-III**

**POLYMER TECHNOLOGY(17A80802b)**

**OBJECTIVES:**

To enable the students to compute molecular weight averages from the molecular weight distribution, Condensation polymerization and transition in polymers

**Unit I**

Introduction; definitions: polymer& macro molecule, monomer, functionality, average functionality, co-polymer, polymer blend., plastic and resin. Classification of polymers: based on source, structure, applications, thermal behavior, mode of polymerization. Concept of average molecular weight of polymers, molecular weight distribution, poly disparity index. Determination of average molecular weights: End group analysis, osmometry, light scattering techniques, viscometer, Gel permeation chromatography.

**Unit II**

Natural polymers: brief study of i) Natural rubber ii) shellac iii) rosin iv) cellulose v) proteins.
Mechanism and kinetics of: Addition or chain polymerization
a) Free radical addition polymerization b) Ionic addition polymerizations
c) Coordination polymerization d) Coordination or step growth or condensation polymerization.

**Unit III**

Methods of polymerization: mass or bulk polymerization process, solution polymerization process, suspension polymerization process and emulsion polymerization method comparison of merits and demerits of these methods. Properties of polymers: crystalline and amorphous status, melting and glass transition temperatures and their determination, effect of polymer structure on mechanical, physical, chemical and thermal properties.

**Unit IV**

Degradation of polymers, Role of the following additives in the polymers: i) Fillers and reinforcing fillers ii) Plasticizers iii) Lubricants iv)Antioxidants and UV stabilizers v) Blowing agents vi)Coupling agents vii)Flame retardants viii) Inhibitors

Brief description of manufacture, properties and uses of: i) Polyethylene (HDPE&LDPE), ii) Poly propylene iii) Polyvinylchloride iv) Polystyrene v) Polytetra fluoroethylene vi) Polymethyl mehacrylate vii) Polyvinylacetate & Polyvinylalcohol.

**Unit V**

Brief description of manufacture, properties and uses of: i) Polyesters (Polyethylene terephthalate polycarbonate and unsaturated polyesters) ii) Nylon(Nylon 66) iii) Phenol-Formaldehyde resins iv) Epoxy resins v) Polyurethane vi) Silicones

Compounding of polymer resins, brief description of: i) Compression and transfer moulding ii) Injection moulding iii) Extrusion iv) Blow moulding v) Calendaring vi) Laminating and pultrusion

**TEXT BOOKS:**

1. Polymer Science & Technology, $2^{nd}$ ed., J.R. Fried, PHI Learning Pvt. Ltd., New Delhi, 2009
2. Plastic materials, J.A. Brydson, Newnes-Butterworth (London) 1989.

**REFERENCES:**

1. Text book of polymer science, F.W.Jr. Bill Meyer, (3rd ed.) John Wiely&sons 1984
2. Introduction to Plastics, J.H. Brison and C.C. Gosselin, Newnes-Butterworth, London 1968.

**Outcome:**

- Classify the polymers and also able to identify the structural configurations of any polymer.
- Distinguish the modification of a polymer and also in a position to examine the mechanism of a polymerization.
- Synthesize any elastomer and optimize their deformation properties on applying force.
- Explain the processing of polymer, identify the mode of deformation of a polymer and test the mechanical strength of a polymer.

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**ELECTIVE-IV**

## TECHNOLOGY OF PHARMACEUTICALS AND FINE CHEMICALS (17A80803a)

**UNIT I**

A brief outline of grades of chemicals, sources of impurities in chemicals, principles (without going into details of individual chemicals) of limit test for arsenic, lead, iron, chloride and sulfate in Pharmaceuticals.

**UNIT II**

Outlines of Preparation, properties, uses and testing of the following Pharmaceuticals - sulfacetamide, paracetamol, riboflavin, nicotinamide,

Outlines of Preparation, properties, uses and testing of the following fine chemicals - Methyl orange, fluorescence, procaine hydrochloride, paramino salicylic acid, isonicatinic acid hydrazide.

**UNIT III**

Manufacture with flowsheets, properties uses and testing of the following Pharmaceuticals – aspirin, penicillin, calcium gluconate.

**UNIT IV**

Manufacture with flowsheets, properties uses and testing of the following ferric ammonium citrate, pthallic anhydride and phenol flourobenzene process and benzene sulfate process, other processes in outline only.

**UNIT V**

Tablet making and coating, granulation equipments, Preparation of capsules, extraction of crude drugs.Sterilization: introduction, risk factor, methods of sterilization, heat (dry and moist), heating with bactericide, filtration, gaseous sterilization and radiation sterilization, suitable example to be discussed.

**TEXT BOOKS:**

1. Remington's Pharmaceutical Science,16th ed, Mac publishing company, 1980.
2. Industrial Chemicals, 3rd ed., Faith, Kayes and Clark, John Wiley & Sons,. 1965.

**REFERENCE:**

1. Blently's Text Book of Pharmaceutical Chemistry, 8th ed, H A Rawlins,
2. B Tindell and Box,. Oxford University Press, London, 1977.

**Outcomes:**

1: Understand the principle of plant design in Pharmaceutical Industry.

2: Understand the knowledge of base chemicals and drug intermediates.

3: Understand kinetics, thermodynamics and plant construction material for the production of bulk drugs and fine chemicals.

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**ELECTIVE-IV**

**FOOD PROCESSING TECHNOLOGY (17A80803b)**

**Objectives:** To impart knowledge to the students about food processing and various unit operations involved in it, packaging, storing and preservation.

**UNIT I**

**Food process engineering - Fundamentals**: Fundamentals of food process engineering, application of quantitative methods of material and energy balances in food engineering practices.

**UNIT II**

**Unit Operations in food industries**: Fluid flow, thermal process calculations, refrigeration, evaporation and dehydration operations in food processing.

**UNIT III**

**Microwave heating:** Theory of microwave heating, microwave properties of foods, comparison of microwave and conventional heating, benefits of microwave heating, applications in food processing, microwave heating equipment, hazards of microwave heating.

**UNIT IV**

**Mechanical Operations in food processing**: Conversion operations, Size reduction and screening of solids, mixing and emulsification, filtration and membrane separation, centrifugation, crystallization, extraction.

**UNIT V**

**Preservation operations:** Preservation methods & Strategies, Thermal Methods, Nabla Factor Sterilization Types Pasteurization Dehydro freezing Irradiation Dosimetry Transport of food & Preservation strategies Cheap and applicable everywhere.

**TEXT BOOKS**

1. R. T. Toledo, "Fundamentals of Food Process Engineering", AVI Publishing Co., 1980.
2. R. Angold,G.Beech and J.Taggart, " Food Biotechnology", Cambridge University Press, 1989.
3. Fundamentals of Food Engineering, D G Rao, PHI, New Delhi, 2012.

**REFERENCES**

1. J. M. Jackson and B. M. Shinn, "Fundamentals of Food Canning Technology", AVI Publishing Co., 1978.
2. J. G. Bernnan, J. R. Butters, N. D. Cowell and A.E.V.Lilley, "Food Engineering Operations", 2$^{nd}$Edn., Applied Science, 1976.

**Outcomes:**

1. Understanding the various causes of food deterioration and food poisoning.
2. Identification of appropriate processing, preservation, and packaging method.
3. Analyze product quality and effect of processing technique on it.

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## ELECTIVE-IV
## CORROSION ENGINEERING (17A80803c)

**OBJECTIVES:**

The course will enable the students to:

1. Be introduced to the principles of electrochemistry as well as the essential elements of electrochemical corrosion.
2. Lay a foundation for understanding the forms of corrosion, the mechanisms of corrosion, electrochemical methods.
3. Develop the thermodynamic and kinetic aspects of electrochemistry, including potential-pH (Pourbaix) diagrams, mixed potential theory, and the theory and application of polarization.
4. Design methods for combating corrosion, the principles and methods leading to mitigation of corrosion problems that might occur in engineering practice.

**UNIT- I:**

**Introduction**

Definitions of Corrosion - Overall classification of types of corrosion-Basic electrochemistry – Galvanic and electrolytic cells – Potential measurements - EMF and Galvanic series – Galvanic corrosion and bimetallic contacts – Eh – pH diagrams, Cost of Corrosion, Metallurgical properties influencing corrosion.

**UNIT-II:**

**Forms of Corrosion**

Uniform attack, galvanic, crevice, pitting, Inter granular, selective leaching, erosion and stress corrosion – Mechanisms, testing procedures and their protection.

**UNIT- III:**

**Electrode kinetics and polarization phenomena**

Electrode – solution interface – Electrode kinetics and polarization phenomena – Exchange current density – Polarization techniques to measure corrosion rates – Mixed potential theory – Activation and diffusion controlled mixed electrodes.

**UNIT IV:**

**Methods of corrosion prevention and control**

Design, coatings and inhibition – Cathodic protection – Stray current corrosion – Passivity phenomena and development of corrosion resistant alloys – Anodic control.

**UNIT-V:**

**Industry Approach**

Selection for a given Chemical Engineering Service Environment- Materials for Chemical Engineering Industry to resist the given chemical Environment.-Ferritic, Austenitic steels and stainless steels- Copper and its alloys-Brasses, bronzes, Nickel and its alloys- Monel alloys-materials for a petroleum refinery industry.

**TEXT BOOKS:**

1. M. G. Fontana, Corrosion Engineering (Third Edition) McGraw-Hill Book Company.
2. Denny A Jones, Principles and Prevention of Corrosion (second edition), Prentice-Hall, N. J. (1996).

**REFERENCE:**

1. H. H. Uhlig and R. W. Revie, Corrosion and Corrosion Control, Wiley (NY) (1985).

**Outcomes:**

At the end of the course, the students will be able to:

1. Understand the electrochemical and metallurgical behavior of corroding systems.
2. Apply the electrochemical and metallurgical aspects of combating eight forms of corrosion.
3. Select or choose the testing procedures for corroding systems.
4. Evaluate the polarization behavior of corroding systems.
5. Design of suitable materials, methods to combat corrosion.
6. Predict the function of corrosion inhibitors.

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## ELECTIVE-V
## PETROLEUM REFINING AND PETROCHEMICALS(17A80804a)

**OBJECTIVES:**

- Learn the formation, refining of crude oil and products of refinery.
- Understand the means of processing data including thermal properties, important products characteristics.
- Develop skills in drawing neat flow diagrams of different petroleum refining processes
- (cracking/reforming/alkylation/isomerization / hydrocracking etc.,) that are aimed at producing high value/demand products.
- Identify important testing methods for important petroleum products.
- Have idea on Indian standards for major petroleum products

**UNIT-I:**

Origin, formation and composition of petroleum: Origin and formation of petroleum, Reserves and deposits of world, Indian Petroleum Industry. Petroleum processing data: Evaluation of petroleum, thermal properties of petroleum fractions, important products, properties and test methods.

**UNIT-II:**

Fractionation of petroleum: Dehydration and desalting of crudes, heating of crude pipe still heaters, distillation of petroleum, blending of gasoline. Treatment techniques: fraction-impurities, treatment of gasoline, treatment of kerosene, treatment of lubes.

**UNIT-III:**

Thermal and catalytic processes: Cracking, catalytic cracking, catalytic reforming, Naphtha cracking, coking, Hydrogenation processes, Alkylation processes, Isomerization process.

**UNIT-IV:**

Petrochemical Industry – Feed stocks Chemicals from methane: Introduction, production of Methanol, Formaldehyde, Ethylene glycol, PTFE, Methylamines.

**UNIT-V:**

Chemicals from Ethane-Ethylene-Acetylene: Oxidation of ethane, production of Ethylene, Manufacture of Vinyl Chloride monomer, vinyl Acetate manufacture, Ethanol from Ethylene, Acetylene manufacture, Acetaldehyde from Acetylene.

**TEXT BOOKS:**

1. Nelson. W.L. "Petroleum refining Engineering", 4 Edition, Mc Graw Hill, New York, 1969.

2. Rao, B.K.B. "Modern Petroleum Refining Processes", 4 Edition, Oxford and IBH Publishing, 2002.

**REFERENCES:**

1. Goldstine. R.F. "The Petroleum Chemicals Industry", Taylor and Francis, London, 1967.

2. Gruese. W.S.and Stevens, D.R. "Chemical Technology of Petroleum", McGraw Hill, 1980.

3 Chauvel. A. and Lefevrev, "Petro Chemicals", Volume 1 and 2, Gulf Publishing company 1989.

**Outcomes:**

- Describe the formation of crude oil, its refining techniques.
- Describe the chemical composition and physical properties of crude oil
- Understand various processes employed in petroleum refinery such that we can meet customer demand in terms of quality & quantity.
- Demonstrate the different methods available for removal of impurities from crude and products manufacture
- Understand, draw and describe the process flow diagrams of various refinery processes like distillation, cracking and reforming etc.,
- Understand the difference between thermal and catalytic cracking.

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**ELECTIVE-V**

**Rheology of Polymers (17A80804b)**

**Unit I**: Stress tensor, principal stress and invariants, polar decomposition theorem, finger tensor, strain tensor, inverse deformation tensors, principal strains, uniaxial extension and simple shear in neo-hookean solid, rate of deformation tensor, Newton's law in three dimensions, uniaxial extension, viscosity models for general viscous fluids and visco-plastic models.

**Unit II** : General linear viscoelastic model, stress relaxation and creep, non-linear viscoelasticity - normal stress difference in shear, shear thinning, interrelations between shear functions, extensional thickening, differential-type constitutive equations - single mode differential constitutive equations and multimode constitutive equations for viscoelastic fluids, integral type constitutive equations, rate-type constitutive equations for viscoelastic fluids, material functions for steady state shear flow, oscillatory shear flow, material functions for steady state extensional flow.

**Unit III**: Shear rheometer: sliding plates, falling ball rheometer, concentric cylinder rheometer, cone and plate rheometer, parallel disks, capillary rheometer, slit rheometer and squeezing flow behavior. Extensional rheometry: simple extension - end clamps, rotating clamps, buoyancy bath, spinning drop, lubricated compression, planner squzeeing, sheet stretching, multiaxial extension, fiber spinning, tubeless siphon, bubble collapse, stagnation flow.

**Unit IV**: Rheology of polymeric liquids: polymer chain conformation, zero shear viscosity, rheology of dilute polymer solutions, entanglement, Reptation Model, effect of long chain branching, effect of molecular weight distribution, temperature dependence.

**Unit V:** Rheology in polymer processing operations: Calendaring and two roll mill, Twin screw extruders, Blow molding, Wire coating, Thermoforming, Sheet extrusion, Internal mixers, Rubber extrusion

Reference books:

1. Rheology, Principles, Measurements and Applications, Christopher W. Macasko, WileyVCH,1994

2. Rheology and Processing of Polymeric Materials, Vol. 1, Oxford University Press, 2007

3. Rheology: Concepts, Methods, and Applications, Prof. Dr. Alexander Ya. Malkin, Prof. Dr. Avraam I Isayev, ChemTec Publishing, 2006

4. Dynamics of Polymeric Liquid, Volume I, R. Byron Bird, Robert C Armstrong, Ole Hassager, John Wiley and Sons, 1976

5. Polymer Processing Fundamentals, Tim A Osswald, Hanser Publishers, Munich, 1998.

6. Melt Rheology and its Role in Plastic Processing: Theory and applications, John M. Dealy, Kurt F. Wissbrun, Reprinted by Chapman and Hall,1999.

7. Principles of Polymer Engineering Rheology, James Lindsay White, John Wiley & Sons, 20-Jul- 1990.

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**ELECTIVE-V**

**PROCESS INTENSIFICATION (17A80804c)**

**UNIT I: Introduction to Process Intensification(PI)**: sustainability-related issues in process industry, definitions of Process Intensification, fundamental principles and techniques of PI, the original ICI PI strategy, benefits of PI and obstacles to PI

Issues in designing of a sustainable, inherently safer processing plant

**UNIT-II: PI Approaches**: STRUCTURE - PI approach in spatial domain, ENERGY - PI approach in thermodynamic domain, SYNERGY - PI approach in functional domain and TIME - PI approach in temporal domain. **Mechanisms involved in PI:** Mechanisms of intensified heat transfer, mass transfer, electrically enhanced processes, micro fluidics

**UNIT –III: Application of PI techniques to heat transfer**: Compact & micro heat exchangers.

**Application of Pi techniques to reactors**: Spinning disc reactors, oscillatory baffled reactors (OBR), Rotating reactors, Micro reactors, membrane reactors, micro reactors, Reactive separation/ super critical operation and other intensified reactor types.

**UNIT-IV: Intensification of Separation Processes:** Distillation, Centrifuges, membranes, drying, precipitation and crystallization.**Intensified Mixing**: Inline mixers, mixing on spinning disk, induction heated mixer

**UNIT –V:** Application areas of PI:Petrochemicals and Fine Chemicals: Refineries, Bulk Chemicals, Fine Chemicals, Fine Chemicals and Pharmaceuticals, bio processing.Offshore Processing, Nuclear Industries, Food and drink water sector, Textiles, Aerospace, biotechnology

**Text Books**

1.David Reay, Colin Ramshaw, Adam Harvey, Process Intensification- Reengineering for efficiency, sustainability and flexibility, Butterworth Heinemann, (Elsevier)2008.

2, Stankiewicz, A. and Moulijn, (Eds.), Reengineering the Chemical Process Plants, Process Intensification, marcel dekker 2003

**JNTUA College of Engineering (Autonomous), Ananthapuramu**

**IV Year B.Tech. Chem. Engg. II-Sem**

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 0 | 0 |

**MOOC – II (17A89906a)**

**JNTUA College of Engineering (Autonomous), Ananthapuramu**

**IV Year B.Tech. Chem. Engg. II-Sem**

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 0 | 0 |

**MOOC – II (17A89906b)**

**JNTUA College of Engineering (Autonomous), Ananthapuramu**

**IV Year B.Tech. Chem. Engg. II-Sem**

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 0 | 0 |

**MOOC – II (17A89906c)**

**JNTUA College of Engineering (Autonomous), Ananthapuramu**

**IV Year B.Tech. Chem. Engg. II-Sem**

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 2 | 1 |

**SEMINAR (17A80805)**

**JNTUA College of Engineering (Autonomous), Ananthapuramu**

**IV Year B.Tech. Chem. Engg. II-Sem**

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 16 | 8 |

**Project work (17A80806)**

**JNTUA College of Engineering (Autonomous), Ananthapuramu**

**IV Year B.Tech. Chem. Engg. II-Sem**

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 0 | 1 |

**COMPREHENSIVE OBJECTIVE TYPE EXAMINATION (17A80807)**

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR**

**COLLEGE OF ENGINEERING (Autonomous), ANANTHAPURAMU**

**Course Structure**

**&**

**Syllabus**

**For**

**B. Tech (Regular- Full Time Program) - R19**

**DEPARTMENT OF CHEMICAL ENGINEERING**

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR**
**COLLEGE OF ENGINEERING (Autonomous), ANANTHAPURAMU**
**B.Tech (Chemical Engineering) 2019-20**
**COURSE STRUCTURE**

**I YEAR I Semester**

| SEMESTER - 1 | | | | | |
|---|---|---|---|---|---|
| **S.No** | **Course No** | **Course Name** | **Category** | **L-T-P** | **Credits** |
| 1 | 19A15101 | Linear Algebra And Calculus | BS | 3-1-0 | 4 |
| 2 | 19A15301 | Engineering Chemistry | BS | 3-0-0 | 3 |
| 3 | 19A10501 | Problem Solving & Programming | ES | 3-1-0 | 4 |
| 4 | 19A10302 | Engineering Workshop | LC | 0-0-2 | 1 |
| 5 | 19A10301 | Engineering Graphics | ES | 1-0-4 | 3 |
| 6 | 19A15302 | Engineering Chemistry Lab | BS | 0-0-3 | 1.5 |
| 7 | 19A10506 | Problem Solving & Programming Lab | ES | 0-0-3 | 1.5 |
| | | | | **Total** | **18** |

**I YEAR II Semester**

| SEMESTER - 2 | | | | | |
|---|---|---|---|---|---|
| **S.No** | **Course No** | **Course Name** | **Category** | **L-T-P** | **Credits** |
| **1** | 19A10801 | Introduction to Chemical Engineering | PC | 2-0-0 | 3 |
| 2 | 19A15501 | Communicative English 1 | HS | 2-0-0 | 2 |
| 3 | 19A15102 | Differential Equations and Vector Calculus | BS | 3-1-0 | 4 |
| 4 | 19A15203 | Engineering Physics | BS | 3-0-0 | 3 |
| 5 | 19A10105 | Strength of Materials | ES | 2-0-0 | 2 |
| 6 | 19A10106 | Engineering Mechanic (Chemical Engineering) | ES | 3-0-0 | 3 |
| 7 | 19A10802 | Material Science for Chemical Engineers | ES | 2-0-0 | 2 |
| 8 | 19A10803 | Chemical Engineering Workshop | LC | 0-0-2 | 1 |
| 9 | 19A15502 | Communicative English Lab-1 | HS | 0-0-2 | 1 |
| 10 | 19A15204 | Engineering Physics Lab | BS | 0-0-3 | 1.5 |
| | | | | **Total** | **21.5** |

**II YEAR I Semester**

| Semester – 3 (Theory - 7, Lab – 3) | | | | | |
|---|---|---|---|---|---|
| **S. No.** | **Course No.** | **Course Name** | **Category** | **L-T-P** | **Credits** |
| 1. | 19A20601 | Complex Variables, Transforms and Partial Differential Equations | BSC | 2-1-0 | 3 |
| 2. | 19A20701 | Organic Chemistry | BSC | 3-0-0 | 3 |
| 3. | 19A20801 | Chemical Process Calculations | PCC | 2-1-0 | 3 |
| 4. | 19A20802 | Chemical Engineering Thermodynamics –I | PCC | 2-1-0 | 3 |

| | | | | | |
|---|---|---|---|---|---|
| 5. | 19A25501 | Fundamentals of Python Programming | ESC | 2-0-0 | 2 |
| 6. | 19A20803 | Momentum Transfer | PCC | 2-1-0 | 3 |
| 7. | 19A25502 | Fundamentals of Python Programming Lab | BSC | 0-0-3 | 1.5 |
| 8. | 19A20702 | Organic Chemistry lab | BSC | 0-0-3 | 1.5 |
| 9. | 19A20804 | Momentum Transfer lab | PCC | 0-0-3 | 1.5 |
| 10. | 19A10804 | Environmental Science | MC | 3-0-0 | 0 |
| | | | | **Total** | **21.5** |

**II YEAR II Semester**

| **Semester – 4 (Theory - 8, Lab – 2)** | | | | | |
|---|---|---|---|---|---|
| **S. No.** | **Course No.** | **Course Name** | **Category** | **L-T-P** | **Credits** |
| 1. | 19A20805 | Chemical Engineering Thermodynamics –II | PCC | 2-1-0 | 3 |
| 2. | 19A20806 | Process Heat Transfer | PCC | 2-1-0 | 3 |
| 3. | 19A20807 | Mechanical Operations | PCC | 2-1-0 | 3 |
| 4. | 19A20808 | Mass Transfer operations -I | PCC | 2-1-0 | 3 |
| 5. | 19A20703 | Analytical Chemistry | BSC | 2-1-0 | 3 |
| 6. | 19A20603 | Numerical Methods, Probability and Statistics | BSC | 2-1-0 | 3 |
| 7. | 19A20901 | Universal Human Values | HE | 2-0-0 | 2 |
| 8. | 19A20809 | Process Heat Transfer lab | PCC | 0-0-3 | 1.5 |
| 9. | 19A20810 | Mechanical Operations lab | PCC | 0-0-3 | 1.5 |
| 10. | 19A28801 | Biology for Engineers | MC | 3-0-0 | 0 |
| | | | | **Total** | **23** |

**III YEAR I Semester**

| semester – 5 | | | | | |
|---|---|---|---|---|---|
| S. No. | Course No. | Course Name | Category | L-T-P | Credits |
| 1. | 19A50801 | Chemical Technology | PCC | 3-0-0 | 3 |
| 2. | 19A50802 | Mass Transfer operations –II | PCC | 2-1-0 | 3 |
| 3. | 19A50803 | Chemical Reaction Engineering –I | PCC | 2-1-0 | 3 |
| 4. | (Professional Elective-I) | | PEC-1 | 3-0-0 | 3 |
| | 19A50804 | Petroleum Refining and Petrochemicals | | | |
| | 19A50805 | Process Modelling and Simulation | | | |
| | 19A50806 | Numerical Methods in Chemical Engineering | | | |
| 5. | (Open Elective-I) | | | | |
| | 19A50807 | Membrane Technology | | | |

| | | | | | |
|---|---|---|---|---|---|
| | 19A50808 | Water Conservation and Management | OEC-1 | 3-0-0 | 3 |
| | 19A50513T | Introduction to Java Programming /Lab19A50513L | | | |
| | 19A50809 | Energy Engineering | | | |
| 6. | 19A50810 | Instrumentation and Process Control | PCC | 2-1-0 | 3 |
| 7 | 19A55401 | Research Methodology | MC | 3-0-0 | 0 |
| 8 | 19A50811 | Mass Transfer operations lab | PCC | 0-0-3 | 1.5 |
| 9 | 19A50812 | Instrumentation and Process Control lab | PCC | 0-0-3 | 1.5 |
| 10 | 19A50813 | Socially Relevant Project | PR | 0-0-1 | 0.5 |
| | | | | Total | 21.5 |

**III YEAR II Semester**

| Semester – 6 | | | | | |
|---|---|---|---|---|---|
| **S. No.** | **Course No.** | **Course Name** | **Category** | **L-T-P** | **Credits** |
| 1. | 19A60801 | Chemical Reaction Engineering -II | PCC | 2-1-0 | 3 |
| 2. | 19A60802 | Chemical Process Equipment Design | PCC | 2-1-0 | 3 |
| 3. | 19A65501 | English Language Skills | HSMC | 3-0-0 | 3 |
| 4. | (Professional Elective-II) | | PEC-2 | 3-0-0 | 3 |
| | 19A60803 | Chemical Plant Design & Economics | | | |
| | 19A60804 | Polymer Science & Engineering | | | |
| | 19A60805 | Food Processing Technology | | | |
| 5. | (Open Elective-II)/MOOCs | | OEC-2 | 3-0-0 | 3 |
| | 19A60806 | Industrial safety and Hazardous management | | | |
| | 19A60807 | Green Technology | | | |
| | 19A60808 | Nuclear Engineering | | | |
| 6. | (Humanities Elective-I) | | HSMC | 3-0-0 | 3 |
| | 19A65401 | Managerial Economics and Financial Analysis | | | |
| | 19A65402 | Business Ethics and Corporate Governance | | | |
| | 19A65403 | Entrepreneurship & Incubation | | | |
| 7. | 19A65406 | Constitution of India | MC | 3-0-0 | 0 |
| 8. | 19A60809 | Chemical Reaction Engineering lab | PCC | 0-0-3 | 1.5 |
| 9. | 19A65502 | English Language Skills lab | HSMC | 0-0-3 | 1.5 |
| 10. | 19A60810 | Socially Relevant Project | PR | 0-0-1 | 0.5 |
| | | | | Total | 21.5 |

**IV YEAR I Semester**

| Semester – 7 | | | | | |
|---|---|---|---|---|---|
| S. No. | Course No | Course Name | Category | L-T-P | Credits |
| 1. | 19A70801 | Transport Phenomena | PCC | 2-1-0 | 3 |
| 2. | 19A70802 | Optimization of Chemical Processes | PCC | 2-1-0 | 3 |
| 3. | (Professional Elective-III) | | PEC-3 | 3-0-0 | 3 |
| | 19A70803 | Industrial Pollution Control Engineering | | | |
| | 19A70804 | Interfacial and Colloidal Science | | | |
| | 19A70805 | Technology of Pharmaceuticals & Fine Chemicals | | | |
| 4. | (Open Elective-III) | | OEC-3 | 3-0-0 | 3 |
| | 19A70806 | Basics of Nanotechnology | | | |
| | 19A70807 | Solid Waste Management | | | |
| | 19A70808 | Process Intensification | | | |
| 5. | (Humanities Elective-II) | | HSMC | 3-0-0 | 3 |
| | 19A75401 | Management Science | | | |
| | 19A75402 | Organizational Behaviour | | | |
| | 19A75403 | Business Environment | | | |
| 6. | 19A70809 | Process Simulation lab | PCC | 0-0-3 | 1.5 |
| 7. | 19A70810 | Process Equipment Design & Drawing lab | PCC | 0-0-3 | 1.5 |
| 8 | 19A70811 | Seminar | PR | 0-0-1 | 0.5 |
| 9. | 19A70812 | Project I | PR | 0-0-3 | 1.5 |
| 10. | 19A70813 | Industrial Training/Skill Development/Research Project | PR | ------ | 2 |
| | | | | Total | 22 |

**IV YEAR II Semester**

| Semester – 8 | | | | | |
|---|---|---|---|---|---|
| **S. No.** | **Course No** | **Course Name** | **Category** | **L-T-P** | **Credits** |
| 1. | (Professional Elective-IV) | | PEC-4 | 3-0-0 | 3 |
| | 19A80801 | Biochemical Engineering | | | |
| | 19A80802 | Computational Fluid Dynamics | | | |
| | 19A80803 | Fuel Cell Technology | | | |
| 2. | (Open Elective-IV) | | OEC-4 | 3-0-0 | 3 |
| | 19A80804 | Design and Analysis of Experiments | | | |
| | 19A80805 | Corrosion Engineering | | | |
| | 19A80806 | Renewable Energy | | | |
| 3. | 19A80807 | **Project II** | **PR** | **0-0-7** | **7** |
| | | | | **Total** | **13** |

**JNTUA COLLEGE OF ENGINEERING (Autonomous) :: ANANTAPURAMU**
**DEPARTMENT OF CHEMICAL ENGINEERING**

| I- Year B.Tech. I-Sem | L | T | P | C |
|---|---|---|---|---|
| | 3 | 1 | 0 | 4 |

## Linear Algebra & Calculus

| Course Objectives: | |
|---|---|
| **1** | This course will illuminate the students in the concepts of calculus and linear algebra. |
| **2** | To equip the students with standard concepts and tools at an intermediate to advanced level mathematics to develop the confidence and ability among the students to handle various real world problems and their applications |

**Bridge Course:** Limits, continuity, Types of matrices

**Unit 1: Matrices**

Rank of a matrix by echelon form, solving system of homogeneous and non-homogeneous equations linear equations. Eigen values and Eigen vectors and their properties, Cayley-Hamilton theorem (without proof), finding inverse and power of a matrix by Cayley-Hamilton theorem, diagonalisation of a matrix, quadratic forms and nature of the quadratic forms, reduction of quadratic form to canonical forms by orthogonal transformation.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- Solving systems of linear equations, using technology to facilitate row reduction determine the rank, eigen values and eigenvectors, diagonal form and different factorizations of a matrix;
- Identify special properties of a matrix, such as positive definite, etc., and use this information to facilitate the calculation of matrix characteristics.

**Unit 2: Mean Value Theorems**

Rolle's Theorem, Lagrange's mean value theorem, Cauchy's mean value theorem, Taylor's and Maclaurin theorems with remainders (without proof)

**Learning Outcomes:**

At the end of this unit, the student will be able to

- Translate the given function as series of Taylor's and Maclaurin's with remainders
- Analyze the behaviour of functions by using mean value theorems

**Unit 3: Multivariable calculus**

Partial derivatives, total derivatives, chain rule, change of variables, Jacobians, maxima and minima of functions of two variables, method of Lagrange multipliers.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- Find partial derivatives numerically and symbolically and use them to analyze and interpret the way a function varies.
- Acquire the Knowledge maxima and minima of functions of several variable
- Utilize Jacobian of a coordinate transformation to deal with the problems in change of Variables.

**Unit 4: Multiple Integrals**

Double integrals, change of order of integration, double integration in polar coordinates, areas enclosed by plane curves. Evaluation of triple integrals, change of variables between Cartesian, cylindrical and spherical polar co-ordinates.

**Learning Outcomes:**

- At the end of this unit, the student will be able to
- Evaluate double integrals of functions of several variables in two dimensions using Cartesian and polar coordinates
- Apply double integration techniques in evaluating areas bounded by region
- Evaluate multiple integrals in Cartesian, cylindrical and spherical geometries

**Unit 5: Special Functions**

Beta and Gamma functions and their properties, relation between beta and gamma functions, evaluation of definite integrals using beta and gamma functions.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- understand beta and gamma functions and its relations
- Conclude the use of special function in evaluating definite integrals

**Text Books:**


1. Erwin Kreyszig, Advanced Engineering Mathematics, 10/e, John Wiley & Sons, 2011.
2. B. S. Grewal, Higher Engineering Mathematics, 44/e, Khanna Publishers, 2017.


**Mapping between Course Outcomes and Programme Outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |

**JNTUA COLLEGE OF ENGINEERING (Autonomous) :: ANANTAPURAMU**

**DEPARTMENT OF CHEMICAL ENGINEERING**

| | L | T | P | C |
|---|---|---|---|---|
| **I- Year B.Tech. I-Sem** | **3** | **0** | **0** | **3** |

**Engineering Chemistry**

| COURSE OBJECTIVES | |
|---|---|
| 1 | To familiarize engineering chemistry and its applications |

| | |
|---|---|
| 2 | To impart the concept of soft and hard waters, softening methods of hard water |
| 3 | To train the students on the principles and applications of electrochemistry, polymers, surface chemistry, and cement |

**Unit1:WaterTechnology**
**(8 hrs)**

Introduction –Soft Water and hardness of water, Estimation of hardness of water by EDTA Method - Boiler troubles - scale and sludge, Industrial water treatment – specifications for drinking water, Bureau of Indian Standards(BIS) and World health organization(WHO) standards, zeolite and ion-exchange processes - desalination of brackish water, reverse osmosis (RO) and electrodialysis.

**Unit 2: Electrochemistry and Applications:** (10 hrs)

Electrodes – concepts, electrochemical cell, Nernst equation, cell potential calculations.

Primary cells – Zn-$MnO_2$ (Leclanche cell), Li Battery

Secondary cells – lead acid and lithium ion batteries- working of the batteries including cell reactions.

Fuel cells- Basic Principles and Working Principles of hydrogen-oxygen, methanol fuel cells

Corrosion: Introduction to corrosion, electrochemical theory of corrosion, differential aeration cell corrosion, galvanic corrosion, metal oxide formation by dry electrochemical corrosion, Pilling Bedworth ratios and uses, Factors affecting the corrosion, cathodic and anodic protection, electroplating and electro less plating (Nickel and Copper).

**Unit 3: Polymers and Fuel Chemistry**:(12 hrs)

Introduction to polymers, functionality of monomers, Mechanism of chain growth, step growth and coordination polymerization,

Thermoplastics and Thermo-setting plastics-: Preparation, properties and applications of PVC and Bakelite

Elastomers – Preparation, properties and applications of Buna S, Buna N, Thiokol

Fuels – Types of fuels, calorific value, numerical problems based on calorific value; Analysis of coal, Liquid Fuels refining of petroleum, fuels for IC engines, knocking and anti-knock agents, Octane and Cetane values, cracking of oils; alternative fuels- propane, methanol and ethanol, bio fuels.

**UNIT-4 Advanced Engineering Materials** **(8 hrs)**

(i)Composites- Definition, Constituents, Classification- Particle, Fibre and Structural reinforced composites, properties and Engineering applications

(ii)Refractories- Classification, Properties, Factors affecting the refractory materials and Applications

(iii)Lubricants- Classification, Functions of lubricants, Mechanism, Properties of lubricating oils and Applications

(iv)Building materials- Portland Cement, constituents, phases and reactivity of clinker, Setting and Hardening of cement.

**Unit 5: Surface Chemistry and Applications:** (10 hrs)

Introduction to surface chemistry, colloids, micelle formation, synthesis of colloids (any two methods with examples), chemical and electrochemical methods (not more than two methods) of preparation of nanometals and metal oxides, stabilization of colloids and nanomaterials by stabilizing agents, solid-gas interface, solid-liquid interface, adsorption isotherm, applications of colloids and nanomaterials – catalysis, medicine, sensors.

| COURSE OUTCOMES | |
|---|---|
| At the end of this course the student will be able to | |
| CO1 | **List** the differences between temporary and permanent hardness of water, **explain**the principles of reverse osmosis and electrodialysis. **compare**quality ofdrinking water with BIS and WHO standards. **illustrate**problems associated with hard water - scale and sludge**. explain** the working principles of different Industrial water treatment processes |
| CO2 | **Apply** Nernst equation for calculating electrode and cell potentials, **apply** Pilling Bedworth rule for corrosion and corrosion prevention, **demonstrate** the corrosion prevention methods and factors affecting corrosion, **compare** different batteries and their applications |
| CO3 | **Explain** different types of polymers and their applications, **Solve the numerical problems based on Calorific value, select** suitable fuels for IC engines, **explain** calorific values, octane number, refining of petroleum and cracking of oils |
| CO4 | Explain the constituents of Composites and its classification Identify the factors affecting the refractory material, Illustrate the functions and properties of lubricants, demonstrate the phases and reactivity of concrete formation, identify the constituents of Portland cement, enumerate the reactions at setting and hardening of the cement |
| CO5 | **Summarize** the applications of SEM, TEM and X-ray diffraction in surface characterization, **explain** the synthesis of colloids with examples, **outline** the preparation of nanomaterials and metal oxides **identify** the application of colloids and nanomaterials in medicine, sensors and catalysis |

Text Books:

1. Engineering Chemistry by KNJayaveera, GVSubba Reddy and C. Ramachandraiah, McGraw Hill Higher Education, Foruth Edition, New Delhi
2. A Text Book of Enigneering Chemistry, Jain and Jain, Dhanapathi Rai Publications, New Delhi

References:

1.A Text book of Engineering Chemistry by SS Dhara, S. Chand Publications, New Delhi

2. Engineering Chemistry by K.B.Chandra Sekhar, UN.Das and Sujatha Mishra, SCITECH Pubblications India Pvt Limited.
3. Concepts of Engineering Chemistry- Ashima Srivastavaf and N.N. Janhavi
4. Text Book of Engineering Chemistry – C. Parameswara Murthy, C.V.Agarwal and Andra Naidu
5. Chemistry of Engineering Materials, C.V.Agarwal, C.Parameswaramurthy and Andranaidu
6. Text Book of Engineering Chemistry, Shashichawla, Dhanapathirai Publications.

**Mapping between Course Outcomes and Programme Outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |

**JNTUA COLLEGE OF ENGINEERING (Autonomous) :: ANANTAPURAMU**
**DEPARTMENT OF CHEMICAL ENGINEERING**

| | L | T | P | C |
|---|---|---|---|---|
| **I- Year B.Tech. I-Sem** | **3** | **1** | **0** | **4** |

**Problem Solving & Programming**

| COURSE OBJECTIVES | |
|---|---|
| 1 | Introduce the internal parts of a computer, and peripherals. |
| 2 | Introduce the Concept of Algorithm and use it to solve computational problems |
| 3 | Identify the computational and non-computational problems |
| 4 | Teach the syntax and semantics of a C Programming language |
| 5 | Demonstrate the use of Control structures of C Programming language |
| 6 | Illustrate the methodology for solving Computational problems |

**Unit 1:**

**Computer Fundamentals: What is a Computer, Evolution of Computers, Generations of Computers, Classification of Computers, Anatomy of a Computer, Memory revisited, Introduction to Operating systems, Operational overview of a CPU.**

**Introduction to Programming, Algorithms and Flowcharts**: Programs and Programming, Programming languages, Compiler, Interpreter, Loader, Linker, Program execution, Fourth generation languages, Fifth generation languages, Classification of Programming languages, Structured programming concept, Algorithms, Pseudo-code, Flowcharts, Strategy for designing algorithms, Tracing an algorithm to depict logic, Specification for converting algorithms into programs.

**Introduction to computer problem solving:** Introduction, the problem-solving aspect, top-down design, implementation of algorithms, the efficiency of algorithms, the analysis of algorithms.

Unit Outcomes:

Student should be able to

1. Identify the different peripherals, ports and connecting cables in a PC (L2)
2. Illustrate the working of a Computer (L3)
3. Select the components of a Computer in the market and assemble a computer (L4)
4. Solve complex problems using language independent notations (L3)

**Unit 2:**

**Types, Operators, and Expressions:** Variable names, data types and sizes, constants, declarations, arithmetic operators, relational and logical operators, type conversions, increment and decrement operators, bitwise operators, assignment operators and expressions, conditional expressions precedence and order of evaluation.

**Input and output:** standard input and output, formatted output-Printf, formatted input-Scanf.

**Control Flow:** Statements and blocks, if-else, else-if, switch, Loops-while and for, Loops-Do-while, break and continue, Goto and labels.

**Learning Outcomes**: Student should be able to

1. Solve Computational problems (L3)
2. Apply Algorithmic approach to solving problems (L3)
3. Analyze the algorithms (L4)

**Unit 3:**

**Fundamental algorithms:** Exchanging the values of two variables, counting, summation of a set of numbers, factorial computation, sine function computation, generation of the Fibonacci sequence, reversing the digits of an integer.

**Functions and Program Structure:** Basics of functions, functions returning non-integers, external variables, scope variables, header variables, register variables, block structure, initialization, recursion, the C processor.

**Learning Outcomes**: Student should be able to

1. Recognize the programming elements of C Programming language (L1)
2. Select the control structure for solving the problem (L4)
3. Apply modular approach for solving the problem (L3)

**Unit 4:**

**Factoring methods:** Finding the square root of a number, the smallest divisor of a number, the greatest common divisor of two integers, generating prime numbers.

**Pointers and arrays:** Pointers and addresses, pointers and function arguments, pointers and arrays, address arithmetic, character pointers and functions, pointer array; pointers to pointers, Multi-dimensional arrays, initialization of arrays, pointer vs. multi-dimensional arrays, command line arguments, pointers to functions, complicated declarations.

**Array Techniques:** Array order reversal, finding the maximum number in a set, removal of duplicates from an order array, finding the k$^{th}$ smallest element

**Learning Outcomes**: Student should be able to

1. Solve mathematical problems using C Programming language (L3)
2. Structure the individual data elements to simplify the solutions (L6)
3. Facilitate efficient memory utilization (L6)

**Unit 5:**

**Sorting and Searching:** Sorting by selection, sorting by exchange, sorting by insertion, sorting by partitioning, binary search.

**Structures:** Basics of structures, structures and functions, arrays of structures, pointers to structures, self-referential structures, table lookup, typedef, unions, bit-fields.

**Some other Features**: Variable-length argument lists, formatted input-Scanf, file access, Error handling-stderr and exit, Line Input and Output, Miscellaneous Functions.

**Learning Outcomes**: Student should be able to

1. Select sorting algorithm based on the type of the data (L4)
2. Organize heterogeneous data (L6)
3. Design a sorting algorithm (L6)

| **COURSE OUTCOMES** | |
|---|---|
| At the end of this course the student will be able to | |
| CO1 | Construct his own computer using parts (L6). |
| CO2 | Recognize the importance of programming language independent constructs (L2) |

| | |
|---|---|
| CO3 | Solve computational problems (L3) |
| CO4 | Select the features of C language appropriate for solving a problem (L4) |
| CO5 | Design computer programs for real world problems (L6) |
| CO6 | Organize the data which is more appropriated for solving a problem (L6) |

**Text Books**:

1. Pradip Dey, and Manas Ghosh, "Programming in C", 2018, Oxford University Press.
2. R.G. Dromey, "How to Solve it by Computer". 2014, Pearson.
3. Brian W. Kernighan, and Dennis M. Ritchie, "The C Programming Language", $2^{nd}$ Edition, Pearson.

**Reference Books:**

1. P.Chenna Reddy, " Computer Fundamentals and C Programming" 2018, BS Publications
2. RS Bichkar " Programming with C", 2012, Universities Press.
3. Pelin Aksoy, and Laura Denardis, "Information Technology in Theory", 2017, Cengage Learning.

**Mapping between Course Outcomes and Programme Outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |

**JNTUA COLLEGE OF ENGINEERING (Autonomous)::ANANTAPURAMU**
**DEPARTMENT OF CHEMICAL ENGINEERING**

**I- Year B.Tech. I-Sem**

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| 0 | 0 | 2 | 1 |

## Engineering Workshop

**(COMMON TO CIVIL, CHEMICAL, CHEMICAL)**

| **Course Objective**: | |
|---|---|
| 1 | To familiarize students with wood working, sheet metal operations, fitting and electrical house wiring skills. |

**Wood Working:**

Familiarity with different types of woods and tools used in wood working and make following joints

a) Half – Lap joint *
b) Mortise and Tenon joint *
c) Corner Dovetail joint or Bridle joint

**Sheet Metal Working:**

Familiarity with different types of tools used in sheet metal working, Developments of following sheet metal job from GI sheets

a) Tapered tray *
b) Conical funnel *
c) Elbow pipe *
d) Brazing

**Fitting:**
Familiarity with different types of tools used in fitting and do the following fitting exercises

a) V-fit *
b) Dovetail fit *
c) Semi-circular fit
d) Wheel Balancing, tubeless tyre puncture and change of two wheeler tyre.

**Electrical Wiring:**
Familiarities with different types of basic electrical circuits and make the following connections

a) Parallel and series *
b) Two way switch *
c) Godown lighting
d) Tube light *
e) Three phase motor
f) Soldering of wires

Note:* Students exercise. Remaining all for demonstration.

| **COURSE OUTCOMES** | |
|---|---|
| At the end of this course the student will be able to | |
| CO1 | Apply wood working skills in real world applications. (L3) |
| CO2 | Build different objects with metal sheets in real world applications. (L3) |
| CO3 | Apply fitting operations in various applications. (L3) |
| CO4 | Apply different types of basic electric circuit connections. (L3) |
| CO5 | Understanding the soldering, brazing and principle of automobile wheel balancing, alignment and operation of power tools. (L2) |

**Mapping between Course Outcomes and Programme Outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |

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**I- Year B.Tech. I-Sem**

| L | T | P | C |
|---|---|---|---|
| 1 | 0 | 4 | 3 |

**ENGINEERING GRAPHICS**
**(COMMON TO CIVIL, CHEMICAL, CHEMICAL)**

| Course Objectives | |
|---|---|
| 1 | Bring awareness that Engineering Drawing is the Language of Engineers. |
| 2 | To know how to represent letters and numbers in drawing sheets.. |
| 3 | To know about the different types of the projections, projection of points, straight lines, planes and regular solids |
| 4 | To know sectional views and development of different types of surfaces. |
| 5 | To know about the projection of orthographic views, isometric views and isometric projections. |

**UNIT-I**

Introduction to Engineering Drawing: Principles of Engineering Graphics and their significance

Curves used in practice:

a) Conic sections – Ellipse, Parabola, Hyperbola & Rectangular Hyperbola (general method)
b) Cycloid, Epicycloid and Hypocycloid – Normal and Tangent
c) Involutes – Normal and Tangent

**Learning Outcomes:**

At the end of this unit the student will be able to

1. Understand the Printing of Letters and dimensioning.(L1)
2. Draw the geometric constructions; drawing parallel and perpendicular lines, and to construct circles, arcs, tangencies, and irregular curves (L6)
3. Construct the Conic sections and cycloidal curves.(L6)

**UNIT –II**

Principles of orthographic projections – First and Third angle projections Projection of points., Projections of lines inclined to one plane and inclined to both planes – True length, true angles of projected lines – Projection of regular planes inclined to one plane and both planes by rotational method.

**Learning Outcomes:**

At the end of this unit the student will be able to

1. Understand the Orthographic Projection in four quadrants (L2)
2. Project the points, lines and planes (L6)

**UNIT –III**

Projection of solids inclined to one plane and inclined to both planes by rotational/auxiliary method – Prism, Cylinder, Pyramid, Cone.

**Learning Outcomes:**

At the end of this unit the student will be able to

1. Project the solids inclined to one or both planes. (L6)
2. draw the solids by auxiliary method. (L6)

**UNIT –IV**

Sections of solids: Sections and Sectional views of regular solids – Prism, Cylinder, Pyramid, Cone – True shapes

Development of solids- Prism, Cylinder, Pyramid, Cone
Interpenetration of Solids – Intersection of Cylinder Vs Cylinder, Cylinder Vs Prism, Cylinder Vs cone, square prism Vs square prism.

**Learning Outcomes:**

At the end of this unit the student will be able to

1. Project the sectional view of regular solids.(L6)
2. Draw the true shapes of the sections.(L2)
3. Draw the development of surfaces of the solids.(L6)
4. Develop the sectional parts of the solids.(L2)

**UNIT –V**

Orthographic projections: Conversion of Pictorial views to orthographic views – Conventions.
Isometric projection: Isometric views of lines, plane figures, simple and truncated solids – orthographic views into isometric views.

**Learning Outcomes:**

At the end of this unit the student will be able to

1. Draw the orthographic views with dimensions.
2. Draw the Isometric views and isometric projections.

| COURSE OUTCOMES | |
|---|---|
| At the end of this course the student will be able to | |
| CO1 | Draw various curves applied in engineering. (L2) |
| CO2 | Plot the projection of points, Lines and planes.(L2) |
| CO3 | Draw the projections of solids inclined to one or both planes. (L2) |
| CO4 | Draw the sectional views and development of surfaces.(L2) |
| CO5 | Draw the orthographic views, Isometric views and isometric projections. (L3) |

**TEXT BOOKS:**

1. Engineering Drawing, N.D. Bhatt, Charotar Publishers
2. Engineering Drawing, K.L. Narayana & P. Kannaih, Scitech Publishers, Chennai.

**REFERENCES:**

1. Engineering Drawing, Johle, Tata McGraw-Hill Publishers.
2. Engineering Drawing, Shah and Rana,2/e, Pearson Education
3. Engineering Drawing and Graphics, Venugopal/New age Publishers
4. Engineering Graphics, John & John.

**Mapping between Course Outcomes and Programme Outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |

**I- Year B.Tech. I-Sem** **L T P C**

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**Engineering Chemistry Lab**

| COURSE OBJECTIVES | |
|---|---|
| 1 | Verify the fundamental concepts with experiments |

**LIST OF EXPERIMENTS**

1. Determination of Hardness of a groundwater sample.
2. pH metric titration of (i) strong acid vs. strong base, (ii) weak acid vs. strong base
3. Determination of cell constant and conductance of solutions
4. Potentiometry - determination of redox potentials and emfs
5. Determination of Strength of an acid in Pb-Acid battery
6. Preparation of a polymer
7. Determination of percentage of Iron in Cement sample by colorimetry
8. Estimation of Calcium in port land Cement
9. Adsorption of acetic acid by charcoal
10. Determination of percentage Moisture content in a coal sample
11. Determination of Viscosity of lubricating oil by Red Viscometer 1
12. Determination of Flash and Fire points of fuels
13. Determination of Calorific value of gases by Junker's gas Calorimeter

| COURSE OUTCOMES | |
|---|---|
| At the end of this course the student will be able to | |
| CO1 | **Determine** the cell constant and conductance of solutions (L3) |
| CO2 | **Prepare** advanced polymer materials (L2) |
| CO3 | **Determine** the physical properties like surface tension, adsorption and viscosity (L3) |
| CO4 | **Estimate** the Iron and Calcium in cement (L3) |
| CO5 | **Calculate** the hardness of water (L4) |

**TEXT BOOKS:**

1. Vogel's Text book of Quantitative Chemical Analysis, Sixth Edition – J. Mendham et al, Pearson Education.
2. Chemistry Practical – Lab Manual by Chandra Sekhar, GV Subba Reddy and Jayaveera

**<u>Mapping between Course Outcomes and Programme Outcomes</u>**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |

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| I- Year B.Tech. I-Sem | L | T | P | C |
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## Problem Solving & Programming Lab

**Laboratory Experiments**#

1. Basic DOS Commands/Unix Commands
2. Familiarize with windows/Linux Environment.
3. Familiarize with development environment of C Language
4. Design a C program which reverses the number
5. Design a C program which finds the second maximum number among the given list of numbers.
6. Construct a program which finds the kth smallest number among the given list of numbers.
7. Design an algorithm and implement using C language the following exchanges

   a $\leftarrow$ b $\leftarrow$ c $\leftarrow$ d

5. Develop a C Program which counts the number of positive and negative numbers separately and also compute the sum of them.
7. Implement the C program which computes the sum of the first n terms of the series Sum = 1 – 3 + 5 -7 + 9
8. Design a C program which determines the numbers whose factorial values are between 5000 and 32565.
9. Design an algorithm and implement using a C program which finds the sum of the infinite series $1 - x^2/2! + x^4/4! - x^6/6! + ....$
10. Design a C program to print the sequence of numbers in which each number is the sum of the three most recent predecessors. Assume first three numbers as 0, 1, and 1.
11. Implement a C program which converts a hexadecimal, octal and binary number to decimal number and vice versa.
12. Develop an algorithm which computes the all the factors between 1 to 100 for a given number and implement it using C.
13. Construct an algorithm which computes the sum of the factorials of numbers between m and n.
14. Design a C program which reverses the elements of the array.
15. Given a list of n numbers, Design an algorithm which prints the number of stars equivalent to the value of the number. The starts for each number should be printed horizontally.
16. Implement the sorting algorithms a. Insertion sort b. Exchange sort c. Selection sort d. Partitioning sort.
17. Illustrate the use of auto, static, register and external variables.
18. Design algorithm and implement the operations creation, insertion, deletion, traversing on a singly linked list.
19. Develop a C program which takes two numbers as command line arguments and finds all the common factors of those two numbers.
20. Design a C program which sorts the strings using array of pointers.

# The above list is not exhaustive. Instructors may add some experiments to the above list. Moreover, 50% of the experiments are to be changed every academic year. Instructors can choose the experiments, provided those experiments are not repetitions.

| COURSE OUTCOMES | |
|---|---|
| At the end of this course the student will be able to | |
| CO1 | Construct a Computer given its parts (L6) |
| CO2 | Select the right control structure for solving the problem (L6) |
| CO3 | Analyze different sorting algorithms (L4) |
| CO4 | Design solutions for computational problems (L6) |
| CO5 | Develop C programs which utilize the memory efficiently using programming constructs like pointers. |

**References**:


1. B. Govindarajulu, "IBM PC and Clones Hardware Trouble shooting and Maintenance", Tata McGraw-Hill, 2nd edition, 2002.

2. R.G. Dromey, “How to Solve it by Computer”. 2014, Pearson.
3. P.Chenna Reddy, “Computer Fundamentals and C Programming” 2018, BS Publications.

**Mapping between Course Outcomes and Programme Outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |

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**I- Year B.Tech. II-Sem**

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## Introduction to Chemical Engineering

**Pre-requisites:** None
**Course Outcomes:** At the end of the course, the student will be able to:

| | |
|---|---|
| CO1 | Understand the role of Chemical Engineers in everyday life and the importance of Chemical Engineering subject. |
| CO2 | Learn about material & energy balance calculations. |
| CO3 | Understand the concept of fluid flow. |
| CO4 | Understand the principles of heat transfer, mass transfer and mechanical operations |
| CO5 | Learn the importance of safety in process industries |

**Course Articulation Matrix**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | - | - | - | - | 2 | 3 | 3 | - | - | - | 3 |
| CO2 | 3 | - | - | - | - | - | - | - | - | - | - | 3 |
| CO3 | 3 | - | - | - | - | - | - | - | - | - | - | 3 |
| CO4 | 3 | - | - | - | - | - | - | - | - | - | - | 3 |
| CO5 | 3 | - | - | - | - | 2 | 3 | 3 | - | - | - | 3 |

## Objectives:

1. To impart the role of Chemical Engineers in everyday life and the importance of Chemical Engineering.
2. To learn the role of various Unit Operations and Unit Processes in Chemical industries.
3. To learn the role of Chemical Engineers in environmental and safety aspects in process industries

## Detailed Syllabus:

**Unit-I**

Introduction, Chemical Engineering in everyday life, Scaling up or down, Engineering applications of portable devices, challenges in petroleum sector, versatility of a Chemical Engineer, role of Chemical Engineers in Biomedical Engineering, similarities in dissimilar applications.

Batch Processing, paint manufacture, transition from batch to continuous processing, Case study: Manufacture of Sulphuric acid, role of basic sciences in Chemical Engineering (Introduction) (Text Book 1)

**Unit-II**

Introduction, Unit operations, basic laws, units and dimensions, partial pressure, vapor pressure.

Solutions, concentration measurements, humidity and saturation. Material and Energy balances.

Flow of fluids: Introduction, nature of fluid, viscosity, velocity profile, flow field, types of fluid motion, laminar and turbulent flow, flow of a fluid past a solid surface, Reciprocating, rotary, and centrifugal pumps(Text Book 2)

**Unit-III**

Heat transfer: Conduction, convection (omit correlations for calculation of heat transfer coefficients, heat transfer with change in phase) and radiation. Flow arrangement in heat exchangers, variation of fluid temperatures in heat exchangers, heat transfer equipment (double pipe & Shell and tube heat exchanger),evaporation, long tube vertical type and forced circulation type evaporators, multiple effect evaporation, methods of feeding(Text Book 2)

**Unit-IV**

Mass transfer: Introduction - Diffusion, mass transfer operation, equipment for gas-liquid operations, contact patterns, classification of separation processes and applications, basic definitions of separation processes, VLE, LLE, boiling point diagram.(Text Book 2)

**Unit-V:**

Introduction to mechanical operations: Size reduction, filtration, basic differences between agitation and mixing.

Types of reactions and reactors.

Introduction to environmental pollution: types and their effect.

Safety in chemical process industries (case study on DDT, environmental hazards of a green project)(Text Book 1&2)

**TEXT BOOK:**

1. Introduction to chemical engineering by S. Pushpavanam, PHI, 2012.
2. Introduction to chemical engineering by S. K. Ghosal, S. K. Sanyal and S. Dutta, TMH publications, 1993.

**REFERENCE:**

1. Unit operations in chemical engineering by W.L. McCabe and J.C. Smith and Peter Harriott, McGraw Hill5th ed. 1993.

**I- Year B.Tech. II-Sem**

| | L | T | P | C |
|---|---|---|---|---|
| | **2** | **0** | **0** | **2** |

## Communicative English 1

**Introduction**

The course is designed to train students in receptive (listening and reading) as well as productive and interactive (speaking and writing) skills by incorporating a comprehensive, coherent and integrated approach that improves the learners' ability to effectively use English language in academic/ workplace contexts. The shift is from *learning about the language* to *using the language*. On successful completion of the compulsory English language course/s in B.Tech., learners would be confident of appearing for international language qualification/proficiency tests such as IELTS, TOEFL, or BEC, besides being able to express themselves clearly in speech and competently handle the writing tasks and verbal ability component of campus placement tests. Activity based teaching-learning methods would be adopted to ensure that learners would engage in actual use of language both in the classroom and laboratory sessions.

| COURSE OBJECTIVES | |
|---|---|
| The students will be able to | |
| 1 | Facilitate effective listening skills for better comprehension of academic lectures and English spoken by native speakers |
| 2 | Focus on appropriate reading strategies for comprehension of various academic texts and authentic materials |
| 3 | Help improve speaking skills through participation in activities such as role plays, discussions and structured talks/oral presentations |
| 4 | Impart effective strategies for good writing and demonstrate the same in summarizing, writing well organized essays, record and report useful information |
| 5 | Provide knowledge of grammatical structures and vocabulary and encourage their appropriate use in speech and writing |

**Unit 1**

**Lesson: On the Conduct of Life: William Hazlitt**

**Listening:** Identifying the topic, the context and specific pieces of information by listening to short audio texts and answering a series of questions. **Speaking:** Asking and answering general questions on familiar topics such as home, family, work, studies and interests; introducing oneself and others. **Reading:** Skimming to get the main idea of a text; scanning to look for specific pieces of information. **Reading for Writing :**Beginnings and endings of paragraphs - introducing the topic, summarizing the main idea and/or providing a transition to the next paragraph. **Grammar and Vocabulary:** Content words and function words; word forms: verbs, nouns, adjectives and adverbs; nouns: countable and uncountable; singular and plural; basic sentence structures; simple question form - wh-questions; word order in sentences.

**Learning Outcomes**

At the end of the module, the learners will be able to

- understand social or transactional dialogues spoken by native speakers of English and identify the context, topic, and pieces of specific information
- ask and answer general questions on familiar topics and introduce oneself/others
- employ suitable strategies for skimming and scanning to get the general idea of a text and locate specific information

- recognize paragraph structure and be able to match beginnings/endings/headings with paragraphs
- form sentences using proper grammatical structures and correct word forms

**Unit 2**

**Lesson: The Brook: Alfred Tennyson**

**Listening:** Answering a series of questions about main idea and supporting ideas after listening to audio texts. **Speaking:** Discussion in pairs/small groups on specific topics followed by short structured talks. **Reading:** Identifying sequence of ideas; recognizing verbal techniques that help to link the ideas in a paragraph together. **Writing:** Paragraph writing (specific topics) using suitable cohesive devices; mechanics of writing - punctuation, capital letters. **Grammar and Vocabulary:** Cohesive devices - linkers, sign posts and transition signals; use of articles and zero article; prepositions.

**Learning Outcomes**

At the end of the module, the learners will be able to

- comprehend short talks on general topics
- participate in informal discussions and speak clearly on a specific topic using suitable discourse markers
- understand the use of cohesive devices for better reading comprehension
- write well structured paragraphs on specific topics
- identify basic errors of grammar/ usage and make necessary corrections in short texts

**Unit 3**

**Lesson: The Death Trap: Saki**

**Listening:** Listening for global comprehension and summarizing what is listened to. **Speaking:** Discussing specific topics in pairs or small groups and reporting what is discussed **Reading:** Reading a text in detail by making basic inferences -recognizing and interpreting specific context clues; strategies to use text clues for comprehension. **Writing:** Summarizing - identifying main idea/s and rephrasing what is read; avoiding redundancies and repetitions. **Grammar and Vocabulary:** Verbs - tenses; subject-verb agreement; direct and indirect speech, reporting verbs for academic purposes.

**Learning Outcomes**

At the end of the module, the learners will be able to

- comprehend short talks and summarize the content with clarity and precision
- participate in informal discussions and report what is discussed
- infer meanings of unfamiliar words using contextual clues
- write summaries based on global comprehension of reading/listening texts
- use correct tense forms, appropriate structures and a range of reporting verbs in speech and writing

**Unit4**

**Lesson: Innovation: Muhammad Yunus**

**Listening:** Making predictions while listening to conversations/ transactional dialogues without video; listening with video. **Speaking:** Role plays for practice of conversational English in academic contexts (formal and informal) - asking for and giving information/directions. **Reading:** Studying the use of graphic elements in texts to convey information, reveal trends/patterns/relationships, communicate processes or display complicated data. **Writing:** Information transfer; describe, compare, contrast, identify significance/trends based on information provided in figures/charts/graphs/tables. **Grammar and Vocabulary:** Quantifying expressions - adjectives and adverbs; comparing and contrasting; degrees of comparison; use of antonyms

**Learning Outcomes**

At the end of the module, the learners will be able to

- ➢ infer and predict about content of spoken discourse
- ➢ understand verbal and non-verbal features of communication and hold formal/informal conversations
- ➢ interpret graphic elements used in academic texts
- ➢ produce a coherent paragraph interpreting a figure/graph/chart/table
- ➢ use language appropriate for description and interpretation of graphical elements

**Unit 5**

**Lesson: Politics and the English Language: George Orwell**

**Listening:** Identifying key terms, understanding concepts and answering a series of relevant questions that test comprehension. **Speaking:** Formal oral presentations on topics from academic contexts - without the use of PPT slides. **Reading:** Reading for comprehension. **Writing:** Writing structured essays on specific topics using suitable claims and evidences. **Grammar and Vocabulary:** Editing short texts –identifying and correcting common errors in grammar and usage (articles, prepositions, tenses, subject verb agreement)

**Learning Outcomes**

At the end of the module, the learners will be able to

- ➢ take notes while listening to a talk/lecture and make use of them to answer questions
- ➢ make formal oral presentations using effective strategies
- ➢ comprehend, discuss and respond to academic texts orally and in writing
- ➢ produce a well-organized essay with adequate support and detail
- ➢ edit short texts by correcting common errors

**Prescribed Text:**

**Language and Life: A Skills Approach- I Edition 2019, Orient Black Swan**

**Reference Books**


- Bailey, Stephen. *Academic writing: A handbook for international students*. Routledge, 2014.
- Chase, Becky Tarver. *Pathways: Listening, Speaking and Critical Thinking*. Heinley ELT; 2nd Edition, 2018.
- Skillful Level 2 Reading & Writing Student's Book Pack (B1) Macmillan Educational.
- Hewings, Martin. *Cambridge Academic English (B2)*. CUP, 2012.
- Oxford Learners Dictionary, 12th Edition, 2011


| COURSE OUTCOMES | |
|---|---|
| At the end of this course the student will be able to | |
| CO1 | Understand the context, topic, and pieces of specific information from social or transactional dialogues spoken by native speakers of English |
| CO2 | Apply grammatical structures to formulate sentences and correct word forms |
| CO3 | Analyze discourse markers to speak clearly on a specific topic in informal discussions |
| CO4 | Evaluate reading/listening texts and to write summaries based on global comprehension of these texts. |
| CO5 | Create a coherent paragraph interpreting a figure/graph/chart/table |

**Mapping between Course Outcomes and Programme Outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |

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| **I- Year B.Tech. II-Sem** | **3** | **1** | **0** | **4** |

**Differential Equations and Vector Calculus**

| COURSE OBJECTIVES | |
|---|---|
| 1 | To enlighten the learners in the concept of differential equations and multivariable calculus |
| 2 | To furnish the learners with basic concepts and techniques at plus two level to lead them into advanced level by handling various real world applications |

**UNIT 1: Linear differential equations of higher order**
Definitions, complete solution, operator D, rules for finding complimentary function, inverse operator, rules for finding particular integral, method of variation of parameters.

**Learning Outcomes:**
At the end of this unit, the student will be able to
- Identify the essential characteristics of linear differential equations with constant Coefficients
- Solve the linear differential equations with constant coefficients by appropriate method

**UNIT 2: Equations reducible to Linear Differential Equations**
Cauchy's and Legendre's linear equations, simultaneous linear equations with constant coefficients, Applications to L-C-R Circuit problems and Mass spring system.

**Learning Outcomes:**
At the end of this unit, the student will be able to
- Classify and interpret the solutions of linear differential equations
- Formulate and solve the higher order differential equation by analyzing physical situations

**UNIT 3: Partial Differential Equations** First order partial differential equations, solutions of first order linear and non-linear PDEs.
Solutions to homogenous and non-homogenous higher order linear partial differential equations.
**Learning Outcomes:**
At the end of this unit, the student will be able to
- apply a range of techniques to find solutions of standard PDEs
- outline the basic properties of standard PDEs

**UNIT4: Vector differentiation**
Scalar and vector point functions, vector operator del, del applies to scalar point functions-Gradient, del applied to vector point functions-Divergence and Curl, vector identities.

**Learning Outcomes:**
At the end of this unit, the student will be able to

- apply del to Scalar and vector point functions
- illustrate the physical interpretation of Gradient, Divergence and Curl

**UNIT 5: Vector integration**
Line integral-circulation-work done, surface integral-flux, Green's theorem in the plane (without proof), Stoke's theorem (without proof), volume integral, Divergence theorem (without proof) and applications of these theorems.

**Learning Outcomes:**
At the end of this unit, the student will be able to

- find the work done in moving a particle along the path over a force field
- evaluate the rates of fluid flow along and across curves
- apply Green's, Stokes and Divergence theorem in evaluation of double and triple integrals.

| **COURSE OUTCOMES** | |
|---|---|
| At the end of this course the student will be able to | |
| .CO1 | Solve the differential equations related to various engineering fields |
| CO2 | Identify solution methods for partial differential equations that model physical processes |
| CO3 | Interpret the physical meaning of different operators such as gradient, curl and divergence |
| CO4 | Estimate the work done against a field, circulation and flux using vector calculus |

**Text Books:**
1. Erwin Kreyszig, Advanced Engineering Mathematics, 10/e, John Wiley & Sons, 2011.
2. B.S. Grewal, Higher Engineering Mathematics, 44/e, Khanna publishers, 2017.

**Reference Books:**
1. Dennis G. Zill and Warren S. Wright, Advanced Engineering Mathematics, Jones and Bartlett, 2011.
2. Michael Greenberg, Advanced Engineering Mathematics, 2/e, Pearson, 2018
3. George B.Thomas, Maurice D. Weir and Joel Hass, Thomas Calculus, 13/e, Pearson Publishers, 2013.
4. R.K.Jain and S.R.K.Iyengar, Advanced Engineering Mathematics, 3/e, Alpha Science International Ltd., 2002.
5. Glyn James, Advanced Modern Engineering Mathematics, 4/e, Pearson publishers, 2011.
6. Micheael Greenberg, Advanced Engineering Mathematics, 9th edition, Pearson edn
7. Dean G. Duffy, Advanced engineering mathematics with MATLAB, CRC Press
8. Peter O'neil, Advanced Engineering Mathematics, Cengage Learning.
9. R.L. Garg Nishu Gupta, Engineering Mathematics Volumes-I &II, Pearson Education
10. B. V. Ramana, Higher Engineering Mathematics, Mc Graw Hill Education.
11. H. k Das, Er. Rajnish Verma, Higher Engineering Mathematics, S. Chand.
12. N. Bali, M. Goyal, C. Watkins, Advanced Engineering Mathematics, Infinity Science Press.

**Mapping between Course Outcomes and Programme Outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |

**JNTUA COLLEGE OF ENGINEERING (Autonomous) :: ANANTAPURAMU**
**DEPARTMENT OF CHEMICAL ENGINEERING**

| I- Year B.Tech. II-Sem | L | T | P | C |
|---|---|---|---|---|
| | 3 | 0 | 0 | 3 |

**Engineering Physics**

| COURSE OBJECTIVES | |
|---|---|
| 1 | To make a bridge between the physics in school and engineering courses. |
| 2 | To understand the concepts of mechanics and employ the applications of oscillations to engineering fields. |
| 3 | To familiarize the basic ideas of acoustics and ultrasonic's with their Engineering applications. |
| 4 | The mechanisms of emission of light, achieving amplification of electromagnetic radiation through stimulated emission, study of propagation of light through transparent dielectric waveguides along with engineering applications. |
| 5 | To evoke interest on applications of superposition effects like interference, diffraction and polarization in engineering. |
| 6. | To open new avenues of knowledge in dielectric and magnetic materials which find potential in the emerging micro device applications. Considering the significance of micro miniaturization of electronic devices and significance of low dimensional materials, the basic concepts of nano materials, their properties and applications in modern emerging technologies are elicited. |

**Unit-1: Introduction to Mechanics and Oscillations**

**Introduction to Mechanics and Oscillations**-Basic laws of vectors and scalars-Rotational frames-Conservative forces – F = - grad V, torque and angular momentum – Simple harmonic oscillators-Damped harmonic oscillator-Heavy, critical and under damping- Energy decay in damped harmonic oscillator- Forced oscillations – Resonance.

**Unit-II: Acoustics and Ultrasonics**

**Acoustics**: Introduction to acoustics – Reverberation – Reverberation time– Sabine's formula- Derivation using growth and decay method – Absorption coefficient and its determination –Factors affecting acoustics of buildings and their remedies.

**Ultrasonics:** Introduction, Properties and Production by magnetostriction & piezoelectric methods - acoustic grating -Non Destructive Testing – pulse echo system through transmission and reflection modes - A,B and C – scan displays, Medical applications

**Unit-III: Lasers and Fiber optics**

**Lasers:** Introduction – Characteristics of laser – Spontaneous and stimulated emission of radiation – Einstein's coefficients – Population inversion – Pumping mechanisms – Nd:YAG laser – He-Ne laser – Applications of lasers.

**Fiber optics-** Introduction to Optical Fibers-Total Internal Reflection-Critical angle of propagation-Acceptance Angle-Numerical Aperture-Classification of fibers based on refractive index profile –Propagation of electromagnetic wave through optical fibers – Modes -Importance of V-number-Fiber optic sensors (Pressure/temperature/chemical change)

**Unit-IV: Wave Optics**

**Interference**-Principle of superposition –Interference of light – Conditions for sustained interference-interference in thin films-Colors in thin films-Newton's Rings-Determination of wavelength and refractive index.

**Diffraction**-Introduction-Fresnel and Fraunhofer diffraction-Fraunhofer diffraction due to single slit and double slit – Diffraction grating- Grating spectra.

**Polarization**-Polarization by double refraction-Nicol's Prism--Half wave and Quarter wave plates- Engineering applications of Polarization.

**UNIT V: Engineering Materials**

**Dielectric Materials:** Introduction-Dielectric polarization- Dielectric constant- Types of polarizations: Electronic and Ionic, Orientation Polarizations (Qualitative) - Lorentz (Internal) field- Clausius- Mossotti equation-Applications of Dielectrics: Ferroelectricity and Piezoelectricity.

**Magnetic Materials:** Introduction-Magnetic dipole moment-Magnetization-Magnetic susceptibility and permeability-Origin of permanent magnetic moment -Classification of Magnetic materials- Hysteresis - Soft and hard magnetic materials-Applications.

**Nanomaterials**: Introduction – Surface area and quantum confinement –Physical properties: electrical and magnetic properties- Synthesis of nanomaterials: Top-down: Ball Milling, Bottom-up: Chemical Vapour Deposition – Applications of nanomaterials.

| **COURSE OUTCOMES** | |
|---|---|
| After studying this course, the student will be able to: | |
| CO1 | Understand the basics of mechanics and types of oscillations. |
| CO2 | Explain sound propagation in buildings, acoustic properties of typically used materials in buildings and the use of ultrasonics. |
| CO3 | Apply the different realms of physics in both scientific and technological systems through the study of lasers and fiber optics. |
| CO4 | Analyze different physical phenomena of optics like interference, diffraction and polarization. |

| | |
|---|---|
| CO5 | Compare the properties of dielectric, magnetic and nano materials along with their engineering applications. |

**Prescribed Text books:**

1. Engineering Physics – Dr. M.N. Avadhanulu & Dr. P.G. Kshirsagar, S. Chand and Company

2. Engineering physics – D.K. Battacharya and Poonam Tandon, Oxford University press.

**Reference Books:**

1. Introduction to modern optics – Grant R Fowles
2. A text book on Optics – Brijlal & Subramanyam
3. Laser Fundamentals – William T. Silfvast, Cambridge University Press
4. Fundamentals of Physics – Halliday, Resnick and Walker, John Wiley &Sons
5. Introduction to Nanotechnology – C P Poole and F J Owens, Wiley
6. Hand Book of Non-destructive evaluation, C.J.Hellier, McGraw-Hill
7. Engineering Physics – K.Thyagarajan, MacGraw Hill Publishers
8. Engineering Physics – M.R.Srinivasan, New Age Publications
9. Engineering Physics – D K Pandey, S. Chaturvedi, Cengage Learning
10. Engineering Physics - Sanjay D. Jain, D. Sahasrambudhe and Girish, University Press
11. Engineering Physics – M. Arumugam, Anuradha Publications

Method of Evaluation:

**Please mention if it is apart from the regular practice**

Data Books Required: Nil

**Mapping between Course Outcomes and Programme Outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |

**JNTUA COLLEGE OF ENGINEERING (Autonomous) :: ANANTAPURAMU**
**DEPARTMENT OF CHEMICAL ENGINEERING**

**I- Year B.Tech. II-Sem**

| | L | T | P | C |
|---|---|---|---|---|
| | 2 | 0 | 0 | 2 |

## Strength of Materials

Unit I

Concept of mechanics of deformable bodies- behavior of mild steel under tension-stress and strain - elastic constants and their relationships, equivalent modulus-factor of safety-principal planes and principal stresses (two dimensional), Mohr's circle representation.

Unit II

Bending moment and shear force diagrams for contilever, simply supported and over hanging beams- bending of beams: theory of simple bending-meutral axis stress distribution across section due to bending moment and shear force-thin cylindrical shells

Unit III

Deflection of beams: equation of deflection curve-slope and deflection by double integration method-moment area method-Macaulay method

Unit IV

Torsion: torsion of solid and hollow circular shafts-combined bending and torsion-springs: leaf springs-closed and open coiled helical springs

Unit V

Columns: theory of columns-combined bending and direct stresses-concept of structural stability-long columns: Euler's theory of buckling, load-Rankine-Gardon formula-Johnson's formula

**Text Books:**

B.K Bansal, strength of Materials, Lakshmi Publications House Pvt.Ltd

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**DEPARTMENT OF CHEMICAL ENGINEERING**
**I- Year B.Tech. II-Sem**

| | L | T | P | C |
|---|---|---|---|---|
| | 3 | 0 | 0 | 3 |

## Engineering Mechanics

***OBJECTIVE:*** *This course will serve as a basic course by introducing the concepts of basic mechanics which will help as a foundation to various courses.*

**UNIT – I**

**INTRODUCTION OF ENGINEERING MECHANICS –** Basic concepts - System of Forces – Moment of Forces and its Application – Couples and Resultant of Force System – Equilibrium of System of Forces - Degrees of Freedom – Free body diagrams –Types of Supports – Support reactions for beams with different types of loading – concentrated, uniformly distributed and uniformly varying loading.

**UNIT – II**

**FRICTION :** Types of friction– laws of Friction – Limiting friction- Cone of limiting friction– static and Dynamic Frictions – Motion of bodies – Wedge, Screw jack and differential Screw jack.

**UNIT – III**

**CENTROID AND CENTER OF GRAVITY:** Centroids of simple figures – Centroids of Composite figures – Centre of Gravity of bodies – Area moment of Inertia - Parallel axis and perpendicular axis theorems - Moments of Inertia of Composite Figures.

**MASS MOMENT OF INERTIA:** Moment of Inertia of Simple solids – Moment of Inertia of composite masses.( Simple problems only)

**UNIT – IV**

**KINEMATICS:** Rectilinear and Curvilinear motion – Velocity and Acceleration – Motion of A Rigid Body – Types and their Analysis in Planar Motion.

**KINETICS :** Analysis as a particle and Analysis as a Rigid Body in Translation – Central Forces of motion – Equations of Plane Motion – Fixed Axis Rotation – Rolling Bodies – Work Energy Method – Equation for Translation – Work Energy application to Particle Motion, Connection System – Fixed axis Rotation and Plane Motion.

**UNIT – V**

**ANALYSIS OF PERFECT FRAMES:** Types of frames – cantilever frames and simply supported frames – Analysis of frames using method of joints, method of sections and tension coefficient method for vertical loads, horizontal loads and inclined loads.

**MECHANICAL VIBRATIONS:** Definitions, Concepts-Simple Harmonic motion-Free vibrations-Simple Compound and Torsional pendulum- Numerical problems

**TEXT BOOKS**:

(1) Engineering Mechanics by Dr.R.K.Bansal, Lakshmi Publications.
(2) Engineering Mechanics by Shames & Rao – Pearson Education.
(3) Engineering Mechanics by Bhavakatti, New age pubilishers

**REFERENCES:**

(1) Engineering Mechanics by Seshigiri Rao, Universities Press, Hyderabad.
(2) Engineering Mechanics – B. Bhattacharyya, Oxford University Publications.

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**DEPARTMENT OF CHEMICAL ENGINEERING**

| | L | T | P | C |
|---|---|---|---|---|
| **I- Year B.Tech. II-Sem** | **2** | **0** | **0** | **2** |

**Material Science for Chemical Engineers**

**Pre-requisites:** None

**Course Outcomes:** At the end of the course, the student will be able to:

| | |
|---|---|
| CO1 | Identify various crystal systems. |
| CO2 | Calculate parameters for simple crystal structures predict the behavior of crystal systems due to imperfections. |
| CO3 | Predict the properties of simple alloys and steels based on their phase diagrams, phase transitions and heat treatment. |

| | |
|---|---|
| CO4 | Describe the mechanical behavior, failure and strengthening mechanisms of various metals, alloys and plastics. |
| CO5 | Identify various types of corrosion, illustrate methods to mitigate corrosion and select suitable material for various chemical processes. |
| CO6 | Proper selection of materials for designing various equipments in a chemical industry |

**Course Articulation Matrix**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | - | - | - | 2 | - | - | - | 3 | - | - | 3 |
| CO2 | 3 | - | 3 | - | 2 | - | - | - | 3 | - | - | 3 |
| CO3 | 3 | - | - | - | 2 | 3 | 3 | 3 | 3 | - | - | 3 |
| CO4 | 3 | 3 | 3 | - | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CO5 | 3 | 3 | 3 | - | - | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CO6 | 3 | 3 | 3 | - | - | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

**Objective:** This course will help students to learn about the relationship between structure and properties of materials, application of various classes of materials including metals, ceramics, polymers.

**Detailed Syllabus:**

**UNIT- I**

**Introduction**: Engineering Materials – Classification – levels of structure.

**Crystal Geometry and Structure Determination**: Space lattice and Unit cell. Bravais lattices, crystal systems with examples. Lattice coordinates, Miller indices, Bravais indices for directions and places: crystalline and non crystalline solids; ionic, covalent and metallic solids; packing efficiency, coordination number; structure determination by Bragg's X-ray diffraction and powder methods.

**UNIT -II**

**Crystal Imperfection**: Point defects, line defects-edge and screw dislocation, Berger's circuit and Berger's vectors, dislocation reaction, dislocation motion, multiplication of dislocations during deformation , role of dislocation on crystal properties; surface defects, dislocation density and stress required to move dislocations.

**UNIT -III**

**Basic thermodynamic functions**: phase diagrams and phase transformation: Primary and binary systems-general types with examples; tie line& lever rule, non equilibrium cooling: phase diagrams of Fe-$Fe_3$-C, Pb-Sn, Cu-Ni systems.

Phase transformations in Fe-$Fe_3$-C steels, Time-Temperature-Transformation (TTT) curves for eutectoid steels and plain carbon steels; effect of alloying elements on properties of steels; types of steels, alloys and other metals used in chemical industry.

**UNIT -IV**

Elastic, an elastic and plastic deformations in solid materials; rubber like elasticity, visco elastic behavior (models); shear strength of real and perfect crystals, work hardening mechanisms, cold working, hot working; dynamic recovery, recrystallization, grain growth, grain size and yield stress, Brief description of heat treatment in steels.

**Magnetic materials**: Terminology and classification, magnetic moments due to electron spin, ferro-magnetism and related phenomena, domain structure, hysteresis loop, soft and hard magnetic materials.

**UNIT- V**

**Fracture in ductile and brittle materials, creep**: mechanism of creep and methods to reduce creeping in materials, creep rates and relations. Fatigue-mechanisms and methods to improve fatigue resistance in materials. Composite materials: types; stress-strain relations in composite materials, applications.

**Oxidation and Corrosion**: Mechanisms of oxidation, oxidation resistant materials, principles and types of corrosion, protection against corrosion.

**TEXT BOOK:**

1. Materials Science and Engineering, 5th ed. V. Raghavan, PHI Learning Pvt. Ltd., New Delhi, 2009.

**REFERENCES:**

1. Elements of Materials Science, L.R. Van Vlack,
2. Science of Engineering Materials, vols. 1&2, Manas Chanda, McMillan Company of India Ltd.

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**DEPARTMENT OF CHEMICAL ENGINEERING**

| | L | T | P | C |
|---|---|---|---|---|
| **I- Year B.Tech. II-Sem** | **0** | **0** | **2** | **1** |

**CHEMICAL ENGINEERING WORKSHOP**

Objective: To get primary understanding on chemical process equipment and instrumentation for the measurement of various process parameters

1. Flow meters: rota meter, venturi meter, orifice meter
2. Thermocouple
3. pH, conductivity and dissolved oxygen
4. gas Chromatography
5. spectrophotometer (UV-VIS)
6. X-Ray Diffractometer
7. Heat exchanger
8. Dryer
9. Distillation
10. PID Controller (Level/Flow control)

**TEXT BOOK:**

1. Introduction to chemical engineering by S. Pushpavanam, PHI, 2012.
2. Introduction to chemical engineering by S. K. Ghosal, S. K. Sanyal and S. Dutta, TMH publications, 1993.

**REFERENCE:**

1. Unit operations in chemical engineering by W.L. McCabe and J.C. Smith and Peter Harriott, McGraw Hill5th ed. 1993.

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**DEPARTMENT OF CHEMICAL ENGINEERING**

**I- Year B.Tech. II-Sem**

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 2 | 1 |

**COMMUNICATIVE ENGLISH LABORATORY-1**

| COURSE OBJECTIVES | |
|---|---|
| 1 | Students will be exposed to a variety of self-instructional, learner friendly modes of language learning |
| 2 | Students will cultivate the habit of reading passages from the computer monitor. Thus providing them with the required facility to face computer based competitive exams like GRE, TOEFL, and GMAT etc. |
| 3 | Students will learn better pronunciation through stress, intonation and rhythm |
| 4 | Students will be trained to use language effectively to face interviews, group discussions, public speaking |
| 5 | Students will be initiated into greater use of the computer in resume preparation, report writing, format making etc |

**Unit 1**

1. Phonetics for listening comprehension of various accents
2. Reading comprehension
3. Describing objects/places/persons

**Learning Outcomes**

At the end of the module, the learners will be able to

- understand different accents spoken by native speakers of English
- employ suitable strategies for skimming and scanning on monitor to get the general idea of a text and locate specific information
- learn different professional registers and specific vocabulary to describe different persons, places and objects

**Unit 2**

1. JAM
2. Small talks on general topics
3. Debates

**Learning Outcomes**

At the end of the module, the learners will be able to

- produce a structured talk extemporarily
- comprehend and produce short talks on general topics
- participate in debates and speak clearly on a specific topic using suitable discourse markers

**Unit 3**

1. Situational dialogues – Greeting and Introduction
2. Summarizing and Note making
3. Vocabulary Building

**Learning Outcomes**

At the end of the module, the learners will be able to

- Learn different ways of greeting and introducing oneself/others
- summarize the content with clarity and precision and take notes while listening to a talk/lecture and make use of them to answer questions
- replenish vocabulary with one word substitutes, homonyms, homophones, homographs to reduce errors in speech and writing

**Unit4**

1. Asking for Information and Giving Directions
2. Information Transfer
3. Non-verbal Communication – Dumb Charade

**Learning Outcomes**

At the end of the module, the learners will be able to

- Learn different ways of asking information and giving directions
- Able to transfer information effectively
- understand non-verbal features of communication

**Unit 5**

1. Oral Presentations
2. Précis Writing and Paraphrasing
3. Reading Comprehension and spotting errors

**Learning Outcomes**

At the end of the module, the learners will be able to

- make formal oral presentations using effective strategies
- learn different techniques of précis writing and paraphrasing strategies

➢ comprehend while reading different texts and edit short texts by correcting common errors

**Suggested Software**

- Young India Films
- Walden Infotech
- Orell

| COURSE OUTCOMES | |
|---|---|
| At the end of this course the student will be able to | |
| CO1 | Remember and understand the different aspects of the English language proficiency with emphasis on LSRW skills |
| CO2 | Apply communication skills through various language learning activities |
| CO3 | Analyze the English speech sounds, stress, rhythm, intonation and syllable division for better listening and speaking comprehension |
| CO4 | Evaluate and exhibit acceptable etiquette essential in social and professional settings |
| CO5 | Create awareness on mother tongue influence and neutralize it in order to improve fluency in spoken English |

**Reference Books**

- Bailey, Stephen. *Academic writing: A handbook for international students*. Routledge, 2014.
- Chase, Becky Tarver. *Pathways: Listening, Speaking and Critical Thinking*. Heinley ELT; 2nd Edition, 2018.
- Skillful Level 2 Reading & Writing Student's Book Pack (B1) Macmillan Educational.
- A Textbook of English Phonetics for Indian Students by T.Balasubramanyam

**Mapping of Course outcomes with Program outcomes:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |

**JNTUA COLLEGE OF ENGINEERING (Autonomous) :: ANANTAPURAMU DEPARTMENT OF CHEMICAL ENGINEERING**

| **I- Year B.Tech. II-Sem** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|
| | **0** | **0** | **3** | **1.5** |

**ENGINEERING PHYSICS LAB**

| COURSE OBJECTIVES | |
|---|---|
| 1 | The Objective of this course is to make the students gain practical knowledge to co-relate with the theoretical studies. |
| 2 | To develop practical applications of engineering materials and use of principle in the right way to implement the modern technology. |

| | |
|---|---|
| 3 | To train engineering students on basis of measurements and the instruments |
| 4 | To equip the students with practical knowledge in electronic and optics experiments |

**LIST OF EXPERIMENTS**

**Any TEN of the following experiments has to be performed during the SEMESTER**

1. Laser: Determination of wavelength using diffraction grating.
2. Laser: Determination of Particle size.
3. Determination of spring constant of springs using Coupled Oscillator
4. Determination of ultrasonic velocity in liquid (Acoustic grating)
5. Determination of dielectric constant and Curie temperature of a ferroelectric material.
6. B-H curve
7. Stewart-Gee's Method
8. Rigidity modulus of material of a wire-dynamic method (Torsional pendulum)
9. Determination of numerical aperture of an optical fiber.
10. Determination of thickness of thin object by wedge method.
11. Determination of radius of curvature of lens by Newton's rings.
12. Determination of wavelengths of various colours of mercury spectrum using diffraction grating in normal incidence method.
13. Determination of dispersive power of the prism
14. Sonometer: Verification of the three laws of stretched strings
15. Meldes experiment: Determination of the frequency of tuning fork

Note: Out of 10 experiments, two experiments will be performed using virtual laboratory.

Data Books Required: Nil

| COURSE OUTCOMES | |
|---|---|
| At the end of this course the student will be able to | |
| CO1 | On Completion of this course, students are able to –<br>Develop skills to impart practical knowledge in real time solution. |
| CO2 | Understand principle, concept, working and application of new technology and comparison of results with theoretical calculations. |
| CO3 | Understand measurement technology, usage of new instruments and real time applications in engineering studies. |
| CO4 | The student will be able to analyze the physical principle involved in the various instruments, also relate the principle to new application. |
| CO5 | The various experiments in the areas of optics, mechanics and thermal physics will nurture the students in all branches of Engineering. |

**Mapping between Course Outcomes and Programme Outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |

## II year –1st Semester

| | | | | |
|---|---|---|---|---|
| **19A20601** | **1. COMPLEX VARIABLES, TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS** | **BSC** | **2-1-0** | **3 Credits** |

**Course Objective:**

This course aims at providing the student to acquire the knowledge on the calculus of functions of complex variables. The aim is to analyze the solutions of partial differential equations.

**Unit-I: Complex Variable – Differentiation**:

Introduction to functions of complex variable-concept of Limit & continuity- Differentiation, Cauchy-Riemann equations, analytic functions (exponential, trigonometric, logarithm), harmonic functions, finding harmonic conjugate-construction of analytic function by Milne Thomson method-Conformal mappings-standard and special transformations (sin z, $e^z$, cos z, $z^2$) Mobius transformations (bilinear) and their properties.

**Learning Outcomes:**

Students will be able to

1. understand functions of Complex variable and its properties.
2. find derivatives of complex functions.
3. understand the analyticity of complex functions .
4. understand the conformal mappings of complex functions.

**Unit-II: Complex Variable – Integration**:

Line integral-Contour integration, Cauchy's integral theorem, Cauchy Integral formula, Liouville's theorem (without proof) and Maximum-Modulus theorem (without proof);power series expansions: Taylor's series, zeros of analytic functions, singularities, Laurent's series; Residues, Cauchy Residue theorem (without proof), Evaluation of definite integral involving sine and cosine, Evaluation of certain improper integrals (around unit circle, semi circle with f(z) not having poles on real axis).

**Learning Outcomes:**

Students will be able to

1. understand the integration of complex functions.
2. apply Cauchy's integral theorem and Cauchy's integral formula.
3. understand singularities of complex functions.
4. evaluate improper integrals of complex functions using Residue theorem.

**Unit-III: Laplace Transforms**

Definition-Laplace transform of standard functions-existence of Laplace Transform – Inverse transform – First shifting Theorem, transforms of derivatives and integrals – Unit step function – Second shifting theorem – Dirac's delta function – Convolution theorem – Laplace transform of Periodic function. Differentiation and integration of transform – solving Initial value problems to ordinary differential equations with constant coefficients using Laplace transforms.

**Learning Outcomes:**

Students will be able to

1. understand the concept of Laplace transforms and find the Laplace transforms of elementary functions.
2. find the Laplace transforms of general functions using its properties.
3. understand Laplace transforms of special functions (Unit step function, Unit Impulse & Periodic).
4. apply Laplace transforms to solve Differential Equations.

**Unit-IV: Fourier series**

Determination of Fourier coefficients (Euler's) – Dirichlet conditions for the existence of Fourier series – functions having discontinuity-Fourier series of Even and odd functions – Fourier series in an arbitrary interval – Half-range Fourier sine and cosine expansions- typical wave forms - Parseval's formula- Complex form of Fourier series.

**Learning Outcomes:**

Students will be able to

1. understand finding Fourier series expression of the given function.
2. determine Fourier coefficients (Euler's) and identify existence of fourier series of the given function.
3. expand the given function in Fourier series given in Half range interval.
4. apply Fourier series to establish Identities among Euler coefficients.
5. find Fourier series of wave forms.

**Unit-V: Partial Differential Equations & Applications**

Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions – Solution of first order PDEs by Lagrange's method- Solution of nonlinear PDEs (Standard forms)-Solution of second order PDEs by Method of separation of variables – Solutions of one-dimensional wave equation, one dimensional heat equation under initial and boundary conditions.

**Learning Outcomes:**

At the end of this unit, the students will be able to

1. form Partial Differential Equations.
2. solve Partial Differential Equations of first order.
3. understand the method of separation of variables.
4. solve applications of Partial Differential Equations.

Text Books:

1. Higher Engineering Mathematics, B.S.Grewal, Khanna publishers.
2. Advanced Engineering Mathematics, by Erwin Kreyszig, Wiley India

Reference Books:

1. Higher Engineering Mathematics, by B.V.Ramana, Mc Graw Hill publishers.
2. Advanced Engineering Mathematics, by Alan Jeffrey, Elsevier.

**Course Outcomes:**

After the completion of course, students will be able to

1. understand the analyticity of complex functions and conformal mappings.
2. apply Cauchy's integral formula and Cauchy's integral theorem to evaluate improper integrals along contours.
3. understand the usage of Laplace Transforms.

4. evaluate the Fourier series expansion of periodic functions.
5. formulate/solve/classify the solutions of Partial differential equations and also find the solution of one-dimensional wave equation and heat equation.

**II year –1st Semester**

| | | | | |
|---|---|---|---|---|
| **19A20701** | **2. ORGANIC CHEMISTRY** | **BSC** | **3-0-0** | **3 Credits** |

**COURSE OBJECTIVES:**

This course aims to provide the student to

- Understand the Mechanism of organic chemical reaction is essential to synthesis new organic compounds in drug and pharmaceutical industries. In order to study their kinetics of reactions to regulate the process for optimization of production of drugs and pharmaceutical, the principles of organic chemistry are essential.
- Carry out industrial processes for the manufacture of drugs and pharmaceuticals, Comprehension on basic reactions, reagents and their applications.
- Explain the electronic behavior of organic molecules, their special and geometrical arrangement of functional groups.
- Conduct the most common reactions like addition, substitution, oxidation, reduction etc., on large scale.

**COURSE OUTCOMES:**

**After completion of the course student shall be able to**

- Analyze the mechanism of organic chemical reaction which are essential to synthesis new organic compounds in drug and pharmaceutical industries

- Acquire the knowledge on chemical processes industrially for the manufacture of drugs, pharmaceuticals and understand the basic reactions, reagents and their applications.
- Illustrate the electronic behaviour of organic molecules, their special and geometrical arrangement of functional groups.
- Explain the reaction mechanisms for different types of reactions.
- Identify the most common reactions like addition, substitution, oxidation, reduction etc., on large scale.

**UNIT I:** Polar effects – Inductive effect, electromeric effect, resonance, hyper conjugation, steric hindrance, and aromaticity – examples. (9h)

**UNIT II:** Electrophilic reactions: a) Friedel-Craft reaction b) Riemer- Teimenn Reaction c) Backmann rearrangement. Nucleophillic reactions : a) Aldol condensation b) Perkin Reaction c) Benzoin condensation.(10h)

**UNIT – III:** Stereo isomerism; Optical isomerism; Symmetry and chirality; Optical isomerism in lactic acid and tartaric acid; Sequence rules; Enantiomers, diastereomers; Geometrical Isomerism; E-Z system of nomenclature, conformational analysis of ethane and Cyclohexane. (12h)

**UNIT.IV:** Some Reagents of Synthetic importance: Preparation and applications of Aluminum Chloride, N-Bromosuccinamide (NBS), Diazomethane, Dicyclohexylcarbodiimide(DCC), Potassiumtertiarybutoxide and Grignard reagent. (12h)

**UNIT.V:** Some Useful Reactions in Organic Synthesis:

i). Protection of functional groups: Hydroxyl, Carbonyl and amino groups

ii). Oxidation: Oxidation of alcohols and carbonyl compounds with suitable examples

iii). Reduction: Reduction of double and triple bonds and carbonyl compounds with suitable

Examples. (12h)

**Text Books:**

1. Text book of Organic Chemistry – Morrsion and Boyd.

2. Organic Reaction Mechanisms by VK Ahulwalia and RK Parashar

3. Vogel's Text Book of Qualitative Organic Analysis.

**References:**

1. Reaction mechanism – Peter Skyes.

2. Text book of Organic Chemistry – P.L. Soni.

3. Organic Chemistry Vol- I-IL. Finar.

4. Reactions and Reagents – O.P. Agrawal.

5. A Text Books of Organic Chemistry- Bahl and ArunBahl, S. Chand company, New Delhi

6. Polymer Science and Technology- Hema Singh, Acme Learning, New Delhi

**II year –1st Semester**

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|---|---|---|---|---|
| **19A20801** | **3. Chemical Process Calculations** | **PCC** | **2-1-0** | **3 Credits** |

**Course Objectives:**

- To introduce chemical process calculations, different unit systems and conversion from one-unit system to another.
- To introduce the use of Log-Log, Semi-Log and triangular graphs and graph plotting software such as MS-Excel, Polymath, Minitab, Origin etc.
- To impart concepts of vapour pressure and calculation of percent saturation of a given vapor-gas mixture.
- To emphasize the importance of basis of calculation and develop a systematic methodology to carry out material balances on chemical processes/equipment without and with reactions including recycle, purge and bypass.
- To convey different thermal effects associated with processes involving chemical reactions and phase changes
- To present how to calculate mass and energy balances involving combustion of fuels.

**UNIT- I**

**Stoichiometric & Composition relations**: Stoichiometric relation, basis of calculations, methods of expressing compositions of mixtures and solutions, density and specific gravity, Baume and API gravity scales.
(For Assignments only: Use of Log-Log and Semi-Log graphs; Graph plotting using plotters like MS-Excel, Polymath, Minitab, Origin, etc..)
**Behavior of Ideal gases**: Kinetic theory of gases, application of ideal gas law, gaseous mixtures, gases in chemical reactions.

**UNIT -II**

**Vapor pressure**: Liquefaction and liquid state, vaporization, boiling point, effect of temperature on vapor pressure, Antoine equation, vapor pressure plots, estimation of critical properties, vapor pressure of immiscible liquids and ideal solutions, Raoult's law, Non-volatile solutes.
**Humidity and Saturation**: Partial saturation, Humidity- Absolute Humidity, Vaporization process, Molal humidity, Relative and percentage saturation, dew point, humid heat, wet bulb and dry bulb temperatures, use of humidity charts, adiabatic vaporization.

**UNIT- III**

**Material balances**: Tie substance, Yield, conversion, limiting reactant, excess reactant, processes involving reactions, Material balances with the help of Stoichiometric equations, Material balances involving drying, dissolution, & crystallization. Material balance calculations for processes involving recycle, bypass and purge.

**UNIT -IV**

**Thermo physics**: Energy, energy balances, heat capacity of gases, liquid and mixture solutions. Kopp's rule, latent heats, heat of fusion and heat of vaporization, Trouton's rule, Kistyakowsky equation for non-polar liquids enthalpy and its evaluation.

**Thermo chemistry**: Calculation and applications of heat of reaction, combustion, formation and neutralization, Kirchoff's equation, enthalpy concentration change,

**UNIT- V**

**Flame Temperature Calculations:** Calculation of theoretical and actual flame temperatures.

**Combustion Calculations**: Introduction, fuels, calorific value of fuels, coal, liquid fuels, gaseous fuels, air requirement and flue gases, combustion calculations, incomplete combustion, material and energy balances, thermal efficiency calculations.

**TEXTBOOKS:**

**1.** Chemical process principles, Part -I, Material and Energy Balance, Hougen O A, Watson K.M. and Ragatz R.A. 2$^{nd}$Edition,John Wiley and Sons, New York, 1963.

**REFERENCES:**

1. Basic principles and calculations in chemical engineering by D.H. Himmelblau, 7$^{th}$ Ed. PHI, 2013
2. Stoichiometry by B.I. Bhatt and S.M. Vora (3rd Ed.) Tata McGraw Hill publishing company, Ltd. New Delhi (1996)

**Data Tables:** Use of steam tables, humidity chart under data tables permitted in the Examination hall

**Course outcomes:**

At the end of the course, student will be able to:

- Identify process calculations relevant to chemical engineering processes including conversion of physical quantities into different unit systems. (L3)
- Predict the behaviour of gases and vapours using ideal gas law.(L6)
- Estimate the composition of the given vapour-gas mixture using the principles of vapour pressure. (L6)
- Solve material balances on chemical processes/equipment without and with reactions including recycle, purge and bypass. (L6)
- Evaluate thermal effects associated with chemical reactions. (L5)
  Calculate mass and energy balances involving combustion of fuels. (L5)

**II year –1$^{st}$ Semester**

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| **19A20802** | **4. CHEMICAL ENGINEERING THERMODYNAMICS - I** | **PCC** | **2-1-0** | **3 Credits** |

**Course Objectives:**

- To introduce the laws of thermodynamics and their scope along with properties of different types.
- To explain how to calculate the heat and work requirements for industrial processes
- To teach the importance of PVT behaviour and its prediction using different equations of state and generalized correlations.
- To expose second law of thermodynamics and its application to find entropy changes.

- To transmit knowledge regarding the conversion of heat into work by power cycles such as Carnot, Rankine, Otto and Diesel cycles.
- To inform different refrigeration cycles and liquefaction processes

**UNIT -I**

**Introduction**: The scope of thermodynamics, temperature, defined quantities; volume, pressure, work, energy, heat, Joules Experiments.

**The first law and other basic concepts:** The first law of thermodynamics, thermodynamic state and state functions, enthalpy, the steady-state steady-flow process, equilibrium, the phase rule, the reversible process, constant-V and constant-P processes, heat capacity, isobaric, isochoric, isothermal, adiabatic and polytrophic processes.

**UNIT -II**

**Volumetric properties of pure fluids:** The PVT behavior of pure substances, virial equations, the ideal gas, the applications of the virial equations, second virial coefficients from potential functions.

**UNIT- III**

Cubic equations of state, generalized correlations for gases.

**The second law of thermodynamics:** Statements of the second law, heat engines, thermodynamic temperatures scales, thermodynamic temperature and the ideal gas scale

**UNIT -IV**

Entropy, Entropy changes of an ideal gas, mathematical statement of the second law

The third law of thermodynamics, entropy from the microscopic view point, calculation of ideal work and lost work.

**Power cycles:** Carnot cycle, Rankine cycle, Otto cycle, Diesel cycle.

**UNIT –V**

**Refrigeration and liquefaction:** The Carnot refrigerator, the vapor compression cycle, the comparison of refrigeration cycles, the choice of refrigerant, absorption refrigeration, the heat pump, liquefaction processes.

**TEXT BOOKS**

1. J.M.Smith and HC Van Ness, Introduction to Chemical Engineering Thermodynamics, 8$^{th}$ ed, Tata McGraw Hill,2017.

**REFERENCE BOOKS**

1. Y.V. C. Rao, Chemical Engineering Thermodynamics, University publications.
2. K. V. Narayanan, Chemical Engineering Thermodynamics, PHI,2001.

**Course outcomes:**

At the end of the course, student will be able to:

- Apply the first and second laws of thermodynamics to chemical processes. (L3)
- Compute the properties of ideal and real mixtures using equations of state and generalized correlations. (L5)
- Analyse the behaviour of flow and non-flow processes using mass and energy balances. (L4)
- Estimate heat and work requirements for industrial processes. (L5)
- Determine the efficiency of processes involving heat into work, refrigeration and liquefaction. (L5)

**II year –1st Semester**

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| | **5. FUNDAMENTALS OF PYTHON PROGRAMMING** | **ESC** | **2-0-0** | **2 Credits** |

**Course Objectives:**

- To teach the fundamentals of Python
- To elucidate problem-solving using a Python programming language
- To introduce a function-oriented programming paradigm through python
- To train in the development of solutions using modular concepts
- To introduce the programming constructs of python

**Course Outcomes:** After completion of the course a successful student is able to

- List the basic constructs of Python
- Design programs for data structure list and manipulating strings
- Apply object orientation concepts, use data structure dictionaries
- Organize data in the form of files

**Unit – I**

**Introduction:** What is a program, Running python, Arithmetic operators, Value and Types.

Variables, Assignments and Statements: Assignment statements, Script mode, Order of operations, string operations, comments.

**Functions**: Function calls, Math functions, Composition, Adding new Functions, Definitions and Uses, Flow of Execution, Parameters and Arguments, Variables and Parameters are local, Stack diagrams, Fruitful Functions and Void Functions, Why Functions.

**Learning Outcomes**: Student should be able to

- List the basic constructs of Python (L1)
- Solve the problems by applying modularity principle (L3)

**Unit – II**

**Conditionals and Recursion**: floor division and modulus, Boolean expressions, Logical operators, Conditional execution, Alternative execution, Chained conditionals, Nested conditionals, Recursion, Infinite Recursion, Keyboard input.
**Fruitful Functions**: Return values, Incremental development, Composition, Boolean functions, More recursion, Leap of Faith, Checking types,

**Learning Outcomes**: Student should be able to

- Apply the conditional execution of the program (L3)
- Apply the principle of recursion to solve the problems (L3)

**Unit - III**

**Iteration**: Reassignment, Updating variables, The while statement, Break, Square roots, Algorithms.
**Strings**: A string is a sequence, len, Traversal with a for loop, String slices, Strings are immutable, Searching, Looping and Counting, String methods, The in operator, String comparison.

**Learning Outcomes**: Student should be able to

- Design programs for manipulating strings (L6)

**Unit – IV**
**Lists**: List is a sequence, Lists are mutable, Traversing a list, List operations, List slices, List methods, Map filter and reduce, Deleting elements, Lists and Strings, Objects and values, Aliasing, List arguments.
**Tuples:** Tuples are immutable, Tuple Assignment, Tuple as Return values, Variable-length argument tuples, Lists and tuples, Dictionaries and tuples, Sequences of sequences.

**Learning Outcomes**: Student should be able to
- Apply object orientation concepts (L3)
- Use data structure lists and tuples (L3)

**Unit – V**

**Files:** Persistence, Reading and writing, Format operator, Filename and paths, Catching exceptions, Databases, Pickling, Pipes, Writing modules.
**Classes and Objects**: Programmer-defined types, Attributes, Instances as Return values, Objects are mutable, Copying.
**Classes and Functions**: Time, Pure functions, Modifiers, Prototyping versus planning.

**Learning Outcomes**: Student should be able to
- Organize data in the form of files (L6)
- Plan programs using object orientation approach (L6)

**Text books:**
- Allen B. Downey, “Think Python”, $2^{nd}$ edition, SPD/O’Reilly, 2016.

**Reference Books:**

- Martin C.Brown, “The Complete Reference: Python”, McGraw-Hill, 2018.
- Kenneth A. Lambert, B.L. Juneja, “Fundamentals of Python”, CENGAGE, 2015.
- R. NageswaraRao, “Core Python Programming”, 2nd edition, Dreamtech Press, 2019

**Course Outcomes**: Student should be able to

- Explain the features of Python language (L2)
- Select appropriate data structure for solving a problem (L4)
- Design object-oriented programs for solving real-world problems (L6)

**II year –1st Semester**

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| **19A20803** | **6. MOMENTUM TRANSFER** | **PCC** | **2-1-0** | **3 Credits** |

**Course Objectives:**

- To introduce the basic concepts of static and dynamic behaviour of fluids
- To disseminate different flow regimes and identification of types of fluids along with necessary equations to represent their behaviour
- To derive Bernouli's theorem and explain its application to fluid flow problems
- To introduce the concept of friction factor and its estimation for different types of flow through pipes and fittings.
- To explain dimensional analysis using Rayleighs and Buchinghm π Methods.
- To expose flow measuring devices such as head and area meters.
- To explain fluid moving machinery and its selection for a given flow problem.

**UNIT- I**

Unit operations and unit processes, unit systems, basic concepts, nature of fluids, hydrostatic equilibrium, applications of fluid statics.

Fluid flow phenomena-Laminar flow, Shear rate, Shear stress, Rheological properties of fluids, Turbulence, Boundary layers.

**UNIT- II**

Basic equation of fluid flow –Mass balance in a flowing fluid; continuity equation, differential momentum balance; equations of motion, Macroscopic momentum balances, Bernoulli equation.

Incompressible Flow in pipes and channels- shear stress and skin friction in pipes, laminar flow in pipes and channels, turbulent flow in pipes and channels, friction from changes in velocity or direction.

**UNIT- III**

Dimensional analysis: Buckingham π Theorem and Rayleigh's method.

Flow of compressible fluids- Definitions and basic equations, Processes of compressible flow, Isentropic flow through nozzles, adiabatic frictional flow, and isothermal frictional flow.

**UNIT -IV**

Flow past immersed bodies, Drag and Drag coefficient, friction in flow through beds of solids, Kozeny-Carman, Blake-Plummer and Ergun equations, and motion of particles through fluids.

Fluidization: Conditions for fluidization, Minimum fluidization velocity, Types of fluidization, Expansion of fluidized beds, Applications of fluidization, Continuous fluidization: Slurry and pneumatic transport.

**UNIT- V**

Transportation and Metering of fluids: Pipes, fittings and valves, Fluid- moving machinery, Fans, blowers, and compressors.

Measurement of flowing fluids: Variable head meters- Orifice meter, Venturi meter, Pitot tube; Area meter- Rota meter.

**TEXT BOOKS:**

1. Unit Operations of Chemical Engineering by W.L.McCabe, J.C.Smith& Peter Harriot, McGraw-Hill, 7$^{th}$ed, 2007

**REFERENCE BOOKS:**

1. Transport processes and unit operations by Christie J. Geankoplis, PHI
2. Unit operations, Vol-1 –Chattopadhya, Khanna publishers
3. Principles of Unit Operations, Foust *et al*, 2$^{nd}$ ed., John Wiley, 1999

4. Chemical Engineering, Vol-I, Coulson and Richardson, Pergamon Press.
5. Unit operations- Brown etal.,Asian Publishing House.

**II year –1st Semester**

| 19A25502 | 7. FUNDAMENTALS OF PYTHON PROGRAMMING LAB | BSC | 0-0-3 | 1.5 Credits |
|---|---|---|---|---|

**Course Objectives:**

1. To train solving computational problems
2. To elucidate solving mathematical problems using Python programming language
3. To illustrate the features of Python language

**Laboratory Experiments**

1. Install Python Interpreter and use it to perform different Mathematical Computations. Try to do all the operations present in a Scientific Calculator

2. Write a function that draws a grid like the following:

```
+ - - - -   + - - - - +
|           |         |
    |           |         |
```

```
    |         |        |
    |         |        |
 +----  +----+
  |        |        |
  |        |        |
  |        |        |
  |        |        |
 +----+----+
```

3. Write a function that draws a Pyramid with # symbols

```
                  #
                # # #
              # # # # #
            # # # # # # #
.
.
.
```

Up to 15 hashes at the bottom

4. The letters of the alphabet can be constructed from a moderate number of basic elemlents, like vertical and horizontal lines and a few curves. Design an alphabet that can be drawn with a minimal number of basic elements and then write functions that draw the letters. The alphabet can belong to any Natural language excluding English. You should consider at least Ten letters of the alphabet.

5. The time module provides a function, also named time that returns the current Greenwich Mean Time in "the epoch", which is an arbitrary time used as a reference point. On UNIX systems, the epoch is 1 January 1970.

```
>>> import time
>>>time.time()
1437746094.5735958
```

Write a script that reads the current time and converts it to a time of day in hours, minutes, and seconds, plus the number of days since the epoch.

6. Given n+r+1 <= $2^r$ .n is the input and r is to be determined. Write a program which computes minimum value of r that satisfies the above.

7. Write a program that evaluates Ackermann function

8. The mathematician SrinivasaRamanujan found an infinite series that can be used to generate a numerical approximation of 1/ $\pi$ :

9. Write a function called estimate_pi that uses this formula to compute and return an estimate of $\pi$.

$$\frac{1}{\pi} = \frac{2\sqrt{2}}{9801} \sum_{k=0}^{\infty} \frac{(4k)!(1103 + 26390k)}{(k!)^4 396^{4k}}$$

It should use a while loop to compute terms of the summation until the last term is smaller than 1e-15 (which is Python notation for $10^{-15}$). You can check the result by comparing it to math.pi.

10. Choose any five built-in string functions of C language. Implement them on your own in Python. You should not use string related Python built-in functions.
11. Given a text of characters. Write a program which counts number of vowels, consonants and special characters.
12. Given a word which is a string of characters. Given an integer say ‘n’. Rotate each character by ‘n’ positions and print it. Note that ‘n’ can be positive or negative.
13. Write program which performs the following operations on list’s. Don’t use built-in functions
    a) Updating elements of a list
    b) Concatenation of list’s
    c) Check for member in the list
    d) Insert into the list
    e) Sum the elements of the list
    f) Push and pop element of list
    g) Sorting of list
    h) Finding biggest and smallest elements in the list
    i) Finding common elements in the list

14. Write a program that reads a file, breaks each line into words, strips whitespace and punctuation from the words, and converts them to lowercase.
15. Write a program that takes a string and prints the letters in decreasing order of frequency.
16. Write a program that reads a word list from a file (see Section 9.1) and prints all the sets of words that are anagrams.

    Here is an example of what the output might look like:

    ['deltas', 'desalt', 'lasted', 'salted', 'slated', 'staled']

    ['retainers', 'ternaries'] ['generating', 'greatening']

    ['resmelts', 'smelters', 'termless']
17. Consider all the files on your PC. Write a program which checks for duplicate files in your PC and displays their location. Hint: If two files have the same checksum, they probably have the same contents.
18. Write a program illustrating the object oriented features supported by Python.
19. Design a Python script to determine the difference in date for given two dates in YYYY:MM:DD format(0 <= YYYY <= 9999, 1 <= MM <= 12, 1 <= DD <= 31) following the leap year rules.
20. Design a Python Script to determine the time difference between two given times in HH:MM:SS format.( 0 <= HH <= 23, 0 <= MM <= 59, 0 <= SS <= 59)

**Course outcomes:** Student should be able to

1. Design solutions to mathematical problems (L6)
2. Organize the data for solving the problem (L6)
3. Develop Python programs for numerical and text based problems (L3)
4. Select appropriate programming construct for solving the problem (L5)
5. Illustrate object oriented concepts (L3)

**Reference Books:**


1. Peter Wentworth, Jeffrey Elkner, Allen B. Downey and Chris Meyers, "How to Think Like a Computer Scientist: Learning with Python 3", 3rd edition, Available at http://www.ict.ru.ac.za/Resources/cspw/thinkcspy3/thinkcspy3.pdf

2. Paul Barry, "Head First Python a Brain Friendly Guide" 2nd Edition, O'Reilly, 2016

3. Dainel Y.Chen "Pandas for Everyone Python Data Analysis" Pearson Education, 2019


**II year –1st Semester**

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| **19A20702** | **8. ORGANIC CHEMISTRY LAB** | **BSC** | **0-0-3** | **1.5 Credits** |

**COURSE OBJECTIVES:** This course aims to provide the student about the

- Detailed organic structure analysis

- Planning and implementation of advanced organic reactions
- Major concepts, theoretical and experimental principles.

**COURSE OUTCOME:**

**After completion of the course, student shall be able to**

- Explain the mechanism of organic chemical reaction is essential to synthesis new organic compounds in drug and pharmaceutical industries. In order to study their kinetics of reactions to regulate the process for optimization of production of drugs and pharmaceutical, the principles of organic chemistry are essential.
- Carry out a chemical process industrially for the manufacture of drugs and pharmaceuticals, understand the basic reactions, reagents and their applications.

**ORGANIC CHEMISTRY LAB:**

1. Criteria of Purity of Solid and Liquid, Determination of Melting Point & Boiling Point.

   Detecting Nitrogen, Sulphur, and Halogens in Organic Compounds.

2. Identification of an Unknown Substance from the following classes of Organic

   Compounds, Alcohols, Phenols, Aldehydes, Ketenes, Carbohydrates and Carboxylic acids.

3. Preparation of Aspririn
4. Preparation of Paracetamol
5. Preparation of Acetanilide
6. Preparation of Sulphonic acid
7. Preparation of derivatives for Aldehydes and Amines.
8. Beckman Rearrangement (Preparation of Benzanilide from Benzophenoneoxime).
9. Determination of strength of a Glycine Solution.
10. Estimation of an Aldehyde.

**TEXT BOOKS:**

1. Text book of Organic Chemistry – Morrsion and Boyd.
2. Organic Reaction Mechanisms by VK Ahulwalia and RK Parashar
3. Vogels Text Book of Qualitative Organic Analysis.

**REFERENCES:**

1. Reaction mechanism – Peter Skyes.
2. Text book of Organic Chemistry – P.L. Soni.
3. Organic Chemistry Vol- I-IL. Finar.
4. Reactions and Reagents – O.P. Agrawal.

5. A Text Books of Organic Chemistry- Bahl and ArunBahl, S. Chand company, New Delhi

6. Polymer Science and Technology- Hema Singh, Acme Learning, New Delhi

**II year –1st Semester**

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| **19A20804** | **9. MOMENTUM TRANSFER LAB** | **PCC** | **0-0-3** | **1.5 Credits** |

**Objective:** The lab provides knowledge on various flow patterns, flow measuring devices and pumps.

1. Identification of laminar and turbulent flows - Major equipment - Reynolds apparatus

2. Measurement of point velocities - Major equipment - Pitot tube setup

3. Verification of Bernoulli's equation - Major equipment – Bernoulli's Apparatus

4. Calibration of Rotameter - Major equipment – Rotameter Assembly

5. Variation of Orifice coefficient with Reynolds Number - Major equipment - Orifice meter Assembly

6. Determination of Venturi coefficient - Major equipment – Venturi meter Assembly

7. Friction losses in Fluid flow in pipes - Major equipment - Pipe Assembly with provision for Pressure measurement

8. Pressure drop in a packed bed for different fluid velocities - Major equipment - Packed bed with Pressure drop measurement

9. Pressure drop and void fraction in a fluidized bed - Major equipment - Fluidized bed with Pressure drop measurement

10. Studying the coefficient of contraction for a given open orifice - Major equipment - Open Orifice Assembly

11. Studying the coefficient of discharge in a V-notch - Major equipment - V-notch Assembly

12. Studying the Characteristics of a centrifugal pump - Major equipment - Centrifugal Pump

13. Drag studies using two different fluids

**II year –1st Semester**

| 19A10804 | 10. ENVIRONMENTAL SCIENCE | MC | 3-0-0 | 0 Credits |
|---|---|---|---|---|

**OBJECTIVE:** To make the students to get awareness on environment, to understand the importance of protecting natural resources, ecosystems for future generations and pollution causes due to the day to day activities of human life to save earth from the inventions by the engineers.

**UNIT – I:**
**MULTIDISCIPLINARY NATURE OF ENVIRONMENTAL STUDIES: –** Definition, Scope and Importance – Need for Public Awareness.
**NATURAL RESOURCES :** Renewable and non-renewable resources – Natural resources and associated problems – Forest resources – Use and over – exploitation, deforestation, case studies – Timber extraction – Mining, dams and other effects on forest and tribal people – Water resources – Use and over utilization of surface and ground water – Floods, drought, conflicts over water, dams – benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. – Energy resources:

**UNIT – II:**
**ECOSYSTEMS:** Concept of an ecosystem. – Structure and function of an ecosystem – Producers, consumers and decomposers – Energy flow in the ecosystem – Ecological succession – Food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the following ecosystem:

a. Forest ecosystem.
b. Grassland ecosystem
c. Desert ecosystem
d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

**BIODIVERSITY AND ITS CONSERVATION :** Introduction 0 Definition: genetic, species and ecosystem diversity – Bio-geographical classification of India – Value of biodiversity: consumptive use, Productive use, social, ethical, aesthetic and option values – Biodiversity at global, National and local levels – India as a mega-diversity nation – Hot-sports of biodiversity – Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – Endangered and endemic species of India – Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

**UNIT – III:**

**ENVIRONMENTAL POLLUTION:** Definition, Cause, effects and control measures of :

a. Air Pollution.
b. Water pollution
c. Soil pollution
d. Marine pollution
e. Noise pollution
f. Thermal pollution
g. Nuclear hazards

**SOLID WASTE MANAGEMENT :** Causes**,** effects and control measures of urban and industrial wastes – Role of an individual in prevention of pollution – Pollution case studies – Disaster management: floods, earthquake, cyclone and landslides.

**UNIT – IV:**

**SOCIAL ISSUES AND THE ENVIRONMENT:** From Unsustainable to Sustainable development – Urban problems related to energy – Water conservation, rain water harvesting, watershed management – Resettlement and rehabilitation of people; its problems and concerns. Case studies – Environmental ethics: Issues and possible solutions – Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies – Wasteland reclamation. – Consumerism and waste products. – Environment Protection Act. – Air (Prevention and Control of Pollution) Act. – Water (Prevention and control of Pollution) Act – Wildlife Protection Act – Forest Conservation Act – Issues involved in enforcement of environmental legislation – Public awareness.

**UNIT – V:**

**HUMAN POPULATION AND THE ENVIRONMENT:** Population growth, variation among nations. Population explosion – Family Welfare Programmed. – Environment and human health – Human Rights – Value Education – HIV/AIDS – Women and Child Welfare – Role of information Technology in Environment and human health – Case studies.

**FIELD WORK :** Visit to a local area to document environmental assets River/forest grassland/hill/mountain – Visit to a local polluted site-Urban/Rural/Industrial/Agricultural Study of common plants, insects, and birds – river, hill slopes, etc..

**TEXT BOOKS** :

(1) Text book of Environmental Studies for Undergraduate Courses by Erach Bharucha for University Grants Commission, Universities Press.
(2) Environmental Studies by Palani Swamy – Pearson education
(3) Environmental Studies by Dr.S.Azeem Unnisa, Academic Publishing Company

**REFERENCES :**

(1) Textbook of Environmental Science by Deeksha Dave and E.Sai Baba Reddy, Cengage Pubilications.
(2) Text book of Environmental Sciences and Technology by M.Anji Reddy, BS Publication.
(3) Comprehensive Environmental studies byJ.P.Sharma, Laxmi publications.
(4) Environmental sciences and engineering – J. Glynn Henry and Gary W. Heinke – Printice hall of India Private limited.
(5) A Text Book of Environmental Studies by G.R.Chatwal, Himalaya Pubilishing House
(6) Introduction to Environmental engineering and science by Gilbert M. Masters and Wendell P. Ela - Printice hall of India Private limited.

**II Year – 2nd Semester**

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| **19A20805** | **1. Chemical Engineering Thermodynamics** | **PCC** | **2-1-0** | **3 Credits** |

**Course Objectives:**

- To introduce Maxwell's relations and their application to generate property relations for homogeneous phases.
- To impart the concept of phase equilibria.
- To present the calculation of property changes of mixing.
- To explain LLE, VLLE, SLE and SVE.
- To educate the calculation of fugacity coefficient using generalized correlations and vapour-liquid equilibrium (VLE) composition for ideal and non-ideal systems
- To teach equilibrium constant and composition for a given reaction at specified temperature and pressure.

**UNIT I**

**Thermodynamic properties of fluids:** Property relations for homogeneous phases, residual properties, two phase systems, thermodynamic diagrams, tables of thermodynamic properties, generalized property correlation for gases.

**Solution Thermodynamics:** Theory, Fundamental property relation, chemical potential as a criterion for phase equilibrium, partial properties, ideal gas mixtures.

**UNIT II**

Fugacity and fugacity coefficient for pure species, fugacity and fugacity coefficient for species in solutions, generalized correlations for Fugacity coefficient, The ideal solutions, excess properties.

**Solution Thermodynamics:** Applications: The liquid phase properties from VLE data, models for the excess Gibbs energy, property changes of mixing

**UNIT III**

**VLE at low to moderate pressures:** The nature of equilibrium, the phase rule, Duhems theorem, VLE: Qualitative behavior, the gamma /Phi formulation of VLE, Dew point and bubble point calculations, flash calculations, solute (1)/solvent (2) systems

**Thermodynamic Properties and VLE:** properties of fluids from the virial equations of state, properties of fluids from cubic equations of state, fluid properties from correlations of the Pitzer type.

**UNIT IV**

**Topics in phase equilibria:** Equilibrium and stability, liquid/liquid equilibrium(LLE), vapor/liquid/liquid equilibrium(VLLE), solid/liquid equilibrium (SLE), solid/vapor equilibrium (SVE).

**Thermodynamic analysis of processes:** Calculation of ideal work, lost work, thermodynamic analysis of steady-state flow processes.

**UNIT V**

**Chemical Reaction Equilibria:** The reaction coordinate, application of equilibrium criterion to chemical reactions, The standard Gibb's energy change and the equilibrium constant, effect of temperature on equilibrium constants, relation of equilibrium constants to composition, equilibrium conversion for single reactions, Phase rule and Duhem's theorem for reacting systems.

**TEXT BOOK:**

1. Introduction to Chemical Engineering Thermodynamics, 6th ed., J.M. Smith, H.C. Van Ness and M.M. Abbott, Tata McGraw-Hill, New Delhi, 2003.

**REFERENCE:**

1. Chemical Engineering Thermodynamics- Y V C Rao , University Publications.

2. Chemical Engineering Thermodynamics, Pradeep Ahuja, PHI Learning Pvt. Ltd., New Delhi, 2009
2. A Text Book of Chemical Engineering Thermodynamics, K.V. Narayanan, PHI Learning Pvt.Ltd., New Delhi, 2001.

**Course outcomes:**

At the end of the course, student will be able to:

- Apply Maxwell's relations to generate property relations for homogeneous phases. (L3)
- Define the criteria for phase equilibrium. (L1)
- Estimate the property changes of mixing (L5).
- Explain LLE, VLLE, SLE and SVE.(L2)
- Calculate fugacity coefficient using generalized correlations and vapour-liquid equilibrium (VLE) composition for ideal and non-ideal systems (L5)
- Determine equilibrium constant and composition for a given reaction at specified temperature and pressure (L5)

**II Year – 2$^{nd}$ Semester**

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| **19A20806** | **2. PROCESS HEAT TRANSFER** | **PCC** | **2-1-0** | **3 Credits** |

**COURSE OBJECTIVES:**

- To demonstrate different modes of heat transfer
- To describe formulae for steady/ unsteady rate of heat transfer by conduction for rectangular, cylindrical and spherical geometries
- To teach how to estimate the heat transfer coefficients for different flow geometries
- To explain the working and design of double pipe, shell and tube heat exchangers and evaporators
- To impart knowledge on the phenomenon of radiation, radiation shields and estimation of emissivity.

**UNIT -I**

**Introduction:** Nature of heat flow, conduction, convection, natural and forced convection, radiation.
**Heat transfer by conduction in Solids:** Fourier's law, thermal conductivity, steady state conduction in plane wall & composite walls, compound resistances in series, heat flow through a cylinder, conduction in spheres.
**Unsteady state heat conduction:** Equation for one-dimensional conduction, Semi-infinite solid.

**UNIT- II**

**Principles of heat flow in fluids:** Typical heat exchange equipment, countercurrent and parallel current flows, energy balances, rate of heat transfer, overall heat transfer coefficient, electrical analogy, critical radius of insulation, logarithmic mean temperature difference, variable overall coefficient, multi-pass exchangers, individual heat transfer coefficients, resistance form of overall coefficient, fouling factors, classification of individual heat transfer coefficients, magnitudes of heat transfer coefficients, effective coefficients for unsteady-state heat transfer.

**UNIT- III**

**Heat Transfer to Fluids without Phase change:** Regimes of heat transfer in fluids, thermal boundary layer, heat transfer by forced convection in flow, heat transfer by forced convection in turbulent flow, the transfer of heat by turbulent eddies and analogy between transfer of momentum and heat, heat transfer to liquid metals, heating and cooling of fluids in forced convection outside tubes.

**UNIT -IV**

**Natural convection:** Natural convection to air from vertical shapes and horizontal planes, effect of natural convection in laminar-flow heat transfer.
**Heat transfer to fluids with phase change:** Heat transfer from condensing vapors, heat transfer to boiling liquids.
**Radiation:** Introduction, properties and definitions, black body radiation, real surfaces and the Gray body, absorption of radiation by opaque solids, radiation between surfaces, radiation Shielding, radiation to semi-transparent materials, combined heat transfer by conduction, convection and radiation.

**UNIT- V**

**Heat exchange equipment:** General design of heat exchange equipment, heat exchangers, condensers, boilers and calendrias, extended surface equipment, heat transfer in agitated vessels, scraped surface heat exchangers, heat transfer in packed beds, heat exchanger effectiveness (NTU method)
**Evaporators:** Evaporators, performance of tubular evaporators, capacity and economy, multiple effect evaporators, methods of feeding, vapor recompression

**TEXT BOOK:**

1. Unit Operations of Chemical Engineering, 6th ed., W.L. McCabe, J.C. Smith and P. Harriot, McGraw-Hill, New York, 2001

**REFERENCES:**

1. Process Heat Transfer, D.Q. Kern, Tata McGraw-Hill, New Delhi, 1997.
2. Heat Transfer, 4th ed., J.P. Holman, McGraw-Hill, New York, 1976.
3. Chemical Engineering, Volume-I, J. Coulson and R.F. Richardson, Pergamon Press

**COURSE OUCOMES:**

At the end of the course the student will be able to

- Determine individual and overall heat transfer coefficients in laminar and turbulent flow conditions. (L5)
- Design of heat exchange equipment such as double pipe heat exchanger, shell and tube heat exchanger used in chemical industry. (L6)
- Estimate the performance (capacity, economy) of a given single/multiple effect evaporator. (L5)
- Calculate heat transfer coefficient in forced convection and natural convection. (L5)
- Analyze radiation heat transfer between different surfaces. (L4)

**II Year – 2nd Semester**

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| **19A20807** | **3. MECHANICAL OPERATIONS** | **PCC** | **2-1-0** | **3 Credits** |

**COURSE OBJECTIVES:**

- To introduce to the concepts of characterization of solids
- To discuss different types of mixers for mixing of solids
- To impart knowledge on screening, size reduction and equipment for size reduction
- To give exposure to Laws of crushing
- To explain the phenomenon of particle settling in fluids and transportation of solids
- To disseminate knowledge on different techniques of particle separation from fluid
- To estimate the power consumption in agitation and mixing of liquids

**UNIT- I**

**Properties, handling and mixing of particulate solids**: Characterization of solid particles, properties of particulate masses, storage and mixing of solids, types of mixers, mixers for cohesive solids, mixers for free flowing solids.

**UNIT- II**

**Size reduction**: Principles of computer simulation of milling operations, size reduction equipment-crushers, grinders, ultra-fine grinders, cutting machines, Equipment operation. Laws of crushing: Kick's law, Bond's law, Rittinger's law Screening, Industrial screening equipment, Effectiveness of the screen, differential & cumulative analysis.

**UNIT -III**

Filtration, cake filters, centrifugal filters, cyclone separators, electro-static precipitators.

Principles of cake filtration, Clarifying filters, vacuum filtration, liquid clarification, gas cleaning, principles of clarification. Introduction to cross flow filtration.

**UNIT- IV**

**Separations based on motion of particles through fluids**: gravity settling processes and centrifugal settling processes, float and sink method, differential settling, coagulation, Flotation-separation of ores, flotation agents

**Crystallization**: crystal geometry, principles of crystallization, equilibria and yields, nucleation, crystal growth

**UNIT- V**

**Agitation and mixing of liquids**: Agitation of liquids, circulation velocities, power consumption in agitated vessels. Blending and mixing of liquids, suspension of solid particles, dispersion operations.

**Introduction to transportation of solid particulate mass**: Belt, screw, apron conveyers, bucket elevators, pneumatic conveying.

**TEXT BOOK:**

1. Unit Operations in Chemical Engineering by W.L. McCabe and J.C. Smith and Peter Harriott, McGraw Hill 7$^{th}$ ed. 2001.

**REFERENCES:**

1. Chemical engineers hand book, J.H. Perry, 7th ed. McGraw Hill
2. Introduction to Chemical Engineering by J.T.Banchero& W.L. Badger., TMH, 1997.

**COURSE OUTCOMES:**

**At the end of the course the student will be able to**

- Estimate average particle diameter using differential and cumulative analysis. (L5)
- Demonstrate the working of different equipment for size reduction, liquid clarification, gas cleaning, blenders and mixers.(L2)
- Evaluate cake and filter medium resistances.(L5)
- Evaluate power consumption in agitated vessels. (L5)
- Explain the principles of crystallization. (L2)
- Describe the working of equipment for transportation of solid particles. (L2)

**II Year – 2$^{nd}$ Semester**

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| **19A20808** | **4. MASS TRANSFER OPERATIONS-I** | **PCC** | **2-1-0** | **3 Credits** |

**Course Objectives:**

- To impart the basic concepts of molecular diffusion, mass transfer coefficients and analysis of different mass transfer processes.
- To discuss the fundamental concepts of mass transfer principles and their applications to real engineering problems.
- To introduce the mass transfer rates and Fick's Law of diffusion.
- To describe convective mass transfer rates and mass transfer coefficients.
- To appraise different types of equipment and their operation for gas-liquid separations.
- To explain the design of mass transfer equipment for absorption, stripping, drying and humidification.

**UNIT- I**

**The Mass Transfer Operations**: Classification of the Mass-Transfer Operations, Choice of Separation Method, Methods of Conducting the Mass-Transfer Operations, Design Principles, Unit Systems

**Molecular Diffusion In Fluids**: Molecular Diffusion, Equation of Continuity, binary solutions, Steady State Molecular Diffusion in Fluids at Rest and in Laminar Flow, estimation of diffusivity of gases and liquids, Momentum and Heat Transfer in Laminar flow

Diffusion:Diffusion in Solids, Fick's Diffusion, Unsteady State Diffusion, Types of Solid Diffusion, diffusion through polymers, diffusion through crystalline solids, Diffusion through porous solids & hydrodynamic flow of gases.

**UNIT- II**

**Mass Transfer Coefficients**: Mass Transfer Coefficients, Mass Transfer Coefficients in Laminar Flow (Explanation of equations only and no derivation), Mass Transfer Coefficients in Turbulent Flow, eddy diffusion, Film Theory, Penetration theory, Surface-renewal Theory, Combination Film-Surface-renewal theory, Surface-Stretch Theory, Mass, Heat and Momentum Transfer Analogies, Turbulent Flow in Circular Pipes. Mass transfer data for simple situations.

Inter Phase Mass Transfer: Concept of Equilibrium, Diffusion between Phases, Material Balances in steady state co-current and counter current stage processes, Stages, Cascades, Kremser – Brown equation.

**UNIT-III**

**Equipment For Gas-Liquid Operations**: Gas Dispersed, Sparged vessels (Bubble Columns), Mechanical agitated equipments(Brief description),Tray towers, General characteristics, Sieve design for absorption and distillation (Qualitative Treatment), Different types of Tray Efficiencies, Liquid Dispersed venturi Scrubbers, Wetted-Wall Towers, Packed Towers, Counter current flow of Liquid & Gas through packing, Mass transfer coefficients for packed towers, End effects and Axial Mixing Tray tower vs Packed towers.

**UNIT-IV**

**Absorption And Stripping**: Absorption equilibrium, ideal and non-ideal solutions selection of a solvent for absorption, one component transferred: material balances. Determination of number of Plates (Graphical), Absorption Factor, estimation of number of plates by Kremser Brown equation, Continuous contact equipment; HETP, Absorption of one component,

Determination of number of Transfer Units and Height of the Continuous Absorber, overall coefficients and transfer units, dilute solutions, overall height of tranasfer units.

**UNIT-V**

**Humidification Operations**: Vapor-Pressure Curve, Definitions, Psychometric Charts, Enthalpy of gas-vapor Mixtures, Humidification and Dehumidification, Operating lines and Design of Packed Humidifiers.

**Drying:** Equilibrium, Definitions, Drying Conditions- Rate of Batch Drying under constant drying conditions, Mechanisms of batch drying, Drying time Through Circulation Drying.

Classification of Drying Operations: Batch and Continuous Drying Equipment.

**TEXT BOOK:**

1. Mass transfer operations by R.E. Treybal, 3$^{rd}$ ed. Mc Graw Hill, 1980.

2. Separation process C.J King, Tata Mc Graw Hill
3. Principles of Mass Transfer and Separation Processes by B K Dutta, Printice Hall of India Pvt Limited, New Delhi

**REFERENCE:**

1. Diffusion mass transfer in fluid system by E. L. Cussler.
2. Transport processes and unit operations by Christie J. Geankoplis
3. Separation Process Principles, J D Seader and E. J. Henley, John Wiley & Sons, Inc,. New York

**Pre-requisite:---Nil---**

***Codes/Tables:*** *Psychrometric Charts may be provided*

**Course outcomes:**

At the end of the course, student will be able to:

- Determine mass transfer rates using Fick's Law.(L5)
- Estimate convective mass transfer rates and mass transfer coefficients using analogies.(L5)
- Explain the concept of inter-phase mass transfer. (L2)
- Design absorber, stripper and humidifier.(L6)
- Estimate drying time.(L5)
- Explain the workingofBatch and Continuous Drying Equipment. (L2)

**II Year – 2nd Semester**

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| **19A20703** | **5. ANALYTICAL CHEMISTRY** | **BSC** | **2-1-0** | **3 Credits** |

**Pre-requisites:** None

**COURSE OBJECTIVES:**

**This course aims to provide the student to**

- Acquire basic principles of simple instrumental methods for estimation of organic/inorganic species.
- Gain basic knowledge of limitations of analytical methods.
- Characterize the Materials synthesized by chemical industry.
- Understand the chromatographic techniques for the separation of impurities in the industrially synthesized compounds.

**COURSE OUTCOMES:**

**After completion of the course student shall be able to**

1. Analyse the statistical data for the analysis in analytical chemistry.
2. Acquire enough knowledge on industrial processes and Identification of Products using different analytical and instrumental techniques.
3. Analyse the compounds by using the TGA, DTA and DSC techniques for the analysis of metals and alloys
4. Gain the knowledge on cyclic voltameter and amperometric titration techniques
5. Learn the basic principles of spectrophotometry like UV-Vis and IR

**UNIT-I: Basic Principles of Quantitative Analysis:** Limitations of analytical methods, Classification of errors, Accuracy, Precision, How to reduce systematic errors, Significant figures, Calculators and Computers, Mean and Standard deviation, Distribution of Random errors, Reliability of Results, Confidence interval , Comparison of results, Comparing the means of two samples, Paired T-test, Correlation and regression, Standard deviations. (8h)

**UNIT-II: Chromatographic Methods:** Column chromatography-general principles, terminology: retention time, rotation volume, separation factor, resolution of peaks. Principles of gas chromatography block diagram of gas chromatograph - detectors (FID, ECD), stationary phases for column, mobile phases, chromatogram, qualitative analysis, special plots, quantitative analysis, HPLC: Principles of High Performance Liquid Chromatography. Block diagram of HPLC Systems, function of each component, stationary phases, eluting solvents, pumps, detectors, quantitative applications of HPLC.Ion Exchange chromatography-seperation of anions and cations.Suppressed & non-suppressed ion chromatography.Numerical calculations. (14h)

**Unit-III: Thermal methods of Analysis:** Introduction to Thermal methods, Thermo gravimetric Analysis (TGA)-principles, and applications (determination of drying temperatures, kinetic methods, automatic thermo gravimetric Analysis) DTA: Differential thermal analysis-Principles and applications (exothermic and endothermic peaks, heat of reaction, catalysis, decompositions etc.,)DSC:Differential scanning calorimetry, principles & applications (exothermic & endothermic peaks, compound purity determination, percentage crystallinity, glass transition temperature). (12h)

**Unit-IV: Electro-Analytical Techniques:** i).Brief introduction about polarography, Basic principle, instrumentation and applications of cyclic voltametry. ii), Amperometric Titrations: Basic principle involved in the Amperometry, Amperometric Titrations and applications, Advantages and disadvantages of Amperometric Titrations. (9h)

**Unit-V: Spectrophotometric Methods:** Introduction to Analysis: Qualitative & Quantitative Analysis;Conventional & Instrumental methods of analysis.

Molecular spectrophotormetry-Beer's law Block diagram of UV-Visible Spectrophotometer – quantitative analysis direct method for the determination metal ions: Chromium, Manganese, Iron, etc in alloys. Infrared spectrophotormetry-principle, instrumentation and Functional group analysis of organic compounds using infrared spectra. Quantitative analysis of organic molecules. Atomic absorption spectrophotormetry(AAS) and flame photometry: principle, instrumentation and applications (Determination of Sodium, Potassium and Calcium.) (12h)

**BOOKS:**

1. Quantitative analysis, R.A.Day& A.L. Underwood , 5th edition, Printice- Hall of India Pvt. Ltd., 2000.

2. Vogel's Text Book of Qualitative chemical analysis, J. Mendham, R.C.Denney, J. Darnes, M.J.K. Thomas, Persar education 6th edition, 2002.

3. Elements of Physical Chemistry-Peter Atkins, Oxford Uni.Press, 3rd Edition, 2010.

**REFERENCES:**

1. Atkin's Physical Chemistry – P. Atkins and J. De Paula, Oxford Univ.Press, 9th Edition, 2012

2. Instrumental lMethods of Chemical Analysis, GurdeepR.Chatwal, Sham K.Ananad, Himalayha publishing House,5th Edition, 2012.

3. Advanced physical chemistry – Gurudeepraj, Goel Publishing House, 2000

4. Essentials of Physical Chemistry- ArunBahl, B.S.Bahl and G.D.Rulasi, S.Chand Publishers,

New Delhi.

**II Year – 2nd Semester**

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| **19A20603** | **6. NUMERICAL METHODS, PROBABILITY AND STATISTICS** | **BSC** | **2-1-0** | **3 Credits** |

## Course Objective:

This course aims at providing the student with the knowledge on

1. various numerical methods for solving equations, interpolating the polynomials, evaluation of integral equations and solution of differential equations.
2. the theory of Probability and random variables.

**Unit-I: Solution of Algebraic & Transcendental Equations:**

Introduction-Bisection method-Iterative method-Regula falsi method-Newton Raphson method

System of Algebraic equations: Gauss Jordan method-Gauss Siedal method.

**Learning Outcomes:**

Students will be able to

1. calculate the roots of equation using Bisection method and Iterative method.
2. calculate the roots of equation using Regula falsi method and Newton Raphson method.
3. solve the system of algebraic equations using Gauss Jordan method and Gauss Siedal method.

**Unit-II: Interpolation**

Finite differences-Newton's forward and backward interpolation formulae – Lagrange's formulae. Gauss forward and backward formula, Stirling's formula, Bessel's formula.

**Learning Outcomes:**

Students will be able to

1. understand the concept of interpolation.
2. derive interpolating polynomial using Newton's forward and backward formulae.
3. derive interpolating polynomial using Lagrange's formulae.
4. derive interpolating polynomial using Gauss forward and backward formulae.

**Unit-III: Numerical Integration & Solution of Initial value problems to Ordinary differential equations**

Numerical Integration: Trapezoidal rule – Simpson's 1/3 Rule – Simpson's 3/8 Rule

Numerical solution of Ordinary Differential equations: Solution by Taylor's series-Picard's Method of successive Approximations-Modified Euler's Method-Runge-Kutta Methods.

**Learning Outcomes:**

Students will be able to

1. solve integral equations using Simson's 1/3 and Simson's 3/8 rule.
2. solve integral equations using Trapezoidal rule.
3. solve initial value problems to ordinary differential equations using Taylor's method.
4. solve initial value problems to ordinary differential equations using Euler's method and Runge Kutta methods.

**Unit-IV: Probability theory:**

Probability, probability axioms, addition law and multiplicative law of probability, conditional probability, Baye's theorem, random variables (discrete and continuous), probability density functions, properties, mathematical expectation.

**Learning Outcomes:**

Students will be able to

1. understand the concept of Probability.
2. solve problems on probability using addition law and multiplication law.
3. understand Random variables and probability mass and density functions.
4. understand stastical constants of random variables.

**Unit-V: Random variables & Distributions:**

Probability distribution - Binomial, Poisson approximation to the binomial distribution and normal distribution-their properties-Uniform distribution-exponential distribution

**Learning Outcomes:**

Students will be able to

1. understand Probability distribution function.
2. solve problems on Binomial distribution.
3. solve problems on Poisson distribution.
4. solve problems on Normal distribution.

**Text Books:**


3. Higher Engineering Mathematics, B.S.Grewal, Khanna publishers.
4. Probability and Statistics for Engineers and Scientists, Ronald E. Walpole,PNIE.
5. Advanced Engineering Mathematics, by Erwin Kreyszig, Wiley India


**Reference Books:**


3. Higher Engineering Mathematics, by B.V.Ramana, Mc Graw Hill publishers.
4. Advanced Engineering Mathematics, by Alan Jeffrey, Elsevier.

**Course Outcomes:**

After the completion of course, students will be able to

1. apply numerical methods to solve algebraic and transcendental equations
2. derive interpolating polynomials using interpolation formulae
3. Solve differential and integral equations numerically
4. apply Probability theory to find the chances of happening of events.
5. understand various probability distributions and calculate their statistical constants.

**II Year – 2nd Semester**

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| **19A20901** | **7. UNIVERSAL HUMAN VALUES** | **HE** | **2-0-0** | **2 Credits** |

**Objectives:**

• To create an awareness on Engineering Ethics and Human Values.
• To instil Moral and Social Values and Loyalty
• To appreciate the rights of Others

**Students will be able to:**

- Identify and analyze an ethical issue in the subject matter under investigation or in a relevant field
- Identify the multiple ethical interests at stake in a real-world situation or practice
- Articulate what makes a particular course of action ethically defensible

- Assess their own ethical values and the social context of problems
- Identify ethical concerns in research and intellectual contexts, including academic integrity, use and citation of sources, the objective presentation of data, and the treatment of human subjects
- Demonstrate knowledge of ethical values in non-classroom activities, such as service learning, internships, and field work
- Integrate, synthesize, and apply knowledge of ethical dilemmas and resolutions in academic settings, including focused and interdisciplinary research

**UNIT I: HUMAN VALUES:** Morals, Values and Ethics-Integrity-Work Ethic-Service learning – Civic Virtue – Respect for others – Living Peacefully – Caring – Sharing – Honesty - Courage- Co Operation – Commitment – Empathy –Self Confidence Character – Spirituality.

**UNIT II: ENGINEERING ETHICS:** Senses of 'Engineering Ethics- Variety of moral issued – Types of inquiry – Moral dilemmas – Moral autonomy –Kohlberg's theory- Gilligan's theory- Consensus and controversy – Models of professional roles- Theories about right action- Self-interest - Customs and religion –Uses of Ethical theories – Valuing time –Co operation – Commitment.

**UNIT III**: **ENGINEERING AS SOCIAL EXPERIMENTATION:** Engineering As Social Experimentation – Framing the problem – Determining the facts – Codes of Ethics – Clarifying Concepts – Application issues – Common Ground - General Principles – Utilitarian thinking respect for persons.

**UNIT IV: ENGINEERS RESPONSIBILITY FOR SAFETY AND RISK:** Safety and risk – Assessment of safety and risk – Risk benefit analysis and reducing risk- Safety and the Engineer- Designing for the safety- Intellectual Property rights (IPR).

**UINIT V: GLOBAL ISSUES:** Globalization – Cross culture issues- Environmental Ethics – Computer Ethics – Computers as the instrument of Unethical behavior – Computers as the object of Unethical acts – Autonomous Computers- Computer codes of Ethics – Weapons Development - Ethics and Research – Analyzing Ethical Problems in research – Intellectual property Rights( IPR).

**TEXT BOOKS:**

1. Engineering Ethics includes Human Values" by M.Govindarajan, S.Natarajananad, V.S.SenthilKumar-PHI Learning Pvt. Ltd-2009
2. "Engineering Ethics" by Harris, Pritchard and Rabins, CENGAGE Learning, India Edition, 2009.
3. "Ethics in Engineering" by Mike W. Martin and Roland Schinzinger – Tata McGraw-Hill– 2003.
4. "Professional Ethics and Morals" by Prof.A.R.Aryasri, DharanikotaSuyodhana-Maruthi Publications.
5. "Professional Ethics and Human Values" by A.Alavudeen, R.Kalil Rahman and M.Jayakumaran- LaxmiPublications.
6. "Professional Ethics and Human Values" by Prof.D.R.Kiran
7. Indian Culture, Values and Professional Ethics" by PSR Murthy-BS Publication

**II Year – 2nd Semester**

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| **19A20809** | **8. PROCESS HEAT TRANSFER LAB** | **PCC** | **0-0-3** | **1.5 Credits** |

**Objective:** This lab will provide practical knowledge on various heat transfer process and equipment like heat exchangers and evaporators.

**List of Experiments:**

1. Determination of total thermal resistance and thermal conductivity of composite wall.
   Major equipment - Composite wall Assembly
2. Determination of thermal conductivity of a metal rod.
   Major equipment - Thermal Conductivity apparatus
3. Determination of natural convective heat transfer coefficient for a vertical tube.
   Major equipment - Natural convection heat transfer apparatus
4. Determination of critical heat flux point for pool boiling of water.
   Major equipment- Pool boiling apparatus
5. Determination of forced convective heat transfer coefficient for air flowing through a pipe
   Major equipment – Forced convection heat transfer apparatus
6. Determination of overall heat transfer coefficient in double pipe heat exchanger.
   Major equipment - Double pipe heat exchanger apparatus
7. Determination of heat transfer coefficient for a helical coil in an agitated vessel.
   Major equipment – Helical coil in a agitated vessel.
8. Study of the temperature distribution along the length of a pin-fin under natural and forced convection conditions
   Major equipment - Pin fin apparatus
9. Estimation of un-steady state film heat transfer coefficient between the medium in which the body is cooled.
   Major equipment - Heat transfer coefficient determination apparatus
10. Determination of Stefan – Boltzmann constant.
    Major equipment - Stefan Boltzmann apparatus
11. Determination of emissivity of a given plate at various temperatures.
    Major equipment - Emissivity determination apparatus

**TEXT BOOK:**

1. Unit Operations of Chemical Engineering, 6th ed., W.L. McCabe, J.C. Smith and P. Harriot, McGraw-Hill, New York, 2001

**REFERENCES:**

1. Process Heat Transfer, D.Q. Kern, Tata McGraw-Hill, New Delhi, 1997.
2. Heat Transfer, 4th ed., J.P. Holman, McGraw-Hill, New York, 1976.
3. Chemical Engineering, Volume-I, J. Coulson and R.F. Richardson, Pergamon Press

**II Year – 2nd Semester**

| 19A20810 | 9.MECHANICAL OPERATIONS LAB | PCC | 3-0-0 | 1.5 Credits |
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**Objective:** The course will equip students with the practical knowledge of different mechanical unit operations & operational conditions of different equipment.

**List of Experiments:**

1. To determine the time of grinding in a ball mill for producing a product with 80 % passing a given screen.
Major equipment - Ball mill Apparatus, Sieve shaker, Different sizes of sieves, weighing balance.
2. To verify the laws of crushing using any size reduction equipment like crushing rolls or vibrating mills and to find out the working index of the material.
Major equipment – Jaw Crusher, Sieve shaker, Different sizes of sieves, Weighing Balance, Energy meter.
3. To find the effectiveness of hand screening and vibrating screen of a given sample.
Major equipment - Vibrating Sieve shaker, Different sizes of sieves, Weighing Balance.
4. To achieve beneficiation of a ore using froth flotation technique.
Major equipment - Froth flotation cell
5. To obtain batch sedimentation data and to calculate the minimum thickener area under given conditions.
Major equipment- Sedimentation apparatus
6. To determine the specific cake resistance and filter medium resistance of a slurry in plate and frame filter press.
Major equipment - Plate and frame filter press.
7. To separate a mixture of particles by Jigging.
Major equipment - Jigging apparatus
8. To calculate separation efficiency of particles in a mixture using cyclone separator.
Major equipment - Cyclone separator
9. To determine reduction ratio of a given sample in a pulverizer.
Major equipment - Pulverizer
1. Filtration Studies using
   a. Plate and Frame Filter Press
   b. Rotary Drum Filter
   c. Batch Centrifuge

11. To Perform mixing studies using Ribbon Mixer.

12. To determine reduction ratio of a given sample in .a grinder Major equipment - Grinder

**TEXT BOOK:**

1. Unit Operations in Chemical Engineering by W.L. McCabe and J.C. Smith and Peter Harriott, McGraw Hill 7th ed. 2001.

**REFERENCES:**

1. Chemical engineers hand book, J.H. Perry, 7th ed. McGraw Hill
2. Introduction to Chemical Engineering by J.T.Banchero& W.L. Badger., TMH, 1997.

**II Year – 2nd Semester**

| 19A28801 | BIOLOGY FOR ENGINEERS | MC | 3-0-0 | 0 Credits |
|---|---|---|---|---|

**Course Objectives:**

- To provide basic understanding about life and life Process. Animal and plant systems.
- To understand what bio molecules are, their structures are functions. Application of certain Bio molecules in Industry.
- Brief introduction about human physiology and bioengineering.
- To understand hereditary units, i.e. DNA (genes) and RNA and their synthesis in living organism.
- How biology Principles can be applied in our daily life using different technologies.
- Brief introduction to the production of transgenic microbes, Plants and animals.

**Unit I:**

**Introduction to Basic Biology**

Cell as Basic unit of life, cell theory, Cell shapes, Cell structure, Cell cycle. Chromosomes. Prokaryotic and eukaryotic Cell. Plant Cell, Animal Cell, Plant tissues and Animal tissues, Brief introduction to five kingdoms of classification.

**Unit Outcomes:**

After completing this unit, the student will be able to

- Summarize the basis of life.
- Understand the difference between lower organisms (prokaryotes) from higher organisms (eukaryotes).
- Understand how organisms are classified.

**Unit II:**

**Introduction to Biomolecules**

Carbohydrates, lipids, proteins, Vitamins and minerals, Nucleic acids (DNA and RNA) and their types. Enzymes, Enzyme application in Industry. Large scale production of enzymes by Fermentation.

**Unit Outcomes:**

After completing this unit, the student will be able to

- Understand what are bio molecules? Their role in living cells, their structure, function and how they are produced.
- Interpret the relationship between the structure and function of nucleic acids.
- Summarize the applications of enzymes in industry.
- Understand what is fermentation and its applications of fermentation in industry.

**Unit III:**

**Human Physiology**

Nutrition: Nutrients or food substances. Digestive system, Respiratory system, (aerobic and anaerobic Respiration). Respiratory organs, respiratory cycle. Excretory system.

**Unit Outcomes:**

After completing this unit, the student will be able to

- Understand what nutrients are
- Understand the mechanism and process of important human functions

**Unit IV:**

**Introduction to Molecular Biology and recombinant DNA Technology**

Prokaryotic gene and Eukaryotic gene structure. DNA replication, Transcription and Translation. DNA technology. Introduction to gene cloning.

**Unit Outcomes:**

After completing this unit, the student will be able to

- Understand and explain about gene structure and replication in prokaryotes and Eukaryotes
- How genetic material is replicated and also understands how RNA and proteins are synthesized.
- Understand about recombinant DNA technology and its application in different fields.

- Explain what is cloning.

**Unit V:**
**Application of Biology**
Brief introduction to industrial Production of Enzymes, Pharmaceutical and therapeutic Proteins, Vaccines and antibodies. Basics of biosensors, biochips, Bio fuels, and Bio Engineering. Basics of Production of Transgenic plants and animals.
**Unit Outcomes:**
After completing this unit, the student will be able to Understand.
- How biology is applied for production of useful products for mankind.
- What are biosensors, biochips etc.
- Understand transgenic plants and animals and their production

**Course Outcomes:**
After studying the course, the student will be able to:
- Explain about cells and their structure and function. Different types of cells and basics for classification of living Organisms.
- Explain about biomolecules, their structure and function and their role in the living organisms. How biomolecules are useful in Industry.
- Briefly about human physiology.
- Explain about genetic material, DNA, genes and RNA how they replicate, pass and preserve vital information in living Organisms.
- Know about application of biological Principles in different technologies for the production of medicines and Pharmaceutical molecules through transgenic microbes, plants and animals.

**TEXT BOOKS:**
1. P.K.Gupta, Cell and Molecular Biology, 5th Edition, Rastogi Publications -
2. U. Satyanarayana. Biotechnology, Books & Allied Ltd 2017

**REFERENCES:**
1. N. A. Campbell, J. B. Reece, L. Urry, M. L. Cain and S. A. Wasserman, "Biology: A Global Approach", Pearson Education Ltd, 2018.
2. T Johnson, Biology for Engineers, CRC press, 2011
3. J.M. Walker and E.B. Gingold, Molecular Biology and Biotechnology 2nd ed.. Panima Publications. PP 434.
4. David Hames, Instant Notes in Biochemistry –2016
5. Phil Tunner, A. Mctennan, A. Bates & M. White, Instant Notes – Molecular Biology –- 2014.

**3rd Year, 1st Semester**

## 1. CHEMICAL TECHNOLOGY

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Pre-requisites:** None

**Course Objectives:**

- Unit operations unit processes involved in manufacture of important and widely employed organic and inorganic chemicals.
- Develop skills in preparing /presenting a neat Engineering drawing for Chemical Process Industries.
- Impart clear description of one latest process along with its Chemistry, Process parameters, Engineering Problems and Optimum Conditions.
- Demonstrate the importance of updating the latest technological developments in producing products economically and environment friendly.
- Appreciate the usage of other engineering principles such as Thermodynamics, Heat, mass and momentum transfer in operation and maintain the productivity

***UNIT – I***

Water and Air: Importance of water, sources, plant location factors related to water, water shortage problems, methods of treating fresh water, methods of obtaining fresh water from saline waters, waste water treatment and disposal, air as a chemical raw material.

Soda ash, caustic soda and chlorine, Glass: manufacture of special glasses

**UNIT – II**

Industrial gases: carbon dioxide, hydrogen and oxygen – products of water gas, producer gas. Nitrogen industries: synthetic ammonia, urea, nitric acid (ammonium nitrate), ammonium chloride, ammonium phosphate and complex fertilizers

Sulphur and sulphuric acid, manufacture of sulphuric acid, hydrochloric acid and some other chemicals –Aluminium sulphate and alum.

**UNIT – III**

Cement manufacture, special cements, miscellaneous calcium compounds, magnesium compounds.

Manufacture of phenols, formaldehyde, vinyl chloride and vinyl acetate, manufacture of phenol- formaldehyde resin and polyvinyl chloride polymer, SBR

**UNIT – IV**

Oils: Definition, constitution, extraction and expression of vegetable oils, refining and hydrogenation of oils.

Synthetic fibers: Classification, manufacture of Nylon 66, polyester fiber and viscose rayon fiber.

Soaps and detergents: Definitions, continuous process for the production of fatty acids, glycerin and soap, production of detergents.

**UNIT – V**

Pulp and paper industry: methods of pulping, production of sulphate and sulphite pulp, production of paper –wet process

Pharmaceutical Industries: Classification, Alkylation, Carboxylation and Acetylation, Condensation and Cyclization, Dehydration, Halogenation, Oxidation, Sulfonation, Amination, Radio isotopes in Medicine, Fermentation and Life processing for Antibiotics, Hormones, and Vitamins, Biologicals, Steroid hormones, isolates and Animals.

**Course Outcomes:** At the end of the course, the student will be able to:

- Make a neat and easy to understand the plant process flow sheet.
- Keeps up the productivity while maintaining all safety norms stipulated, during their job
- Solve Engineering problems that are likely to come across during the operation of plants.
- Suggest alternative manufacturing process in terms of Economic viability of the product.

**Text books:**

1. Shreve's Chemical Process Industries edited by Austin, Mc. graw-Hill.5$^{th}$ ed.1985.
2. Dryden's Outlines of Chemical Technology edited by M. Gopal Rao and M. Sittig, 2$^{nd}$ ed. 1973.

**References:**

1. Industrial Chemistry by B.K. Sharma,
2. Hand book of industrial chemistry Vol 1& II K.H.Davis& F.S. Berner Edited by S.C. Bhatia, CBS publishers
3. Chemical Technology: G.N. Panday, Vol 1& Vol II.

**3$^{rd}$ Year, 1$^{st}$ Semester**

## 2. MASS TRANSFER OPERATIONS-II

| L | T | P | C |
|---|---|---|---|
| 2 | 1 | 0 | 3 |

**Course Objectives:**

To introduce stage wise mass transfer operations, principles of various stage wise contact processes like distillation, extraction and leaching and drying

- To appraise design aspects of the equipment for utilized for distillation, extraction and leaching and drying.
- To coach the importance of VLE for ideal non-ideal systems (miscible and immiscible liquids) in mass transfer operations.
- To enlighten on different types of distillation such as: batch & continuous, flash vaporization, steam distillation and differential distillation.
- To impart distillation column design using McCabe Thiele and Ponchon-Savarit methods.

**UNIT-I**

Distillation: Fields of applications, VLE for miscible liquids, immiscible liquids, steam distillation, Positive and negative deviations from ideality, enthalpy-concentration diagrams, flash vaporization and differential distillation for binary and multi component mixtures, Batch distillation with Reflux.

**UNIT-II**

Continuous rectification-binary systems, multistage tray towers –method of Mc Cabe and Thiele, enriching section, stripping section, feed introduction, total reflux, minimum and optimum reflux ratios, use of open steam, types of condensers, partial condensers, effect of cold reflux, multiple feeds, tray efficiencies, continuous-contact equipment (packed towers)

Multistage (tray) towers –the method of Ponchon and Savarit, the enriching and stripping sections, feed tray location, total reflux, minimum and optimum reflux ratios, types of reboilers, use of open steam, condenser and reflux accumulators, Azeotropic distillation, extractive distillation, comparison of Azeotropic and extractive distillation.

**UNIT- III**

Liquid-Liquid operations: fields of usefulness, liquid-liquid equilibrium, equilateral triangular co-ordinates, choice of solvent, stage wise contact, multistage cross-current extraction, Multi stage counter current without reflux

Multi stage counter current with reflux, Differential (continuous contact) extractors, spray towers, packed towers, mechanically agitated counter-current extractors, centrifugal extractors, dilute solutions, super critical fluid extraction, fractional extraction.

**UNIT-IV**

Leaching: Fields of applications, preparation of solid for leaching, types of leaching, leaching equilibrium, single stage and multi stage leaching calculations, constant under flow conditions, equipment for leaching operation.

**UNIT-V**

Adsorption: Adsorption, types of adsorptions, nature of adsorbents, adsorption equilibrium, single gases and vapors, Adsorption Hysteresis, effect of temperature, Heat of adsorption, vapor and gas mixtures: One component adsorbed, Effect of change of temperature or pressure. Liquids, Adsorption of solute from dilute solution, The Freundlich equation, Adsorption from concentrated solutions, adsorption operations, stage wise operation, application of Freundlich equation to single and Multistage adsorption (cross current & counter current).

Fluidized and teeter beds, continuous contact, steady state moving bed adsorbers, unsteady state–fixed bed adsorbers, adsorption wave, elution, pressure swing and vacuum swing adsorption (qualitative treatment), ion-exchange: principles of ion exchange, techniques and applications.

**Text Book:**

1. Mass transfer operations by R.E. Treybal, 3rd ed. Mc Graw Hill, 1980.

**Reference Books:**


1. Principles of Mass Transfer and Separation Processes by B K Dutta, Printice Hall of India Pvt Limited, New Delhi
2. Transport processes and unit operations by Christie J. Geankoplis
3. Separation Process Principles, J D Seader and E. J. Henley, John Wiley & Sons, Inc, New York

3rd Year, 1st Semester

## 3. CHEMICAL REACTION ENGINEERING – I

| L | T | P | C |
|---|---|---|---|
| 2 | 1 | 0 | 3 |

**Course Objectives:**

- To explain the temperature dependency of rate of reaction as per Arrhenius law, Collision theory and Transition State theory.
- To teach how to determine kinetics of a chemical reaction both at constant and variable volume from the experimental data using integral, differential and method of fractional lives.
- To inform how to obtain the rate law for a non-elementary chemical reaction from a given mechanism
- To describe the designing of reactors for conducting homogenous reactions under isothermal conditions.

**UNIT I**

Overview of chemical reaction engineering-classification of reactions, variables affecting the rate of reaction definition of reaction rate, kinetics of homogenous reactions- concentration dependent term of rate equation, Temperature dependent term of rate equation, searching for a mechanism, predictability of reaction rate from theory.

**Interpretation of batch reactor data- constant volume batch reactor**:- Analysis of total pressure data obtained in a constant-volume system, the conversion, Integral method of analysis of data– general procedure, irreversible unimolecular type first order reactions, irreversible bimolecular type second order reactions, irreversible trimolecular type third order reactions, empirical reactions of nth order, zero-order reactions, overall order of irreversible reactions from the half-life, fractional life method, irreversible reactions in parallel, homogenous catalyzed reactions, autocatalytic reactions, irreversible reactions in series.

**UNIT II**

**Constant volume batch reactor**– first order reversible reactions, second order reversible reactions, reversible reactions in general, reactions of shifting order, Differential method of analysis of data. Varying volume batch reactor–differential method of analysis, integral method of analysis, zero order, first order, second order, nth order reactions, temperature and reaction rate, the search for a rate equation.

**UNIT III**

**Introduction to reactor design**- general discussion, symbols and relationship between $C_A$ and $X_A$. Ideal reactors for a single reaction- Ideal batch reactor, Steady-state mixed flow reactor, Steady-state plug reactors.

**Design for single reactions**- Size comparison of single reactors, Multiple- reactor systems, Recycle reactor, Autocatalytic reactions.

**UNIT IV**

**Design for parallel reactions**- introduction to multiple reactions, qualitative discussion about product distribution, quantitative treatment of product distribution and of reactor size.

**Multiple reactions**-Irreversible first order reactions in series, quantitative discussion about product distribution, quantitative treatment, plug flow or batch reactor, quantitative treatment, mixed flow reactor, first-order followed by zero-order reaction, zero order followed by first order reaction.

**UNIT V**

**Temperature and Pressure effects**- single reactions- heats of reaction from thermodynamics, heats of reaction and temperature, equilibrium constants from thermodynamics, equilibrium conversion, general graphical design procedure, optimum temperature progression, heat effects, adiabatic operations, non-adiabatic operations, comments and extensions. Exothermic reactions in mixed flow reactors-A special problem, multiple reactions.

**Course outcomes:**

At the end of the course, student will be able to:

- Derive the rate law for non-elementary chemical reactions based on the specified mechanism.
- Determine kinetics of a chemical reaction from the experimental data using integral, differential and fractional life methods.
- Design reactors for conducting homogenous reactions under isothermal conditions.
- Select suitable contacting patterns or operating conditions for maximizing the selectivity for parallel and series reactions.
- Show conversion as a function of temperature under adiabatic/non-adiabatic conditions.

**TEXT BOOK:**

1. Chemical Reaction Engineering, 3$^{rd}$ ed., O. Levenspiel, John Wiely & Sons, 1999.

**REFERENCES:**

1. Elements of Chemical Reaction Engineering, 2$^{nd}$ ed., H.S. Fogler, PHI Learning Pvt. Ltd., New Delhi, 2010.
2. Chemical Engineering Kinetics, 3$^{rd}$ ed., J.M. Smith, McGraw-Hill, New York, 1981.

**3$^{rd}$ Year, 1$^{st}$ Semester**

## Professional Elective-I

## PE1. PETROLEUM REFINING AND PETROCHEMICALS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:**

- Learn the formation, refining of crude oil and products of refinery.
- Understand the means of processing data including thermal properties, important products characteristics.
- Develop skills in drawing neat flow diagrams of different petroleum refining processes
- (cracking/reforming/alkylation/isomerization / hydrocracking etc.,) that are aimed at producing high value/demand products.

- Identify important testing methods for important petroleum products.
- Have idea on Indian standards for major petroleum products

**UNIT-I**

Origin, formation and composition of petroleum: Origin and formation of petroleum, Reserves and deposits of world, Indian Petroleum Industry. Petroleum processing data: Evaluation of petroleum, thermal properties of petroleum fractions, important products, properties and test methods.

**UNIT-II**

Fractionation of petroleum: Dehydration and desalting of crudes, heating of crude pipe still heaters, distillation of petroleum, blending of gasoline. Treatment techniques: fraction-impurities, treatment of gasoline, treatment of kerosene, treatment of lubes.

**UNIT-III**

Thermal and catalytic processes: Cracking, catalytic cracking, catalytic reforming, Naphtha cracking, coking, Hydrogenation processes, Alkylation processes, Isomerization process.

**UNIT-IV**

Petrochemical Industry – Feed stocks Chemicals from methane: Introduction, production of Methanol, Formaldehyde, Ethylene glycol, PTFE, Methylamines.

**UNIT-V**

Chemicals from Ethane-Ethylene-Acetylene: Oxidation of ethane, production of Ethylene, Manufacture of Vinyl Chloride monomer, vinyl Acetate manufacture, Ethanol from Ethylene, Acetylene manufacture, Acetaldehyde from Acetylene.

**Course Outcomes:**

At the end of the course, student will be able to

- Describe the formation of crude oil, its refining techniques.
- Explain about the crude oil distillation and its products.
- Acquire knowledge about catalytic cracking / reforming processes.
- Evaluate the petrochemical feedstock for manufacture of various value-added chemicals.
- Explain the technologies of low carbon alkane and alkynes based high value chemicals.

**TEXT BOOKS:**

1. Nelson. W.L. “Petroleum refining Engineering”, 4 Edition, Mc Graw Hill, New York, 1969.

2. Rao, B.K.B. “Modern Petroleum Refining Processes”, 4 Edition, Oxford and IBH Publishing, 2002.

**REFERENCES:**

1. Goldstine. R.F. “The Petroleum Chemicals Industry”, Taylor and Francis, London, 1967.

2. Gruese. W.S.and Stevens, D.R. “Chemical Technology of Petroleum”, McGraw Hill, 1980.

3 Chauvel. A. and Lefevrev, “Petro Chemicals”, Volume 1 and 2, Gulf Publishing company 1989.

**3rd Year, 1st Semester**

## Professional Elective-I
## PE2. PROCESS MODELING AND SIMULATION

| L | T | P | C |
|---|---|---|---|
| 2 | 1 | 0 | 3 |

**Course Objectives:**
- Learn to develop mathematical model for problems.
- To impart knowledge on modelling of various equipment and their simulation using different numerical techniques.
- Formulate a chemical engineering problem as a mathematical model, and select an appropriate solution method.
- Understand the computational requirements of various solution options and use this understanding in the selection of the solution method
- Formulate and solve process design problems, based on fundamental analysis and using mathematical models of chemical processes

**UNIT I**

**Mathematical models for chemical engineering systems**: classification of mathematical models- steady state vs dynamic models, lumped vs distributed parameter models, deterministic vs stochastic models. **Examples of mathematical models-** Two heated tanks, batch reactor, constant volume CSTRs, non-isothermal CSTR, reactor with mass transfer, ideal binary distillation column, batch distillation with holdup.

**UNIT II**

**Empirical model building**- method of least squares, linear, polynomial and multiple regression, non-Linear regression. **Solution of Non- Linear Algebraic equations**- bisection, false position, Quasi Newton and Newton- Raphson methods.

**UNIT III**

**Numerical integration**- Trapezoidal rule, Simpson's rule and Newton– Cotes formula. **Numerical solution of differential equations**- Euler's method, Runge- Kutta methods, predictor corrector methods.

**UNIT IV**

**Numerical solution of partial differential equations**- elliptic, parabolic and hyperbolic equations. finite difference methods, Leibman's method, Crank Nicholson method. Applications to steady state and Unsteady state heat conduction and temperature distribution problems.

**UNIT V**

**Process Simulation examples**: VLE dew point and bubble point calculations, binary distillation column, gravity flow tank, batch reactor, Non- isothermal CSTR, countercurrent heat exchanger.
**Process simulation using modular and equation based solving approaches**: Developing a simulation model, a simple flow sheet, Sequential modular approach, Simultaneous modular approach, Equation solving approach.

**Course Outcomes:** At the end of the course, the student will be able to:

1. Understand the stages involved in the development of a process model.
2. Formulate a chemical engineering problem as a mathematical model from basic engineering principles.
3. Identify the appropriate numerical solutions used in solving the models
4. Apply various simulation tools for solving the chemical engineering models developed.
5. Understand the solution techniques for solving ODEs.

**Text Books:**

1. Process modelling, Simulation and Control for Chemical Engineers, 2nd ed., W. L. Luyben, McGraw-Hill, New York, 1990.
2. Numerical Methods for Engineers, S.K. Gupta, Wiley Eastern, New Delhi, 1995.

**Reference Books:**

1. Numerical Methods for Engineers and Scientists, S.S. Rao
2. Introduction to Numerical Methods in Chemical Engineering, P. Ahuja, PHI learning Pvt. Ltd., New Delhi, 2010
1. Process Modeling and Simulation, Amiya K. Jana, 2012.

3rd Year, 1st Semester

**Professional Elective-I**
**PE3. NUMERICAL METHODS IN CHEMICAL ENGINEERING**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:**

- To instruct the concept of Matrices in solving linear algebraic equations
- To elucidate the different numerical methods to solve nonlinear algebraic equations
- To disseminate the use of different numerical techniques for carrying out numerical integration and numerical differentiation.
- To introduce curve fitting using method of least squares
- To teach different methods to solve ordinary differential equations.
- To explain the importance of numerical methods to solve chemical engineering problems.

**UNIT I**

Elementary row transformations - Rank, Eigen Values, Solution of system of linear equations by Gauss elimination and Gauss Jordan, Gauss Siedel and LU decomposition methods.

**UNIT II**

**Solution of Nonlinear Algebraic Equations**: Introduction, Bisection method, Newton-Raphson, Regula Falsi and Secant method. Chemical engineering problems involving solution of linear and Non-linear algebraic equations.

**UNIT III**

**Regression Analysis**: Introduction, least squares curve-fitting methods, Newton's forward formulae, Newton's backward formulae. Interpolation Polynomial, Lagrangian Interpolation (Unequal Intervals), cubic spline interpolation.

**UNIT IV**

**Numerical differentiation:** Three-point Lagrangian formulae.

**Numerical Integration:** Trapezoidal rule, Simpson's 1/3 and 3/8 rules, integration with unequal segments, Chemical engineering problems involving numerical differentiation and integration.

**UNIT V**

**Solution of ordinary Differential Equations-** Introduction to ordinary Differential Equations, Initial and boundary value problems, Euler method, modified Euler, Runge-Kutta 4th order method, Predictor Corrector method, Milne's method, Chemical engineering problems involving single, and a system of ODEs.

**Introduction to Partial Differential Equations**: elliptic, parabolic and hyperbolic equations and their applications in chemical engineering.

**Course Outcomes**

At the end of the course the student will be able to

- Solve system of linear algebraic equations using Gauss elimination, Gauss Jordan, Gauss Siedel and LU decomposition methods
- Solve linear/nonlinear algebraic and transcendental equations using numerical methods
- Apply cure fitting techniques to approximate a function for the given data
- Evaluate definite integral and derivative (for the given data or function) using numerical methods
- Solve ordinary differential equations by Euler's method, modified Euler's method, Runge Kutta method, Predictor Corrector method and Milne's method.
- Apply numerical methods to different Chemical Engineering problems.

**TEXT BOOK:**

1. Numerical methods for Engineers, S.K. Gupta, New Age International (P) Limited, Publishers, 1998
2. Introductory Methods of Numerical Analysis, S.S. Sastry, PHI publisher.

**REFERENCE BOOKS:**

1. Mathematical methods in Chemical Engineering, S. Puspavanam, Prentice Hall of India PHI,1998 ISBN 81-203-1262-7
2. Mathematical methods in Chemical and environmental
3. Engineering, Ajay K. Roy, Thomson Learning, 2000 ISBN 981-240-375-2
4. Engineering Mathematics, Volume - II, E. Rukmangadachari & E. Keshava Reddy, Pearson Publisher.
5. Engineering Mathematics, Volume - II, by G.S.S.Raju, CENGAGE publisher.
6. Mathematical Methods by T.K.V. Iyengar, B.Krishna Gandhi, S.Ranganatham and M.V.S.S.N.Prasad, S. Chand publication.
7. Higher Engineering Mathematics, by B.V.Ramana, Mc Graw Hill publishers.
8. Advanced Engineering Mathematics, by Erwin Kreyszig, Wiley India.

**3rd Year, 1st Semester**

## OPEN ELECTIVE -I

## OE1. MEMBRANE TECHNOLOGY

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:**

1. Explain the basic principles of membrane separation processes.
2. Describe about the characterization of membrane.
3. Introduce the concepts of polarization, fouling, module and process design
4. Review the membrane modules used for the industrial applications
5. Discuss the preparation of synthetic membranes

**UNIT- I**

**Introduction:** Separation processes, Introduction to membrane processes, definition of a membrane, classification of membranes. Preparation of Synthetic membranes: Types of Membrane materials, preparation of Synthetic membranes, phase inversion membranes, preparation technique for immersion precipitation, and preparation technique for composite membranes.

**UNIT- II**

**Characterization of membranes;** Introduction, membrane characterization, characterization of porous membranes, characterization of non-porous membranes.

Transport in membranes: introduction, driving forces, non-equilibrium thermodynamics, transport through porous, non-porous, and ion exchange membranes.

**UNIT- III**

**Membrane Processes:** Introduction, Osmosis, pressure driven membrane processes: Introduction, microfiltration, membranes for microfiltration, industrial applications, ultrafiltration: membranes for ultrafiltration, industrial applications, reverse Osmosis and nano filtration: membranes for reverse osmosis and nanofiltration, industrial applications, Electrically Driven processes: Introduction, electrodialysis, Process parameters, membranes for electrodialysis, applications, Membrane electrolysis, Bipolar membranes, Fuel Cells.

**UNIT- IV**

Concentration driven membrane processes: gas separation: gas separation in porous and non-porous membranes, membranes for gas separation, applications, pervaporation, membranes for pervaporation, applications, dialysis: membranes for dialysis, applications, liquid membranes: aspects, liquid membrane development, choice of the organic solvent and carrier, applications, introduction to membrane reactors.

**UNIT- V**

Polarization phenomenon and fouling: Introduction to concentration polarization, turbulence promoters, pressure drop, gel layer model osmotic pressure model, boundary layer resistance model, concentration polarization in diffusive membrane separations and electro dialysis, membrane fouling, methods to reduce fouling, compaction. Module and process design: Introduction, plate and frame module, spiral wound module, tubular module, capillary module, hollow fiber module, comparison of module configurations.

**Course Outcomes:**

At the end of the course, student will be able to

1. Explain various types of membranes and preparation techniques.
2. Understand the characterization and transport in membranes.
3. Understand the underlined principles and importance of ultrafiltration, reverse osmosis, electro dialysis, nano filtration etc., in industrial waste water treatment.
4. Learn gas separation in porous and non-porous membranes.

**Text Books:**

1. Membrane Separations, M.H.V. Mulder, Springer Publications, 2007
2. Rate-Controlled Separations, P. C. Wanket, Elsevier Applied Science, London,1994.

**Reference Books:**

1. Membrane Technology in the Chemical Industry, S.P. Nunes, K.V. Peinemann, Wiley-VCH
2. Membrane Processes in Separation and Purification, J.G.Crespo, K.W.Bodekes, Kluwer Academic Publications.
3. Membrane Separation Processes, K. Nath, PHI Pvt. Ltd., New Delhi,2008.

**3rd Year, 1st Semester**

## OPEN ELECTIVE-I

## OE2. WATER CONSERVATION AND MANAGEMENT

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Pre-Requisites:** Water resources and Preservation methods

**Course Objectives:**

1. To apply concepts of water resources management and design techniques.
2. To plan and design water harvesting and groundwater recharge structures.
3. To design water supply and sanitation system.

**UNIT I**

Introduction: water cycle, water storage, water quality; water conservation in homes; water conservation in the work place, water resources planning. Water resources systems – irrigation management, water quality management, groundwater management, water conveyance and distribution systems.

**UNIT II**

Design Techniques: Environmental Restoration. Evaluate results of participatory mapping of water resources and challenges, soil and water conservation, conservation through reforestation. Check dams for controlling runoff and plugging gullies.

**UNIT III**

Introduction: concept of watershed, need for watershed management, concept of sustainable development and Hydrology of small watersheds. Principles of water harvesting, methods of rainwater harvesting, design of rainwater harvesting structures. Artificial recharge of groundwater in small watersheds, methods of artificial recharge.

**UNIT IV**

Introduction: Epidemiological aspects of water quality- methods for low-cost water treatment - Specific contaminant removal systems. Water quality monitoring

**UNIT V**

Water Conservation in Industries: Conservation of Water for Cooling, Water Conservation in Pre-treatment Plant, Water Conservation in Softening Plants, Water Conservation in Demineralization Plant, Treatment of Condensate, Treatment and Disposal of wastewater in process industry. Water Recycling and Water Audit.

**Course Outcomes:**

At the end of the course, student will be able to

- Explain water resource planning.
- Prepare water auditing to be able to apply the principles to many situations and make recommendations for water conservation measures.
- Design low-cost water management system.
- Predict water quality and conservation.
- Practice industrial water conservation techniques.

**Text Books:**

1. Chatterjee, S. N., Water Resources Conservation and Management, Atlantic Publishers, 2008
2. Loucks, D.P. and Eelco van Beek (2005), "Water Resources Systems Planning and Management – An introduction to methods, models and applications", Studies and Reports in Hydrology, UNESCO Publishing

**Reference Books:**

1. Mohan Seneviratne., A Practical Approach to Water Conservation for Commercial and Industrial Facilities, 1st Edition, Elsevier Science, 2007.
2. Jeff Sturman, GoenHo, Kuruvilla Mathew., Water Auditing and Water Conservation, IWA Publishing, 2004.
3. Claude E. Boyd., Water Quality: An Introduction, springer Science & Business Media, 2000.
4. Loucks, D.P., Stedinger, J.R. and Haith, D.A. (1982) "Water Resources Systems Planning and Analysis", Prentice Hall Inc. N York
5. Muthy, J. V. S., Watershed Management, New Age International Publishers, 1998

**3rd Year, 1st Semester**

## OPEN ELECTIVE-I
## OE3. ENERGY ENGINEERING

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:**

- To acquaint the student with the conventional energy sources and their utilization.
- To understand the importance of heat recovery and energy conservation methods and energy audit

**UNIT -I**

Sources of energy, types of fuels- energy and relative forms. Calorific value- gross and net value, calculation of calorific value from fuel analysis, experimental determination energy resources present and future energy demands with reference to India.

**Coal:** origin, occurrence, reserves, petrography, classification, ranking, analysis, testing, storage, coal carbonization and by-product recovery, liquefaction of coal, gasification of coal, burning of coal and firing mechanism, burning of pulverized coal.

**UNIT- II**

**Liquid fuels:** petroleum: origin, occurrence, reserves, composition, classification, characteristics, fractionation, reforming, cracking, petroleum products, specification of petroleum products, burning of liquid fuels.

Natural gas, coke oven gas, producer gas, water gas, LPG, burning of gaseous fuels, hydrogen (from water) as future fuel, fuel cells, flue gas, analysis: orsat apparatus.

**UNIT -III**

**Steam Plant:** Run time cycle, boiler plant, steam cost, steam distribution and utilization, combined heat and power systems, energy from biomass and biogas plants, gas purification, solar energy, wind energy, energy storage.

**UNIT -IV**

Waste heat recovery, sources of waste heat and potential application, various types of heat recovery systems, regenerators, recuperators, waste heat boilers

**Energy conservation:** conservation methods in process industries, theoretical analysis, practical limitations.

**UNIT-V**

**Energy auditing:** short term, medium-term, long-term schemes, energy conversion, energy index, energy cost, representation of energy consumption, Sankey diagram, energy auditing.

**Course Outcomes:**

At the end of the course, the student will be able to:

- Explain conventional energy sources and their utilization requirements with reference to Indian Scenario
- Classify different catalytic Cracking and Reforming processes
- Estimate steam production cost and its quality
- Describe energy production and storage for solar and wind
- Explain heat recovery from processes and effective utilization of waste heat

**Text Books:**

1. Fuels, Furnaces and Refractories, O.P.Gupta
2. Fuels and Combustion, 3rd ed., Samir Sarkar, Universities Press, 2009.

**Reference Books:**

1. Non-conventional Energy Resources, G.D.Rai, Khanna Publishers
2. Fuel and Energy, Harker and Backhurst, Academic press London 1981
3. Fuel Science- Harker and Allen, Oliver and Boyd, 1972

**3rd Year, 1st Semester**

## 6. INSTRUMENTATTION AND PROCESS CONTROL

| L | T | P | C |
|---|---|---|---|
| 2 | 1 | 0 | 3 |

**Pre Requisites:** Mathematics-II

**Course Objectives:**

1. Describe the various elements of instruments, measurement of temperature, pressure and level in process industries.
2. Define the basics of process control and develop transfer function models for dynamic processes.
3. Draw the block diagrams and analyze process stability

**UNIT- I**

Elements of instruments, static and dynamic characteristics, basic concepts of first order type instruments, mercury in glass thermometer, bimetallic thermometer, pressure spring thermometer. Industrial thermocouples, thermocouple wires, thermo couple wells. Head, density and specific gravity, direct measurement of liquid level, pressure measurement in open vessels, level measurements in pressure vessels. Pressure vacuum and head: liquid column manometers, measuring elements for gauge pressure and vacuum, indicating elements for pressure gauges, measurement of absolute pressure, measuring pressure in corrosive liquids.

**UNIT- II**

**Introduction to process dynamics and control:** Laplace transforms, Inverse Laplace transform, Response of First Order Systems. Physical examples of first order systems- Liquid level, mixing process, R- C circuit. Linearization.
Response of first order systems in series- interacting and non- interacting systems, second order systems, transportation lag.

**UNIT- III**

**Control system:** Components of a control system, Servo Vs regulator problem, development of block diagram. **Controllers and final control elements:** Control valve and its construction, PD, PI, PID controllers. **Stability**: Concept of Stability, Stability criterion, Routh test for stability.

**UNIT- IV**

**Root locus**: concept of root locus, rules for plotting the root locus diagram.
**Introduction to frequency response**: Substitution rule, Bode diagrams
**Control systems design by frequency response**: Bode stability criterion, Gain and Phase margins.

**UNIT- V**

**Controller tuning**: Tuning of P, PD, PI, PID controllers, Ziegler- Nichols technique, Cohen and Coon rules.
**Advanced control strategies:** Cascade control, feed forward control, ratio control, Smith predictor.

**Text Books:**

1. Industrial instrumentation by Donald P. Eckman, Wiley eastern, 1950.
2. Process Systems Analysis and Control, $2^{nd}$ ed., D.R. Coughanowr, McGraw-Hill, 1991

**Reference Books:**

1. Chemical Process Control, G. Stephanopoulos, PHI Learning Pvt. Ltd., New Delhi, 2010
2. Process Control, B.W. Bequette, PHI Learning Pvt. Ltd., New Delhi, 2010

**Course Outcomes:**

At the end of the course, student will be able to

1. Illustrate the various instruments for measuring various process variables such as temperature, pressure, flow.
2. Evaluate the transfer functions for various first order and second order examples.
3. Explain the various types of controllers using block diagram along with the concept of stability.
4. Analyze in more detail the stability criteria using various methods.
5. Explain about the various controller tuning techniques.

**3rd Year, 1st Semester**

## 7. REASERCH METHODOLOGY

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 0 |

**Course Objectives:** The objective of this course is

1. To understand the basic concepts of research and research problem
2. To make the students learn about various types of data collection and sampling design
3. To enable them to know the method of statistical evaluation
4. To make the students understand various testing tools in research
5. To make the student learn how to write a research report
6. To create awareness on ethical issues n research

**UNIT I**

**Introduction to Research**

Meaning of Research – Objectives of Research – Types of Research – Research Approaches – Guidelines for Selecting and Defining a Research Problem – Research Design – Concepts related to Research Design – Basic Principles of Experimental Design.

**LEARNING OUTCOMES: -** After completion of this unit student will

- Understand the concept of research and its process
- Explain various types of research
- Know the steps involved in research design
- Understand the different research approaches

**UNIT II**

**Sampling Design**

Steps in Sampling Design –Characteristics of a Good Sample Design – Random Sampling Design. Measurement and Scaling Techniques-Errors in Measurement – Tests of Sound Measurement – Scaling and Scale Construction Techniques – Time Series Analysis – Interpolation and Extrapolation. Data Collection Methods – Primary Data – Secondary data – Questionnaire Survey and Interviews.

**LEARNING OUTCOMES: -** After completion of this unit student will

- Understand the concept of sampling and sampling design

- Explain various techniques in measurement and scaling
- Learn various methods of data collection
- Design survey questionnaires for different kinds of research

**UNIT III**

**Correlation and Regression Analysis**

Method of Least Squares – Regression vs Correlation – Correlation vs Determination – Types of Correlations and Their Applications

**LEARNING OUTCOMES: -** After completion of this unit student will

- Know the association of two variables
- Understand the importance of correlation and regression
- Compare and contrast correlation and regression
- Learn various types of correlation
- Apply the knowledge of C&R Analysis to get the results

**UNIT IV**

**Statistical Inference**

Tests of Hypothesis – Parametric vs Non-parametric Tests – Hypothesis Testing Procedure – Sampling Theory – Sampling Distribution – Chi-square Test – Analysis of variance and Co-variance – Multivariate Analysis

**LEARNING OUTCOMES: -** After completion of this unit student will

- Know the statistical inference
- Understand the hypothesis testing procedure
- Compare and contrast Parametric and Non-parametric Tests
- Understand the use of chi-square test in investigating the distribution of categorical variables
- Analyze the significance of variance and covariance

**UNIT V Report Writing and Professional Ethics**

Interpretation of Data – Report Writing – Layout of a Research Paper – Techniques of Interpretation- Making Scientific Presentations in Conferences and Seminars – Professional Ethics in Research.

**LEARNING OUTCOMES: -** After completion of this unit student will

- Learn about report writing
- Understand how to write research paper
- Explain various techniques of interpretation
- Understand the importance of professional ethics in research
- Design a scientific paper to present in the conferences/seminars

**Text Books:**

1. Research Methodology: Methods and Techniques – C.R.Kothari, 2nd Edition, New Age International Publishers.

2. Research Methodology: A Step by Step Guide for Beginners- Ranjit Kumar, Sage Publications

**REFERENCES:**

1. Research Methodology and Statistical Tools – P.Narayana Reddy and G.V.R.K.Acharyulu, 1st Edition, Excel Books, New Delhi.

2. Business Research Methods–Donald R. Cooper & Pamela S Schindler, 9/e,

3. S C Gupta, Fundamentals of Statistics,7th Edition Himalaya Publications

| **COURSE OUTCOMES:** At the end of the course, students will be able to | |
|---|---|
| CO1 | Define the basic concepts and its methodologies |
| CO2 | Understand the concept of sampling, research design etc. |
| CO3 | Demonstrate the knowledge of research processes |
| CO4 | Analyze the importance of research articles in their academic discipline |

| | |
|---|---|
| CO5 | Select appropriate testing tools used in research |
| CO6 | Design a research paper without any ethical issues |

**3rd Year, 1st Semester**

## 8. MASS TRANSFER OPERATIONS LAB

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 3 | 1.5 |

**Laboratory Experiments:**

1. Estimation of diffusivity coefficients for vapor in gas
2. Estimation of solid diffusion coefficient in air
3. Steam distillation
4. Simple distillation
5. Evaluation of HETP in packed towers
6. Vapor Liquid Equilibria
7. Batch Drying

8. Evaluation of Mass transfer coefficients for Surface Evaporation
9. Evaluation of Mass transfer coefficients for Wetted wall column
10. Liquid- Liquid Equilibria (Tie line data)
11. Ternary Liquid Equilibria (binodal curve)
12. Leaching
13. Adsorption studies

**TEXT BOOK:**

1. Mass transfer operations by R.E. Treybal, 3rd ed. Mc Graw Hill, 1980.

**REFERENCE:**

1. Principles of Mass Transfer and Separation Processes by B K Dutta, Printice Hall of India Pvt Limited, New Delhi
2. Transport processes and unit operations by Christie J. Geankoplis
3. Separation Process Principles, J D Seader and E. J. Henley, John Wiley & Sons, Inc,. New York
4. Mass transfer operations Laboratory manual by Mr.M.kalyan kumar, lambert publications, June 2019.

**Course outcomes:**

At the end of the course, student will be able to:

- Analyse different types of distillation such as: batch & continuous, flash vaporization, steam distillation and differential distillation.
- Design distillation columns using McCabe Thiele and Ponchon-Savarit methods.
- Demonstrate Azeotropic distillation, extractive distillation and ion exchange.
- Explain types of adsorptions, nature of adsorbents, adsorption equilibrium, Adsorption

**3rd Year, 1st Semester**

## 9. INSTRUMENTATION AND PROCESS CONTROL LAB

| L | T | P | C |
|---|---|---|---|
| **0** | **0** | **3** | **1.5** |

**Pre Requisites:** Instrumentation and Process Control

**Course Objectives:**

1. Study about process dynamics and various forms of mathematical models to express them
2. Determine the time lag for first and second order systems.
3. Emphasize theoretical concepts of open and close loop runs on liquid level and liquid temperature.

**List of Experiments:**

1.Calibration and determination of time lag of various first and second order instruments

Major equipment - First order instrument like Mercury-in-Glass thermometer and Overall second order instrument like Mercury-in-Glass thermometer in a thermal well

2. Experiments with single tank system.
   Single tank - Step Response
   Single tank - Impulse Response

3. Experiments with two tank system with interaction.
   Interacting Tanks – Step Response
   Interacting Tanks – Impulse Response

4.Experiments with two tank system without interaction.

Non Interacting Tanks – Step Response

Non Interacting Tanks – Impulse Response

5. Level control trainer

Major equipment - Level control trainer set up with computer

6. Temperature control trainer

Major equipment - Temperature control trainer with computer

7. Experiments on proportional, reset, rate mode of control etc.

Major equipment – PID control apparatus

8. Control valve characteristics

Major equipment – Control valve set up

9. Estimation of damping coefficient for U-tube manometer

Major equipment - U-tube manometer.

**Course Outcomes:**

At the end of the course, student will be able to

1. Calculate the time lag for first and second order systems.
2. Compare and contrast the response for interacting and non-interacting systems.
3. Compare the open and closed loop systems.
4. Evaluate the controller actions for level and temperature control for a given process.
5. Compare the different types of controllers.

**3rd Year, 1st Semester**

## 10. SOCIALLY RELAVANT PROJECT

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 0.5 | 0.5 |

**3rd Year, 2nd Semester**

## 1. CHEMICAL REACTION ENGINEERING – II

| L | T | P | C |
|---|---|---|---|
| 2 | 1 | 0 | 3 |

**Course Objectives:**

- Learn the importance of RTD and the compartmental models for modelling of Non-ideal flow reacting vessels.
- Calculate the conversions based on segregated flow model, dispersion model and tanks-in-series models.
- Knowledge of rate law given the rate controlling step in catalytic reactions, internal and external diffusion effects.
- Learn the factors influencing catalyst decay, the role of pore diffusion on catalyst activity rate.
- Shrinking core model for spherical particles of unchanging size and design the fluid-solid reactors.

**UNIT I**
**Basics of non-ideal flow**: E, the exit age distribution function of fluid, the RTD, conversion in non-ideal flow reactors, diagnosing reactors (qualitative discussion only).
**The dispersion model**: axial dispersion, correlations for axial dispersion, chemical reaction and dispersion.

**UNIT II**
**The tanks in series model**: pulse response experiments and the RTD, chemical conversion. The convection model for laminar flow- the convective model and its RTD, chemical conversion in laminar flow reactors
**Earliness of mixing, segregation and RTD**: self-mixing of a single fluid, mixing of two miscible fluids.

**UNIT III**
**Catalysis and Catalytic reactors**: catalysts, steps in catalytic reactions, synthesizing a rate law, mechanism and rate limiting step.
**Heterogeneous reactions**: Introduction to Solid catalyzed reactions: The rate equation for Surface Kinetics- Pore diffusion resistance combined with surface kinetics, Porous catalyst particles, heat effects during reaction, Performance equations for reactors containing porous catalyst particles.

**UNIT IV**
Solid catalyzed reactions- Experimental methods for finding rates. Deactivating catalysts- mechanisms of catalyst deactivation, the rate and performance equations.

**UNIT V**
**Fluid-fluid reactions**: kinetics- the rate equation.
**Fluid-particle reactions**: kinetics- selection of a model, shrinking core model for spherical particles of unchanging size, rate of reaction for shrinking spherical particles, extensions, determination of rate controlling step.

**Course Outcomes:**
At the end of the course, the student will be able to:
1. Modeling of compartmental models for Non-ideal flow reacting vessels
2. Calculation of conversions based on various models
3. Students can design the fluid-solid reactors.

**Text Books:**
2. Chemical Reaction Engineering, 3rd ed., O. Levenspiel, John Wiley & Sons, 1999.
2. Elements of Chemical Reaction Engineering, 4th ed., H.S. Fogler, PHI Learning Pvt. Ltd., New Delhi, 2010.

**Reference Books:**
1. Chemical Engineering Kinetics, 3rd ed., J.M. Smith, McGraw-Hill, New York, 1981.
2. The Engineering of Chemical Reactions, 2nd ed., L.D. Schmidt, Oxford University Press, New Delhi, 2010

**3rd Year, 2nd Semester**

## 2. CHEMICAL PROCESS EQUIPMENT DESIGN

| L | T | P | C |
|---|---|---|---|
| 2 | 1 | 0 | 3 |

**OBJECTIVES:**

- Study design safe process and design appropriate equipment like reactors, mass transfer heat transfer equipment, pipelines storage tanks etc.
- Study relevant codes for design of chemical plant equipment as per the standard procedures specified by design code books.
- Learn the fabrication techniques and testing methods.
- Learn design and engineering skills directly applied in design, installation and commissioning of equipments.

**UNIT-I**

Basic Considerations in Process Equipment Design: Introduction, general design procedure, fabrication techniques, equipment classification, power for rotational motion, drives for process equipment Materials of Construction: Mechanical properties, materials, corrosion, corrosion prevention, choice of material.

**UNIT-II**

Design Considerations: Introduction, stress created due to static and dynamic loads, design stress, combined stresses and theories of failure, fatigue, brittle fracture, creep, effects of temperature, radiation and fabrication methods. Process Hazards and Safety Mechanisms in Equipment Design: Introduction, hazards in process industries, safety measures, safety measures in equipment design, pressure relief devices.

**UNIT-III**

Material Handling Equipment Design: Piping in fluid transportation process-selection of piping material, design of piping system, pumping of fluids: selection of pumps, design procedures for pumps, compression and expansion of fluids: selection of compressors, fans and blowers, vacuum system equipment, turbines and expanders, design procedures for compressors, turbines and expanders Heat Transfer Equipment Design: Selection of heat exchangers types- key heat exchanger types available, preliminary selection of heat exchanger types, Design of key heat exchanger types- Double pipe and multiple double pipe exchangers, shell and tube heat exchangers, plate exchangers, compact exchangers, air cooled exchangers.

**UNIT-IV**

Separation Equipment Design: Distillation design procedures for columns with sieve trays, with random packing, with structural packing, Absorption and Stripping design procedures for trayed columns, packed columns separating dilute solutions Equipment Selection for liquid-liquid extraction: Design procedure for liquid-liquid extraction, selection of sorbent for separation by adsorption, basic adsorption cycles, selection of appropriate adsorption cycles, general design for separation by adsorption

**UNIT-V**

Pressure Vessels: Introduction, operating condition, pressure vessel codes, selection of materials, vessels operating at low temperatures and elevated temperatures, Design conditions and stresses. Design of shell and its components, Fabrication, Inspection and Tests.

**TEXT BOOKS:**


1. Joshi's Process Equipment Design, Fourth Edition by V. V. Mahajani and S. B. Umarji, Macmillan Publishers India Ltd., 2009.
2. Plant Design and Economics for Chemical Engineers, Fifth Edition by Max. S. Peters, Klans Timmerhaus and Ronald E. West, Mc GrawHill International Edition, 2004.


**REFERENCE BOOKS:**


1. Coulson J.M. and Richardson J.F., Chemical Engineering Vol.VI (An introduction to Chemical Engineering Design), Pergamon Press, 1993. Outcome: The student will be able to do 1. Mechanical design of pressure vessels

2. Process design of separation equipments for distillation, absorption, stripping, liquid-liquid extraction, adsorption
3. Selection of piping materials, pumps, compressors, compressors, fans and blowers, vacuum system equipment, turbines and expanders
4. Design of material handling equipment like piping system, pumps, compressors, turbines and expanders

**3rd Year, 2nd Semester**

## 3. ENGLISH LANGUAGE SKILLS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES**

1. To develop awareness in students of the relevance and importance of technical communication and presentation skills.
2. To prepare the students for placements
3. To train students to use language appropriately for presentations and interviews
4. To enhance the documentation skills of the students with emphasis on formal and informal writing

**UNIT 1**

**LSRW SKILLS**

**Introduction to LSRW Skills – Definition – Importance of LSRW Skills - Advantages and Disadvantages of Oral and Written Skills – Advantages and disadvantages of Written & Speaking skills - Barriers to effective communication**

| OUTCOMES |
|---|
| To recall and memorize the basic concepts of LSRW skills |
| To understand the various components of oral and written skills |
| To apply English language skills to avoid barriers to effective communication |

**UNIT II**

**VERBAL & NON-VERBAL SKILLS**

**Informal and Formal Conversation - Non-verbal Skills–Kinesics, Proxemics, Chronemics, Haptics, Oculesics, Paralinguistic features – Body language for interviews**

| |
|---|
| To understand the basic components of non-verbal communication. |
| To apply the knowledge of the difference between informal and formal conversation in order to meet the demands of work place environment. |
| To analyze non-verbal interpretations in multicultural context. |

**UNIT III**

**ACADEMIC WRITING SKILLS**

**Writing Skills–Art of condensation- summarizing and paraphrasing - Abstract Writing, Synopsis Writing – Formal Letter Writing - Report Writing**

| |
|---|
| To understand the basic components of written communication. |
| To apply knowledge of different formats of written communication needed in work place environment. |
| To analyze the structure of letters, reports etc. |

**UNIT IV**

**CREATIVE WRITING SKILLS**

**Film Review Writing – Creative Writing- Short Story Writing – Speeches for academic settings – Writing Skits – Script for Short Films/Web Series**

| |
|---|
| To apply writing skills in creative writing to meet the demands of documentation in professional life |
| To analyze different figures of speech in creative writing |
| To evaluate different aspects creative and academic writing to become effective at written communication |

**UNIT V**

**PROFESSIONAL SPEAKING SKILLS**

**Job Interviews –Types of Job Interviews – Characteristics of a job interview - Interview Preparation Techniques –How to overcome Stage fright**
**Group Discussions(GD): Importance of Group Discussion- Characteristics of a GD - GD as a tool for selection – GD Strategies – Do's & Don't of GD - GD Vs Debates**

| |
|---|
| To analyze the different aspects of interviews and group discussions |
| To evaluate the group dynamics to excel in group discussions |
| To design and develop strategies to answer effectively in interviews |

**Text Books:**

1. **Effective Technical Communication,** Ashrif Rizvi, TataMcGrahill, 2011
2. **Technical Communication** by Meenakshi Raman & Sangeeta Sharma,3rd Edition, O U Press 2015

**Reference Books:**

1. **Communication Skills by Pushpalatha& Sanjay Kumar, Oxford Univsesity Press**
2. Books on **TOEFL/GRE/GMAT/CAT/IELTS** by Barron's/DELTA/Cambridge University Press.2012.
3. **Soft Skills for Everyone,** Butterfield Jeff, Cengage Publications, 2011.
4. **Management Shapers Series** by Universities Press (India) Pvt Ltd., Himayatnagar, Hyderabad 2008.
5. **Successful Presentations** by John Hughes & Andrew Mallett, Oxford.
6. **Winning at Interviews** by Edgar Thorpe and Showick Thorpe, Pearson
7. Winning Resumes and Successful Interviews by Munish Bhargava, Mc Graw Hill

WEB LINKS

1. **https://blog.allaboutlearningpress.com/listening-comprehension/**
2. **https://www.englishclub.com/**
3. **https://www.helpguide.org/articles/relationships-communication/nonverbal-communication.htm**
4. **https://www.slideshare.net/poojavrs/lsrw-109040479**
5. https://www.slideshare.net/nandapalit/non-verbal-verbal-communication

**3rd Year, 2nd Semester**

## PROFESSIONAL ELECTIVE-II

## PE1. CHEMICAL PLANT DESIGN AND ECONOMICS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:**

- To familiarize the students about various economic aspects of chemical processes
- Learn basics of Cost estimation, Working Capital and Capital Investment and understand the time value of money
- Learn the importance of Cash flow diagrams and Break-even analysis.
- Study depreciation methods and methods of estimation of profitability of an industry
- Study the procedures adopted for Replacement and Selection from Alternatives.

**UNIT I**

Introduction, Process Design development. General design considerations, Cost and asset accounting. Cash flow for industrial operations, factors effecting investment and production cost, capital investments, estimation of capital investments, cost indices, cost factors in capital investment

**UNIT II**

Organizations for presenting capital investments, estimates by compartmentalization, estimation of total product of cost direction, production costs, fixed charges, plant overhead costs, financing.

Interest and investment cost, type interest, nominal and effective interest rates, continuous interest, present worth and discount annuities, cost due interest on investment, source of capital.

**UNIT III**

Taxes and insurances, type of taxes: federal income taxes, insurance-types of insurance, self-insurance.

Depreciation: types of depreciation, services life, salvage value, present value, methods for determining depreciation, single unit and group depreciation.

**UNIT IV**

Profitability: alternative investments and replacements, profitability standards, discounted cash flow, capitalized cost, pay out period, alternative investments, analysis with small investments, increments and replacements.

**UNIT V**

Optimum design and design strategy, incremental cost, general procedure for determining optimum condition, comparison of graphical and analytical methods, optimum production rates, semi continuous cyclic operation, fluid dynamics, mass transfer strategy of linearization

**Course Outcomes:**
At the end of the course, the student will be able to:

1. Explain the design considerations, cash flow and various costs involved in process Industries
2. Calculate different types of interest & Predict the Present worth and annuities
3. Explain types of taxes and Solve problems on depreciation using various methods
4. Analyze alternative investments, pay out period for an investment and rate of return
5. Solve linear programming problems (LPP) by graphical and algebraic methods

**Text Book:**
1. Plant Design and Economics for Chemical Engineering, $4^{th}$ ed., M.S. Peters and K.D. Timmermans, McGraw-Hill,1991

**Reference Books:**
1. Process Engineering Economics, Schweyer, McGraw-Hill, 2002

**Course Outcomes:**

- Estimate various costs involved in a process industry and evaluate the tax burden of an establishment
- They will be ready with tools to estimate profitability of a company
- Find the replacement costs of an equipment and select best one from different alternatives
- Compute break even period for an investment and rate of return

**$3^{rd}$ Year, $2^{nd}$ Semester**

## PROFESSIONAL ELECTIVE-II

## PE2. POLYMER SCIENCE AND ENGINEERING

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:**
To enable the students

1. To compute molecular weight averages from the molecular weight distribution
2. Condensation polymerization and transition in polymers

**UNIT I**

Introduction; definitions: polymer& macro molecule, monomer, functionality, average functionality, co-polymer, polymer blend., plastic and resin. Classification of polymers: based on source, structure, applications, thermal behavior, mode of polymerization. Concept of average molecular weight of polymers, molecular weight distribution, poly disparity index. Determination of average molecular weights: End group analysis, osmometry, light scattering techniques, viscometer, Gel permeation chromatography.

**UNIT II**

Natural polymers: brief study of i) Natural rubber ii) shellac iii) rosin iv) cellulose v) proteins.
Mechanism and kinetics of: Addition or chain polymerization
a) Free radical addition polymerization b) Ionic addition polymerizations
c) Coordination polymerization d) Coordination or step growth or condensation polymerization.

**UNIT III**

Methods of polymerization: mass or bulk polymerization process, solution polymerization process, suspension polymerization process and emulsion polymerization method comparison of merits and demerits of these methods. Properties of polymers: crystalline and amorphous status, melting and glass transition temperatures and their determination, effect of polymer structure on mechanical, physical, chemical and thermal properties.

**UNIT IV**

Degradation of polymers, Role of the following additives in the polymers: i) Fillers and reinforcing fillers ii) Plasticizers iii) Lubricants iv) Antioxidants and UV stabilizers v) Blowing agents vi) Coupling agents vii) Flame retardants viii) Inhibitors
Brief description of manufacture, properties and uses of: i) Polyethylene (HDPE&LDPE), ii) Poly propylene iii) Polyvinylchloride iv) Polystyrene v) Polytetrafluoroethylene vi) Polymethyl methacrylate vii) Polyvinyl acetate & Polyvinyl alcohol.

**UNIT V**

Brief description of manufacture, properties and uses of: i) Polyesters (Polyethylene terephthalate polycarbonate and unsaturated polyesters) ii) Nylon(Nylon 66) iii) Phenol- Formaldehyde resins iv) Epoxy resins v) Polyurethane vi) Silicones
Compounding of polymer resins, brief description of: i) Compression and transfer moulding ii) Injection moulding iii) Extrusion iv) Blow moulding v) Calendaring vi) Laminating and pultrusion

**Course Outcomes:**

At the end of the course, the student will be able to:

1. Classify the polymers and also able to identify the structural configurations of any polymer
2. Distinguish the modification of a polymer and also in a position to examine the mechanism of a polymerization
3. Synthesize any elastomer and optimize their deformation properties on applying force
4. Explain the processing of polymer, identify the mode of deformation of a polymer and test the mechanical strength of a polymer

**Text Books:**

1. Polymer Science & Technology, 2$^{nd}$ ed., J.R. Fried, PHI Learning Pvt. Ltd., New Delhi, 2009
2. Plastic materials, J.A. Brydson, Newnes-Butterworth (London) 1989.

**References Books:**

1. Text book of polymer science, F.W.Jr. Bill Meyer, (3rd ed.) John Wiely&sons 1984
2. Introduction to Plastics, J.H. Brison and C.C. Gosselin, Newnes-Butterworth, London 1968.

**3rd Year, 2nd Semester**

**PROFESSIONAL ELECTIVE-II**

**PE3. FOOD PROCESSING TECHNOLOGY**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:**
To impart knowledge to the students about food processing and various unit operations involved in it, packaging, storing and preservation.

**UNIT I**
**Food process engineering - Fundamentals**: Fundamentals of food process engineering, application of quantitative methods of material and energy balances in food engineering practices.

**UNIT II**
**Unit Operations in food industries**: Fluid flow, thermal process calculations, refrigeration, evaporation and dehydration operations in food processing.

**UNIT III**
**Microwave heating:** Theory of microwave heating, microwave properties of foods, comparison of microwave and conventional heating, benefits of microwave heating, applications in food processing, microwave heating equipment, hazards of microwave heating.

**UNIT IV**
**Mechanical Operations in food processing**: Conversion operations, Size reduction and screening of solids, mixing and emulsification, filtration and membrane separation, centrifugation, crystallization, extraction.

**UNIT V**

**Preservation operations:** Preservation methods & Strategies, Thermal Methods, Nabla Factor Sterilization Types Pasteurization Dehydro freezing Irradiation Dosimetry Transport of food & Preservation strategies Cheap and applicable everywhere.

**Course Outcomes:**

1. Understanding the various causes of food deterioration and food poisoning.
2. Identification of appropriate processing, preservation, and packaging method.
3. Analyze product quality and effect of processing technique on it.

**Text Books**


1. R. T. Toledo, "Fundamentals of Food Process Engineering", AVI Publishing Co., 1980.
2. R. Angold,G.Beech and J.Taggart, " Food Biotechnology", Cambridge University Press, 1989.
3. Fundamentals of Food Engineering, D G Rao, PHI, New Delhi, 2012.

**Reference Books**


1. J. M. Jackson and B. M. Shinn, "Fundamentals of Food Canning Technology", AVI Publishing Co., 1978.
2. J. G. Bernnan, J. R. Butters, N. D. Cowell and A.E.V.Lilley, "Food Engineering Operations", 2nd Edn., Applied Science, 1976.


**3rd Year, 2nd Semester**

## OPEN ELECTIVE-II
## OE1. INDUSTRIAL SAFETY AND HAZARDOUS MANAGEMENT

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:**

- Have awareness of different hazards in process industries
- Classification of hazards and their identifications
- Precautions in chemical storage and handling
- Learn risk analysis techniques and quantify them

**UNIT I**

Introduction, Factors Contributing to the Costs of Accidents, List of some Notable accidents in the process industry/selected case histories, some common features of high-cost accidents, reasons for high priority towards safety.

**UNIT II**

Material hazards1: Introduction Hazardous substances-categories, Toxicity, Radiation, Flammability, Ignition, Fires and explosions.

**UNIT III**

Material hazards 2: Fire balls, Fire damage, run away chemical reaction, incompatible materials, material safety and data sheets

Process and plant Hazards: Hazards of pressure, causes of over pressures, flow deviations, effects of leakages/releases, hazards of temperatures.

**UNIT IV**

Hazard analysis: process safety management, process hazards analysis, hazards analysis methods, check list, preliminary hazard analysis, what-if / check list, hazard and operability analysis, FMEA, Fault tree analysis, cause and consequence analysis.

**UNIT V**

Preventive and protective measures: Safety options, process safety approaches, inherent safety and design, plant layout, inherent security, explosion prevention and protection, personal protective systems, plant modifications and management change, relief valves and rupture discs, breather vents for storage tanks, explosions vents, flame arresters, flare systems

**Course Outcomes**

1. Understand how thorough safety is ensured in an organization.
2. Classify and identify hazards in chemical industries
3. Take precautions in chemical storage and handling
4. Perform fault tree and event tree risk analysis and quantify them
5. Suggest emergency management plans

**Text Book:**

1. Chemical process industry safety by K S N Raju, Mc-Graw Hill education (India) Pvt.Ltd,2014
2. Chemical process Safety by Crowl

**Reference Books:**

1. Chemical process safety by Sanders, 6$^{th}$ Ed.,

**3$^{rd}$ Year, 2$^{nd}$ Semester**

**OPEN ELECTIVE -II**

**OE2. GREEN TECHNOLOGY**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**UNIT I**

**An introduction to environmental issues**: Role of chemical processes and chemical products, Global environmental issues, Air and water quality issues, Ecology.

**Risk concept**: Description of risk, Risk assessment concept, Dose-response, Exposure assessment.

**UNIT II**

**Evaluating exposures:** Occupational exposures: recognition, evaluation, control,

Exposure assessment for chemicals in the ambient environment, Designing safer chemicals.

**Green chemistry**: Green chemistry methodologies, Optimization based frameworks for the design of green chemical synthesis pathway.

**UNIT III**

**Evaluating environmental fate:** Chemical and physical property estimation, Estimating environmental persistence, Estimating ecosystem risk, Classifying environmental risk based on chemical structure.

**UNIT IV**

**Life-cycle concepts**: Life-cycle assessment, Life-cycle impact assessment

**UNIT V**

Material flows in chemical manufacturing, Assessing opportunities for waste exchanges and by-product synergies.

**Text Book**

1. Shonnard, D. Allen, D. Green Engineering: Environmentally Conscious Design of Chemical Processes.

**3rd Year, 2nd Semester**

## OPEN ELECTIVE -II
## OE3. NUCLEAR ENGINEERING

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**UNIT-1**

**Introduction:** Motivation for Nuclear Energy, India's Nuclear Power Program

**Nuclear Physics:** Nuclear model of the atom - Equivalence of mass and energy - Binding - Radio activity - Half life - Neutron interactions - Cross sections.

**UNIT-II**

**Nuclear Reactions and Reactor Materials**

Mechanism of nuclear fission and fusion - Radio activity - Chain reactions - Critical mass and composition - nuclear fuel cycles and its characteristics - Uranium production and purification - Zirconium, thorium, beryllium.

**UNIT-III**

**Reprocessing**

Nuclear fuel cycles - spent fuel characteristics - Role of solvent extraction in reprocessing - Solvent extraction equipment.

**UNIT-IV**

**Nuclear Reactors**

Reactors - Types of fast breeding reactors - Design and construction of fast breeding reactors - heat transfer techniques in nuclear reactors - reactor shielding.

**UNIT-V**

**Safety, Disposal and Proliferation**

Nuclear plant safety- Safety systems - Changes and consequences of an accident - Criteria for safety - nuclear waste - Type of waste and its disposal - Radiation hazards and their prevention - Weapons proliferation.

**Text Book**s:

1. Thomas J.Cannoly, " Fundamentals of Nuclear Engineering ", John Wiley (1978).
2. G,Vaidyanathan," Nuclear Reactor Engineering", Chand Publishers, 2013

**Reference Books**:

1. Collier J.G., and G.F.Hewitt, " Introduction to Nuclear Power ", (1987), Hemisphere Publishing, New York.
2. Lamarsh U.R. " Introduction to Nuclear Engineering Second Edition ", (1983), Addison Wesley M.A.
3. Lipschutz R.D. " Radioactive Waste - Politics, Technology and Risk ", (1980), Ballingor, Cambridge. M.A.

**3rd Year, 2nd Semester**

| Subject Code | Title of the Subject | L | T | P | C |
|---|---|---|---|---|---|
| **19A65401** | **MANAGERIAL ECONOMICSAND FINANCIAL ANALYSIS(HS-I)** | 3 | 0 | 0 | 3 |

| **COURSE OBJECTIVES:** The objective of this course is | |
|---|---|
| 1 | To inculcate the basic knowledge of micro economics and financial accounting |
| 2 | To make the students learn how demand is estimated for different products, input-outputrelationship for optimizing production and cost |
| 3 | To know the various types of Market Structures & pricing methods and its strategies |
| 4 | To give an overview on investment appraisal methods to promote the students to learnhow to plan long-term investment decisions. |
| 5 | To provide fundamental skills on Accounting and to explain the process of preparingFinancial statements |

| **COURSE OUTCOMES:** At the end of the course, students will be able to | |
|---|---|
| CO1 | Define the concepts related to Managerial Economics, financial accounting andmanagement. |
| CO2 | Understand the fundamentals of Economics viz., Demand, Production, cost, revenueand markets |
| CO3 | Apply the concepts of production, cost and revenues for effective business decisions |
| CO4 | Analyze how to invest their capital and maximize returns |
| CO5 | Evaluate the capital budgeting techniques |
| CO6 | Develop theaccounting statements and evaluate the financial performance of businessentity. |

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | 3 | | | | | | | | | |
| CO2 | | | | | | | | | 3 | | | | | | |
| CO3 | | | | | | | | | | | | 3 | | | |
| CO4 | | | | | | | | | 3 | | | | | | |
| CO5 | | | | | | | | | 3 | | | | | | |
| CO6 | | | | | | | | | 3 | | | 3 | | | |

**SYLLABUS**

**UNIT-I:Managerial Economics**

Introduction – Nature, meaning, significance, functions and advantages. Demand-Concept, Function, Law of Demand - DemandElasticity- Types – Measurement. Demand Forecasting- Factors governing Forecasting, Methods. Managerial Economics and Financial Accounting and Management.

**LEARNING OUTCOMES:**At the end of the Unit, the learners will be able to

State the Nature of Managerial Economics and its importance

- Understand the concept of demand andits determinants
- Analyze the Elasticity and degree of elasticity
- EvaluateDemand forecasting methods
- Design the process of demand estimation for different types of demand

**UNIT-II: Production and Cost Analysis**

Introduction – Nature, meaning, significance, functions and advantages. Production Function– Least-cost combination– Shortrun and longrun Production Function- Isoquants andIsocosts, MRTS - Cobb-Douglas Production Function - Laws of Returns - Internal and External Economies of scale. Cost&Break-Even Analysis - Cost concepts and Cost behavior- Break-Even Analysis (BEA) -Determination of Break-Even Point (Simple Problems)-Managerial significance and limitations of Break-Even Analysis.

**LEARNING OUTCOMES:**At the end of the Unit, the learners will be able to

- Define the production function, Input-Output relationship and different cost concepts
- Apply the least-cost combination of inputs
- Analyze the behavior of various cost concepts
- Evaluate BEA for real time business decisions
- Develop profit appropriation for different levels of business activity

**UNIT-III: Business Organizations and Markets**

Introduction – Nature, meaning, significance, functions and advantages.Forms of Business Organizations- Sole Proprietary - Partnership - Joint Stock Companies - Public Sector Enterprises.Types of Markets - Perfect and Imperfect Competition - Features of Perfect Competition – Monopoly-Monopolistic Competition–Oligopoly-Price-Output Determination - Pricing Methods and Strategies.

**LEARNING OUTCOMES:**At the end of the Unit, the learners will be able to

- Explain the structure of markets, features of different markets and forms of businessorganizations
- Apply the price output relationship in different markets
- Analyze the optimum output levels to maximize profit in different markets
- Evaluate price-output relationship to optimize cost,revenue and profit

**UNIT- IV:Capital Budgeting**

Introduction – Nature, meaning, significance, functions and advantages. Typesof Working Capital,Components, Sources of Short-term and Long-term Capital, Estimating Working capital requirements. Capital Budgeting– Features, Proposals,Methods and Evaluation. Projects – Pay Back Method, Accounting Rate of Return (ARR) Net Present Value (NPV) Internal Rate Return (IRR) Method (sample problems)

**LEARNING OUTCOMES:**At the end of the Unit, the learners will be able to

- Explain the concept of capital budgeting and its importance in business
- Contrast and compare different investment appraisal methods
- Analyze the process of selection of investment alternatives using different appraisal methods
- Evaluate methods of capital budgeting for investment decision making and for maximizingreturns
- Design different investment appraisals and make wise investments

**UNIT-V: Financial Accounting and Analysis**

Introduction – Nature, meaning, significance, functions and advantages. Concepts and Conventions- Double-Entry Book Keeping, Journal, Ledger, Trial Balance- Final Accounts (Trading Account, Profit and Loss Account and Balance Sheet with simple adjustments). ***Financial Analysis -*** Analysis and Interpretation of Liquidity Ratios, Activity Ratios, and Capital structure Ratios and Profitability.

**LEARNING OUTCOMES:**At the end of the Unit, the learners will be able to

- Discuss the concept,convention and significance of accounting
- Apply the fundamental knowledge of accounting while posting the journal entries
- Analyze the process and preparation of final accounts and financial ratios
- Evaluate the financial performance of an enterprise by using financial statements

**<u>Text Books:</u>**

1. Varshney&Maheswari: Managerial Economics, Sultan Chand, 2013.
2. Aryasri: Business Economics and Financial Analysis, 4/e, MGH, 2019

**References:**


1. Ahuja Hl Managerial economics Schand,3/e,2013
2. S.A. Siddiqui and A.S. Siddiqui: Managerial Economics and Financial Analysis, New Age International, 2013.
3. Joseph G. Nellis and David Parker: Principles of Business Economics, Pearson, 2/e, New Delhi.
4. Domnick Salvatore: Managerial Economics in a Global Economy, Cengage, 2013.


**Data Books Required:**

Present Value Factors table

**3rd Year, 2nd Semester**

| Subject Code | Title of the Subject | L | T | P | C |
|---|---|---|---|---|---|
| 19A65402 | ENTREPRENEURSHIP& INCUBATION (HS-I) | 3 | 0 | 0 | 3 |

| COURSE OBJECTIVES:The objective of this course is | |
|---|---|
| 1 | To make the student understand about Entrepreneurship |
| 2 | To enable the student in knowing various sources of generating new ideas insetting up ofnew enterprise |
| 3 | To facilitate the student in knowing various sources of finance in starting upof a business |
| 4 | To impart knowledge about various government sources which provide financial assistance to entrepreneurs/ women entrepreneurs |
| 5 | To encourage the student in creating and designing business plans |

| COURSE OUTCOMES: At the end of the course, students will be able to | |
|---|---|
| CO1 | Define the Concepts related to the Entrepreneurship and Incubators |
| CO2 | Understand the concept of Entrepreneurship and challenges in the world of competition. |
| CO3 | Apply the Knowledge in generating ideas for New Ventures. |
| CO4 | Analyze various sources of finance and subsidies to entrepreneur/women Entrepreneurs. |
| CO5 | Evaluate the role of central government and state government in promoting Entrepreneurship. |
| CO6 | Create and design business plan structure through incubations. |

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | 3 | | | | | | | | | |
| CO2 | | 1 | | | | 2 | | | 3 | | | | | | |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO3** | | 2 | | | | 1 | | | | | | 3 | | | |
| **CO4** | | 1 | | | | | | | 3 | | | | | | |
| **CO5** | | 3 | | | | | | | 3 | | | | | | |
| **CO6** | | | | | | | 1 | | 3 | | | 3 | | | |

**Syllabus**

### UNIT-I: Entrepreneurship

Introduction-Nature, meaning, significance, functions and advantages. concept, characteristics- knowledge and skills requirement - process - Factors supporting entrepreneurship - Differences between Entrepreneur and Intrapreneur - entrepreneurial mindset and personality - Recent trends.

### LEARNING OUTCOMES

At the end if the Unit, the learners will be able to

- Understand theconcept of Entrepreneur and Entrepreneurship in India
- Analyzerecent trends in Entrepreneurship across the globe
- Develop a creative mind set and personality in starting a business.

### UNIT-II: Women Entrepreneurship

Introduction – Nature, meaning, significance, functions and advantages. Growth of women entrepreneurship in India. - Issues & Challenges - Entrepreneurial motivations.Entrepreneurship Development and Government. Role, of Central and State Government - incentives, subsidies and grants – Export-oriented Units - Fiscal and Tax concessions.

### LEARNING OUTCOMES

At the end of the Unit, the learners will be able to

- Understand the role of government in promoting women entrepreneurship
- Analyze the role of export-oriented units
- Evaluate the tax concessions available for Women entrepreneurs

### UNIT-III:Product Development

Introduction – Nature, meaning, significance, functions and advantages. Startup Initiatives - Generating business/ Service idea – Sources and methods –Identifying opportunities - Feasibility study - Market feasibility, technical/operational feasibility, Financial feasibility. Developing business plan, Preparing project report, Presenting business plan to investors.

## LEARNING OUTCOMES

At the end if the Unit, the learners will be able to

- Analyze the sources of new methods in generating business idea
- Evaluate market feasibility, financial feasibility and technical feasibility
- Design and draw business plansin project preparation and prepare project reports

## UNIT-IV:Startups

Introduction – Nature, meaning, significance, functions and advantages. Fundamentals of Business Incubation - Principles and good practices of business incubation- Process of business incubation and the business incubator and how they operate and influence theType/benefits of incubators - Corporate/educational / institutional incubators - Broader business incubation environment - Pre- Incubation and Post - Incubation process - Idea lab, Business plan structure -Value proposition **LEARNING OUTCOMES**

At the end of the Unit, the learners will be able to:

- Understand the importance of business incubation
- Apply brilliant ideas in the process of business incubation
- Analyze the process of business incubation/incubators.
- Design their own business incubation/incubators as viable-business unit.

## UNIT-V: Finance

Introduction – Nature, meaning, significance, functions and advantages. Sources - Long term and Short term - Institutional Finance – Commercial Banks, SFC's and NBFC's in India, Role in small and medium business - Entrepreneurship development programs in India - The entrepreneurial journey- Institutions supporting entrepreneurship development.

## LEARNING OUTCOMES

At the end of the Unit, the learners will be able to

- Understand the various sources of finance in Starting the new venture
- Analyze the role of banks and other financial institutions in promoting entrepreneurshipin India
- Evaluatethe need and importance of MSMEs in the growth of country

## TEXT BOOKS

1. D F Kuratko and T V Rao, **Entrepreneurship** - A South-Asian Perspective – Cengage Learning, 2012. (For PPT,

Case Solutions Faculty may visit :login.cengage.com) 2 .Nandan H, Fundamentals of Entrepreneurship, PHI, 2013

# REFERENCES


1. Vasant Desai,Small Scale Industries and Entrepreneurship, HimalayaPublishing 2012.
2. Rajeev Roy Entrepreneurship, 2nd Edition, Oxford, 2012.
3. B.JanakiramandM.Rizwana‖ Entrepreneurship Development: Text & Cases, Excel Books, 2011.
4. Stuart Read, Effectual Entrepreneurship, Routledge, 2013.


## E-RESOURCES

1. Entrepreneurship-Through-the-Lens-of-enture Capital
2. http://www.onlinevideolecture.com/?course=mba-programs&subject=entrepreneurship
3. http://nptel.ac.in/courses/122106032/Pdf/7_4.pd
4. http://freevideolectures.com/Course/3514/Economics-/-Management-/-Entrepreneurhip/50

**(Elective-I -VI SEMESTER)**
**(w.e.f Academic Year 2019-20)**

| Subject Code | Title of the Subject | L | T | P | C |
|---|---|---|---|---|---|
| | **BUSINESS ETHICS AND CORPORATE GOVERNANCE** | 3 | 0 | 0 | 3 |

| **COURSE OBJECTIVES :** The objectives of this course are | |
|---|---|
| 1 | To make the student understand the principles of business ethics |
| 2 | To enable them in knowing the ethics in management |
| 3 | To facilitate the student's role in corporate culture |
| 4 | To impart knowledge about the fair-trade practices |
| 5 | To encourage the student in creating knowing about the corporate governance |

**UNIT-I: ETHICS**

Introduction – Meaning – Nature, Scope, significance, Loyalty, and ethical behavior - Value systems - Business Ethics, Types, Characteristics, Factors, Contradictions and Ethical Practices in Management- Corporate Social Responsibility – Issues of Management – Crisis Management.

**LEARNING OUTCOMES: -** After completion of this unit student will

- Understand the meaning of loyalty and ethical Behavior
- Explain various types of Ethics
- Analyze the corporate social responsibility of management

**UNIT-II: ETHICS IN MANAGEMENT**

Introduction Ethics in production, finance, ,Human Resource Management and, Marketing ,Management - Technology Ethics and Professional ethics - The Ethical Value System – Universalism, Utilitarianism, Distributive Justice, Social Contracts, Individual Freedom of Choice, Professional Codes; Culture and Ethics – Ethical Values in different Cultures, Culture and Individual Ethics.

**LEARNING OUTCOMES: -** After completion of this unit student will

- Understand the meaning of Marketing Ethics

- Compare and contrast technical ethics and professional ethics
- Develop ethical values

**UNIT-III: CORPORATE CULTURE**

Introduction, Meaning, definition, Nature, Scope, Functions, and significance – Cross cultural issues in Ethics - - Emotional Honesty – Virtue of humility – Promote happiness – karma yoga – proactive – flexibility and purity of mind. The Ethical Value System – Universalism, Utilitarianism, Distributive Justice, Social Contracts, Individual Freedom of Choice, Professional Codes; Culture and Ethics – Ethical Values in different Cultures, Culture and Individual Ethics.

**LEARNING OUTCOMES: -** After completion of this unit student will

- Define Universalism Utilitarianism, Distributive
- Understand the corporate culture in business
- Analyze Ethical Value System Ethical Values in different Cultures

**UNIT- IV: LEGAL FRAME WORK**

Law and Ethics, Agencies enforcing Ethical Business Behavior, Legal Impact– Environmental Protection, Fair Trade Practices, legal Compliances, Safeguarding Health and wellbeing of Customers.

**LEARNING OUTCOMES: -** After completion of this unit student will

- Understand Law and Ethics
- Analyze Different fair-trade practices
- Make use of Environmental Protection and Fair-Trade Practices

**UNIT -V : CORPORATE GOVERNANCE**

Introduction, meaning – scope Nature - Issues, need, corporate governance code, transparency & disclosure, role of auditors, board of directors and shareholders. Global issues, accounting and regulatory frame work, corporate scams, committees in India and abroad, corporate social responsibility. of BODs composition, Cadbury Committee - various committees - reports - Benefits and Limitations.

**LEARNING OUTCOMES: -** After completion of this unit student will

- Understand corporate governance code
- Analyze role of auditors, board of directors and shareholders in corporate governance
- Implementing corporate social responsibility in India.

**Text books.**

1. Murthy CSV: Business Ethics and Corporate Governance, HPH

2. Bholananth Dutta, S.K. Podder – Corporation Governance, VBH.

**Reference books**

1. Dr. K. Nirmala, Karunakara Readdy : Business Ethics and Corporate Governance, HPH

2. H.R.Machiraju: Corporate Governance

3. K. Venkataramana, Corporate Governance, SHBP.

4. N.M.Khandelwal : Indian Ethos and Values for Managers

| **COURSE OUTCOMES:** At the end of the course, students will be able to | |
|---|---|
| CO1 | Define the Ethics and Types of Ethics. |
| CO2 | Understand business ethics and ethical practices in management |
| CO3 | Understand the role of ethics in management |
| CO4 | Apply the knowledge in cross cultural ethics |
| CO5 | Analyze law and ethics |
| CO6 | Evaluate corporate governance |

**3rd Year, 2nd Semester**

## 7. CONSTITUTION OF INDIA

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 0 |

**COURSE OBJECTIVES:** The objective of this course is

1. To Enable the student to understand the importance of constitution
2. To understand the structure of executive, legislature and judiciary
3. To understand philosophy of fundamental rights and duties
4. To understand the autonomous nature of constitutional bodies like Supreme Court and high court controller and auditor general of India and Election Commission of India.
5. To understand the central-state relation in financial and administrative control

**UNIT-I**

**Introduction to Indian Constitution**

Constitution -Meaning of the term - Indian Constitution- Sources and constitutional history - Features– Citizenship – Preamble - Fundamental Rights and Duties - Directive Principles of State Policy.

**LEARNING OUTCOMES: -**After completion of this unit student will

- Understand the concept of Indian constitution
- Apply the knowledge on directive principle of state policy
- Analyze the History and features of Indian constitution
- Learn about Preamble, Fundamental Rights and Duties

**UNIT-II**

**Union Government and its Administration**

Structure of the Indian Union - Federalism - Centre-State relationship – President’s Role, power and position - PM and Council of ministers - Cabinet and Central Secretariat –Lok Sabha - Rajya Sabha - The Supreme Court and High Court - Powers and Functions

**LEARNING OUTCOMES: -**After completion of this unit student will

- Understand the structure of Indian government
- Differentiate between the state and central government
- Explain the role of President and Prime Minister
- Know the Structure of supreme court and High court

**UNIT-III**

**State Government and its Administration**

Structure of the State Govt. - Governor - Role and Position -CM and Council of Ministers - State Secretariat- Organization Structure and Functions

**LEARNING OUTCOMES: -**After completion of this unit student will

- Understand the structure of state government
- Analyze the role of Governor and Chief Minister
- Explain the role of State Secretariat
- Differentiate between structure and functions of state secretariat

**UNIT-IV**

**Local Administration**

District's Administration Head - Role and Importance - Municipalities - Mayor and role of Elected Representatives -CEO of Municipal Corporation Panchayati Raj - Functions– PRI –Zilla Parishath - Elected officials and their roles – CEO, Zilla Parishath - Block level Organizational Hierarchy - (Different departments) - Village level - Role of Elected and Appointed officials - Importance of grass root democracy

**LEARNING OUTCOMES: -**After completion of this unit student will

- Understand the local Administration
- Compare and contrast district administration's role and importance
- Analyze the role of Mayor and elected representatives of Municipalities
- Learn about the role of Zilla Parishath block level organization

**UNIT-V**

**Election Commission**

Election Commission- Role of Chief Election Commissioner and Election Commissionerate - State Election Commission -Functions of Commissions for the welfare of SC/ST/OBC and Women

**LEARNING OUTCOMES: -**After completion of this unit student will

- Know the role of Election Commission
- Contrast and compare the role of Chief Election commissioner and Commissionerate
- Analyze the role of state election commission
- Evaluate various commissions viz SC/ST/OBC and women

**Text Books**

1. Durga Das Basu, Introduction to the Constitution of India, Prentice – Hall of India Pvt. Ltd.. New Delhi

2. Subash Kashyap, Indian Constitution, National Book Trust

**REFERENCES:**

1. J.A. Siwach, Dynamics of Indian Government & Politics,

2. H.M.Sreevai, Constitutional Law of India, 4th edition in 3 volumes (Universal Law Publication)
3. J.C. Johari, Indian Government and Politics, Hans India
4. M.V. Pylee, Indian Constitution Durga Das Basu, Human Rights in Constitutional Law, Prentice – Hall of India Pvt. Ltd.. New Delhi

**E-RESOURCES**:

1.nptel.ac.in/courses/109104074/8
2.nptel.ac.in/courses/109104045/
3.nptel.ac.in/courses/101104065/
4.www.hss.iitb.ac.in/en/lecture-details
5.www.iitb.ac.in/en/event/2nd-lecture-institute-lecture-series-indian-constitution

| **COURSE OUTCOMES:** At the end of the course, students will be able to | |
|---|---|
| CO1 | State the historical background of the constitution making and its importance for building a democratic India. |
| CO2 | Understand the functioning of three wings of the government ie., executive, legislative and judiciary. |
| CO3 | Demonstrate the value of the fundamental rights and duties for becoming good citizen of India. |
| CO4 | Analyze the decentralization of power between central, state and local self-government |
| CO5 | Appraise the knowledge in strengthening of the constitutional institutions like CAG, Election Commission and UPSC for sustaining democracy. |
| CO6 | Develop themselves as responsible citizens and pave way to build a democratic country. |

**3rd Year, 2nd Semester**

## 8. CHEMICAL REACTION ENGINEERING LAB

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 3 | 1.5 |

**Course Objectives:**

- Operate lab equipments like CSTR, Batch, PFR reactors.
- Analyze the concentration versus time data and determine the specific rate constant and the order of the reaction.
- Compare theoretical and experimental conversions in a CSTR and PFR.
- Estimate RTD and model parameters in a CSTR, PFR, packed bed and CSTR in-series.

1. Determination of the order of a reaction using a batch reactor and analyzing the data by (a) differential method (b) integral method.
2. Determination of the activation energy of a reaction using a batch reactor.
3. To determine the effect of residence time on conversion and to determine the rate constant using a CSTR.
4. To determine the specific reaction rate constant of a reaction of a known order using a batch reactor.
5. To determine the order of the reaction and the rate constant using a tubular reactor.
6. CSTRs in series- comparison of experimental and theoretical values for space times and volumes of reactors.
7. Mass transfer with chemical reaction (solid-liquid system) – determination of mass transfer coefficient.
8. Mass transfer with chemical reaction (liquid-liquid system) – determination of mass transfer coefficient
9. Axial mixing in a packed bed. Determination of RTD and dispersion number for a packed-bed using tracer
10. Determination of RTD and dispersion number in a tubular reactor using a tracer.

**Course Outcomes:**

- Skills of deriving the kinetic expressions by performing the experiments on batch and continuous flow reactors.
- Understand the effects of non-ideal flow.
- Proficient to estimate RTD and model parameters in a CSTR, PFR, packed bed and CSTR in-series

**3rd Year, 2nd Semester**

## 9. ENGLISH LANGUAGE SKILLS LAB

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 3 | 1.5 |

1. To improve the students' fluency in English, through a well-developed vocabulary and enable them to listen to English spoken at normal conversational speed by educated English speakers and respond appropriately in different socio-cultural and professional contexts.
2. Further, they would be required to communicate their ideas relevantly and coherently in writing.
3. To prepare all the students for their placements.
4. To initiate them into greater use of the computer in resume preparation, report writing, format making etc.
5. To train them to use language effectively to face interviews, group discussions, public speaking.

### UNIT-I: COMMUNICATIVE COMPETENCY

1. Reading Comprehension
2. Listening comprehension
3. Vocabulary for competitive purpose

| OUTCOMES |
|---|
| To recall and memorize the basic concepts of reading and listening skills |
| To understand the various components to build up vocabulary |
| To apply English language skills to avoid barriers to effective reading and listening |

### UNIT-II: TECHNICAL WRITING

1. Email Writing
2. CV/Resume Writing
3. Mini Project Writing

| |
|---|
| To understand the basic components of writing Emails |
| To apply the knowledge of writing eye catching resumes |
| To analyze different ways of writing a mini project |

**UNIT-III: ORAL PRESENTATION SKILLS**

1. Self-Introduction – Introducing Others – Welcome Speech – Vote of Thanks
2. Oral Presentation-Individual/Impromptu Speeches/ JAM
3. Stage Dynamics– Barriers to Effective Presentation

| |
|---|
| To understand the basic components of speeches |
| To apply knowledge of different forms of presentation. |
| To analyze stage dynamics for effective presentation |

**UNIT-IV:** TECHNICAL **PRESENTATION SKILLS**

1. Information Transfer
2. PPT Presentation
3. Poster Presentation

| |
|---|
| To apply knowledge of different types of pictograms to transfer the information |
| To analyze the techniques of preparing PPTs |
| To evaluate different skills in poster presentation |

**UNIT-V: PROFESSIONAL SKILLS**

1. Group discussions-II
2. Interview skills
3. Answering Strategies

| |
|---|
| To analyze the different aspects of interviews and group discussions |
| To evaluate the group dynamics to excel in group discussions |
| To design and develop strategies to answer effectively in interviews |

REFERENCE BOOKS


1. DELTA's key to the Next Generation TOEFL Test: Advanced Skill Practice.
2. TOEFL & GRE (KAPLAN, AARCO & BARRONS, USA, Cracking GRE by CLIFFS)
3. Train2success.com

1. Objective English for Competitive Exams, Hari Mohana Prasad, 4th edition, Tata Mc Graw Hill.

2. Technical Communication by Meenakshi Raman & Sangeeta Sharma, O U Press 2009.
3. Books on TOEFL/GRE/GMAT/CAT/IELTS by Barron's/DELTA/Cambridge University Press.2012.
4. Handbook for Technical Writing by David A McMurrey & Joanne Buckely CENGAGE Learning 2008.
5. English for Technical Communication for Engineering Students, Aysha Vishwamohan, Tata Mc Graw-Hill 2009.
6. Word Power Made Handy, Shalini Verma, S Chand Publications, 2011.
7. Effective Technical Communication, Ashrif Rizvi, TataMcGrahill, 2011.

WEB LINKS

1. https://www.slideshare.net/ruschellecossid/reading-comprehension-56872438

2. https://www.slideshare.net/FiveEEE/listening-comprehension-40031081

3. https://www.slideshare.net/shrutisalunkhe2/english-for-competitive-exams

4. https://www.slideshare.net/nidhipandey16/email-writing-52942112

5. https://www.slideshare.net/aamirmuhammadaamir77/resume-writing-ppt

6. https://www.powershow.com/view/1d8cf2-OWFhN/Mini_Project_Report_Writing_Workshop_powerpoint_ppt_presentation

7. https://www.slideshare.net/8788902/oral-presentations-28994496

8. https://www.slideshare.net/nandapalit/presentation-skills-33500438

9. https://www.slideshare.net/ritikadhameja/group-discussion-46255658

10. https://www.slideshare.net/vikkerkar/interview-skills-presentation

**3rd Year, 2nd Semester**

## 10. SOCIALLY RELAVANT PROJECT

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 0.5 | 0.5 |

**-----as per regulation-------**

**IV Year I-Sem**

## 1. TRANSPORT PHENOMENA

| L | T | P | C |
|---|---|---|---|
| 2 | 1 | 0 | 3 |

**Pre-requisite:** Fluid Mechanics for Chemical Engineers, Process heat transfer, Mass Transfer operations- I & II and Chemical Reaction Engineering I and II

**Course Objectives:**

- Different types of fluids, their flow characteristics and different mathematical models applied to actual situations
- Mechanism of fluids in motion under different conditions.

**UNIT-I**

Viscosity and the mechanisms of momentum transfer: Newton's law of viscosity (molecular momentum transport), generalization of Newton's law of viscosity, pressure and temperature dependence of viscosity, molecular theory of the viscosity of gases at low density, molecular theory of the viscosity of liquids. Thermal conductivity and the mechanisms of energy transport: Fourier's law of heat conduction (molecular energy transport), temperature and pressure dependence of thermal conductivity, and theory of thermal conductivity of gases at low density. Diffusivity and the mechanisms of mass transport: Fick's law of binary diffusion (molecular mass transport), temperature and pressure dependence of diffusivities, theory of diffusion in gases at low density.

**UNIT -II**

Shell momentum balances and velocity distributions in laminar flow: shell momentum balances and boundary conditions, flow of a falling film, flow through a circular tube, flow through annulus, flow of two adjacent immiscible fluids, creeping flow around a sphere.

**UNIT -III**

Shell energy balances and temperature distributions in solids and laminar flow: shell energy balances; boundary conditions, heat conduction with an electrical heat source, heat conduction with a nuclear heat source, heat conduction with a viscous heat source, heat conduction with a chemical heat source, heat conduction through composite walls, heat conduction in a cooling fin, forced convection, free convection.

**UNIT -IV**

Concentration distributions in solids and laminar flow: shell mass balances; boundary conditions, diffusion through a stagnant gas film, diffusion with a heterogeneous chemical reaction, diffusion with a homogeneous chemical reaction, diffusion into a falling liquid film (gas absorption), diffusion into a falling liquid film (solid dissolution), diffusion and chemical reaction inside a porous catalyst.

**UNIT -V**

The equations of change: Derivation of the equation of continuity in Rectangular and Polar coordinates, the equation of motion, the equation of energy, the equation of continuity of a component in multi component mixture (in rectangular coordinates only) the equations of change in terms of the substantial derivative. Use of equations of change to solve one dimensional steady state problems of momentum, heat and component transfer, Introduction to Turbulent transport, Time smoothing of equation change.

**Course Outcomes:**

At the end of the course, the student will be able to:

1. Derive equations of continuity in rectangular and polar coordinates
2. Develop equation of motion, energy and component continuity for rectangular coordinate system.
3. Solve one dimensional steady state problems of momentum, heat and mass transfer using equations of change
4. Formulate time smoothing of equations of change for turbulent transport.

**Text Book:**

1. Transport Phenomena by Bird R.B., Stewart W.C., Lightfoot F.N., 2$^{nd}$ ed. John Wiley & Sons Inc, U.S.A, 1960.

**Reference Books:**

1. Transport phenomena for engineers by L. Theodore, International text book company, U.S.A.1971.
2. Transport processes and unit operations by C.J. Geankoplis, PHI, 3$^{rd}$ed. 1997.
3. Fundamental of heat, momentum and mass transfer, Welty, Wicks and Wilson, John Wiley.

**Codes / Tables:** 1. Leonard – Jones potential parameters and critical properties.
2. Equations of change (from Bird)

**IV Year I-Sem**

## 2.OPTIMIZATION OF CHEMICAL PROCESSES

| L | T | P | C |
|---|---|---|---|
| 2 | 1 | 0 | 3 |

**OBJECTIVES:**

- To learn problem formulation of optimization.
- To realize the numerical methods of un-constrained optimization.
- To learn linear programming and its applications
- To understand the use of genetic algorithms in optimization
- To know the applications of numerical optimization.

**UNIT I**

**Nature and organization of optimization problems**: Introduction to optimization, scope and hierarchy of optimization, examples of applications of optimization, essential features of optimization problems, general procedure for solving optimization problems, Optimization of a manufacturing problem with a stepwise procedure, obstacles of optimization, constraints in optimization, examples and formulation of constrained optimization problems.

**Basic concepts of optimization**: Continuity of functions, unimodal versus Multimodal functions. Convex and Concave functions, convex region, Necessary and sufficient conditions for an extremum of an unconstrained function.

**UNIT II**

**Optimization of unconstrained single variable functions:** Region elimination methods: Fibonacci search, Golden section search. Polynomial approximation methods- Sequential search

**Methods specifying optimum by a point:** Newton's method, Secant method, Quadratic interpolation, Cubic interpolation. Applications of one- dimensional search methods to chemical engineering problems.

**UNIT III**

**Unconstrained multivariable optimization:** Random search methods, grid search, uni-variate search, multivariable Newton's method, steepest descent method, Conjugate search directions, Conjugate gradient method

.

**UNIT IV**

**Optimization of Unit operations:** Optimal pipe diameter, optimizing recovery of waste heat, optimization of multiple effect evaporator, Determination of optimal reflux ratio for staged distillation column, shell and tube heat exchanger.

**UNIT V**

**Linear programming and applications:** Basic concepts in linear programming, graphical solution, artificial variable technique, exceptional cases in LPP, non-existing feasible solution, degeneracy, duality in linear programming, dual simplex method, revised simplex method.

**Course Outcomes:**

At the end of the course, the student will be able to:

1. Ability to define, understand and explain the concept of Optimization of Chemical Processes
2. Ability to formulate Optimization Problems with given constraints
3. Ability to apply and analyze the optimization criterion for solving problems
4. Ability to investigate constrained and unconstrained optimization techniques
5. Ability to investigate different methods of optimization and to suggest a technique for specific problem
6. Ability to solve problems using advanced optimization techniques like Genetic algorithms and other optimization techniques for industrial problems of relevance especially chemical industries

**Text Books:**


1. Optimization of Chemical Processes, T.F. Edgar and D.M. Himmelblau, McGraw-Hill, New York, 2001.
2. Optimization for Engineering Design, Kalyan Moy Deb, PHI Pvt. Ltd., New Delhi, 2000


**Course Outcomes:**

1. Knowledge of optimization to formulate the problems and analyze the optimization criterion for solving problems
2. Apply different methods of optimization and to suggest a technique for specific problem
3. Advanced optimization techniques like Genetic algorithms and other optimization techniques can be used to solve the industrial problems of relevance to the chemical industry

**IV Year I-Sem**

**Professional Elective-III**

**PE1.INDUSTRIAL POLLUTION & CONTROL ENGINEERING:**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

The aim of this course is that the students will learn the essential principles used in industrial pollution abatement and understand important issues in industrial pollution abatement and pertinent environmental legislations.

**UNIT I :** Types of emissions from chemical industries and effects of environment, environment legislation, Type of pollution, sources of wastewater, Effluent guidelines and standards. Characterization of effluent streams, oxygen demands and their determination (BOD, COD, and TOC), Oxygen sag curve, BOD curve mathematical, controlling of BOD curve, self-purification of running streams, sources and characteristics of pollutants in fertilizer, paper and pulp industry, petroleum and petroleum industry.

**UNITII:** General methods of control and removal of sulfur dioxide, oxides of nitrogen and organic vapors from gaseous effluent, treatment of liquid and gaseous effluent in fertilizer industry. Air pollution sampling and measurement: Types of pollutant and sampling and measurement, ambient air sampling: collection of gaseous air pollutants, collection of particulate air pollutants. Stack sampling: sampling system, particulate sampling, and gaseous sampling. Analysis of air pollutants: Sulphur dioxide, nitrogen oxides, carbon monoxide, oxidants and Ozones, hydrocarbons, particulate matter.

**UNIT III :** Air pollution control methods and equipments: Source collection methods: raw material changes, process changes, and equipment modification. Cleaning of gaseous equipments particulate emission control: collection efficiency, control equipment like gravitational settling chambers, Cyclone separators, fabric filters, ESP and their constructional details and design aspects. Scrubbers: wet scrubbers, spray towers, centrifugal scrubbers, packed beds and plate columns, venturi scrubbers, their design aspects. Control of gaseous emissions: absorption by liquids, absorption equipments, adsorption by solids, equipment and the design aspects.

**UNIT IV**: Introduction to waste water treatment, biological treatment of wastewater, bacterial and bacterial growth curve, aerobic processes, suspended growth processes, activated aerated lagoons and stabilization ponds, attached growth processes, trickling filters, rotary drum filters, anaerobic processes.

**UNIT V:** Methods of primary treatments: screening, sedimentation, flotation, neutralization, and methods of tertiary treatment. A brief study of carbon absorption, ion exchange, reverse osmosis, ultra-filtration, chlorination, ozonation, treatment and disposal. Hazardous waste management: nuclear wastes: health and environment effects, sources and disposal methods. Chemical wastes:

health and environmental effects, treatment and disposal: treatment and disposal by industry, off site treatment and disposal, treatment practices in various countries. Biomedical wastes: types of wastes and their control.

**TEXT BOOKS:**

1. Environmental Pollution and Control Engineering, C. S. Rao – Wiley Eastern Limited, India, New Delhi, 1993.
2. Pollution Control in Process Industries, S.P. Mahajan, Tata McGraw-Hill, New Delhi, 1985.

**REFERENCES**:

1. Wastewater Treatment, M. Narayana Rao and A.K.Datta, Oxford and IHB publ. New Delhi.

**OUTCOMES:**

1. Understand the different types of wastes generated in an industry, their effects on living and non-living things.
2. Understand environmental regulatory legislations and standards and climate changes.
3. Understand about the quantification and analysis of wastewater and treatment.
4. Understand the different unit operations and unit processes involved in conversion of highly polluted water to potable standards.
5. Understand the atmospheric dispersion of air pollutants, and operating principles, design calculations of particulate control devices.

**IV Year I-Sem**

## PE2. INTERFACIAL AND COLLOIDAL SCIENCE

| L | T | P | C |
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Pre Requisites: NIL

**Course Objectives:**

1. Understand the basic nomenclature, concepts and tools of colloid and interface science and engineering; multi-phase nano-systems; mechanics and thermodynamics on small scales.
2. Explain the difference between the surface and bulk dominated regimes, their behavior and exploitation of nano-systems.
3. Importance of various components of interfacial science in different chemical engineering industries viz. food, paint and pharmaceutical industries are emphasized.

**UNIT I**

Basic concepts of Colloids and Interfaces: Introduction, Examples of Interfacial Phenomena, Solid-Fluid Interfaces, Colloids. Properties of Colloid Dispersions: Introduction, Sedimentation under Gravity, Sedimentation in a Centrifugal Field, Brownian Motion, Osmotic pressure, Optical properties, Electrical Properties, Rheological Properties of Colloid Dispersions.

**UNIT II**

Surfactants micelles, films and their properties: Introduction, Surfactants and their Properties, Emulsions and Microemulsions, foams. Emulsion polymerization, liquid-liquid extraction& membranes.

**UNIT III**

Surface and Interfacial Tension: Introduction, Surface tension, Interfacial Tension, Contact Angle and Wetting, Shape of the Surfaces and interfaces. Measurement of Surface and Interfacial Tension, Measurement of Contact Angle

**UNIT IV**

Intermolecular and Surface Forces: Introduction, Vanderwalls Forces. Intermolecular and Surface Forces: Electrostatic double layer force, The DLVO theory, Non-DLVO forces.

**UNIT V**

Adsorption at interfaces: Introduction, The Gibbs Dividing surface, Gibbs Adsorption Equation, Langmuir and Frumkin Adsorption Isotherms, Surface Equation of state(EOS), Effect of Salt on Adsorption of Surfactants. Adsorption Isotherms incorporating the Electrostatic Effects, Calculation of Free energy of Adsorption.

**Text Books:**

1. Interfacial Science: An Introduction by G.Barnes, I.Gentle, Oxford University Press, USA, 2006.
2. Foundations of Colloid Science by R. J. Hunter, 2nd edition, Oxford University Press, USA, 2001.

**Reference Books:**

1. Principles of Colloid and Surface Chemistry, Third edition, Revised and Expanded, Paul C. Hiemenz and Raj Rajagopalan.
2. Physical Chemistry of Sciences, 6th edition, A. Adamson, 1997.
3. Colloid and Interface Science by Pallab Ghosh, PHI, New Delhi.

**Course Outcomes:** At the end of the course, student will be able to

1. Distinguish between colloid and interface and explain properties of colloid dispersion
2. Explain the differences between surfactants, emulsions
3. Apply the methods for measurement of contact angle, surface tension and interfacial tension 4. Explain about the various forces acting on colloids
5. Explain about the adsorption evaluating techniques.

**IV Year I-Sem**

**Professional Elective-III**

## PE3. TECHNOLOGY OF PHARMACEUTICALS AND FINE CHEMICALS

| L | T | P | C |
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**UNIT I**

A brief outline of grades of chemicals, sources of impurities in chemicals, principles (without going into details of individual chemicals) of limit test for arsenic, lead, iron, chloride and sulfate in Pharmaceuticals.

**UNIT II**

Outlines of Preparation, properties, uses and testing of the following Pharmaceuticals - sulfacetamide, paracetamol, riboflavin, nicotinamide,

Outlines of Preparation, properties, uses and testing of the following fine chemicals - Methyl orange, fluorescence, procaine hydrochloride, paramino salicylic acid, isonicatinic acid hydrazide.

**UNIT III**

Manufacture with flowsheets, properties, uses and testing of the following Pharmaceuticals – aspirin, penicillin, calcium gluconate.

**UNIT IV**

Manufacture with flowsheets, properties, uses and testing of the following ferric ammonium citrate, pthallic anhydride and phenol fluorobenzene process and benzene sulfate process, other processes in outline only.

**UNIT V**

Tablet making and coating, granulation equipments, Preparation of capsules, extraction of crude drugs. Sterilization: introduction, risk factor, methods of sterilization, heat (dry and moist), heating with bactericide, filtration, gaseous sterilization and radiation sterilization, suitable example to be discussed.

**Course Outcomes:**

At the end of the course, the student will be able to:

1. Understand the principle of plant design in Pharmaceutical Industry
2. Understand the knowledge of base chemicals and drug intermediates
3. Understand kinetics, thermodynamics and plant construction material for the production of bulk drugs and fine chemicals

**Text Books:**

1. Remington's Pharmaceutical Science,16th ed, Mac publishing company, 1980.
2. Industrial Chemicals, 3rd ed., Faith, Kayes and Clark, John Wiley & Sons,. 1965.

**References Books:**

1. Blently's Text Book of Pharmaceutical Chemistry, 8th ed, H A Rawlins,
2. B Tindell and Box,. Oxford University Press, London, 1977

**IV Year I-Sem**

**Open Elective-III**

**OE1. BASICS OF NANOTECHNOLOGY**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:**

- Basic knowledge of nanotechnology, classification and properties of nanomaterials
- Various methods of synthesis of nanomaterials
- Applications of nanomaterials

**UNIT I**

Introduction: History and Scope, Can Small Things Make a Big Difference? Classification of Nanostructured Materials, Fascinating Nanostructures, Applications of Nanomaterials, Nature: The Best of Nanotechnologist, Challenges and Future Prospects.

**UNIT II**

Unique Properties of Nanomaterials: Microstructure and Defects in Nanocrystalline Materials: Dislocations, Twins, stacking faults and voids, Grain Boundaries, triple and disclinations. Effect of Nano-dimensions on Materials Behaviour: Elastic properties, Melting Point, Diffusivity, Grain growth characteristics, Enhanced solid solubility.

**UNIT III**

Magnetic Properties: Soft magnetic nanocrystalline alloy, Permanent magnetic nanocrystalline materials, Giant Magnetic Resonance, Electrical Properties, Optical Properties, Thermal Properties and Mechanical Properties.

**UNIT IV**

Synthesis Routes: Bottom-up approaches: Physical Vapor Deposition, Inert Gas Condensation, Laser Ablation, Chemical Vapor Deposition, Molecular Beam Epitaxy, Sol-gel method, Self-assembly

**UNIT V**

Top-down approaches: Mechanical alloying, Nano-lithography.

Consolidation of Nano powders: Shock wave consolidation, Hot isostatic pressing and Cold isostatic pressing Spark plasma sintering.

Applications of Nanomaterials: Nano-electronics, Nano sensors, Nano catalysts, Structure and Engineering, Automotive Industry, Water- Treatment and the environment, Nano-medical applications, Textiles, Paints, Energy, Defence and Space Applications

**Text Books**

1. Text Book of Nano Science and Nano Technology – B.S. Murthy, P. Shankar, Baldev Raj, B.B. Rath and James Munday, University Press-IIM.
2. Introduction to Nanotechnology – Charles P. Poole, Jr., and Frank J. Owens, Wley India Edition, 2012.

**Reference Books:**

1. Nano: The Essentials by T.Pradeep, Mc Graw- Hill Education.
2. Nanomaterials, Nanotechnologies and Design by Michael F. Ashby, Paulo J. Ferreira and Daniel L.Schodek
3. Transport in Nano structures- David Ferry, Cambridge University press 2000
4. Nanofabrication towards biomedical application: Techniques, tools, Application and impact – Ed. Challa S.,S. R. Kumar, J. H. Carola.
5. Carbon Nanotubes: Properties and Applications- Michael J. O'Connell.
6. Electron Transport in Mesoscopic systems - S. Dutta, Cambridge University press.

**IV Year I-Sem**

**Open Elective-III**

## OE2. SOLID WASTE MANAGEMENT

| L | T | P | C |
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| 3 | 0 | 0 | 3 |

**Course Objectives:**

- Material flow in society and generation of solid waste source
- Clarification of solid waste on characterization of the same
- Understand the sense of onsite handling storage and collection systems including transportation
- Understand processing technologies with mechanical volume reduction and thermal volume reduction corporate land filling, deep well injections.
- Learn to estimate material recovery energy recovery from a given waste data using case standing

**Unit I**

**Introduction:** Definition, characteristics and perspectives of solid waste. Types of solid waste. Physical and chemical characteristics. Variation of composition and characteristics. Municipal, industrial, special and hazardous wastes.

**General aspects** Overview of material flow in society. Reduction in raw material usage. Reduction in solid waste generation. Reuse and material recovery. General effects on health and environment. Legislations.

**Unit II**

**Engineered systems:** Typical generation rates. Estimation and factors effecting generation rates. On site handling. Storage and processing. Collection systems and devices. Transfer and transport.

**Unit III**

**Processing Techniques:** Mechanical volume reduction. Thermal volume reduction. Component separation. Land filling and land forming. Deep well injection.

**Unit IV**

**Material recovery:** Mechanical size alteration. Electromagnetic separation. Drying and dewatering. Other material recovery systems. Recovery of biological conversion products. Recovery of thermal conversion products.

**Energy recovery:** Energy recovery systems and efficiency factors. Determination of output and efficiency. Details of energy recovery systems. Combustion incineration and heat recovery. Gasification and pyrolysis. Refuse derived fuels (RDF).

**Unit V**

**Case studies:** Major industries and management methods used in typical industries – Coal fired power stations, textile industry, oil refinery, distillery, sugar industry, and radioactive waste generation units.

**Course Outcomes:**
The student should be able to:

1. 1.Apply his knowledge of characterization of waste and develop a suitable management plan
2. Assess the cost of transportation laboratory processing of solid waste
3. Identify hazardous nature of waste if any and can suggest suitable dumping methods.
4. Suggest processing waste for material for energy recovery.
5. Develop a management plan for land filling composting deep well injection for non-recoverable waste.

**Text Books:**

1. Howard S. Peavy, Environmental Engineering, McGraw Hill International Edition, 1986.
2. Dutta, Industrial Solid Water Management and Land Filling Practice, Narose Publishing House, 1999.


**Reference Books:**

1. Sastry C.A., Waste Treatment Plants, Narose Publishing House, 1995.
2. Lagrega, Hazardous Waste Management, McGraw Hill, 1994.

**IV Year I-Sem**

## Open Elective-III

## OE3. PROCESS INTENSIFICATION

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Pre-Requisites**: Process heat transfer, Mass Transfer-I, Mass Transfer-II

**Course Objectives:**

1. Explain the concept of Process Intensification.
2. Define the limitations of intensification for the chemical processes.
3. Describe the techniques of intensification to a range of chemical processes.

**UNIT I**

**Introduction to Process Intensification (PI)**: sustainability-related issues in process industry, definitions of Process Intensification, fundamental principles and techniques of PI, the original ICI PI strategy, benefits of PI and obstacles to PI, Issues in designing of a sustainable, inherently safer processing plant

**UNIT-II**

**PI Approaches**: STRUCTURE - PI approach in spatial domain, ENERGY - PI approach in thermodynamic domain, SYNERGY - PI approach in functional domain and TIME - PI approach in temporal domain. **Mechanisms involved in PI:** Mechanisms of intensified heat transfer, mass transfer, electrically enhanced processes, micro fluidics

**UNIT –III**

**Application of PI techniques to heat transfer**: Compact & micro heat exchangers.
**Application of Pi techniques to reactors**: Spinning disc reactors, oscillatory baffled reactors (OBR), Rotating reactors, Micro reactors, membrane reactors, micro reactors, Reactive separation/ super critical operation and other intensified reactor types.

**UNIT-IV**

**Intensification of Separation Processes:** Distillation, Centrifuges, membranes, drying, precipitation and crystallization. **Intensified Mixing**: Inline mixers, mixing on spinning disk, induction heated mixer

**UNIT –V**

Application areas of PI:Petrochemicals and Fine Chemicals: Refineries, Bulk Chemicals, Fine Chemicals, Fine Chemicals and Pharmaceuticals, bio processing. Offshore Processing, Nuclear Industries, Food and drink water sector, Textiles, Aerospace, biotechnology

**Course Outcomes:**

At the end of the course, student will be able to

1. Be familiar with process intensification in industrial processes.
2. Assess the values and limitations of process intensification, cleaner technologies and waste minimization options.
3. Measure and monitor the usage of raw materials and wastes generating from production and frame the strategies for reduction, reuse and recycle.
4. Process challenges using intensification techniques.
5. Describe the applications of process intensification in various chemical industries.

**Text Books:**

1 David Reay, Colin Ramshaw, Adam Harvey, Process Intensification-Reengineering for efficiency, sustainability and flexibility, Butterworth Heinemann, (Elsevier) 2008.

2. Stankiewicz, A. and Moulijn, (Eds.), Reengineering the Chemical Process Plants, Process Intensification, Marcel Dekker 2003

**Reference Books:**

1. Frerich Johannes Keil, Modeling of process intensification, Wiley 2007
2. Juan Gabriel Segovia Hernandez, Andrian Bonilla-Petericiolet, Process Intensification in Chemical Engineering: Design optimization and control, Springer 2016.

**IV B. Tech- I Sem(Chem)**

| Subject Code | Title of the Subject | L | T | P | C |
|---|---|---|---|---|---|
| 19A75401 | **MANAGEMENT SCIENCE** | 3 | 0 | 0 | 3 |

| **COURSE OBJECTIVES :** The objectives of this course are | |
|---|---|
| 1 | To provide fundamental knowledge on Management, Administration, Organization & its concepts. |
| 2 | To make the students understand the role of management in Production |
| 3 | To impart the concept of HRM in order to have an idea on Recruitment, Selection, Training &Development, job evaluation and Merit rating concepts |
| 4 | To create awareness on identify Strategic Management areas & the PERT/CPM for better Project Management |
| 5 | To make the students aware of the contemporary issues in management |

**Syllabus**

**UNIT- I:INTRODUCTION**

Management-Concept and meaning-Nature-Functions-Management as a Science and Art and both. Schools of Management Thought-Taylor's Scientific Theory-Henry Fayol's principles-Eltan Mayo's Human relations-Systems Theory- **Organisational Designs**-Line organization-Line & Staff Organization-Functional Organization-Matrix Organization-Project Organization-Committee form of Organization-Social responsibilities of Management.

**LEARNING OUTCOMES:**At the end if the Unit, the learners will be able to

- Understand the concept of management and organization
- Analyze the organization chart & structure for an enterprise.
- Apply the concepts & principles of management in real life industry.
- Evaluate and interpret the theories and the modern organization theory.

**UNIT-II:OPERATIONSMANAGEMENT**

Principles and Types of Plant Layout-Methods of Production (Job, batch and Mass Production), Work Study- Statistical Quality Control- Deming's contribution to Quality. **Materials Management -** Objectives- Inventory-Functions - Types, Inventory Techniques-EOQ-ABC Analysis-Purchase Procedure and Stores Management- **Marketing Management -**Concept- Meaning - Nature-Functions of Marketing - Marketing Mix- Channels of Distribution -Advertisement and Sales Promotion- Marketing Strategies based on Product Life Cycle.

**LEARNING OUTCOMES:**At the end of the Unit, the learners will be able to

- Understand the core concepts of Management Science and Operations Management
- Apply the knowledge of Quality Control, Work-study principles in real life industry.
- Analyze Marketing Mix Strategies for an enterprise
- Evaluate Materials departments &Determine EOQ
- Create and design advertising and sales promotion

**UNIT-III:HUMAN RESOURCES MANAGEMENT (HRM)**

HRM- Evolution of HRM - Definition and Meaning – Nature-Managerial and Operative functions--Job Analysis -Human Resource Planning(HRP)–Process of Recruitment&Selection- Training and Development-Performance Appraisal-Methods of Performance Appraisal – Placement-Employee Induction-Wage and Salary Administration.

**LEARNING OUTCOMES:**At the end if the Unit, the learners will

- Understand the concepts of HRM in Recruitment, Selection, Training & Development
- Apply Managerial and operative Functions
- Analyze the need of training
- Evaluate performance appraisal
- Design the basic structure of salaries and wages

**UNIT-IV:STRATEGIC& PROJECT MANAGEMENT**

Strategy Definition& Meaning-Vision - Mission- Goals- Corporate Planning Process- Environmental Scanning-Steps in Strategy Formulation and Implementation-SWOT Analysis
**Project Management-** Network Analysis- Programme Evaluation and Review Technique (PERT) - Critical Path Method (CPM) Identifying Critical Path - Probability of Completing the project within given time - Project Cost Analysis - Project Crashing (Simple problems).

**LEARNING OUTCOMES:** At the end of the Unit, the learners will be able to

- Understand Mission, Objectives, Goals & strategies for an enterprise
- Apply SWOT Analysis to strengthen the project
- Analyze Strategy formulation and implementation
- Evaluate PERT and CPM Techniques
- Creative in completing the projects within given time

**UNIT -V:Contemporary Issues In Management**

The concept of Management Information System(MIS)- Materials Requirement Planning (MRP)-Customer Relations Management(CRM)- Total Quality Management (TQM)- Six Sigma Concept-Supply Chain Management(SCM)- Enterprise Resource Planning (ERP)- Performance Management-Business Process Outsourcing (BPO) - Business Process Re-engineering and Bench Marking -Balanced Score Card-Knowledge Management.

**LEARNING OUTCOMES**At the end if the Unit, the learners will be able to

- Understand modern management techniques
- Apply Knowledge in Understanding in modern
- Analyze CRM,MRP,TQM
- Evaluate Six Sigma concept and SCM

**Text Books:**

1. A.R Aryasri, Management Science, TMH, 2013
2. Stoner, Freeman, Gilbert, Management, Pearson Education,New Delhi, 2012.

**References:**

1. Koontz & Weihrich, Essentials of Management, 6/e, TMH, 2005.
2. Thomas N.Duening & John M.Ivancevich, ManagementPrinciples and Guidelines,Biztantra.
3. Kanishka Bedi, Production and Operations Management, Oxford University Press, 2004.
4. Samuel C.Certo, Modern Management, 9/e, PHI, 2005

| **COURSE OUTCOMES:** At the end of the course, students will be able to | |
|---|---|
| CO1 | Define the Management ,and its Functions |
| CO2 | Understand the concepts & principles of management and designs of organization in a practical world |
| CO3 | Apply the knowledge of Work-study principles & Quality Control techniques in industry |
| CO4 | Analyze the concepts of HRM in Recruitment, Selection and Training & Development. |
| CO5 | Evaluate PERT/CPM Techniques for projects of an enterprise and estimate time & cost of project & to analyze the business through SWOT. |
| CO6 | Create Modern technology in management science. |

**IV B. Tech- I Sem(Chem)**

**(w.e.fAcademic Year 2019-20)**

| Subject Code | Title of the Subject | L | T | P | C |
|---|---|---|---|---|---|
| | **ORGANISATIONAL BEHAVIOUR** | 3 | 0 | 0 | 3 |

| **COURSE OBJECTIVES :** | |
|---|---|
| 1 | **Toenablestudent's comprehension of organizational behavior** |
| 2 | **To offer knowledge to students onself motivation, leadership and management** |
| 3 | **To facilitate them to become powerful leaders** |
| 4 | **To Impart knowledge about group dynamics** |
| 5 | **To make them understand the importance of change and development** |

**Syllabus**

**Unit-I: Introduction**

, Meaning, definition, nature,scope and functions - Organizing Process – Making organizing effective -Understanding Individual Behavior –Attitude -Perception - Learning – Personality.

**LEARNING OUTCOMES:-**After completion of this unit student will

- Understand the concept of OrganizationalBehavior
- Contrast and compare Individual& Group Behavior andattitude
- Evaluate personality types

**Unit-II: Motivation and Leading**

Theories of Motivation- Maslow'sHierarchy of Needs - Hertzberg's Two Factor Theory - Vroom's theoryof expectancy - McCLelland's theory of needs–Mc Gregor's theory X and theory Y– Adam's equity theory – Locke's goal setting theory– Alderfer'sERG theory - Leadership–research,theories, traits - LeadersVs Managers.

**LEARNING OUTCOMES:-**After completion of this unit student will

- Understand the concept of Motivation
- Analyze theTheories of motivation
- Explain how employees are motivated according to Maslow's Needs Hierarchy

**Unit-III: Organizational Culture**

Introduction – Meaning, scope, definition, Nature - Orgnanizational Climate - Leadership - Traits Theory–Managerial Grid - Transactional Vs Transformational Leadership - Qualities of goodLeader - Conflict Management -Evaluating Leader- Women and Corporate leadership.

**LEARNING OUTCOMES:-**After completion of this unit student will

- Understand the theconcept of Leadership
- Contrast and compare Traits theoryand Managerial Grid
- Distinguish the difference betweenTransactional and Transformational Leadership
- Evaluate the qualities of good leaders

**Unit-IV:Group Dynamics**

Introduction – Meaning, scope, definition, Nature- Types of groups - Determinants of groupbehavior - Group process – Group Development - Group norms - Group cohesiveness - Small Groups - Group decision making - Team building - Conflict in the organization– Conflict resolution

**LEARNING OUTCOMES: -**After completion of this unit student will

- Understand theconcept of Group Dynamics
- Contrast and compare Group behavior and group development
- Evaluate how to resolve conflicts in the organization

**Unit-V:Organizational Change and Development**

Introduction –Nature, Meaning, scope, definition and functions- Organizational Culture - Changing the Culture – Change Management – Work Stress Management - Organizational management – Managerial implications of organization's change and development

**LEARNING OUTCOMES:-**After completion of this unit student will

- Understand the importance of organizational change and development
- Apply change management in the organization
- Analyze work stress management
- Evaluate Managerial implications of organization

**TEXT BOOKS**:

1. Luthans, Fred, OrganisationalBehaviour, McGraw-Hill, 12 Th edition 2011 2. P Subba Rao,OrganisationalBehaviour,HimalyaPublishing House 2017

**References**

- McShane, Organizational Behaviour, TMH 2009
- Nelson,OrganisationalBehaviour, Thomson, 2009.
- Robbins, P.Stephen, Timothy A. Judge, OrganisationalBehaviour, Pearson 2009.

- Aswathappa,OrganisationalBehaviour,Himalaya, 2009

| **COURSE OUTCOMES:** At the end of the course, students will be able to | |
|---|---|
| CO1 | Define the Organizational Behavior ,its nature and scope. |
| CO2 | Understand the nature and concept of Organizational behavior |
| CO3 | Apply theories of motivation to analyze the performance problems |
| CO4 | Analyze the different theories of leadership |
| CO5 | Evaluate group dynamics |
| CO6 | Develop as powerful leader |

**IV B. Tech- I Sem(Chem)**

**(w.e.f academic year 2019-20)**

| Subject Code | Title of the Subject | L | T | P | C |
|---|---|---|---|---|---|
| | **Business Environment** | 3 | 0 | 0 | 3 |

| **Course Objectives** | |
|---|---|
| 1 | To make the student understand about the business environment |
| 2 | To enable them in knowing the importance of fiscal and monitory policy |
| 3 | To facilitate them in understanding the export policy of the country |
| 4 | To Impart knowledge about the functioning and role of WTO |
| 5 | To Encourage the student in knowing the structure of stock markets |

**Syllabus**

**Unit-I:Overview of Business Environment**

Introduction – meaning Nature,Scope ,significance, functions and advantages. Types- Internal & External, Micro and Macro. Competitive structure of industries -Environmental analysis- advantages & limitations of environmental analysis& Characteristics of business.

**Learning Outcomes: -**After completion of this unit student will

- Understand the concept of Business environment
- Classify various types of business environment
- Evaluate the environmental analysis in business
- Discuss the Characteristics of Business.

**Unit-II:Fiscal Policy**

Introduction – Nature, meaning, significance, functions and advantages. Public Revenues - Public Expenditure - Public debt - Development activities financed by publicexpenditure - Evaluation of recent fiscal policy of GOI. Highlights of Budget- Monetary Policy - Demand and Supply of Money –RBI -Objectives of monetary and credit policy - Recent trends- Role of Finance Commission.

**Learning Outcomes: -**After completion of this unit student will

- Understand the concept of public revenue and public Expenditure
- Identify the functions of RBI and its role
- Analyze the Monitory policy in India
- Know the recent trends and the role of Finance Commission in the development of our country
- Differentiate between Fiscal and Monitory Policy

**Unit-III:India's Trade Policy**

Introduction – Nature, meaning, significance, functions and advantages. Magnitude and direction of Indian International Trade - Bilateral and Multilateral TradeAgreements - EXIM policy and role of EXIM bank -Balance of Payments– Structure & Major components - Causes for Disequilibrium in Balance of Payments - Correction measures.

**Learning Outcomes:-**After completion of this unit student will

- Understand the role ofIndian international trade
- Understand and explain the need for Export and EXIM Policies
- Analyze causes for Disequilibrium and correction measure
- Differentiate between Bilateral and Multilateral Trade Agreements

**UNIT-IV:World Trade Organization**

Introduction – Nature, meaning, significance, functions and advantages. Organization and Structure - Role andfunctions of WTO in promoting world trade - Agreements in the Uruguay Round –TRIPS, TRIMS, and GATT - Disputes Settlement Mechanism - Dumping and Anti-dumping Measures.

**Learning Outcomes: -**After completion of this unit student will

- Understand the role of WTO in trade
- AnalyzeAgreements on trade by WTO
- Understand the Dispute Settlement Mechanism
- Compare and contrast the Dumping and Anti-dumping Measures.

**Unit-V:Money Markets And Capital Markets**

Introduction – Nature, meaning, significance, functions and advantages. Features and components of Indian financial systems - Objectives, features and structure of money markets and capital markets - Reforms and recent development – SEBI - StockExchanges - Investor protection and role of SEBI.

**Learning Outcomes: -**After completion of this unit student will

- Understand the components of Indian financial system
- Know the structure of Money markets and Capital markets
- Analyze the Stock Markets
- Apply the knowledge in future investments
- Understand the role of SEBI in investor protection.

**TEXT BOOKS**:

1. Francis Cherunilam (2009), International Business: Text and Cases, Prentice Hall of India.
2. K. Aswathappa, Essentials of Business Environment: Texts and Cases & Exercises 13th Revised Edition.HPH2016

**REFERENCE BOOKS**:

1.K. V. Sivayya, V. B. M Das (2009), Indian Industrial Economy, Sultan Chand Publishers, New Delhi, India.
2. Sundaram, Black (2009), International Business Environment Text and Cases, Prentice Hall of India, New Delhi, India.
3. Chari. S. N (2009), International Business, Wiley India.
4.E. Bhattacharya (2009), International Business, Excel Publications, New Delhi.

| **COURSE OUTCOMES:** At the end of the course, students will be able to | |
|---|---|
| CO1 | Define Business Environment and its Importance. |
| CO2 | Understand various types of business environment. |
| CO3 | Apply the knowledge of Money markets in future investment |
| CO4 | Analyze India's Trade Policy |
| CO5 | Evaluate fiscal and monitory policy |
| CO6 | Develop a personal synthesis and approach for identifying business opportunities |

**IV Year I-Sem**

## 6.PROCESS SIMULATION LAB

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 3 | 1.5 |

**Objective**: To make the student familiar with software's and simulation of chemical processes equipment.

The following experiments have to be conducted using C and MATLAB

2. General introduction to MATLAB
3. Functions (log, exp, conv, roots).
4. Matlab Scripts and function files
5. Gravity Flow tank.
6. Three CSTRs in series – open loop
7. Three CSTRs in series – Closed loop
8. Non isothermal CSTR
9. Binary Distillation column
10. Batch Reactor isothermal; Batch reactor non isothermal – closed loop
11. Isothermal batch reactor – open loop
12. Heat Exchanger
13. Interacting System- two tank liquid level
14. Non interacting system-two tank liquid level
15. Plug flow reactor
16. Bubble point calculations
17. Dew point calculations

**Text Books**:

1. A Guide to MATLAB for Chemical Engineering Problem Solving, Kip D. Hauch
2. Understanding MATLAB A Textbook for Beginners by S.N. Alam

**Pre-requisite**: Fluid mechanics for chemical Engineers, Process Heat transfer, Mass transfer operation- 1 & 2, Chemical Reaction Engineering.

**Course Outcomes:**

1. Helps to interconnect knowledge of mathematics, science, and engineering to real world problems.
2. Helps to identify, formulate, and solve engineering problems

(for ex: most of chemical engineering problems are based on transport equations consisting broader areas of kinetics, thermodynamics and mass transfer which can be thoroughly solved using MATLAB inbuilt functions)

- The complex multi component distillation column design can be modeled and simulated
- System of ordinary and partial differential equations obtained in multiple reactors in series/parallel can be solved
- Process control and optimization of reactors can be handled easily

3. "Genetic algorithms" can be implemented at a more pronounced way via MATLAB to solve various linear and non linear models of chemical engineering systems.
4. Most fascinating approach of Artificial Neural Networks (ANN) for electrical related concepts of chemical engineering systems can also be well handled in MATLAB
5. Steady state and unsteady state problems of chemical engineering and allied fields can be modeled and solved using MATLAB

**IV Year I-Sem**

## 7.PROCESS EQUIPMENT DESIGN AND DRAWING LAB

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 3 | 1.5 |

**Objectives:** To make the student familiar with design and drawing aspects of chemical processes equipments.

1. Drawing of flow sheet symbols.
2. Drawing of instrumentation symbols.
3. Drawing of instrumentation diagrams.
4. Mechanical aspects chemical equipment design and drawing of following equipment.
    a) Double pipe heat exchanger
    b) Shell and tube heat exchanger
    c) Evaporator
    d) Distillation column
    e) Batch reactor.

**Text Book:**

1. Process Equipment Design by M. V. Joshi
2. Chemical Process Equipment Design and Drawing, S.C. Maidargi, PHI, 2013

**Reference Books**:

1. Process Equipment Design by Brownell and Young
2. Chemical Process Equipment Design by Bhattacharya
3. Process Equipment Design by Wallas

**Pre-requisite:** Chemical Process equipment design

**Course Outcome:**

- Students would gain knowledge to develop key concepts and techniques to design the process equipment in a process plant. These key concepts would be utilized to make design and operating decisions.

**IV Year II-Sem**

## Professional Elective - IV
## PE1. BIOCHEMICAL ENGINEERING

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:**

- Study introduction to the application of chemical engineering principles in biochemical systems.
- Be enabled to understand the biological systems and kinetics of enzymatic reactions.
- Learn the kinetics of growth of microorganisms, hence be able to control the process.
- Be able to design equipments for handing biological processes.
- Study Operations utilized in the purification of biological products enable them to recommend, install and easily learn to operate the equipments.

**UNIT I**

Introduction to microbiology: Biophysics and the cell doctrine, the structure of cells, important cell types, from nucleotides to RNA and DNA, amino acids into proteins. Kinetics of enzyme catalyzed reaction: the enzyme substrate complex and enzyme action, simple enzyme kinetics with one and two substrates, other patterns of substrate concentration dependence, modulation and regulation of enzyme activity, other influences on enzyme activity.

**UNIT II**

Immobilized enzyme technology: enzyme immobilization, industrial processes, utilization and regeneration of cofactors. Immobilized enzyme kinetics: effect of external mass transfer resistance, analysis of intraparticle diffusion and reaction.

Kinetics of cellular growth in batch and continuous culture, models for cellular growth – unstructured, structured and cybernetic models. Thermal death kinetics of cells and spores

**UNIT III**

Introduction to metabolic pathways, biosynthesis, transport across cell membranes, end products of metabolism, stoichiometry of cell growth and product formation.

Design and analysis of biological reactors: batch reactors, fed-batch reactors, enzyme catalyzed reactions in CSTR, CSTR reactors with recycle and cell growth, ideal plug flow reactors, sterilization reactors, sterilization of gases, packed bed reactors using immobilized catalysts. Fermentation technology: medium formulation, design and operation of a typical aseptic, aerobic fermentation process.

**UNIT IV**

Transport phenomena in bioprocess systems: Gas-liquid mass transfer in cellular systems, determination of oxygen transfer rates, overall $k_La$' estimates and power requirements for sparged and agitated vessels, scaling of mass transfer equipment, heat transfer.

**UNIT V**

Downstream processing: Strategies to recover and purify products; separation of insoluble products-filtration and centrifugation; cell disruption-mechanical and non-mechanical methods; separation of soluble products: liquid-liquid extractions, membrane separation (dialysis, ultra-filtration and reverse osmosis), chromatographic separation-gel permeation chromatography, electrophoresis, final steps in purification – crystallization and drying.

**Course Outcomes:**

At the end of the course, the student will be able to:

1. Classify microorganisms based on the structure and characteristics of various types of cells
2. Analyze the kinetics of enzyme catalyzed reactions
3. Explain the methods of enzyme immobilization and the applications of immobilized enzymes
4. Evaluate the kinetics of cell growth including substrate utilization and product formation
5. Demonstrate the design and analysis of various types of bioreactors
6. Identify various downstream processing strategies for product recovery and purification

**TEXT BOOKS:**

1. Biochemical Engineering Fundamentals, 2nd ed., J.E. Bailey and D.F. Ollis, McGraw-Hill, New York, 1987.

2. Bioprocess Engineering, 2nd ed., M. L. Shuler and F. Kargi, PHI Learning Pvt. Ltd, New Delhi, 2009.

**REFERENCES:**

1. Biochemical Engineering, J. M. Lee, Prentice-Hall, New Jersey 1992.

2. Bioprocess Engineering Principles, P. M. Doran, Elsevier, Gurgaon, 2005.

**IV Year II-Sem**

**Professional Elective - IV**

## PE2. COMPUTATIONAL FLUID DYNAMICS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Prerequisite:** Fluid mechanics for chemical engineers, process heat transfer, mass transfer operations, chemical reaction engineering, process modeling & simulation

**Course Objective:** This subject deals with different mathematical methods like finite difference techniques to solve Navier - Stokes equations & other fluid flow problems

**UNIT I**

Introduction - Finite difference methods- finite element method - finite volume method- Treatment of boundary conditions- Governing differential equations. Finite difference methods - Taylor's series - Errors associated with FDE- FDE formulation for steady state heat transfer problems.

**UNIT II**

Cartesian, cylindrical and spherical coordinate systems- boundary conditions- Un steady state heat conduction Explicit Method - Stability criteria - Implicit Method - Crank Nickolson method - 2-D FDE formulation ADI- ADE. Finite volume method - Generalized differential equation, Basic rules for control volume approach, Source term linearization, boundary conditions. Un-steady state one, two, three-dimensional heat conduction.

**UNIT III**

Convection and diffusion, different methods i.e., upwind scheme, Exponential scheme, Hybrid scheme, power law scheme, calculation of flow field, staggered grid method, pressure and velocity corrections, SIMPLE Algorithms & SIMPLER (revised algorithm). Solution methods of elliptical, parabolic and hyperbolic partial differential equations in fluid mechanics - Burgers equation.

**UNIT IV**

Formulations for incompressible viscous flows - vortex methods -pressure correction methods.

**UNIT V**

Treatment of compressible flows- potential equation, Navier - Stokes equation - flow field dependent variation methods, boundary conditions. Linear fluid flow problems, 2-I) and 3- 1) fluid flow problems.

**Course Outcomes:**

At the end of the course, the student will be able to:

1. Derive governing equations of fluid flow and heat transfer
2. Discretize the equations using Finite difference and volume formulation
3. Solve the discredited equations using different techniques
4. Apply pressure velocity coupling algorithms
5. Simplify Navier-Stokes equation to a given flow problem along with boundary conditions
6. Explain grid generation techniques

**Text Books:**

1. Numerical heat transfer and fluid flow - S.V. Patankar
2. Computational Fluid Dynamics, T.J. Chung, Cambridge University
3. Text Book of Fluid Dynamics, Frank Chorlton, CBS Publishers

**IV Year II-Sem**

**Professional Elective - IV**

# PE3. FUEL CELL TECHNOLOGY

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Pre-Requisites**: Hydrogen energy and fuel cells

**Course Objectives:**

1. To describe how to produce, store, use hydrogen and show the difficulties.
2. To present hydrogen applications especially fuel cells.
3. To describe working principle of fuel cell.
4. To describe manufacture and working principle of SOFC

**UNIT- I**

**Overview of Fuel Cells:** What is a fuel cell, brief history, classification, how does it work, why do we need fuel cells, Fuel cell basic chemistry and thermodynamics, heat of reaction, theoretical electrical work and potential, theoretical fuel cell efficiency.

**UNIT- II**

**Fuels for Fuel Cells:** Hydrogen, Hydrocarbon fuels, effect of impurities such as CO, S and others, liquid hydrogen and compressed hydrogen-metal hydrides, alkaline fuel cell.

**UNIT- III**

**Fuel cell electrochemistry:** electrode kinetics, types of voltage losses, polarization curve, fuel cell efficiency, Tafel equation, exchange currents, current density, power density, potential and thermodynamics of fuel cell, Introduction to direct methanol fuel cell.

**Fuel cell process design:** Main PEM fuel cell components, materials, properties and processes: membrane, electrode, gas diffusion layer, bi-polar plates, Fuel cell operating conditions: pressure, temperature, flow rates, humidity.

**UNIT- IV**

Main components of solid-oxide fuel cells, Cell stack and designs, Electrode polarization, testing of electrodes, cells and short stacks, Cell, stack and system modeling.

**UNIT- V**

**Fuel processing:** Direct and in-direct internal reforming, Reformation of hydrocarbons by steam, $CO_2$ and partial oxidation, Direct electro-catalytic oxidation of hydrocarbons, carbon decomposition, Sulphur tolerance and removal, Using renewable fuels for SOFCs.

**Course Outcomes:**

At the end of the course, student will be able to

1. Learn working principle of fuel cells.
2. Understand the hydrogen production and storage methods.
3. Select the suitable materials for electrode, membrane for fuel cells.
4. Be familiar with fuel cell types and their applications.

5. Design and stack making process.

**Text Books:**

1. Hoogers G., Fuel Cell Technology Hand Book, CRC Press, 2003.
2. Karl Kordesch& Gunter Simader, Fuel Cells and Their Applications, VCH Publishers, NY, 2001.

**Reference Books:**

1. F. Barbir, PEM Fuel Cells: Theory and Practice, 2nd Ed., Elsevier/Academic Press, 2013.
2. Subhash C. Singal and Kevin Kendall, High Temperature Fuel Cells: Fundamentals, Design and Applications, 2003.
3. O'Hayre, R. P., S. Cha, W. Colella, F. B. Prinz, Fuel Cell Fundamentals, Wiley, NY 2006.

**IV Year II-Sem**

## OPEN ELECTIVE- IV
## OE1. DESIGN AND ANALYSIS OF EXPERIMENTS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:**

- Which factors affect a given experiment?
- Find the most significant factor for an experiment.
- Calculate the factor levels that optimize the outcome of an experiment.
- Factorial Design of experiments.

**UNIT- I**

Introduction to probability, probability laws, Baye's theorem. Probability distributions, parameters and statistics. Normal and t-distributions, central limit theorem, random sampling and declaration of independence significance tests

**UNIT- II**

Randomization and blocking with paired comparisons significance tests and confidence interval for means, variances, proportions and frequencies.

**UNIT-III**

Analysis of variance, experiments to compare k-treatment means, Two-way factorial designs, blocking, Yate's algorithm

**UNIT- IV**

Fractional factorial designs at two levels, concept of design resolution, Simple modeling with least squares (regression analysis), Matrix versions of normal equations

**UNIT- V**

Mechanistic model building, Empirical and mechanistic models, model building process, model testing with diagnostic parameters.

**Course Outcomes:**

At the end of the course, the student will be able to:

1. Predict how many numbers of experiments are to be carried out, given the number of important factors
2. Design an experiment and calculate the factor levels that optimize a given objective
3. Use response surface methodology to optimize the process, by considering curvature effects
4. Understand strategy in planning and conducting experiments

**Text Book:**

1. Statistics for experimenters by G.E.P. Box, William G. Hunter and J.S. Hunter, John Wiley & Sons.

**Reference Book:**

1. "Design and analysis of experiments" by D.C. Montgomery, $2^{nd}$ edition John Wiley and sons, New York (1984).

**IV Year II-Sem**

**OPEN ELECTIVE- IV**
**OE2. CORROSION ENGINEERING**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives:**
The course will enable the students to:
1. Be introduced to the principles of electrochemistry as well as the essential elements of electrochemical corrosion.
2. Lay a foundation for understanding the forms of corrosion, the mechanisms of corrosion, electrochemical methods.
3. Develop the thermodynamic and kinetic aspects of electrochemistry, including potential-pH
4. (Pourbaix) diagrams, mixed potential theory, and the theory and application of polarization.
5. Design methods for combating corrosion, the principles and methods leading to mitigation of corrosion problems that might occur in engineering practice.

**UNIT- I**
**Introduction**
Definitions of Corrosion - Overall classification of types of corrosion-Basic electrochemistry – Galvanic and electrolytic cells – Potential measurements - EMF and Galvanic series – Galvanic corrosion and bimetallic contacts – Eh – pH diagrams, Cost of Corrosion, Metallurgical properties influencing corrosion.

**UNIT-II**
**Forms of Corrosion**
Uniform attack, galvanic, crevice, pitting, inter granular, selective leaching, erosion and stress corrosion – Mechanisms, testing procedures and their protection.

**UNIT- III**
**Electrode kinetics and polarization phenomena**
Electrode – solution interface – Electrode kinetics and polarization phenomena – Exchange current density – Polarization techniques to measure corrosion rates – Mixed potential theory – Activation and diffusion controlled mixed electrodes.

**UNIT IV**
**Methods of corrosion prevention and control**
Design, coatings and inhibition – Cathodic protection – Stray current corrosion – Passivity phenomena and development of corrosion resistant alloys – Anodic control.

**UNIT-V**

**Industry Approach**

Selection for a given Chemical Engineering Service Environment- Materials for Chemical Engineering Industry to resist the given chemical Environment. -Ferritic, Austenitic steels and stainless steels- Copper and its alloys-Brasses, bronzes, Nickel and its alloys- Monel alloys-materials for a petroleum refinery industry.

**Course Outcomes:**

At the end of the course, the student will be able to:

1. Understand the electrochemical and metallurgical behaviour of corroding systems
2. Apply the electrochemical and metallurgical aspects of combating eight forms of corrosion
3. Select or choose the testing procedures for corroding systems
4. Evaluate the polarization behaviour of corroding systems
5. Design of suitable materials, methods to combat corrosion
6. Predict the function of corrosion inhibitors

**TEXT BOOKS:**

1. M. G. Fontana, Corrosion Engineering (Third Edition) McGraw-Hill Book Company.

2. Denny A Jones, Principles and Prevention of Corrosion (second edition), Prentice-Hall, N. J. (1996).

**REFERENCE:**

1. H. H. Uhlig and R. W. Revie, Corrosion and Corrosion Control, Wiley (NY) (1985).

**IV Year II-Sem**

**OPEN ELECTIVE- IV**
**OE3. RENEWABLE ENERGY**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Pre Requisites:** Knowledge of various Energy Sources

**Course Objectives:**

1. Understand the various forms of conventional energy resources.
2. Summarize the present energy scenario and the need for energy conservation
3. Explain the concept of various forms of renewable energy

**UNIT I**

INTRODUCTION

World energy status, Current energy scenario in India, Environmental aspects of energy utilization, Environment - Economy - Energy and Sustainable Development, Energy planning. Classification of Energy resources, Advantages and Disadvantages of Non-Conventional source of energy, Renewable energy resources - potentials -achievements – applications.

**UNIT II**

SOLAR ENERGY

Basic concepts, Solar thermal systems – Flat plate and concentrating collectors, Solar passive space - Solar heating and cooling techniques – Solar desalination – Solar Pond - Solar cooker - Solar dryers-Solar furnaces - Solar pumping, Solar greenhouse- Solar thermal power plant –Solar photo voltaic conversion – Solar cells – types of PV technologies, PV applications.

**UNIT III**

WINDENERGY

Introduction-Background-Availability- wind power plants, Power from the wind, Wind energy conversion systems, site characteristics, Wind turbines types – Horizontal and vertical axis-design principles of wind turbine, Magnus effect- Performance. Wind energy Applications – New developments - Safety and environmental aspects

**UNIT IV**

BIOMASS ENERGY

Biomass – usable forms- composition- fuel properties – applications, Biomass resources, Biomass conversion technologies - direction combustion - pyrolysis – gasification -anaerobic digestion, Bioethanol and Biodiesel Production – Recent developments. Energy farming, Biogas technology - Family biogas plants, Community and institutional biogas plants – design consideration – applications.

**UNIT V**

OTHER RENEWABLE ENERGY SOURCES

Tidal energy – Wave energy – Open and closed OTEC Cycles – Small hydro – Geothermal energy Fuel cell technology - types, principle of operation – applications. Hydrogen energy production - Storage system.

**Text Books:**

1. Rai. G.D. "Non-Conventional Energy Sources", Khanna Publishers, New Delhi, 1999.
2. Sukhatme. S.P. "Solar Energy", Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997.

**Reference Books:**

1. Kothari. P, K C, Singal and Rakesh Ranjan, "Renewable Energy Sources and Emerging Technologies", PHI Pvt. Ltd., New Delhi, 2008
3. Godfrey Boyle, Renewable Energy, Power for a Sustainable Future, Oxford University Press, U.K, 1996.
4. Twidell. J.W. & Weir, A., Renewable Energy Sources, EFN Spon Ltd., UK, 1986.
5. Tiwari. G.N. Solar Energy – Fundamentals Design, Modelling and applications, Narosa Publishing House, New Delhi, 2002.

**Course Outcomes:** At the end of the course, student will be able to

1. Describe the need of renewable energy resources, historical and latest developments.
2. Describe the use of solar energy in different applications like - heating, cooling, desalination, power generation, drying, cooking etc.
3. Describe the need of Wind Energy and Biomass energy resources
4. Compare Solar, Wind and bio energy systems, their prospects, Advantages and limitations
5. Evaluate the potential of fuel cells, wave power, tidal power and geothermal principles and their applications.

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**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR COLLEGE OF ENGINEERING (Autonomous), ANANTHAPURAMU**

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## B.Tech (Chemical Engineering) (R20)
## Course Structure

| SEMESTER – I | | | | | | | |
|---|---|---|---|---|---|---|---|
| **S.No.** | **Course No** | **Course Name** | **Category** | **L** | **T** | **P** | **Credits** |
| 1 | 20A15101 | Linear Algebra and Calculus<br>Common to All branches of Engineering | BS | 3 | 0 | 0 | 3 |
| 2 | 20A15301 | Engineering Chemistry<br>Common to CE, MECH, CHEM | BS | 3 | 0 | 0 | 3 |
| 3 | 20A10506 | C-Programming & Data Structures<br>Common to CE, MECH, CHEM | ES | 3 | 0 | 0 | 3 |
| 4 | 20A15501 | Communicative English<br>Common to EEE, ECE, CSE, CHEM | HS | 3 | 0 | 0 | 3 |
| 5 | 20A10303 | EngineeringWorkshop<br>Common to CE, MECH, CHEM | LC | 0 | 0 | 3 | 1.5 |
| 6 | 20A10508 | IT Workshop<br>Common to CE, MECH, CHEM | LC | 0 | 0 | 3 | 1.5 |
| 7 | 20A15302 | Engineering Chemistry Lab<br>Common to CE, MECH, CHEM | BS | 0 | 0 | 3 | 1.5 |
| 8 | 20A10507 | C-Programming & Data Structures Lab<br>Common to CE, MECH, CHEM | ES | 0 | 0 | 3 | 1.5 |
| 9 | 20A15501 | Communicative English Lab<br>Common to EEE, ECE, CSE, CHEM | HS | 0 | 0 | 3 | 1.5 |
| | | | | | | Total | 19.5 |

**Induction Program – 3 weeks**

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR COLLEGE OF ENGINEERING (Autonomous), ANANTHAPURAMU**

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## B.Tech (Chemical Engineering) (R20)

## Course Structure

| SEMESTER – II | | | | | | | |
|---|---|---|---|---|---|---|---|
| **S.No.** | **Course No** | **Course Name** | **Category** | **L** | **T** | **P** | **Credits** |
| 1 | 20A15102 | Differential Equations and Vector Calculus<br>Common to all branches of Engineering except CSE | BS | 3 | 0 | 0 | 3 |
| 2 | 20A15203 | EngineeringPhysics<br>Common to CE, MECH, CHEM | BS | 3 | 0 | 0 | 3 |
| 3 | 20A10801 | Basic Thermodynamics | ES | 3 | 0 | 0 | 3 |
| 4 | 20A10401 | Basic Electrical & Electronics Engineering<br>Common to Mech, CSE, Chem | ES | 3 | 0 | 0 | 3 |
| 5 | 20A10301 | Engineering Drawing<br>Common to CE, MECH, CHEM | LC | 1 | 0 | 2 | 2 |
| 6 | 20A10302 | Engineering Graphics Lab<br>Common to CE, MECH, CHEM | LC | 0 | 0 | 2 | 1 |
| 7 | 20A10802 | Basic Thermodynamics Lab | ES | 0 | 0 | 3 | 1.5 |
| 8 | 20A15204 | Engineering Physics Lab<br>Common to Civil, Mech, Chem | BS | 0 | 0 | 3 | 1.5 |
| 9 | 20A10402 | Basic Electrical & Electronics Engineering Lab<br>Common to Mech, CSE, Chem | ES | 0 | 0 | 3 | 1.5 |
| 10 | 20A19101 | Universal Human Values<br>Common to CE, MECH, CHEM | MC | 3 | 0 | 0 | 0.0 |
| | | | | | | Total | 19.5 |

***For 2020 Admitted batch only**

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR COLLEGE OF ENGINEERING (Autonomous), ANANTHAPURAMU

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**B.Tech (Chemical Engineering) (R20)**
**Course Structure**

| | | SEMESTER – III | | | | | |
|---|---|---|---|---|---|---|---|
| **S. No.** | **Course No** | **Course Name** | **Category** | **L** | **T** | **P** | **Credits** |
| 1 | 20A35101 | Numerical Methods and Probability Theory<br>Common to CE, CHEM | BS | 3 | 0 | 0 | 3 |
| 2 | 20A30801 | Chemical Process Calculations | PC/ES | 3 | 0 | 0 | 3 |
| 3 | 20A30802 | Momentum Transfer | PC/ES | 3 | 0 | 0 | 3 |
| 4 | 20A30803 | Chemical Technology | PC/ES | 3 | 0 | 0 | 3 |
| 5 | 20A30804 | Mechanical Operations | PC/ES | 3 | 0 | 0 | 3 |
| 6 | 20A30805 | Momentum Transfer Lab | PC/ES | 0 | 0 | 3 | 1.5 |
| 7 | 20A30806 | Mechanical Operations Lab | PC/ES | 0 | 0 | 3 | 1.5 |
| 8 | 20A30807 | Chemical Technology Lab | PC/ES | 0 | 0 | 3 | 1.5 |
| 9 | 20A30808 | Skill oriented Course – 1(Analytical Techniques for Chemical Engineers) | SC | 1 | 0 | 2 | 2 |
| 10 | 20A10803 | Mandatory non-credit Course-II<br>Environmental Science<br>Common to CE, MECH, CHEM | MC | 3 | 0 | 0 | 0 |
| | | | | | | Total | 21.5 |

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR COLLEGE OF ENGINEERING (Autonomous), ANANTHAPURAMU**

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**B.Tech (Chemical Engineering) (R20)**
**Course Structure**

| | | **SEMESTER – IV** | | | | | |
|---|---|---|---|---|---|---|---|
| **S. No.** | | **Course Name** | **Category** | **L** | **T** | **P** | **Credits** |
| **1** | 20A45301 | Organic Chemistry | BS | 3 | 0 | 0 | 3 |
| **2** | 20A40801 | Process Heat Transfer | PC/ES | 3 | 0 | 0 | 3 |
| 3 | 20A40802 | Chemical Engineering Thermodynamics | PC/ES | 3 | 0 | 0 | 3 |
| 4 | 20A40803 | Instrumentation & Process Control | PC/ES | 3 | 0 | 0 | 3 |
| 5 | 20A49101a | Humanities Elective-1<br>Common to Civil, Mech, Chemical<br>Managerial Economics & Financial Analysis | HS | 3 | 0 | 0 | 3 |
| | 20A49101b | Entrepreneurship & Incubation | | | | | |
| | 20A49101c | Business Ethics And Corporate Governance | | | | | |
| 6 | 20A40804 | Process Heat Transfer Lab | PC/ES | 0 | 0 | 3 | 1.5 |
| 7 | 20A40805 | Organic Chemistry Lab | BS | 0 | 0 | 3 | 1.5 |
| 8 | 20A40806 | Instrumentation & Process Control Lab | PC/ES | 0 | 0 | 3 | 1.5 |
| 9 | 20A40807 | Skill oriented Course – II(Industrial Safety and Hazard Management) | SC | 1 | 0 | 2 | 2 |
| 10 | 20A49102 | Mandatory non-credit Course-III<br>Design Thinking for Innovation<br>Common to All Branches | MC | 2 | 1 | 0 | 0 |
| 11 | 20A49901 | NSS/NCC/NSO Activities | - | 0 | 0 | 2 | 0 |
| | | | | | | Total | 21.5 |

**JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS), ANANTAPUR**
**B.TECH. – CHEMICAL ENGINEERING**
**Course Structure (R20)**

| **Semester–V** | | | | | | |
|---|---|---|---|---|---|---|
| S.No. | Course Code | Course Name | L | T | P | Credits |
| 1. | 20A50801 | Chemical Reaction Engineering | 3 | 0 | 0 | 3 |
| 2. | 20A50802 | Mass Transfer Operations – I | 3 | 0 | 0 | 3 |
| 3. | 20A50803 | Chemical Process Equipment Design | 3 | 0 | 0 | 3 |
| 4. | 20A50804a<br>20A50804b<br>20A50804c | Professional Elective Course – I<br>1. Environmental Engineering<br>2. Process Modeling and Simulation<br>3. Material Science for Chemical Engineers | 3 | 0 | 0 | 3 |
| 5. | 20A50805 | Open Elective Course – I*<br>Common to All Branches<br>Energy Conversion and storage Devices | 3 | 0 | 0 | 3 |
| 6. | 20A50806 | Environmental Engineering Lab | 0 | 0 | 3 | 1.5 |
| 7. | 20A50807 | Chemical Reaction Engineering Lab | 0 | 0 | 3 | 1.5 |
| 8. | 20A50808 | Skill oriented course – III<br>Computer applications in Chemical Engineering | 1 | 0 | 2 | 2 |
| 9. | 20A50809 | Evaluation of Community Service Project | | | | 1.5 |
| 10 | 20A55401 | **Mandatory Non-credit Course**<br>Indian Constitution (CIV, ME, CHEM) | 2 | 0 | 0 | 0 |
| | | Total | | | | 21.5 |

**Note:**

1. A student is permitted to register for Honours or a Minor in IV semester after the results of III Semester are declared and students may be allowed to take maximum two subjects per semester pertaining to their Minor from V Semester onwards.
2. A student shall not be permitted to take courses as Open Electives/Minor/Honours with content substantially equivalent to the courses pursued in the student's primary major.
3. A student is permitted to select a Minor program only if the institution is already offering a Major degree program in that discipline

# JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR COLLEGE OF ENGINEERING (Autonomous), ANANTHAPURAMU

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## B.Tech (Chemical Engineering) (R20)
## Course Structure

| Semester–VI | | | | | | |
|---|---|---|---|---|---|---|
| **S.No.** | **Course Code** | **Course Name** | **L** | **T** | **P** | **Credits** |
| **1.** | 20A60801 | Chemical Plant Design & Economics | 3 | 0 | 0 | 3 |
| **2.** | 20A60802 | Mass Transfer Operations – II | 3 | 0 | 0 | 3 |
| **3.** | 20A60803 | Transport Phenomena | 3 | 0 | 0 | 3 |
| **4.** | 20A60804a<br>20A60804b<br>20A60804c | **Professional Elective Course– II**<br>1. Fluidization Engineering<br>2.NumericalMethods in Chemical Engineering<br>3. Solid-Fluid Reactions | 3 | 0 | 0 | 3 |
| **5.** | 20A60805 | Open Elective Course – II*<br>Common to All Branches<br>Green Technology | 3 | 0 | 0 | 3 |
| **6.** | 20A60806 | Mass Transfer Operations Laboratory | 0 | 0 | 3 | 1.5 |
| **7.** | 20A60807 | Chemical Process Equipment Design &Drawing Laboratory | 0 | 0 | 3 | 1.5 |
| **8.** | 20A60808 | Chemical Process Simulation Lab | 0 | 0 | 3 | 1.5 |
| **9.** | 20A65502 | **Skill oriented course - IV**<br>Soft Skills (CIV, ME, Chemical) | 1 | 0 | 2 | 2 |
| **10.** | 20A69901 | **Mandatory Non-credit Course**<br>Intellectual Property Rights & Patents<br>(Civil, ME, CHEM) | 2 | 0 | 0 | 0 |
| | | **Total** | | | | **21.5** |
| Industry Internship (Mandatory) for 6 - 8 weeks duration during summer vacation | | | | | | |

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR COLLEGE OF ENGINEERING (Autonomous), ANANTHAPURAMU**

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**B.Tech (Chemical Engineering) (R20)**
**Course Structure**

| **Semester-VII** | | | | | | |
|---|---|---|---|---|---|---|
| **S.No.** | **Course Code** | **Course Name** | **L** | **T** | **P** | **Credits** |
| **1.** | 20A70801a<br>20A70801b<br>20A70801c | **Professional Elective Course– III**<br>1. Petroleum & Petrochemical Technology<br>2. Energy Engineering<br>3. Basics of Nano Technology | 3 | 0 | 0 | 3 |
| **2.** | 20A70802a<br>20A70802b<br>20A70802c | **Professional Elective Course– IV**<br>1.Corrosion Engineering<br>2.Optimization of Chemical Processes<br>3. Pharmaceutical & Fine Chemicals | 3 | 0 | 0 | 3 |
| **3.** | 20A70803a | **Professional Elective Course– V**<br>* MOOCs course offered in Swayam/ NPTEL | 3 | 0 | 0 | 3 |
| **4.** | 20A75401a<br>20A75401b<br>20A75401c | Humanities Elective<br>Common to All Branches<br>1. Management science<br>2. Business environment<br>3. Organizational behaviour | 3 | 0 | 0 | 3 |
| **5.** | 20A70804 | **Open Elective Course – III***<br>Common to All Branches<br>Industrial Pollution Control Engineering | 3 | 0 | 0 | 3 |
| **6.** | 20A70805 | **Open Elective Course – IV***<br>Common to All Branches<br>Solid Waste Management | 3 | 0 | 0 | 3 |
| **7.** | 20A70806 | **Skill oriented course – V**<br>Applications of AI & ML in Chemical Engg | 1 | 0 | 2 | 2 |
| **8.** | 20A70807 | Evaluation of Industry Internship | | | | 3 |
| **Total** | | | | | | **23** |

| **Semester-VIII** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **S.No.** | **Course Code** | **Course Name** | **Category** | **L** | **T** | **P** | **Credits** |
| **1.** | 20A80101 | Full Internship & Project work | PR | | | | 12 |
| | | | | | | **Total** | **12** |

**HONOURS DEGREE IN <Chemical Engineering>**
**Stream 1: Material Science & Engineering**

| S.No. | Course Code | Course Name | Contact Hours per week | | Credits |
|---|---|---|---|---|---|
| | | | L | T | |
| 1 | 20A08H11 | Surface Engineering | 3 | 1 | 4 |
| 2 | 20A08H12 | Powder Metallurgy | 3 | 1 | 4 |
| 3 | 20A08H13 | Synthesis & Characterization of Materials | 3 | 1 | 4 |
| 4 | 20A08H14 | Material Production, Planning & Control | 3 | 1 | 4 |
| **SUGGESTED MOOCs**** | | | | | |
| 5 | 20A08H15a | MOOC I* Advanced Materials and Processes | -- | -- | 2 |
| 6 | 20A08H16a | MOOC II* Aluminum based Alloys and Metal Matrix | -- | -- | 2 |

**** Based on the availability of courses offered by NPTEL SWAYAM with a minimum of 12 weeks duration.**

**HONOURS DEGREE IN <Chemical Engineering>**
**Stream 2: Environment**

| S.No. | Course Code | Course Name | Contact Hours per week | | Credits |
|---|---|---|---|---|---|
| | | | L | T | |
| 1 | 20A08H21 | Air Pollution Control Techniques | 3 | 1 | 4 |
| 2 | 20A08H22 | Solid & Hazardous Waste Management | 3 | 1 | 4 |
| 3 | 20A08H23 | Environmental Impact Assessment (EIA) | 3 | 1 | 4 |
| 4 | 20A08H24 | Environmental Biotechnology | 3 | 1 | 4 |
| **SUGGESTED MOOCs** | | | | | |
| 5 | 20A08H25a | MOOC I* *Environment and Development | -- | -- | 2 |
| 6 | 20A08H26a | MOOC II* *Environmental Modeling & Simulation | -- | -- | 2 |

**** Based on the availability of courses offered by NPTEL SWAYAM with a minimum of 12 weeks duration.**

## MINORS

### Stream 1: Green Technology & Sustainable Engineering

| S.No. | Course Code | Course Title | Contact Hours per week | | | Credits |
|---|---|---|---|---|---|---|
| | | | L | T | P | |
| 1. | 20A08M11 | Solar Energy Engineering | 3 | 1 | 0 | 4 |
| 2. | 20A08M12 | Renewable Energy Systems | 3 | 1 | 0 | 4 |
| 3. | 20A08M13 | Energy Conversion | 3 | 1 | 0 | 4 |
| 4. | 20A08M14 | Technology Economics | 3 | 1 | 0 | 4 |
| 5. | 20A08M15a | MOOC I**Challenges to Sustainable Development | -- | -- | | 2 |
| 6. | 20A08M16a | MOOC II**Sustainable Management of Biodiversity | -- | -- | | 2 |

**** Based on the availability of courses offered by NPTEL SWAYAM with a minimum of 12 weeks duration.**

## MINORS

### Stream 2: Waste Management Technology

| S.No. | Course Code | Course Title | Contact Hours per week | | | Credits |
|---|---|---|---|---|---|---|
| | | | L | T | P | |
| 1. | 20A08M21 | Integrated Waste Management for a Smart City | 3 | 1 | 0 | 4 |
| 2. | 20A08M22 | Municipal Solid Waste Management | 3 | 1 | 0 | 4 |
| 3. | 20A08M23 | Plastic Waste Management | 3 | 1 | 0 | 4 |
| 4. | 20A08M24 | Solid and Hazardous Waste Management | 3 | 1 | 0 | 4 |
| 5. | 20A08M25a | MOOC I* Energy Conservation & Waste Heat Recovery | -- | -- | | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 6. | 20A08M26a | MOOC II*<br>Wastewater Treatment & Recycling | -- | -- | | 2 |

**JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS), ANANTAPUR**

**Chemical Engineering**

| | | Open Elective Course – I* | | | | |
|---|---|---|---|---|---|---|
| **S.No.** | **Course Code** | **Course Name** | **L** | **T** | **P** | **Credits** |
| **1.** | 20A50105 | Experimental Stress Analysis | 3 | 0 | 0 | 3 |
| **2.** | 20A50205 | Electric Vehicle Engineering | 3 | 0 | 0 | 3 |
| **3.** | 20A50305 | Optimization Techniques | 3 | 0 | 0 | 3 |
| **4.** | 20A50405 | Basics of Electronics and Communication | 3 | 0 | 0 | 3 |
| **5.** | 20A50505 | Introduction to Java Programming | 3 | 0 | 0 | 3 |
| **6.** | 20A50805 | Energy Conversion and Storage Devices | 3 | 0 | 0 | 3 |
| **7.** | 20A55101 | Optimization Methods (Mathematics) | 3 | 0 | 0 | 3 |
| **8.** | 20A55201 | Material Characterization | 3 | 0 | 0 | 3 |
| **9.** | 20A55401 | E-Business (H & SS) | 3 | 0 | 0 | 3 |
| **10.** | 20A55301 | Chemistry Of Energy Materials (Chemistry) | 3 | 0 | 0 | 3 |

***It is mandatory that the candidate should select any subject other than parent branch subject.**

| | | Open Elective Course – II | | | | |
|---|---|---|---|---|---|---|
| **S.No.** | **Course** | **Course Name** | **L** | **T** | **P** | **Credits** |
| **1.** | 20A60105 | Disaster Management(CIVIL) | 3 | 0 | 0 | 3 |
| **2.** | 20A60205 | Renewable Energy Systems(EEE) | 3 | 0 | 0 | 3 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **3.** | 20A60305 | Solar Energy Systems(MECH) | 3 | 0 | 0 | 3 |
| **4.** | 20A60405 | Basics of Integrated Circuits Applications(ECE) | 3 | 0 | 0 | 3 |
| **5.** | 20A60505 | Introduction to Linux Programming (CSE) (CSE) | 3 | 0 | 0 | 3 |
| **6.** | 20A60805 | Green Technology(CHEM) | 3 | 0 | 0 | 3 |
| **7.** | 20A65101 | Mathematical Modelling & Simulation (Common for CIVIL,MECH &CHEM)(Mathemtics) | 3 | 0 | 0 | 3 |
| **8.** | 20A65102 | Wavelet transforms and its Applications (Common for EEE&ECE) (Mathemtics) | 3 | 0 | 0 | 3 |
| **9.** | 20A65103 | Statistical Methods for Data Science CSE (Data Science) (Mathemtics) | 3 | 0 | 0 | 3 |
| **10.** | 20A65201 | Physics Of Electronic Materials And Devices (Physics) | 3 | 0 | 0 | 3 |
| **11.** | 20A65501 | Academic Writing and Public Speaking(H & SS) | 3 | 0 | 0 | 3 |
| **12.** | 20A65301 | Chemistry Of Polymers And Its Applications ( Chemistry) | 3 | 0 | 0 | 3 |

***It is mandatory that the candidate should select any subject other than parent branch subject.**

**JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS), ANANTAPUR**

**Chemical Engineering**

| | | **Open Elective Course – III*** | | | | |
|---|---|---|---|---|---|---|
| **S.No.** | **Course Code** | **Course Name** | **L** | **T** | **P** | **Credits** |
| **1.** | 20A70103 | Building Technology for Engineers (CIVIL) | 3 | 0 | 0 | 3 |
| **2.** | 20A70204 | Battery Management Systems (EEE) | 3 | 0 | 0 | 3 |
| **3.** | 20A70304 | Modern Manufacturing Methods (MECH) | 3 | 0 | 0 | 3 |
| **4.** | 20A70404 | Digital Electronics (ECE) | 3 | 0 | 0 | 3 |
| **5.** | 20A70504 | CyberSecurity (CSE) | 3 | 0 | 0 | 3 |
| **6.** | 20A70804 | Industrial Pollution Control Engineering (CHEM) | 3 | 0 | 0 | 3 |
| 7. | 20A75101 | Numerical Methods for Engineers | 3 | 0 | 0 | 3 |
| **8.** | 20A75201 | SMART MATERIALS AND DEVICES (Physics) | **3** | **0** | **0** | **3** |
| **9.** | 20A75501 | Employability Skills (H&SS) | **3** | **0** | **0** | **3** |
| **10.** | 20A75301 | GREEN CHEMISTRY AND CATALYSIS FOR SUSTAINABLE ENVIRONMENT ( Chemistry) | **3** | **0** | **0** | **3** |

***It is mandatory that the candidate should select any subject other than parent branch subject.**

| | | **Open Elective Course – IV*** | | | | |
|---|---|---|---|---|---|---|

| S.No. | Course Code | Course Name | L | T | P | Credits |
|---|---|---|---|---|---|---|
| **1.** | 20A70104 | Environmental Impact and Assessment (CIVIL) | 3 | 0 | 0 | 3 |
| **2.** | 20A70205 | IOT Applications in Electrical Engineering | 3 | 0 | 0 | 3 |
| **3.** | 20A70305 | Material Handling Equipment (MECH) | 3 | 0 | 0 | 3 |
| **4.** | 20A70405 | Principles of Digital Signal Processing (ECE) | 3 | 0 | 0 | 3 |
| **5.** | 20A70505 | Introduction to DBMS (CSE) | 3 | 0 | 0 | 3 |
| **6.** | 20A70805 | Solid Waste management (CHEM) | 3 | 0 | 0 | 3 |
| 7. | 20A75102 | Number theory and its Applications (Mathemtics) | 3 | 0 | 0 | 3 |
| **8.** | 20A75202 | Sensors and Actuators For Engineering Applications (Physics) | **3** | **0** | **0** | **3** |
| **9.** | 20A79102 | English Literary Spectrum (H & Ss) | **3** | **0** | **0** | **3** |
| **10.** | 20A75302 | Chemistry Of Nanomaterials And Applications ( Chemistry) | **3** | **0** | **0** | **3** |

***It is mandatory that the candidate should select any subject other than parent branch subject.**

**JNTUACEA** **R20**
**2020-21**

**JNTUA COLLEGE OF ENGINEERING (Autonomous)::ANANTAPURAMU**
**DEPARTMENT OF CHEMICAL ENGINEERING**

**I- Year B.Tech. I-Sem**

| L | P | T | C |
|---|---|---|---|
| 3 | 0 | 1 | 3 |

## 20A15101 Linear Algebra & Calculus
## Common to all branches of Engineering

**Course Objectives:**

- This course will illuminate the students in the concepts of calculus and linear algebra.
- To equip the students with standard concepts and tools at an intermediate to advanced level mathematics to develop the confidence and ability among the students to handle various real world problems and their applications.

**Bridge Course:** Limits, continuity, Types of matrices

**Unit 1: Matrices**

Rank of a matrix by echelon form, solving system of homogeneous and non-homogeneous equations linear equations. Eigen values and Eigen vectors and their properties, Cayley-Hamilton theorem (without proof), finding inverse and power of a matrix by Cayley-Hamilton theorem, diagonalisation of a matrix, quadratic forms and nature of the quadratic forms, reduction of quadratic form to canonical forms by orthogonal transformation.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- Solving systems of linear equations, using technology to facilitate row reduction determine the rank, eigenvalues and eigenvectors, diagonal form and different factorizations of a matrix;

- Identify special properties of a matrix, such as positive definite, etc., and use this information to facilitate the calculation of matrix characteristics.

**Unit 2: Mean Value Theorems**

Rolle's Theorem, Lagrange's mean value theorem, Cauchy's mean value theorem, Taylor's and Maclaurin theorems with remainders (without proof)

**Learning Outcomes:**

At the end of this unit, the student will be able to

- Translate the given function as series of Taylor's and Maclaurin's with remainders
- Analyze the behaviour of functions by using mean value theorems

**Unit 3: Multivariable calculus**

Partial derivatives, total derivatives, chain rule, change of variables, Jacobians, maxima and minima of functions of two variables, method of Lagrange multipliers.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- Find partial derivatives numerically and symbolically and use them to analyze and interpretthe way a function varies.
- Acquire the Knowledge maxima and minima of functions of several variable
- Utilize Jacobian of a coordinate transformation to deal with the problems in change of variables

**Unit 4: Multiple Integrals**

Double integrals, change of order of integration, double integration in polar coordinates, areas enclosed by plane curves. Evaluation of triple integrals, change of variables between Cartesian, cylindrical and spherical polar co-ordinates.

**Learning Outcomes:**

- At the end of this unit, the student will be able to
- Evaluate double integrals of functions of several variables in two dimensions usingCartesian and polar coordinates
- Apply double integration techniques in evaluating areas bounded by region
- Evaluate multiple integrals in Cartesian, cylindrical and spherical geometries

**Unit 5: Special Functions**

Beta and Gamma functions and their properties, relation between beta and gamma functions, evaluation of definite integrals using beta and gamma functions.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- understand beta and gamma functions and its relations
- Conclude the use of special function in evaluating definite integrals

**Text Books:**

1. Erwin Kreyszig, Advanced Engineering Mathematics, 10/e, John Wiley & Sons, 2011.
2. B. S. Grewal, Higher Engineering Mathematics, 44/e, Khanna Publishers, 2017.

**JNTUA COLLEGE OF ENGINEERING (Autonomous)::ANANTAPURAMU**
**DEPARTMENT OF CHEMICAL ENGINEERING**

**I- Year B.Tech. I-Sem** **L T P C**
**2 1 0 3**

**20A15301 Engineering Chemistry**
**Common to Civil, Mech & Chem**

| Subject Code | Title of the Subject | L | T | P | C |
|---|---|---|---|---|---|
| 19A53101 | Engineering Chemistry | 2 | 1 | - | 3 |

| COURSE OBJECTIVES | |
|---|---|
| 1 | To familiarize engineering chemistry and its applications |
| 2 | To impart the concept of soft and hard waters, softening methods of hard water |
| 3 | To train the students on the principles and applications of electrochemistry, polymers, surface chemistry, and cement |

| COURSE OUTCOMES | |
|---|---|
| CO1 | **list** the differences between temporary and permanent hardness of water, **explain**the principles of reverse osmosis and electrodialysis. **compare**quality ofdrinking water with BIS and WHO standards. **illustrate**problems associated with hard water - scale and sludge**. explain** the working principles of different Industrial water treatment processes |
| CO2 | **apply** Nernst equation for calculating electrode and cell potentials, **apply** Pilling Bedworth rule for corrosion and corrosion prevention, **demonstrate** the corrosion prevention methods and factors affecting corrosion, **compare** different batteries and their applications |
| CO3 | **explain** different types of polymers and their applications, **Solve the numerical problems based on Calorific value, select** suitable fuels for IC engines, **explain** calorific values, octane number, refining of petroleum and cracking of oils |
| CO4 | explain the constituents of Composites and its classification Identify the factors |

| | |
|---|---|
| | affecting the refractory material, Illustrate the functions and properties of lubricants, demonstrate the phases and reactivity of concrete formation, identify the constituents of Portland cement, enumerate the reactions at setting and hardening of the cement |
| CO5 | **summarize** the applications of SEM, TEM and X-ray diffraction in surface characterization, **explain** the synthesis of colloids with examples, **outline** the preparation of nanomaterials and metal oxides **identify** the application of colloids and nanomaterials in medicine, sensors and catalysis |

## Mapping between Course Outcomes and Programme Outcomes

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |

## SYLLABUS

**Unit 1: Water Technology** **(8 hrs)**

Introduction –Soft Water and hardness of water, Estimation of hardness of water by EDTA Method - Boiler troubles **-** scale and sludge, Industrial water treatment – specifications for drinking water, Bureau of Indian Standards(BIS) and World health organization(WHO) standards, zeolite and ion-exchange processes - desalination of brackish water, reverse osmosis (RO) and electrodialysis.

**Unit 2: Electrochemistry and Applications:** (10 hrs)

Electrodes – concepts, electrochemical cell, Nernst equation, cell potential calculations.

Primary cells – Zn-$MnO_2$ (Leclanche cell), Li Battery

Secondary cells – lead acid and lithium ion batteries- working of the batteries including cell reactions.

Fuel cells- Basic Principles and Working Principles of hydrogen-oxygen, methanol fuel cells

Corrosion: Introduction to corrosion, electrochemical theory of corrosion, differential aeration cell corrosion, galvanic corrosion, metal oxide formation by dry electrochemical corrosion, Pilling Bedworth ratios and uses, Factors affecting the corrosion,cathodic and anodic protection, electroplating and electro less plating (Nickel and Copper).

**Unit 3: Polymers and Fuel Chemistry**:(12 hrs)

Introduction to polymers, functionality of monomers, Mechanism of chain growth, step growth and coordination polymerization,

Thermoplastics and Thermo-setting plastics-: Preparation, properties and applications of PVC and Bakelite

Elastomers – Preparation, properties and applications of Buna S, Buna N, Thiokol

Fuels – Types of fuels, calorific value, numerical problems based on calorific value; Analysis of coal, Liquid Fuels refining of petroleum, fuels for IC engines, knocking and anti-knock agents, Octane and Cetane values, cracking of oils; alternative fuels- propane, methanol and ethanol, bio fuels.

**UNIT-4 Advanced Engineering Materials (8 hrs)**

(i)Composites- Definition, Constituents, Classification- Particle, Fibre and Structural reinforced composites, properties and Engineering applications
(ii)Refractories- Classification, Properties, Factors affecting the refractory materials and Applications
(iii)Lubricants- Classification, Functions of lubricants, Mechanism, Properties of lubricating oils and Applications
(iv)Building materials- Portland Cement, constituents, phases and reactivity of clinker, Setting and Hardening of cement.

**Unit 5: Surface Chemistry and Applications:** (10 hrs)

Introduction to surface chemistry, colloids, micelle formation, synthesis of colloids (any two methods with examples), chemical and electrochemical methods (not more than two methods) of preparation of nanometals and metal oxides, stabilization of colloids and nanomaterials by stabilizing agents, solid-gas interface, solid-liquid interface, adsorption isotherm, applications of colloids and nanomaterials – catalysis, medicine, sensors.

**Text Books:**

1. Engineering Chemistry by KNJayaveera, GVSubba Reddy and C. Ramachandraiah, McGraw Hill Higher Education, Foruth Edition, New Delhi
2. A Text Book of Enigneering Chemistry, Jain and Jain, Dhanapathi Rai Publications, New Delhi

References:

1.A Text book of Engineering Chemistry by SS Dhara, S. Chand Publications, New Delhi

2. Engineering Chemistry by K.B.Chandra Sekhar, UN.Das and Sujatha Mishra, SCITECH Pubblications India Pvt Limited.
3. Concepts of Engineering Chemistry- Ashima Srivastavaf and N.N. Janhavi
4. Text Book of Engineering Chemistry – C. Parameswara Murthy, C.V.Agarwal and Andra Naidu
5. Chemistry of Engineering Materials, C.V.Agarwal, C.Parameswaramurthy and Andranaidu
6. Text Book of Engineering Chemistry, Shashichawla, Dhanapathirai Publications.

**JNTUA COLLEGE OF ENGINEERING (Autonomous)::ANANTAPURAMU**
**DEPARTMENT OF CHEMICAL ENGINEERING**

**I- Year B.Tech. I-Sem**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

## 20A10506 C-Programming & Data Structures

**Common to Civil, Mech & Chem**

**Course Objectives:**

- To illustrate the basic concepts of C programming language.
- To discuss the concepts of Functions, Arrays, Pointers and Structures.
- To familiarize with Stack, Queue and Linked lists data structures.
- To explain the concepts of non-linear data structures like graphs and trees.
- To learn different types of searching and sorting techniques.

**Course Outcomes:**

1. Analyse the basicconcepts of C Programming language. (L4)
2. Design applications in C, using functions, arrays, pointers and structures. (L6)
3. Apply the concepts of Stacks and Queues in solving the problems. (L3)
4. Explore various operations on Linked lists. (L5)
5. Demonstrate various tree traversals and graph traversal techniques. (L2)
6. Design searching and sorting methods L3)

**Unit-1**

**Introduction to C Language** - C language elements, variable declarations and data types, operators and expressions, decision statements - If and switch statements, loop control statements - while, for, do-while statements, arrays.

**At the end of the Unit, students should be able to:**

- Use Cbasic concepts to write simple C programs. (L3)
- Use iterative statements for writing the C programs (L3)
- Use arrays to process multiple homogeneous data. (L3)
- Test and execute the programs and correct syntax and logical errors. (L4)
- Translate algorithms into programs. (L4)
- Implement conditional branching, iteration and recursion. (L2)

**Unit – 2**

Functions, types of functions, Recursion and argument passing, pointers, storage allocation, pointers to functions, expressions involving pointers, Storage classes – auto, register, static, extern, Structures, Unions, Strings, string handling functions, and Command line arguments.

**At the end of the Unit, students should be able to:**

- Writing structured programs using C Functions. (L5)
- Writing C programs using various storage classes to control variable access. (L5)
- Apply String handling functions and pointers. (L3)
- Use arrays, pointers and structures to formulate algorithms and write programs.(L3)

**Unit-3**

**Data Structures**, Overview of data structures, stacks and queues, representation of a stack, stack related terms, operations on a stack, implementation of a stack, evaluation of arithmetic expressions, infix, prefix, and postfix notations, evaluation of postfix expression, conversion of expression from infix to postfix, recursion, queues - various positions of queue, representation of queue, insertion, deletion, searching operations.

**At the end of the Unit, students should be able to:**

- Describe the operations of Stack. (L2)
- Explain the different notations of arithmetic expression. (L5)
- Develop various operations on Queues. (L6)

**Unit – 4**

**Linked Lists**– Singly linked list, dynamically linked stacks and queues, polynomials using singly linked lists, using circularly linked lists, insertion, deletion and searching operations, doubly linked lists and its operations, circular linked lists and its operations.

**At the end of the Unit, students should be able to:**

- Analyze various operations on singly linked list. (L4)
- Interpret operations of doubly linked lists. (L2)
- Apply various operations on Circular linked lists. (L6)

**Unit-5**

**Trees**- Tree terminology, representation, Binary trees, representation, binary tree traversals. binary tree operations, **Graphs**- graph terminology, graph representation, elementary graph operations, Breadth First Search (BFS) and Depth First Search (DFS), connected components, spanning trees. **Searchingand Sorting**– sequential search, binary search, exchange (bubble) sort, selection sort, insertion sort.

**At the end of the Unit, students should be able to:**

- Develop the representation of Tress. (L3)
- Identify the various Binary tree traversals. (L3)
- Illustrate different Graph traversals like BFS and DFS. (L2)
- Design the different sorting techniques (L6)
- Apply programming to solve searching and sorting problems. (L3)

**Text Books:**

1. The C Programming Language, Brian W Kernighan and Dennis M Ritchie, Second Edition, Prentice Hall Publication.

2. Fundamentals of Data Structures in C, Ellis Horowitz, SartajSahni, Susan Anderson-Freed, Computer Science Press.
3. Programming in C and Data Structures, J.R.Hanly, Ashok N. Kamthane and A. AnandaRao, Pearson Education.
4. B.A.Forouzon and R.F. Gilberg, "COMPUTER SCIENCE: A Structured Programming Approach Using C", Third edition, CENGAGE Learning, 2016.
5. Richard F. Gilberg&Behrouz A. Forouzan, "Data Structures: A Pseudocode Approach with C", Second Edition, CENGAGE Learning, 2011.

**Reference Books:**

1. PradipDey and ManasGhosh, Programming in C, Oxford University Press, 2nd Edition 2011.
2. E.Balaguruswamy, "C and Data Structures", 4th Edition, TataMcGraw Hill.
3. A.K.Sharma, Computer Fundamentals and Programming in C, 2nd Edition, University Press.
4. M.T.Somashekara, "Problem Solving Using C", PHI, 2nd Edition 2009.

**JNTUA COLLEGE OF ENGINEERING (Autonomous) :: ANANTAPURAMU**
**DEPARTMENT OF CHEMICAL ENGINEERING**

**I-YearB.Tech. I-Sem**

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**20A15501 Communicative English 1**
**Common to EEE,ECE, CSE & CHEM**

## Introduction

The course is designed to train students in receptive (listening and reading) as well as productive and interactive (speaking and writing) skills by incorporating a comprehensive, coherent and integrated approach that improves the learners' ability to effectively use English language in academic/ workplace contexts. The shift is from *learning about the language* to *using the language*. On successful completion of the compulsory English language course/s in B.Tech., learners would be confident of appearing for international language qualification/proficiency tests such as IELTS, TOEFL, or BEC, besides being able to express themselves clearly in speech and competently handle the writing tasks and verbal ability component of campus placement tests. Activity based teaching-learning methods would be adopted to ensure that learners would engage in actual use of language both in the classroom and laboratory sessions.

## Course Objectives

- ➢ Facilitate effective listening skills for better comprehension of academic lectures and English spoken by native speakers
- ➢ Focus on appropriate reading strategies for comprehension of various academic texts and authentic materials
- ➢ Help improve speaking skills through participation in activities such as role plays, discussions and structured talks/oral presentations
- ➢ Impart effective strategies for good writing and demonstrate the same in summarizing, writing well organized essays, record and report useful information
- ➢ Provide knowledge of grammatical structures and vocabulary and encourage their appropriate use in speech and writing

## Unit 1

**Lesson: On the Conduct of Life: William Hazlitt**

**Listening:** Identifying the topic, the context and specific pieces of information by listening to short audio texts and answering a series of questions. **Speaking:** Asking and answering general questions on familiar topics such as home, family, work, studies and interests; introducing oneself and others. **Reading:** Skimming to get the main idea of a text; scanning to look for specific pieces of information. **Reading for Writing :**Beginnings and endings of paragraphs - introducing the topic, summarizing the main idea and/or providing a transition to the next paragraph. **Grammar**

**and Vocabulary:** Content words and function words; word forms: verbs, nouns, adjectives and adverbs; nouns: countable and uncountable; singular and plural; basic sentence structures; simple question form - wh-questions; word order in sentences.

**Learning Outcomes**

At the end of the module, the learners will be able to

- understand social or transactional dialogues spoken by native speakers of English and identify the context, topic, and pieces of specific information
- ask and answer general questions on familiar topics and introduce oneself/others
- employ suitable strategies for skimming and scanning to get the general idea of a text and locate specific information
- recognize paragraph structure and be able to match beginnings/endings/headings with paragraphs
- form sentences using proper grammatical structures and correct word forms

**Unit 2**

**Lesson: The Brook: Alfred Tennyson**

**Listening:** Answering a series of questions about main idea and supporting ideas after listening to audio texts. **Speaking:** Discussion in pairs/small groups on specific topics followed by short structured talks. **Reading:** Identifying sequence of ideas; recognizing verbal techniques that help to link the ideas in a paragraph together. **Writing:** Paragraph writing (specific topics) using suitable cohesive devices; mechanics of writing - punctuation, capital letters. **Grammar and Vocabulary:** Cohesive devices - linkers, sign posts and transition signals; use of articles and zero article; prepositions.

**Learning Outcomes**

At the end of the module, the learners will be able to

- comprehend short talks on general topics
- participate in informal discussions and speak clearly on a specific topic using suitable discourse markers
- understand the use of cohesive devices for better reading comprehension
- write well structured paragraphs on specific topics
- identify basic errors of grammar/ usage and make necessary corrections in short texts

**Unit 3**

**Lesson: The Death Trap: Saki**

**Listening:** Listening for global comprehension and summarizing what is listened to. **Speaking:** Discussing specific topics in pairs or small groups and reporting what is discussed **Reading:** Reading a text in detail by making basic inferences -recognizing and interpreting specific context clues; strategies to use text clues for comprehension.**Writing:** Summarizing - identifying main idea/s and rephrasing what is read; avoiding redundancies and repetitions. **Grammar and Vocabulary:** Verbs - tenses; subject-verb agreement; direct and indirect speech, reporting verbs for academic purposes.

**Learning Outcomes**

At the end of the module, the learners will be able to

- comprehend short talks and summarize the content with clarity and precision
- participate in informal discussions and report what is discussed
- infer meanings of unfamiliar words using contextual clues
- write summaries based on global comprehension of reading/listening texts
- use correct tense forms, appropriate structures and a range of reporting verbs in speech and writing

**Unit4**

**Lesson: Innovation: Muhammad Yunus**

**Listening:** Making predictions while listening to conversations/ transactional dialogues without video; listening with video. **Speaking:** Role plays for practice of conversational English in academic contexts (formal and informal) - asking for and giving information/directions. **Reading:** Studying the use of graphic elements in texts to convey information, reveal trends/patterns/relationships, communicate processes or display complicated data. **Writing:** Information transfer; describe, compare, contrast, identify significance/trends based on information provided in figures/charts/graphs/tables. **Grammar and Vocabulary:** Quantifying expressions - adjectives and adverbs; comparing and contrasting; degrees of comparison; use of antonyms

**Learning Outcomes**

At the end of the module, the learners will be able to

- infer and predict about content of spoken discourse
- understand verbal and non-verbal features of communication and hold formal/informal conversations
- interpret graphic elements used in academic texts
- produce a coherent paragraph interpreting a figure/graph/chart/table
- use language appropriate for description and interpretation of graphical elements

**Unit 5**

**Lesson: Politics and the English Language: George Orwell**

**Listening:** Identifying key terms, understanding concepts and answering a series of relevant questions that test comprehension. **Speaking:** Formal oral presentations on topics from academic contexts - without the use of PPT slides. **Reading:** Reading for comprehension. **Writing:** Writing structured essays on specific topics using suitable claims and evidences. **Grammar and Vocabulary:** Editing short texts –identifying and correcting common errors in grammar and usage (articles, prepositions, tenses, subject verb agreement)

**Learning Outcomes**

At the end of the module, the learners will be able to

- take notes while listening to a talk/lecture and make use of them to answer questions
- make formal oral presentations using effective strategies
- comprehend, discuss and respond to academic texts orally and in writing
- produce a well-organized essay with adequate support and detail
- edit short texts by correcting common errors

**Prescribed Text:**

Language and Life: A Skills Approach- I Edition 2019, Orient Black Swan

**Reference Books**

- Bailey, Stephen. *Academic writing: A handbook for international students*. Routledge, 2014.
- Chase, Becky Tarver. *Pathways: Listening, Speaking and Critical Thinking*. Heinley ELT; 2nd Edition, 2018.
- Skillful Level 2 Reading & Writing Student's Book Pack (B1) Macmillan Educational.
- Hewings, Martin. *Cambridge Academic English (B2)*. CUP, 2012.
- Oxford Learners Dictionary, $12^{th}$ Edition, 2011

**Course Outcomes**

At the end of the course, the learners will be able to

- Understand the context, topic, and pieces of specific information from social or transactional dialogues spoken by native speakers of English
- Apply grammatical structures to formulate sentences and correct word forms
- Analyze discourse markers to speak clearly on a specific topic in informal discussions
- Evaluate reading/listening texts and to write summaries based on global comprehension of these texts.
- Create a coherent paragraph interpreting a figure/graph/chart/table

**JNTUACEA** **R20**
**2020-21**

**JNTUA COLLEGE OF ENGINEERING (Autonomous) :: ANANTAPURAMU**
**DEPARTMENT OF CHEMICAL ENGINEERING**

**I- Year B.Tech. I-Sem**

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**20A10303 Engineering Workshop**
**Common to CIVIL, MECH & CHEM**

| **Course Objective**: | |
|---|---|
| 1 | To familiarize students with wood working, sheet metal operations, fitting and electrical house wiring skills. |

**Wood Working:**

Familiarity with different types of woods and tools used in wood working and make following joints

a) Half – Lapjoint
b) Mortise and Tenonjoint
c) Corner Dovetail joint or Bridlejoint

**Sheet Metal Working:**

Familiarity with different types of tools used in sheet metal working, Developments of following sheet metal job from GI sheets

a)Taperedtray b)Conicalfunnel
c)Elbowpipe d)Brazing

**Fitting:**

Familiarity with different types of tools used in fitting and do the following fitting exercises

a) V-fit b)Dovetailfit c) Semi-circularfit
d) Bicycle tyre puncture and change of two wheeler tyre

**Electrical Wiring:**

Familiarities with different types of basic electrical circuits and make the following connections

a) Parallelandseries b) Twowayswitch c)Godownlighting
d) Tubelight e) Threephasemotor f) Soldering ofwires

**Power tools:**

Demonstration of a) Circular Saw b) Power Planer
c) Zig Saw d) Buffing Machine

After completion of t lab the student will be able to

| **COURSE OUTCOMES** | |
|---|---|
| At the end of this course the student will be able to | |
| CO1 | Apply wood working skills in real world applications.(L3) |
| CO2 | Build different objects with metal sheets in real world applications.(L3) |
| CO3 | Apply fitting operations in various applications.(L3) |
| CO4 | Apply different types of basic electric circuit connections.(L3) |
| CO5 | Understand the operation of power tools.(L2) |

Note: In each section a minimum of three exercises are to be carried out.

JNTUA College of Engineering (Autonomous) Ananthapuramu
Department of Computer Science and Engineering
B.Tech I (R20) I Year
20A10508 IT Workshop
(Common to CE, MECH & CHEM)

**L-T-P-C**

**0-0-3-1.5**

Note: Use open source tools for implementation of the following exercises.

Course Objectives:

- To make the students know about the internal parts of a computer, assembling and dissembling a computer from the parts, preparing a computer for use by installing the operating system
- To provide Technical training to the students on Productivity tools like Word processors, Spreadsheets, Presentations and LAteX
- To learn about Networking of computers and use Internet facility for Browsing and Searching
- To learn about Google Forms and Google Sites

**Preparing your Computer**

**Task 1: Learn about Computer:** Identify the internal parts of a computer, and its peripherals. Represent the same in the form of diagrams including Block diagram of a computer. Write specifications for each part of a computer including peripherals and specification of Desktop computer. Submit it in the form of a report.

**Task 2: Assembling a Computer:** Disassemble and assemble the PC back to working condition. Students should be able to trouble shoot the computer and identify working and non-working parts. Student should identify the problem correctly by various methods

**Task 3: Install Operating system:** Student should install Linux on the computer. Student may install another operating system (including proprietary software) and make the system dual boot or multi boot. Students should record the entire installation process.

**Task 4**: **Operating system features**: Students should record the various features that are supported by the operating system(s) installed. They have to submit a report on it. Students should be able to access CD/DVD drives, write CD/DVDs, access pen drives, print files, etc. Students should install new application software and record the installation process.

**Networking and Internet**

**Task 5: Networking**: Students should connect two computers directly using a cable or wireless connectivity and share information. Students should connect two or more computers using switch/hub and share information. Crimpling activity, logical configuration etc. should be done by the student. The entire process has to be documented.

**Task 6: Browsing Internet**: Student should access the Internet for Browsing. Students should search the Internet for required information. Students should be able to create e-mail account and send email. They should get acquaintance with applications like Facebook, skype etc. If Intranet mailing facility is available in the organization, then students should share the information using it. If the operating system supports sending messages to multiple users (LINUX supports it) in the same network, then it should be done by the student. Students are expected to submit the information about different browsers available, their features, and search process using different natural languages, and creating e-mail account.

**Task 7: Antivirus:** Students should download freely available Antivirus software, install it and use it to check for threats to the computer being used. Students should submit information about the features of the antivirus used, installation process, about virus definitions, virus engine etc.

**Productivity tools**

**Task 8: Word Processor:** Students should be able to create documents using the word processor tool. Some of the tasks that are to be performed are inserting and deleting the characters, words and lines, Alignment of the lines, Inserting header and Footer, changing the font, changing the colour, including images and tables in the word file, making page setup, copy and paste block of text, images, tables, linking the images which are present in other directory, formatting paragraphs, spell checking, etc. Students should be able to prepare project cover pages, content sheet and chapter pages at the end of the task using the features studied. Students should submit a user manual of the word processor considered, Image Manipulation tools.

**Task 9: Presentations:** creating, opening, saving and running the presentations, selecting the style for slides, formatting the slides with different fonts, colours, creating charts and tables, inserting and deleting text, graphics and animations, bulleting and numbering, hyperlinking, running the slide show, setting the timing for slide show.

**Task 10: Spreadsheet:** Students should be able to create, open, save the application documents and format them as per the requirement. Some of the tasks that may be practiced are Managing the worksheet environment, creating cell data, inserting and deleting cell data, format cells, adjust the cell size, applying formulas and functions, preparing charts, sorting cells. Students should submit a user manual of the Spreadsheet

**Task 11: LateX:** Introduction to Latex and its installation and different IDEs. Creating first document using Latex, using content into sections using article and book class of LaTeX. Styling Pages: reviewing and customizing different paper sizes and formats. Formatting text (styles, size, alignment, colors and adding bullets and numbered items, inserting mathematical symbols, and images, etc.). Creating basic tables, adding simple and dashed borders, merging rows and columns. Referencing and Indexing: cross-referencing (refer to sections, table, images), bibliography (references).

**References:**


1. Introduction to Computers, Peter Norton, McGraw Hill
2. MOS study guide for word, Excel, Powerpoint& Outlook Exams, Joan Lambert, Joyce Cox, PHI.
3. Introduction to Information Technology, ITL Education Solutions limited, Pearson Education.
4. Networking your computers and devices, Rusen, PHI
5. Trouble shooting, Maintaining & Repairing PCs, Bigelows, TMH
6. Lamport L. LATEX: a document preparation system: user's guide and reference manual. Addison-wesley; 1994.


**Course Outcomes:**

- Disassemble and Assemble a Personal Computer and prepare the computer ready to use.
- Prepare the Documents using Word processors and Prepare spread sheets for calculations .using excel and also the documents using LAteX.
- Prepare Slide presentations using the presentation tool.
- Interconnect two or more computers for information sharing.
- Access the Internet and Browse it to obtain the required information.

**JNTUA COLLEGE OF ENGINEERING (Autonomous)::ANANTAPURAMU**
**DEPARTMENT OF CHEMICAL ENGINEERING**

**I- Year B.Tech. I-Sem** **L T PC**
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**20A15302 Engineering Chemistry Lab**
**Common to CIVIL, MECH & CHEM**

| COURSE OBJECTIVES | |
|---|---|
| 1 | Verify the fundamental concepts with experiments |

| COURSE OUTCOMES | |
|---|---|
| CO1 | **determine** the cell constant and conductance of solutions (L3) |
| CO2 | **prepare** advanced polymer materials (L2) |
| CO3 | **determine** the physical properties like surface tension, adsorption and viscosity (L3) |
| CO4 | **estimate** the Iron and Calcium in cement (L3) |
| CO5 | **calculate** the hardness of water (L4) |

**Mapping between Course Outcomes and Programme Outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |

## LIST OF EXPERIMENTS

1. Determination of Hardness of a groundwater sample.
2. pH metric titration of (i) strong acid vs. strong base, (ii) weak acid vs. strong base
3. Determination of cell constant and conductance of solutions
4. Potentiometry - determination of redox potentials and emfs
5. Determination of Strength of an acid in Pb-Acid battery
6. Preparation of a polymer
7. Determination of percentage of Iron in Cement sample by colorimetry
8. Estimation of Calcium in port land Cement
9. Adsorption of acetic acid by charcoal
10. Determination of percentage Moisture content in a coal sample
11. Determination of Viscosity of lubricating oil by Red Viscometer 1
12. Determination of Flash and Fire points of fuels
13. Determination of Calorific value of gases by Junker's gas Calorimeter

**TEXT BOOKS:**

1. Vogel's Text book of Quantitative Chemical Analysis, Sixth Edition – J. Mendham et al, Pearson Education.
2. Chemistry Practical – Lab Manual by Chandra Sekhar, GV Subba Reddy and Jayaveera

**JNTUA COLLEGE OF ENGINEERING (Autonomous)::ANANTAPURAMU**
**DEPARTMENT OF CHEMICAL ENGINEERING**

**I- Year B.Tech. I-Sem**

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**Common to CE, MECH & CHEM**

**20A10507 C-Programming & Data Structures Lab**

**Course Objectives:**

- To get familiar with the basic concepts of C programming.
- To design programs using arrays, strings, pointers and structures.
- To illustrate the use of Stacks and Queues
- To apply different operations on linked lists.
- To demonstrate Binary search tree traversal techniques.
- To design searching and sorting techniques.

**Week l**

Write C programs that use both recursive and non-recursive functions

i) To find the factorial of a given integer.
ii) To find the GCD (greatest common divisor) of two given integers.
iii) To solve Towers of Hanoi problem.

**Week 2**

a) Write a C program to find both the largest and smallest number in a list of integers.
b) Write a C program that uses functions to perform the following:
i) Addition of Two Matrices ii) Multiplication of Two Matrices

**Week 3**

a) Write a C program that uses functions to perform the following operations:
i) To insert a sub-string in to a given main string from a given position.
ii) To delete n characters from a given position in a given string.

**Week 4**

a) Write a C program that displays the position or index in the string S where the string T begins, or – 1 if S doesn‘t contain T.

b) Write a C program to count the lines, words and characters in a given text.

**Week 5**

a) Write a C Program to perform various arithmetic operations on pointer variables.

b) Write a C Program to demonstrate the following parameter passing mechanisms:

i) call-by-value ii) call-by-reference

**Week 6**

Write a C program that uses functions to perform the following operations:

i) Reading a complex number
ii) Writing a complex number
iii) Addition of two complex numbers
iv) Multiplication of two complex numbers

(Note: represent complex number using a structure.)

**Week 7**

Write C programs that implement stack (its operations) using

i) Arrays
ii) Pointers

**Week 8**

Write C programs that implement Queue (its operations) using

i) Arrays
ii) Pointers

**Week 9**

Write a C program that uses Stack operations to perform the following:

i) Converting infix expression into postfix expression
ii) Evaluating the postfix expression

**Week 10**

Write a C program that uses functions to perform the following operations on singly linked list.

i) Creation ii) Insertion iii) Deletion iv) Traversal

**Week 11**

Write a C program that uses functions to perform the following operations on Doubly linkedlist.

i) Creation ii) Insertion iii) Deletion iv) Traversal

**Week 12**

Write a C program that uses functions to perform the following operations on circular linkedlist.

i) Creation ii) Insertion iii) Deletion iv) Traversal

**Week 13**

Write a C program that uses functions to perform the following:

i) Creating a Binary Tree of integers

ii) Traversing the above binary tree in preorder, inorder and postorder.

**Week 14**

Write C programs that use both recursive and non-recursive functions to perform the following searching operations for a key value in a given list of integers:

i) Linear search
ii) Binary search

**Week 15**

Write a C program that implements the following sorting methods to sort a given list of integers in ascending order

i) Bubble sort
ii) Selection sort
iii) Insertion sort

**Text Books:**

1. Programming in C and Data Structures, J.R.Hanly, Ashok N. Kamthane and A. Ananda Rao, Pearson Education.
2. B.A.Forouzon and R.F. Gilberg, "COMPUTER SCIENCE: A Structured Programming Approach Using C", Third edition, CENGAGE Learning, 2016.
3. Richard F. Gilberg & Behrouz A. Forouzan, "Data Structures: A Pseudocode Approach with C", Second Edition, CENGAGE Learning, 2011.

**Reference Books:**

1. PradipDey and ManasGhosh, Programming in C, Oxford University Press, 2nd Edition 2011.
2. E.Balaguruswamy, "C and Data Structures", 4th Edition, Tata Mc Graw Hill.
3. A.K.Sharma, Computer Fundamentals and Programming in C, 2nd Edition, University Press.
4. M.T.Somashekara, "Problem Solving Using C", PHI, 2nd Edition 2009.

**Course Outcomes**

- Demonstrate basic concepts of C programming language. (L2)
- Develop C programs using functions, arrays, structures and pointers. (L6)
- Illustrate the concepts Stacks and Queues. (L2)
- Design operations on Linked lists. (L6)
- Apply various Binary tree traversal techniques. (L3)
- Develop searching and sorting methods. (L6)

**JNTUA COLLEGE OF ENGINEERING (Autonomous) :: ANANTAPURAMU**
**DEPARTMENT OF CHEMICAL ENGINEERING**

**I- Year B.Tech. I-Sem**

**20A15501 Communicative English Lab**
**Common to EEE, ECE, CSE & CHEM**

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**Course Objectives**

- students will be exposed to a variety of self instructional, learner friendly modes of language learning
- students will cultivate the habit of reading passages from the computer monitor. Thus providing them with the required facility to face computer based competitive exams like GRE, TOEFL, and GMAT etc.
- students will learn better pronunciation through stress, intonation and rhythm
- students will be trained to use language effectively to face interviews, group discussions, public speaking
- students will be initiated into greater use of the computer in resume preparation, report writing, format making etc

**Course Outcomes**

- CO1: Remember and understand the different aspects of the English language proficiency with emphasis on LSRW skills
- CO2: Apply communication skills through various language learning activities
- CO3: Analyze the English speech sounds, stress, rhythm, intonation and syllable division for better listening and speaking comprehension.
- CO4: Evaluate and exhibit acceptable etiquette essential in social and professional settings
- CO5: Create awareness on mother tongue influence and neutralize it in order to improve fluency in spoken English.

**Unit 1**

1. Phonetics for listening comprehension of various accents
2. Reading comprehension
3. Describing objects/places/persons

**Learning Outcomes**

At the end of the module, the learners will be able to

- understand different accents spoken by native speakers of English
- employ suitable strategies for skimming and scanning on monitor to get the general idea of a text and locate specific information
- learn different professional registers and specific vocabulary to describe different persons, places and objects

**Unit 2**

1. JAM
2. Small talks on general topics
3. Debates

**Learning Outcomes**

At the end of the module, the learners will be able to

- produce a structured talk extemporarily
- comprehend and produce short talks on general topics
- participate in debates and speak clearly on a specific topic using suitable discourse markers

**Unit 3**

1. Situational dialogues – Greeting and Introduction
2. Summarizing and Note making
3. Vocabulary Building

**Learning Outcomes**

At the end of the module, the learners will be able to

- Learn different ways of greeting and introducing oneself/others
- summarize the content with clarity and precision and take notes while listening to a talk/lecture and make use of them to answer questions
- replenish vocabulary with one word substitutes, homonyms, homophones, homographs to reduce errors in speech and writing

**Unit4**

1. Asking for Information and Giving Directions
2. Information Transfer
3. Non-verbal Communication – Dumb Charade

**Learning Outcomes**

At the end of the module, the learners will be able to

- Learn different ways of asking information and giving directions
- Able to transfer information effectively
- understand non-verbal features of communication

**Unit 5**

1. Oral Presentations
2. Précis Writing and Paraphrasing
3. Reading Comprehension and spotting errors

**Learning Outcomes**

At the end of the module, the learners will be able to

- make formal oral presentations using effective strategies
- learn different techniques of précis writing and paraphrasing strategies
- comprehend while reading different texts and edit short texts by correcting common errors

**Suggested Software**

- Young India Films
- Walden Infotech
- Orell

**Reference Books**


- Bailey, Stephen. *Academic writing: A handbook for international students*. Routledge, 2014.
- Chase, Becky Tarver. *Pathways: Listening, Speaking and Critical Thinking*. Heinley ELT; 2nd Edition, 2018.
- Skillful Level 2 Reading & Writing Student's Book Pack (B1) Macmillan Educational.
- Hewings, Martin. *Cambridge Academic English (B2)*. CUP, 2012.
- A Textbook of English Phonetics for Indian Students by T.Balasubramanyam


**JNTUACEA** **R20**

**2020-21**

**JNTUA COLLEGE OF ENGINEERING (Autonomous):: ANANTAPURAMU**
**DEPARTMENT OF CHEMICAL ENGINEERING**

| | L | P | T | C |
|---|---|---|---|---|
| **I- Year B.Tech. II-Sem** | **3** | **0** | **0** | **3** |

**20A15102 Differential Equations and Vector Calculus**
**Common to All branches of Engineering except CSE**

**Course Objectives:**

1) To enlighten the learners in the concept of differential equations and multivariable calculus.
2) To furnish the learners with basic concepts and techniques at plus two level to lead them into advanced level by handling various real world applications.

**UNIT 1: Linear differential equations of higher order**

Definitions, complete solution, operator D, rules for finding complimentary function, inverse operator, rules for finding particular integral, method of variation of parameters.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- Identify the essential characteristics of linear differential equations with constant Coefficients
- Solve the linear differential equations with constant coefficients by appropriate method

**UNIT 2: Equations reducible to Linear Differential Equations**

Cauchy's and Legendre's linear equations, simultaneous linear equations with constant coefficients, Applications to L-C-R Circuit problems and Mass spring system.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- Classify and interpret the solutions of linear differential equations
- Formulate and solve the higher order differential equation by analyzing physical situations

**UNIT 3: Partial Differential Equations** First order partial differential equations, solutions of first order linear and non-linear PDEs.

Solutions to homogenous and non-homogenous higher order linear partial differential equations.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- apply a range of techniques to find solutions of standard PDEs
- outline the basic properties of standard PDEs

**UNIT4: Vector differentiation**

Scalar and vector point functions, vector operator del, del applies to scalar point functions-Gradient, del applied to vector point functions-Divergence and Curl, vector identities.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- apply del to Scalar and vector point functions
- illustrate the physical interpretation of Gradient, Divergence and Curl

**UNIT 5: Vector integration**

Line integral-circulation-work done, surface integral-flux, Green's theorem in the plane (without proof), Stoke's theorem (without proof), volume integral, Divergence theorem (without proof) and applications of these theorems.

**Learning Outcomes:**
At the end of this unit, the student will be able to

- find the work done in moving a particle along the path over a force field
- evaluate the rates of fluid flow along and across curves
- apply Green's, Stokes and Divergence theorem in evaluation of double and triple
- integrals

**Text Books:**
1. Erwin Kreyszig, Advanced Engineering Mathematics, 10/e, John Wiley & Sons, 2011.
2. B.S. Grewal, Higher Engineering Mathematics, 44/e, Khanna publishers, 2017.

**Reference Books:**
1. Dennis G. Zill and Warren S. Wright, Advanced Engineering Mathematics, Jones and Bartlett, 2011.
2. Michael Greenberg, Advanced Engineering Mathematics, 2/e, Pearson, 2018
3. George B.Thomas, Maurice D. Weir and Joel Hass, Thomas Calculus, 13/e, Pearson Publishers, 2013.
4. R.K.Jain and S.R.K.Iyengar, Advanced Engineering Mathematics, 3/e, Alpha Science International Ltd., 2002.
5. Glyn James, Advanced Modern Engineering Mathematics, 4/e, Pearson publishers, 2011.
6. Micheael Greenberg, Advanced Engineering Mathematics, 9th edition, Pearson edn
7. Dean G. Duffy, Advanced engineering mathematics with MATLAB, CRC Press
8. Peter O'neil, Advanced Engineering Mathematics, Cengage Learning.
9. R.L. Garg Nishu Gupta, Engineering Mathematics Volumes-I &II, Pearson Education
10. B. V. Ramana, Higher Engineering Mathematics, Mc Graw Hill Education.
11. H. k Das, Er. Rajnish Verma, Higher Engineering Mathematics, S. Chand.
12. N. Bali, M. Goyal, C. Watkins, Advanced Engineering Mathematics, Infinity Science Press.

**Course Outcomes:**
At the end of the course, the student will be able to

- solve the differential equations related to various engineering fields
- Identify solution methods for partial differential equations that model physical processes
- interpret the physical meaning of different operators such as gradient, curl and divergence
- estimate the work done against a field, circulation and flux using vector calculus

**JNTUA COLLEGE OF ENGINEERING (Autonomous) :: ANANTAPURAMU**
**DEPARTMENT OF CHEMICAL ENGINEERING**

**I- Year B.Tech. II-Sem**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Engineering Physics**
**Common to CIVIL, MECH & CHEM**

| COURSE OBJECTIVES | |
|---|---|
| 1 | To make a bridge between the physics in school and engineering courses. |
| 2 | To understand the concepts of mechanics and employ the applications of oscillations to engineering fields. |

| | |
|---|---|
| 3 | To familiarize the basic ideas of acoustics and ultrasonics with their Engineering applications. |
| 4 | The mechanisms of emission of light, achieving amplification of electromagnetic radiation through stimulated emission, study of propagation of light through transparent dielectric waveguides along with engineering applications. |
| 5 | To evoke interest on applications of superposition effects like interference, diffraction and polarization in engineering. |
| 6. | To open new avenues of knowledge in dielectric and magnetic materials which find potential in the emerging micro device applications. Considering the significance of micro miniaturization of electronic devices and significance of low dimensional materials, the basic concepts of nano materials, their properties and applications in modern emerging technologies are elicited. |

| **COURSE OUTCOMES** | |
|---|---|
| After studying this course, the student will be able to: | |
| CO1 | Understand the basics of mechanics and types of oscillations. |
| CO2 | Explain sound propagation in buildings, acoustic properties of typically used materials in buildings and the use of ultrasonics. |
| CO3 | Apply the different realms of physics in both scientific and technological systems through the study of lasers and fiber optics. |
| CO4 | Analyze different physical phenomena of optics like interference, diffraction and polarization. |
| CO5 | Compare the properties of dielectric, magnetic and nano materials along with their engineering applications. |

## Mapping between Course Outcomes and Programme Outcomes

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |

**Unit-1: Introduction to Mechanics and Oscillations**

**Introduction to Mechanics and Oscillations**-Basic laws of vectors and scalars-Rotational frames-Conservative forces – F = - grad V, torque and angular momentum – Simple harmonic oscillators-Damped harmonic oscillator-Heavy, critical and under damping- Energy decay in damped harmonic oscillator- Forced oscillations – Resonance.

**Unit-II: Acoustics and Ultrasonic's**

**Acoustics**: Introduction to acoustics – Reverberation – Reverberation time– Sabine's formula-Derivation using growth and decay method – Absorption coefficient and its determination – Factors affecting acoustics of buildings and their remedies.

**Ultrasonics:** Introduction, Properties and Production by magnetostriction & piezoelectric methods - acoustic grating -Non Destructive Testing – pulse echo system through transmission and reflection modes - A,B and C – scan displays, Medical applications

**Unit-III: Lasers and Fiber optics**

**Lasers:** Introduction – Characteristics of laser – Spontaneous and stimulated emission of radiation – Einstein's coefficients – Population inversion – Pumping mechanisms – Nd:YAG laser – He-Ne laser – Applications of lasers.

**Fiber optics-** Introduction to Optical Fibers-Total Internal Reflection-Critical angle of propagation-Acceptance Angle-Numerical Aperture-Classification of fibers based on refractive index profile –Propagation of electromagnetic wave through optical fibers – Modes -Importance of V-number-Fiber optic sensors (Pressure/temperature/chemical change)

**Unit-IV: Wave Optics**

**Interference**-Principle of superposition –Interference of light – Conditions for sustained interference-interference in thin films- Colors in thin films-Newton's Rings-Determination of wavelength and refractive index.

**Diffraction**-Introduction-Fresnel and Fraunhofer diffraction-Fraunhofer diffraction due to single slit and double slit – Diffraction grating- Grating spectra.

**Polarization**-Polarization by double refraction-Nicol's Prism--Half wave and Quarter wave plates- Engineering applications of Polarization.

**UNIT V:Engineering Materials**

**Dielectric Materials:** Introduction-Dielectric polarization- Dielectric constant- Types of polarizations: Electronic and Ionic, Orientation Polarizations (Qualitative) - Lorentz (Internal) field – Clausius - Mossotti equation - Applications of Dielectrics: Ferro electricity and Piezoelectricity.

**Magnetic Materials:** Introduction-Magnetic dipole moment-Magnetization-Magnetic susceptibility and permeability- Origin of permanent magnetic moment -Classification of Magnetic materials- Hysteresis - Soft and hard magnetic materials-Applications.

**Nanomaterials**: Introduction – Surface area and quantum confinement –Physical properties: electrical and magnetic properties- Synthesis of nanomaterials: Top-down: Ball Milling, Bottom-up: Chemical Vapour Deposition – Applications of nanomaterials.

**Prescribed Text books:**

1. Engineering Physics – Dr. M.N. Avadhanulu & Dr. P.G. Kshirsagar, S. Chand and Company

2. Engineering physics – D.K. Battacharya and Poonam Tandon, Oxford University press.

**Reference Books:**

1. Introduction to modern optics – Grant R Fowles
2. A text book on Optics – Brijlal & Subramanyam
3. Laser Fundamentals – William T. Silfvast, Cambridge University Press
4. Fundamentals of Physics – Halliday, Resnick and Walker, John Wiley &Sons
5. Introduction to Nanotechnology – C P Poole and F J Owens, Wiley
6. Hand Book of Non-destructive evaluation, C.J.Hellier, McGraw-Hill
7. Engineering Physics – K.Thyagarajan, MacGraw Hill Publishers
8. Engineering Physics – M.R.Srinivasan, New Age Publications
9. Engineering Physics – D K Pandey, S. Chaturvedi, Cengage Learning
10. Engineering Physics - Sanjay D. Jain, D. Sahasrambudhe and Girish, University Press
11. Engineering Physics – M. Arumugam, Anuradha Publications

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**2020-21**

**JNTUA COLLEGE OF ENGINEERING (Autonomous) :: ANANTAPURAMU**
**DEPARTMENT OF CHEMICAL ENGINEERING**

| | L | T | P | C |
|---|---|---|---|---|
| **I- Year B.Tech. II-Sem** | **3** | **0** | **0** | **3** |

**20A10801 Basic Thermodynamics**

**Objective:**

To provide the students with the terminology of thermodynamics like system, properties, processes, reversibility, equilibrium, phases, components; the relationship between heat and work by understanding the significance of the thermodynamic laws.

**UNIT -I**

**Introduction:**The scope of thermodynamics, temperature, defined quantities; volume, pressure, work, energy, heat, Joules Experiments. The first law and other basic concepts: The first law of thermodynamics, thermodynamic state and state functions, enthalpy, the steady-state steady-flow process, equilibrium, the phase rule, the reversible process, constant-V and constant- P processes, heat capacity, isobaric, isochoric, isothermal, adiabatic and polytrophic processes.

**UNIT -II**

**Volumetric properties of pure fluids:**The PVT behavior of pure substances, virial equations, the ideal gas, the applications of the virial equations, second virial coefficients from potential functions. Cubic equations of state, generalized correlations for gases, generalized correlations for liquids, molecular theory of fluids.

**UNIT- III**

**The second law of thermodynamics:**Statements of the second law, heat engines, thermodynamic temperatures scales, thermodynamic temperature and the ideal gas scale Entropy, Entropy changes of an ideal gas, mathematical statement of the second law, the third law of thermodynamics, entropy from the microscopic view point, calculation of ideal work and lost work.

**UNIT -IV**

**Power cycles:**Carnot cycle, Rankine cycle, Otto cycle, Diesel cycle. Refrigeration and liquefaction: The Carnot refrigerator, the vapor compression cycle, the comparison of refrigeration cycles, the choice of refrigerant, absorption refrigeration, the heat pump, liquefaction processes.

**UNIT –V**

**Thermodynamic properties of fluids:**Property relations for homogeneous phases, residual properties, two phase systems, thermodynamic diagrams, tables of thermodynamic properties, generalized property correlation for gases.

**TEXT BOOKS**

1. J. M. Smith and HC Van Ness, Introduction to Chemical Engineering Thermodynamics, 6$^{th}$ed, McGraw Hill,2003.

**REFERENCE**

1. Y.V. C. Rao, Chemical Engineering Thermodynamics, University publications.

2. K. V. Narayanan, Chemical Engineering Thermodynamics, PHI,2001

**Outcome:** This course will enable the student to understand the spontaneity and energy efficiency of a process.

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**DEPARTMENT OF CHEMICAL ENGINEERING**

**I- Year B.Tech. I-Sem**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**20A10401 Basic Electrical & Electronics Engineering**

**Common to MECH, CSE & CHEM**

## PART- A

**Course Objectives:**

To make the students learn about:

| | |
|---|---|
| 1 | The basics of AC & DC Circuits, DC generators & motors. |
| 2 | The construction and operation of Transformers, Induction motors and their performance aspects will be studied. |

**Course Outcomes**:

After completing the course, the student should be able to :

| | |
|---|---|
| CO1 | understand the basics of AC & DC circuits and AC & DC machines |
| CO2 | analyse the circuit elements, various AC and DC machines |

**Mapping of Course outcomes with Program outcomes:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |

## Syllabus:

**UNIT – I**

**Introduction to DC & AC Circuits**

Ohm's Law, Basic Circuit Components, Kirchhoff's Laws, Resistive Networks, Series Parallel Circuits, Star-Delta and Delta-Star Transformation. Principle of AC Voltages, Waveforms and Basic Definitions, Root Mean Square and Average Values of Alternating Currents and Voltage, Form Factor and Peak Factor, Phasor Representation of Alternating Quantities, The 'j' Operator and Phasor Algebra, Basic concepts of AC series circuits.

**Outcomes** : After the completion of the unit the students will be able to
1. Perceive and analyse the basic laws of electrical circuits
2. Apply to basic laws to solve real life problems

**UNIT-II**

**DC Machines**

Constructional details of DC Machines

**DC Generators:** Principle of Operation, EMF equation, Types, O.C.C. of a DC Shunt Generator

**DC Motors**:Principle of Operation, Types, Torque Equation, Losses and Efficiency Calculation, Swinburne's Test, concepts of speed control.

**Outcomes:** After the completion of the unit the students will be able to
1. Apprehend and interpret basic principles of DC machines
2. Evaluate the performance of DC machines

**UNIT-III**

**AC Machines**

**Transformers:** Principles of Operation, Constructional Details, Losses and Efficiency, Regulation of Transformer, Testing: OC & SC Tests.

**Three Phase Induction Motors**: Principle of Operation, Slip and Rotor Frequency, Torque (Simple Problems).

**Alternators:** Principle of Operation, Constructional Details, EMF Equation, Voltage Regulation by Synchronous Impedance Method.

**Outcomes :** After the completion of the unit the students will be able to
1. Identify different types of AC machines
2. Analyse the performance of various AC machines

**TEXT BOOKS:**

1. Basic Electrical Engineering - By M.S.Naidu and S. Kamakshiah – TMH.
2. Basic Electrical Engineering –By T.K.Nagasarkar and M.S. Sukhija Oxford University Press.
3. Electrical and Electronic Technology-By Hughes – Pearson Education.

**REFERENCES:**

1. Theory and Problems of Basic Electrical Engineering by D.P.Kothari & I.J. Nagrath PHI.
2. Principles of Electrical Engineering by V.K Mehta, S.Chand Publications.
3. Fundamentals of Electrical Electronics Engineering by T.Thyagarajan, SCITECH Publications 5th Edition-2007

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DEPARTMENT OF CHEMICAL ENGINEERING

I –Year B.Tech.I -Semester

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

BASIC ELECTRICAL & ELECTRONICS ENGINEERING

20A10401 ELECTRONICS ENGINEERING
PART- B
**Common to MECH, CSE & CHEM**

| **COURSE OBJECTIVES** | |
|---|---|
| The students will be able to | |
| 1 | Understand principle and terminology of electronics. |
| 2 | Analyse the characteristics of electronic devices and understand the working of basic circuits such as rectifiers, amplifiers, filters, oscillators. |
| 3 | Understand the concept of Digital Logic |
| 4 | Understand the Concept & Principles of Digital Logic |

| **COURSE OUTCOMES** | |
|---|---|
| At the end of this course the student will be able to | |
| CO1 | Able to apply the knowledge of diodes, Zener diodes, BJT's and FET's for applications of different circuits. |
| CO2 | Analyse the applications of operational amplifiers. |
| CO3 | Solve problems of various digital logic gates and circuits. |
| CO4 | Correlate the fundamental concepts to various Real life applications of today. |

**UNIT I**

**Diodes and Transistors**: Semiconductor Diode, Zener Diode, Rectifier Circuits, Wave Shaping Circuits,Bipolar Junction Transistors(operating modes modes,Configurations and Charecteristics), Introduction to Transistor Biasing and Transistor as an amplifier, Introduction to Field-Effect Transistors (Configurations and characteristics).

**UNIT II**

**Operational Amplifiers**: Op-amp Equivalent Circuit, Ideal and practical Op-amp characteristics, Op-Amp Applications (Inverting amplifier, Non -inverting amplifier, Summing, scaling & averaging amplifiers, integrator, differentiator, Active filters, oscillators and comparators).

**UNIT III**

**Digital Electronics**: Number Systems and Codes, Logic Gates, Boolean Theorems, DeMogan's Theorems, Algebraic Simplification, Karnaugh Map Method. Binary Addition, 2's Complement System, Full Adder, BCD Adder. NAND and NOR gate Latches, S-R Flip-Flop, JK Flip-Flop, D Flip-Flop, Introduction to Shift registers and Counters

**Text Books:**

1. Boylested, R. L. and Nashelsky, L., Electronic Devices and Circuit Theory, Pearson Education
2. Ramakant A.Gayakwad, Op-Amps and Linear Integrated Circuits, Eastern Economy Edition
3.M.Morris Mano and Michael D.Ciletti, Digital Design, Pearson Education,4th Edition

**References:**

1. R. Muthusubramanian, S. Salivahanan, "Basic Electrical and Electronics Engineering", Tata McGraw-Hill Education.
2. Bell, D. A., Electronic Devices and Circuits, Oxford University Press
3. 3.R.J. Tocci: Digital Systems; PHI, 6e, 2001.

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**DEPARTMENT OF CHEMICAL ENGINEERING**

**I- Year B.Tech. II-Sem**

| L | T | P | C |
|---|---|---|---|
| 1 | 0 | 2 | 2 |

**20A10301 Engineering Drawing**
**Common to CIVIL, MECH & CHEM**

**Course Objectives:**

- Bring awareness that Engineering Drawing is the Language ofEngineers.
- Familiarize how industry communicates technicalinformation.
- Teach the practices for accuracy and clarity in presenting the technicalinformation.
- Develop the engineering imagination essential for successfuldesign.

**Unit:I**

**Introduction to Engineering Drawing:** Principles of Engineering Drawing and its significance-Conventions in drawing-lettering - BIS conventions.
a)Conic sections including the rectangular hyperbola- general methodonly,
b) Cycloid, epicycloids andhypocycloid c) Involutes

**Learning Outcomes:**

At the end of this unit the student will be able to

1. Lettering and dimensioning by freehand (L1)
2. Create geometric constructions; drawing parallel and perpendicular lines, and to construct circles, arcs, tangencies, and irregular curves (L6)
3. Create Conic sections and cycloidal curves.(L6)

**Unit: II**

**Projection of points, lines and planes:** Projection of points in any quadrant, lines inclined to one or both planes, finding true lengths, angle made by line. Projections of regular plane surfaces.

**Learning Outcomes:**

At the end of this unit the student will be able to

1. Understand the Projection of the objectives in four quadrants (L2)
2. Project the points, lines and planes (L6)

**Unit: III**

**Projections of solids:** Projections of regular solids inclined to one or both planes by rotational or auxiliaryviewsmethod.

**Learning Outcomes:**

At the end of this unit the student will be able to

1.Project the solids in both planes. (L6)

2. To draw the solids by auxiliary method. (L6)

**Unit: IV**

**Sections of solids:** Section planes and sectional view of right regular solids- prism, cylinder, pyramid and cone. True shapes of the sections.

**Learning Outcomes:**

At the end of this unit the student will be able to

1.Project the sectional view of regular solids.(L6)
2. Understand how to draw the true shapes of the sections.(L2)

**Unit:V**

**Development of surfaces:** Development of surfaces of right regular solids-prism, cylinder, pyramid, cone and their sectional parts.

**Learning Outcomes:**

At the end of this unit the student will be able to

1. Draw the development of surfaces of the solids.(L6)
2. Understand to develop the sectional parts of the solids.(L2)

**Text Books:**


1. K.L.Narayana & P.Kannaiah, Engineering Drawing, 3/e, Scitech Publishers, Chennai, 2012.
2. N.D.Bhatt, Engineering Drawing, 53/e, Charotar Publishers,2016.


**Reference Books:**


1. Dr K.Prahlada Rao, Dr. S. Krishnaiah, Prof.A.V.S. Prasad, Engineering Graphics, Amaravati publications.
2. Dhanajay A Jolhe, Engineering Drawing, Tata McGraw-Hill, Copy Right,2009
3. Venugopal, Engineering Drawing and Graphics, 3/e, New Age Publishers,2000
4. Shah and Rana, Engineering Drawing, 2/e, Pearson Education,2009
5. K.C.John, Engineering Graphics, 2/e, PHI,2013
6. Basant Agarwal & C.M.Agarwal, Engineering Drawing, Tata McGraw-Hill, Copy Right, 2008.


**Course Outcomes:**

After completing the course, the student will be able to

- draw various curves applied in engineering.(L2)
- show projections of solids and sections graphically. (L2)
- draw the development of surfaces of solids.(L3)

**Additional Sources**

1. Youtube: http-sewor,Carleton.cag,kardos/88403/drawings.html conic sections-online, red woods.edu

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**DEPARTMENT OF CHEMICAL ENGINEERING**

**I- Year B.Tech. II-Sem**

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 2 | 1 |

**20A10302 Engineering Graphics Lab**
**Common to CIVIL, MECH & CHEM**

**Course Objectives:**

- Instruct the utility of drafting & modelling packages in orthographic and isometric drawings.
- Instruct graphical representation of machinecomponents.

**Computer Aided Drafting:**
**Introduction to Geometric Modeling:** Basic drawing and editing commands: line, circle, rectangle, erase, view, undo, redo, snap, object editing, moving, copying, rotating, scaling, mirroring, layers, templates, polylines, trimming, extending, stretching, fillets,arrays,dimensions.
Dimensioning principles and conventional representations.
**Orthographic Projections:** Systems of projections, conventions and application to orthographic projections - simple objects.
**Isometric Projections:** Principles of isometric projection- Isometric scale; Isometric views: lines, planes, simple solids.

**Text Books:**

1. K. Venugopal, V.Prabhu Raja, Engineering Drawing + Auto Cad, New Age International Publishers.
2. Kulkarni D.M, AP Rastogi and AK Sarkar, Engineering Graphics with Auto Cad, PHI Learning, Eastern Economy editions.

**Reference Books:**

1. T. Jayapoovan, Engineering Graphics using Auto Cad, Vikas Publishing House
2. K.L.Narayana & P.Kannaiah, Engineering Drawing, 3/e, Scitech Publishers, Chennai, 2012.
3. Linkan Sagar, BPB Publications, Auto Cad 2018 Training Guide.
4. K.C.John, Engineering Graphics, 2/e, PHI,2013
5. Basant Agarwal & C.M.Agarwal, Engineering Drawing, Tata McGraw-Hill, Copy Right, 2008.

**Course Outcomes:**

After completing the course, the student will be able to

- Use computers as a drafting tool.(L2)
- Draw isometric and orthographic drawings using CAD packages.(L3)

Additional Sources: 1. Youtube: http-sewor,Carleton.cag, kardos/88403/drawings.html conic sections-online, red woods.edu.

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**DEPARTMENT OF CHEMICAL ENGINEERING**

| I- Year B.Tech. II-Sem | L | T | P | C |
|---|---|---|---|---|
| | 0 | 0 | 3 | 1.5 |

## 20A10802 Basic Thermodynamics Lab

**Objectives:**

To gain insight into basic concepts taught in Chemical Engineering Thermodynamics theory course by performing hands on experiments.

**Course Contents:**

1. Mechanical equivalent of heat – heat, work and the first law of thermodynamics

2. Calorimetry – heat capacities, heat of formation, Hess's law

3. Thermodynamic cycles – adiabatic, isothermal, isochoric processes

4. Equation of state – ideal gas law, virial equation of pressure

5. Property change of mixing – volume, enthalpy and entropy changes

6. Raoult's law and Henry's law – applications in volatile organic compounds

7. Phase equilibria: VLE, LLE, humidity, solid-fluid equilibria, polymer-vapor equilibria8. Equilibrium solubility of solids – effect of temperature, measurement of pKa9. Reaction equilibria – liquid phase, gas phase (Le Chatelier principle), equilibrium constant10. Enthalpy/entropy driven physical processes

**Text Books:**

1. M. D. Koretsky, Engineering and Chemical Thermodynamics, , John Wiley & Sons, 20132. Laboratory manual

**Reference Books:**

1. N. de Nevers, Physical and Chemical Equilibrium for Chemical Engineers, 2nd Ed., Wiley, 2012.2. J. W. Tester and M. Modell, Thermodynamics and Its Applications, 3rd Ed., Prentice Hall, 1997.

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**DEPARTMENT OF CHEMICAL ENGINEERING**

**I- Year B.Tech. II-Sem**

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 3 | 1.5 |

**20A15204 ENGINEERING PHYSICS LAB**

**Common to CIVIL, MECH & CHEM**

| COURSE OBJECTIVES | |
|---|---|
| 1 | The Objective of this course is to make the students gain practical knowledge to co-relate with the theoretical studies. |
| 2 | To develop practical applications of engineering materials and use of principle in the right way to implement the modern technology. |
| 3 | To train engineering students on basis of measurements and the instruments |
| 4 | To equip the students with practical knowledge in electronic and optics experiments |

| COURSE OUTCOMES | |
|---|---|
| CO1 | On Completion of this course, students are able to –<br>Develop skills to impart practical knowledge in real time solution. |
| CO2 | Understand principle, concept, working and application of new technology and comparison of results with theoretical calculations. |
| CO3 | Understand measurement technology, usage of new instruments and real time applications in engineering studies. |
| CO4 | The student will be able to analyze the physical principle involved in the various instruments, also relate the principle to new application. |
| CO5 | The various experiments in the areas of optics, mechanics and thermal physics will nurture the students in all branches of Engineering. |

**Mapping between Course Outcomes and Programme Outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO5 | | | | | | | | | | | | |

**LIST OF EXPERIMENTS**

**Any TEN of the following experiments has to be performed during the SEMESTER**

1. Laser: Determination of wavelength using diffraction grating.
2. Laser: Determination of Particle size.
3. Determination of spring constant of springs using Coupled Oscillator
4. Determination of ultrasonic velocity in liquid (Acoustic grating)
5. Determination of dielectric constant and Curie temperature of a ferroelectric material.
6. B-H curve
7. Stewart-Gee's Method
8. Rigidity modulus of material of a wire-dynamic method (Torsional pendulum)
9. Determination of numerical aperture of an optical fiber.
10. Determination of thickness of thin object by wedge method.
11. Determination of radius of curvature of lens by Newton's rings.
12. Determination of wavelengths of various colours of mercury spectrum using diffraction grating in normal incidence method.
13. Determination of dispersive power of the prism
14. Sonometer: Verification of the three laws of stretched strings
15. Meldes experiment: Determination of the frequency of tuning fork

Note: Out of 10 experiments, two experiments will be performed using virtual laboratory.

Data Books Required: Nil

**JNTUA COLLEGE OF ENGINEERING (Autonomous) :: ANANTAPURAMU**
**DEPARTMENT OF CHEMICAL ENGINEERING**

| I- Year B.Tech. II-Sem | L | T | P | C |
|---|---|---|---|---|
| | 0 | 0 | 1.5 | 0.75 |

**20A10402 BASIC ELECTRICAL ENGINEERING LAB**

**(PART-A - ½ LAB)**

**Common to MECH ,CSE& CHEM**

**Course Objectives:** To make the student learn about:

| | |
|---|---|
| 1 | The DC motors, DC Generators and know various characteristics, performance analysis of DC machines and speed control techniques of DC machines. |
| 2 | Various test conditions of single phase transformers. |

**Course Outcomes**:

After completing the course, the student should be able to do the following:

| | |
|---|---|
| CO1 | Learn about DC motors, DC Generators and know various characteristics, performance analysis of DC machines and speed control techniques of DC machines. |
| CO2 | Various test conditions of single phase transformers. |

**Mapping of Course outcomes with Program outcomes:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |

## Syllabus:

The following experiments are required to be conducted as compulsory experiments:

1. Swinburne's Test on DC Shunt Machine (Predetermination of Efficiency of a Given DC Shunt Machine Working as Motor and Generator).
2. OC & SC Tests on Single-Phase Transformer (Predetermination of Efficiency and Regulation at Given Power Factors and Determination of Equivalent Circuit).
3. Brake Test on 3-Phase Induction Motor ( Determination of Performance Characteristics )
4. Regulation of Alternator by Synchronous Impedance Methods.
5. Speed Control of D.C.Shunt Motor by

a) Armature Voltage Control B) Field Flux Control Method

6. Brake Test on D.C Shunt Motor



**JNTUA COLLEGE OF ENGINEERING (Autonomous) :: ANANTAPURAMU**
**DEPARTMENT OF CHEMICAL ENGINEERING**

| **I- Year B.Tech. II-Sem** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|
| | **0** | **0** | **1.5** | **0.75** |

## 20A10402 BASIC ELECTRONICS ENGINEERING LAB

**Common to MECH, CSE & CHEM**

**(PART-B - ½ LAB )**

**(Common to ME & CHEM)**

| **COURSE OBJECTIVES** | |
|---|---|
| The students will be able to | |
| 1 | Understand the characteristics of PN junction diode and zener diode. |
| 2 | Understand the characteristics of BJT in CE and CB configurations |
| 3 | Learn the frequency response of CE Amplifier |
| 4 | Exposed to linear and digital integrated circuits |

| **COURSE OUTCOMES** | |
|---|---|
| At the end of this course the student will be able to, | |
| CO1 | Learn the characteristics of basic electronic devices like PN junction diode, Zener diode & BJT. |
| CO2 | Analyze the application of diode as rectifiers, clippers and clampers. |
| CO3 | Learn the fundamental principles of amplifier circuits and need of Bias in Amplifier circuits. |
| CO4 | Learn the basics of linear integrated circuits and understand characteristics of operational amplifier. |
| CO5 | Learn about available digital ICs and verify truth tables of logic gates and flip flops. |

**LIST OF EXPERIMENTS:**

1. PN Junction diode characteristics A) Forward bias B) Reverse bias.
2. Zener diode characteristics and Zener as voltage Regulator
3. Full Wave Rectifier with & without filter
4. Wave Shaping Circuits (Clippers & Clampers)
5. Input & Output characteristics of Transistor in CB / CE configuration
6. Frequency response of CE amplifier.

7. Inverting and Non-inverting Amplifiers using Op Amps
8. Verification of Truth Table of AND, OR, NOT, NAND, NOR, Ex-OR, Ex-NOR gates using ICs
9. Verification of Truth Tables of RS, JK, T & D flip flops using respective ICs

**LAB REQUIREMENTS:**

Cathode Ray Oscilloscopes (30MHz)

Signal Generator /Function Generators (3 MHz)

Dual Regulated Power Supplies ( 0 – 30V)

IC Trainer Kit

Bread Boards

Electronic Components

**JNTUA COLLEGE OF ENGINEERING (Autonomous) :: ANANTAPURAMU**
**(Common to All Branches of Engineering)**

**20AS19101 UNIVERSAL HUMAN VALUES**

**Common to CIVIL, MECH & CHEM**

**I - Year B.Tech. II-Sem** **L T P C**

**3 0 0 0**

1. ***Introduction:***

This course discusses the role of human values in one's family. It, very briefly, touches issues related to their role in the society and the nature, which needs to be discussed at length in one more semester for which the foundation course names as"H-102 Universal Human Values 2 : "Understanding Harmony" is designed which may be covered in their III or IV Semester.

In the Induction Program, students would get an initial exposure to human values through Universal HumanValues–I.This exposure is to be augmented by this compulsory full semester foundation course.

**2.Learning Objectives:**

1. Exposure to the value of life, society and harmony
2. Leading towards holistic perspective based on self-exploration about themselves (human being), family, and society and nature/existence.
3. Bringing transition from the present state to Universal Human Order
4. Instill commitment and courage to act.
5. Know about appropriate technologies and management patterns

**3. COURSE TOPICS:**

**Unit 1: Course Introduction - Need, Basic Guidelines, Content and Process for Value Education**

Universal Human Values-I - Self-Exploration - content and process; 'Natural Acceptance' and Experiential Validation - self-exploration - Continuous Happiness and Prosperity - Human Aspirations - current scenario - Method to fulfill the above human aspirations: understanding and living in harmony at various levels.

**Unit 2: Understanding Harmony in the Human Being - Harmony in Myself!**

human being as a co-existence of the sentient 'I' and the material'Body' - the needs - happiness and physical facility -the Body as an instrument of 'I' - the characteristics and activities of 'I' and harmony in 'I' - the harmony of I with the Body

**Unit 3: Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship**

Values in human relationship; meaning of Justice; Trust and Respect; Difference between intention and competence; the other salient values in relationship - the harmony in the society: Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals - Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

**Unit 4: Understanding Harmony in the Nature and Existence - Whole existence as Coexistence**

the harmony in the Nature - Interconnectedness and mutual fulfillment among the four orders of nature- recyclability and self-regulation in nature - Understanding Existence as Co-existence of mutually interacting units in all- pervasive space - Holistic perception of harmony at all levels of existence.

**Unit 5: Implications of the above Holistic Understanding of Harmony on Professional Ethics**

Humanistic Education - Competence in professional ethics: professionalcompetence - people friendly and eco-friendly production systems - appropriate technologies and management patterns for above production systems. Individuals as socially and ecologically responsible engineers, technologists and managers

**Text Book**

1. *A Foundation Course in Human Values and Professional Ethics*, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1
2. Teachers' Manual for *A Foundation Course in Human Values and Professional Ethics*, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53-2

**Reference Books**

1. JeevanVidya: EkParichaya, ANagaraj, JeevanVidyaPrakashan, Amarkantak, 1999
2. HumanValues,A.N.Tripathi,NewAgeIntl.Publishers,NewDelhi,2004.
3. The Story of Stuff (Book).
4. Economy of Permanence - J C Kumarappa 8.

Bharat Mein Angreji Raj - PanditSunderlal 9.

Rediscovering India - byDharampal

5. Hind Swaraj or Indian Home Rule - by Mohandas K.Gandhi
6. India Wins Freedom - Maulana Abdul Kalam Azad 12.

Vivekananda - Romain Rolland(English)

**COURSE OUTCOMES:**

By the end of the course,

CO1: Define terms like Natural Acceptance, Happiness and Prosperity

CO2: Understand awareness of oneself, and ones surroundings (family, society, nature)

CO3: Apply what they have learnt to their own self in different day-to-daysettings in real life

CO4: Relate human values with human relationship and human society.

CO5: Justify the need for universal human values and harmonious existence

CO6: Develop as socially and ecologically responsible engineers

**II B.TECH I SEMESTER**

## 1. 20A35101 NUMERICAL METHODS &PROBABILITY THEORY

**Common to CIVIL & CHEM**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

This course aims at providing the student with the knowledge on various numerical methods for solving equations, interpolating the polynomials, evaluation of integral equations and solution of differential equations. The theory of Probability and random variables.

**UNIT - I**

**Solution of Algebraic & Transcendental Equations:**

Introduction-Bisection method-Iterative method-Regula falsi method-Newton Raphson method

System of Algebraic equations: Gauss Jordan method-Gauss Siedal method.

**Interpolation**

Finite differences-Newton's forward and backward interpolation formulae – Lagrange's formulae. Gauss forward and backward formula, Stirling's formula, Bessel's formula.

**UNIT – III**

**Numerical Integration & Solution of Initial value problems to Ordinary differential equations**

Numerical Integration: Trapezoidal rule – Simpson's 1/3 Rule – Simpson's 3/8 Rule

Numerical solution of Ordinary Differential equations: Solution by Taylor's series-Picard's Method of successive Approximations-Modified Euler's Method-Runge-Kutta Methods.

**UNIT – IV**

**Probability theory, Random variables & Distributions:**

Probability, probability axioms, addition law and multiplicative law of probability, conditional probability, Baye's theorem, random variables (discrete and continuous), probability density functions, properties, mathematical expectation.

Probability distribution - Binomial, Poisson approximation to the binomial distribution and normal distribution-their properties-Uniform distribution-exponential distribution.

**UNIT – V**

**Descriptive statistics**

Data science, Statistics Introduction, Population vs Sample, Collection of data, primary and secondary data, Type of variable: dependent and independent Categorical and Continuous variables, Data visualization, Measures of Central tendency, Measures of Variability (spread or variance) Skewness, Kurtosis, correlation, correlation coefficient, rank correlation, regression coefficients, method of least squares, regression lines.

**TEXT BOOKS:**


1. Higher Engineering Mathematics, B.S.Grewal, Khanna publishers.
2. Probability and Statistics for Engineers and Scientists, Ronald E. Walpole,PNIE.
3. Advanced Engineering Mathematics, by Erwin Kreyszig, Wiley India.


**REFERENCES:**


1. Higher Engineering Mathematics, by B.V.Ramana, Mc Graw Hill publishers.
2. Advanced Engineering Mathematics, by Alan Jeffrey, Elsevier.


**Online Learning Resources:**

1. https://onlinecourses.nptel.ac.in/noc17_ma14/preview
2. nptel.ac.in/courses/117101056/17
3. http://nptel.ac.in/courses/111105090

**Course Outcomes :** Student will be able to

- apply numerical methods to solve algebraic and transcendental equations
- derive interpolating polynomials using interpolation formulae
- Solve differential and integral equations numerically
- apply Probability theory to find the chances of happening of events.
- understand various probability distributions and calculate their statistical constants.

**II B.TECH I SEMESTER**

## 2. 20A30801 CHEMICAL PROCESS CALCULATIONS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

- To introduce chemical process calculations, different unit systems and conversion from one unit system to another.
- To introduce the use of Log-Log, Semi-Log and triangular graphs and graph plotting software such as MS-Excel, Polymath, Minitab, Origin etc.
- To impart concepts of vapour pressure and calculation of percent saturation of a given vapor-gas mixture.
- To emphasize the importance of basis of calculation and develop a systematic methodology to carry out material balances on chemical processes/equipment without and with reactions including recycle, purge and bypass.
- To convey different thermal effects associated with processes involving chemical reactions and phase changes
- To present how to calculate mass and energy balances involving combustion of fuels.

**UNIT- I**

**Stoichiometric & Composition relations**: Stoichiometric relation, basis of calculations, methods of expressing compositions of mixtures and solutions, density and specific gravity, Baume and API gravity scales.
(For Assignments only: Use of Log-Log and Semi-Log graphs; Graph plotting using plotters like MS-Excel, Polymath, Minitab, Origin, etc..)
**Behaviour of Ideal gases**: Kinetic theory of gases, application of ideal gas law, gaseous mixtures, gases in chemical reactions.

**UNIT -II**

**Vapor pressure**: Liquefaction and liquid state, vaporization, boiling point, effect of temperature on vapor pressure, Antoine equation, vapor pressure plots, estimation of critical properties, vapor pressure of immiscible liquids and ideal solutions, Raoult's law, Non-volatile solutes.
**Humidity and Saturation**: Partial saturation, Humidity- Absolute Humidity, Vaporization process, Molal humidity, Relative and percentage saturation, dew point, humid heat, wet bulb and dry bulb temperatures, use of humidity charts, adiabatic vaporization.

**UNIT- III**

**Material balances**: Tie substance, Yield, conversion, limiting reactant, excess reactant, processes involving reactions, Material balances with the help of Stoichiometric equations, Material balances involving drying, dissolution, & crystallization. Material balance calculations for processes involving recycle, bypass and purge.

**UNIT -IV**

**Thermo physics**: Energy, energy balances, heat capacity of gases, liquid and mixture solutions. Kopp's rule, latent heats, heat of fusion and heat of vaporization, Trouton's rule, Kistyakowsky equation for non-polar liquids enthalpy and its evaluation.
**Thermo chemistry**: Calculation and applications of heat of reaction, combustion, formation and neutralization, Kirchoff's equation, enthalpy concentration change,

**UNIT- V**

**Flame Temperature Calculations:** Calculation of theoretical and actual flame temperatures.

**Combustion Calculations**: Introduction, fuels, calorific value of fuels, coal, liquid fuels, gaseous fuels, air requirement and flue gases, combustion calculations, incomplete combustion, material and energy balances, thermal efficiency calculations.

**TEXT BOOKS:**

1.Chemical process principles, Part -I, Material and Energy Balance, Hougen O A, Watson K.M. and Ragatz R.A. 2$^{nd}$Edition,John Wiley and Sons, New York, 1963.

**REFERENCES:**

1. Basic principles and calculations in chemical engineering by D.H. Himmelblau, 7$^{th}$ Ed. PHI, 2013
2. Stoichiometry by B.I. Bhatt and S.M. Vora (3rd Ed.) Tata McGraw Hill publishing company, Ltd. New Delhi (1996)

**Data Tables:** Use of steam tables, humidity chart under data tables permitted in the Examination hall

**Course outcomes:**

At the end of the course, student will be able to:

- Identify process calculations relevant to chemical engineering processes including conversion of physical quantities into different unit systems.
- Predict the behaviour of gases and vapours using ideal gas law.
- Estimate the composition of the given vapour-gas mixture using the principles of vapour pressure.
- Solve material balances on chemical processes/equipment without and with reactions including recycle, purge and bypass.
- Evaluate thermal effects associated with chemical reactions.
  Calculate mass and energy balances involving combustion of fuels.

**II B.TECH I SEMESTER**

## 3. 20A30802 MOMENTUM TRANSFER

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

- To introduce the basic concepts of static and dynamic behaviour of fluids
- To disseminate different flow regimes and identification of types of fluids along with necessary equations to represent their behaviour
- To derive Bernouli's theorem and explain its application to fluid flow problems
- To introduce the concept of friction factor and its estimation for different types of flow through pipes and fittings.
- To explain dimensional analysis using Rayleighs and Buchinghm $\pi$ Methods.
- To expose flow measuring devices such as head and area meters.
- To explain fluid moving machinery and its selection for a given flow problem.

**UNIT- I**

Unit operations and unit processes, unit systems, basic concepts, nature of fluids, hydrostatic equilibrium, applications of fluid statics.

Fluid flow phenomena-Laminar flow, Shear rate, Shear stress, Rheological properties of fluids, Turbulence, Boundary layers.

**UNIT- II**

Basic equation of fluid flow –Mass balance in a flowing fluid; continuity equation, differential momentum balance; equations of motion, Macroscopic momentum balances, Bernoulli equation.

Incompressible Flow in pipes and channels- shear stress and skin friction in pipes, laminar flow in pipes and channels, turbulent flow in pipes and channels, friction from changes in velocity or direction.

**UNIT- III**

Dimensional analysis: Buckingham $\pi$ Theorem and Rayleigh's method.

Flow of compressible fluids- Definitions and basic equations, Processes of compressible flow, Isentropic flow through nozzles, adiabatic frictional flow, and isothermal frictional flow.

**UNIT -IV**

Flow past immersed bodies, Drag and Drag coefficient, friction in flow through beds of solids, Kozeny-Carman, Blake-Plummer and Ergun equations, and motion of particles through fluids.

Fluidization: Conditions for fluidization, Minimum fluidization velocity, Types of fluidization, Expansion of fluidized beds, Applications of fluidization, Continuous fluidization: Slurry and pneumatic transport.

**UNIT- V**

Transportation and Metering of fluids: Pipes, fittings and valves, Fluid- moving machinery, Fans, blowers, and compressors.

Measurement of flowing fluids: Variable head meters- Orifice meter, Venturi meter, Pitot tube; Area meter- Rota meter.

**TEXT BOOKS:**

1. Unit Operations of Chemical Engineering by W.L. McCabe, J.C.Smith& Peter Harriot, McGraw-Hill, 7$^{th}$ed, 2007

**REFERENCES:**


1. Transport processes and unit operations by Christie J. Geankoplis, PHI
2. Unit operations, Vol-1 –Chattopadhya, Khanna publishers
3. Principles of Unit Operations, Foust *et al*, 2$^{nd}$ ed., John Wiley, 1999
4. Chemical Engineering, Vol-I, Coulson and Richardson, Pergamon Press.
5. Unit operations- Brown et al., Asian Publishing House.

**II B.TECH I SEMESTER**

## 4. 20A30803 CHEMICAL TECHNOLOGY

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

- Unit operations unit processes involved in manufacture of important and widely employed organic and inorganic chemicals.
- Develop skills in preparing /presenting a neat Engineering drawing for Chemical Process Industries.
- Impart clear description of one latest process along with its Chemistry, Process parameters, Engineering Problems and Optimum Conditions.
- Demonstrate the importance of updating the latest technological developments in producing products economically and environment friendly.
- Appreciate the usage of other engineering principles such as Thermodynamics, Heat, mass and momentum transfer in operation and maintain the productivity

**UNIT – I**

Water and Air: Importance of water, sources, plant location factors related to water, water shortage problems, methods of treating fresh water, methods of obtaining fresh water from saline waters, waste water treatment and disposal, air as a chemical raw material.

Soda ash, caustic soda and chlorine, Glass: manufacture of special glasses

**UNIT – II**

Industrial gases: carbon dioxide, hydrogen and oxygen – products of water gas, producer gas. Nitrogen industries: synthetic ammonia, urea, nitric acid (ammonium nitrate), ammonium chloride, ammonium phosphate and complex fertilizers

Sulphur and sulphuric acid, manufacture of sulphuric acid, hydrochloric acid and some other chemicals –Aluminum sulphate and alum.

**UNIT – III**

Cement manufacture, special cements, miscellaneous calcium compounds, magnesium compounds.

Manufacture of phenols, formaldehyde, vinyl chloride and vinyl acetate, manufacture of phenol-formaldehyde resin and polyvinyl chloride polymer, SBR

**UNIT – IV**

Oils: Definition, constitution, extraction and expression of vegetable oils, refining and hydrogenation of oils.

Synthetic fibers: Classification, manufacture of Nylon 66, polyester fiber and viscose rayon fiber.

Soaps and detergents: Definitions, continuous process for the production of fatty acids, glycerin and soap, production of detergents.

**UNIT – V**

Pulp and paper industry: methods of pulping, production of sulphate and sulphite pulp, production of paper –wet process

Pharmaceutical Industries: Classification, Alkylation, Carboxylation and Acetylation, Condensation and Cyclization, Dehydration,Halogenation, Oxidation, Sulfonation, Amination, Radio isotopes in Medicine, Fermentation and Life processing for Antibiotics, Hormones, and Vitamins, Biologicals, Steroid hormones, isolates and Animals.

**TEXT BOOKS:**

1. Shreve's Chemical Process Industries edited by Austin, Mc.graw-Hill.5$^{th}$ ed.1985.

2. Dryden's Outlines of Chemical Technology edited by M. Gopal Rao and M. Sittig, $2^{nd}$ ed. 1973.

**References:**

1. Industrial Chemistry by B.K. Sharma,
2. Hand book of industrial chemistry Vol 1& II K.H.Davis& F.S. Berner Edited by S.C. Bhatia, CBS publishers
3. Chemical Technology: G.N. Panday, Vol 1& Vol II.

**II B.TECH I SEMESTER**

## 5. 20A30804 MECHANICAL OPERATIONS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

- To introduce to the concepts of characterization of solids

- To discuss different types of mixers for mixing of solids
- To impart knowledge on screening, size reduction and equipment for size reduction
- To give exposure to Laws of crushing
- To explain the phenomenon of particle settling in fluids and transportation of solids
- To disseminate knowledge on different techniques of particle separation from fluid
- To estimate the power consumption in agitation and mixing of liquids

**UNIT- I**

**Properties, handling and mixing of particulate solids**: Characterization of solid particles, properties of particulate masses, storage and mixing of solids, types of mixers, mixers for cohesive solids, mixers for free flowing solids.

**UNIT- II**

**Size reduction**: Principles of computer simulation of milling operations, size reduction equipment-crushers, grinders, ultra-fine grinders, cutting machines, Equipment operation. Laws of crushing: Kick's law, Bond's law, Rittinger's law

Screening, Industrial screening equipment, Effectiveness of the screen, differential & cumulative analysis.

**UNIT -III**

Filtration, cake filters, centrifugal filters, cyclone separators, electro-static precipitators.

Principles of cake filtration, Clarifying filters, vacuum filtration, liquid clarification, gas cleaning, principles of clarification. Introduction to cross flow filtration.

**UNIT- IV**

**Separations based on motion of particles through fluids**: gravity settling processes and centrifugal settling processes, float and sink method, differential settling, coagulation, Flotation-separation of ores, flotation agents

**Crystallization**: crystal geometry, principles of crystallization, equilibria and yields, nucleation, crystal growth

**UNIT- V**

**Agitation and mixing of liquids**: Agitation of liquids, circulation velocities, power consumption in agitated vessels. Blending and mixing of liquids, suspension of solid particles, dispersion operations.

**Introduction to transportation of solid particulate mass**: Belt, screw, apron conveyers, bucket elevators, pneumatic conveying.

**TEXT BOOK:**

1. Unit Operations in Chemical Engineering by W.L. McCabe and J.C. Smith and Peter Harriott, McGraw Hill 7$^{th}$ ed. 2001.

**REFERENCES:**

1. Chemical engineers hand book, J.H. Perry, 7th ed. McGraw Hill

2. Introduction to Chemical Engineering by J.T.Banchero & W.L. Badger., TMH, 1997.

**II B.TECH I SEMESTER**

## 6. 20A30805 MOMENTUM TRANSFER LAB

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 3 | 1.5 |

**COURSE OBJECTIVES:** The lab provides knowledge on various flow patterns, flow measuring devices and pumps.

1. Identification of laminar and turbulent flows - Major equipment - Reynolds apparatus
2. Measurement of point velocities - Major equipment - Pitot tube setup
3. Verification of Bernoulli's equation - Major equipment – Bernoulli's Apparatus
4. Calibration of Rotameter - Major equipment – Rotameter Assembly
5. Variation of Orifice coefficient with Reynolds Number - Major equipment - Orifice meter Assembly
6. Determination of Venturi coefficient - Major equipment – Venturi meter Assembly
7. Friction losses in Fluid flow in pipes - Major equipment - Pipe Assembly with provision for Pressure measurement
8. Pressure drop in a packed bed for different fluid velocities - Major equipment - Packed bed with Pressure drop measurement
9. Pressure drop and void fraction in a fluidized bed - Major equipment - Fluidized bed with Pressure drop measurement
10. Studying the coefficient of contraction for a given open orifice - Major equipment - Open Orifice Assembly
11. Studying the coefficient of discharge in a V-notch - Major equipment - V-notch Assembly
12. Studying the Characteristics of a centrifugal pump - Major equipment - Centrifugal Pump
13. Drag studies using two different fluids

**II B.TECH I SEMESTER**

## 7. 20A30807 CHEMICAL TECHNOLOGY LAB

| L | T | P | C |
|---|---|---|---|

0 0 3 1.5

**COURSE OBJECTIVES:**

1. To determine the acid, iodine and saponification value of a given sample.
2. To determination of Saponification value

**List of Experiments:**

1. Determination of Acid value of Coconut oil
2. Determination of Iodine value
3. Determination of Saponification value
4. Estimation of acid insolubles, available lime and calcium carbonate
5. Estimation of available chlorine in bleaching powder
6. Estimation of glucose
7. Estimation of total cellulose in saw dust
8. Preparation of soap
9. Application of pH meter to find acidity and alkalinity of a solution
10. Preparation of phenol formaldehyde resin
11. Determination of viscosity by red wood viscometer
12. Estimation of silica and moisture content in cement analysis
13. Analysis of the percentage of ash and lactose content in the given milk sample

**II B.TECH I SEMESTER**

**8. 20A30806 MECHANICAL OPERATIONS LAB**

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 3 | 1.5 |

**COURSE OBJECTIVES:** The course will equip students with the practical knowledge of different mechanical unit operations & operational conditions of different equipment.

**List of Experiments:**

1. To determine the time of grinding in a ball mill for producing a product with 80 % passing a given screen.
Major equipment - Ball mill Apparatus, Sieve shaker, Different sizes of sieves, weighing balance.
2. To verify the laws of crushing using any size reduction equipment like crushing rolls or vibrating mills and to find out the working index of the material.
Major equipment – Jaw Crusher, Sieve shaker, Different sizes of sieves, Weighing Balance, Energy meter.
3. To find the effectiveness of hand screening and vibrating screen of a given sample.
Major equipment - Vibrating Sieve shaker, Different sizes of sieves, Weighing Balance.
4. To achieve beneficiation of a ore using froth flotation technique.
Major equipment - Froth flotation cell
5. To obtain batch sedimentation data and to calculate the minimum thickener area under given conditions.
Major equipment- Sedimentation apparatus
6. To determine the specific cake resistance and filter medium resistance of a slurry in plate and frame filter press.
Major equipment - Plate and frame filter press.
7. To separate a mixture of particles by Jigging.
Major equipment - Jigging apparatus
8. To calculate separation efficiency of particles in a mixture using cyclone separator.
Major equipment - Cyclone separator
9. To determine reduction ratio of a given sample in a pulverizer.
Major equipment - Pulverizer
10. Filtration Studies using
    a. Plate and Frame Filter Press
    b. Rotary Drum Filter
    c. Batch Centrifuge
11. To Perform mixing studies using Ribbon Mixer.

12. To determine reduction ratio of a given sample in .a grinder Major equipment - Grinder

**II B.TECH I SEMESTER**

## 9. 20A30808 SKILL ORIENTED COURSE – 1 (ANALYTICAL TECHNIQUES FOR CHEMICAL ENGINEERS)

| L | T | P | C |
|---|---|---|---|
| 1 | 0 | 2 | 2 |

**COURSE OBJECTIVES:**

**This course aims to provide the student to**

- Acquire basic principles of simple instrumental methods for estimation of organic/inorganic species.
- Gain basic knowledge of limitations of analytical methods.
- Characterize the Materials synthesized by chemical industry.
- Understand the chromatographic techniques for the separation of impurities in the industrially synthesized compounds.
    - Learn the basic principles of spectrophotometry like UV-Vis and IR

**UNIT I: Basic Principles of Quantitative Analysis**

Limitations of analytical methods, Classification of errors, Accuracy, Precision, How to reduce systematic errors, Significant figures, Calculators and Computers, Mean and Standard deviation, Distribution of Random errors, Reliability of Results, Confidence interval , Comparison of results, Comparing the means of two samples, Paired T-test, Correlation and regression, Standard deviations.

**UNIT II: Chromatographic Methods:**

Column chromatography-general principles, terminology: retention time, rotation volume, separation factor, resolution of peaks. Principles of gas chromatography, block diagram of gas chromatograph - detectors (FID, ECD), stationary phases for column, mobile phases, chromatogram, qualitative analysis, special plots, quantitative analysis, HPLC: Principles of High Performance Liquid Chromatography. Block diagram of HPLC Systems, function of each component, stationary phases, eluting solvents, pumps, detectors, quantitative applications of HPLC. Ion Exchange chromatography-seperation of anions and cations. Suppressed & non-suppressed ion chromatography. Numerical calculations.

**UNIT III: Thermal methods of Analysis:**

Introduction to Thermal methods, Thermogravimetric Analysis (TGA)-principles, and applications (determination of drying temperatures, kinetic methods, automatic thermo gravimetric Analysis) DTA: Differential thermal analysis-Principles and applications (exothermic and endothermic peaks, heat of reaction, catalysis, decompositions etc.,)DSC: Differential scanning calorimetry, principles & applications (exothermic & endothermic peaks, compound purity determination, percentage crystallinity, glass transition temperature).

**UNIT IV: Electro-Analytical Techniques**

i). Brief introduction about polarography, Basic principle, instrumentation and applications of cyclic voltametry.

ii), Amperometric Titrations: Basic principle involved in the Amperometry, Amperometric Titrations and applications, Advantages and disadvantages of Amperometric Titrations.

**UNIT-V: Spectrophotometric Methods:**

Introduction to Analysis: Qualitative & Quantitative Analysis; Conventional & Instrumental methods of analysis. Molecular spectrophotometry-Beer's law Block diagram of UV-Visible Spectrophotometer – quantitative analysis direct method for the determination metal ions: Chromium, Manganese, Iron, etc in alloys. Infrared spectrophotormetry-principle, instrumentation and Functional group analysis of organic compounds using infrared spectra. Quantitative analysis of organic molecules. Atomic absorption spectrophotometry(AAS) and flame photometry: principle, instrumentation and applications (Determination of Sodium, Potassium and Calcium.)

**TEXT BOOKS:**

1. Quantitative analysis, R.A.Day& A.L. Underwood , 5$^{th}$ edition, Printice- Hall of India Pvt. Ltd., 2000.
2. Vogel's Text Book of Qualitative chemical analysis, J. Mendham, R.C.Denney, J. Darnes, M.J.K. Thomas, Persar education 6$^{th}$ edition, 2002.
3. Elements of Physical Chemistry-Peter Atkins, Oxford Uni.Press, 3$^{rd}$ Edition, 2010.

**REFERENCES:**

1. Atkin's Physical Chemistry – P. Atkins and J. De Paula, Oxford Univ.Press, 9$^{th}$ Edition, 2012
2. Instrumental lMethods of Chemical Analysis, GurdeepR.Chatwal, Sham K.Ananad,
3. Himalayha publishing House,5$^{th}$ Edition, 2012.
4. Advanced physical chemistry – Gurudeepraj, Goel Publishing House, 2000
5. Essentials of Physical Chemistry- ArunBahl, B.S.Bahl and G.D.Rulasi, S.Chand Publishers, New Delhi.

**COURSE OUTCOMES:**
**After completion of the course student shall be able to**

- Analyse the statistical data for the analysis in analytical chemistry.
- Acquire enough knowledge on industrial processes and Identification of Products using different analytical and instrumental techniques.
- Analyse the compounds by using the TGA, DTA and DSC techniques for the analysis of metals and alloys
- Gain the knowledge of cyclic voltameter and amperometric titration techniques

**II B.TECH I SEMESTER**

## 10. 20A10803 ENVIRONMENTAL SCIENCE
## Common to CIVIL, MECH & CHEM

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 0 |

**COURSE OBJECTIVES:** To make the students to get awareness on environment, to understand the importance of protecting natural resources, ecosystems for future generations and pollution causes due to the day to day activities of human life to save earth from the inventions by the engineers.

**UNIT – I:**

**MULTIDISCIPLINARY NATURE OF ENVIRONMENTAL STUDIES: –** Definition, Scope and Importance – Need for Public Awareness.

**NATURAL RESOURCES :** Renewable and non-renewable resources – Natural resources and associated problems – Forest resources – Use and over – exploitation, deforestation, case studies – Timber extraction – Mining, dams and other effects on forest and tribal people – Water resources – Use and over utilization of surface and ground water – Floods, drought, conflicts over water, dams – benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. – Energy resources:

**UNIT – II:**

**ECOSYSTEMS:** Concept of an ecosystem. – Structure and function of an ecosystem – Producers, consumers and decomposers – Energy flow in the ecosystem – Ecological succession – Food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the following ecosystem:

a. Forest ecosystem.
b. Grassland ecosystem
c. Desert ecosystem
d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

**BIODIVERSITY AND ITS CONSERVATION :** Introduction 0 Definition: genetic, species and ecosystem diversity – Bio-geographical classification of India – Value of biodiversity: consumptive use, Productive use, social, ethical, aesthetic and option values – Biodiversity at global, National and local levels – India as a mega-diversity nation – Hot-sports of biodiversity – Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – Endangered and endemic species of India – Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

**UNIT – III:**

**ENVIRONMENTAL POLLUTION:** Definition, Cause, effects and control measures of :

a. Air Pollution.
b. Water pollution
c. Soil pollution
d. Marine pollution
e. Noise pollution
f. Thermal pollution
g. Nuclear hazards

**SOLID WASTE MANAGEMENT :** Causes**,** effects and control measures of urban and industrial wastes – Role of an individual in prevention of pollution – Pollution case studies – Disaster management: floods, earthquake, cyclone and landslides.

**UNIT – IV:**

**SOCIAL ISSUES AND THE ENVIRONMENT:** From Unsustainable to Sustainable development – Urban problems related to energy – Water conservation, rain water harvesting, watershed management – Resettlement and rehabilitation of people; its problems and concerns. Case studies – Environmental ethics: Issues and possible solutions – Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies – Wasteland reclamation. – Consumerism and waste products. – Environment Protection Act. – Air (Prevention and Control of Pollution) Act. – Water (Prevention and control of Pollution) Act – Wildlife Protection Act – Forest Conservation Act – Issues involved in enforcement of environmental legislation – Public awareness.

**UNIT – V:**

**HUMAN POPULATION AND THE ENVIRONMENT:** Population growth, variation among nations. Population explosion – Family Welfare Programmed. – Environment and human health – Human Rights – Value Education – HIV/AIDS – Women and Child Welfare – Role of information Technology in Environment and human health – Case studies.

**FIELD WORK :** Visit to a local area to document environmental assets River/forest grassland/hill/mountain – Visit to a local polluted site-Urban/Rural/Industrial/Agricultural Study of common plants, insects, and birds – river, hill slopes, etc..

**TEXT BOOKS** :

(1) Text book of Environmental Studies for Undergraduate Courses by Erach Bharucha for University Grants Commission, Universities Press.
(2) Environmental Studies by Palani Swamy – Pearson education
(3) Environmental Studies by Dr.S.Azeem Unnisa, Academic Publishing Company

**REFERENCES :**

(1) Textbook of Environmental Science by Deeksha Dave and E.Sai Baba Reddy, Cengage Pubilications.
(2) Text book of Environmental Sciences and Technology by M.Anji Reddy, BS Publication.
(3) Comprehensive Environmental studies byJ.P.Sharma, Laxmi publications.
(4) Environmental sciences and engineering – J. Glynn Henry and Gary W. Heinke – Printice hall of India Private limited.
(5) A Text Book of Environmental Studies by G.R.Chatwal, Himalaya Pubilishing House
(6) Introduction to Environmental engineering and science by Gilbert M. Masters and Wendell P. Ela - Printice hall of India Private limited.

**II B.TECH II SEMESTER**

## 1. 20A45301 ORGANIC CHEMISTRY

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

This course aims to provide the student to

- Understand the Mechanism of organic chemical reaction is essential to synthesis new organic compounds in drug and pharmaceutical industries. In order to study their kinetics of reactions to regulate the process for optimization of production of drugs and pharmaceutical, the principles of organic chemistry are essential.
- Carry out a processes industrially for the manufacture of drgus and pharmaceuticals, Comprehension on basic reactions, reagents and their applications is needed.
- Explain the electronic behaviour of organic molecules, their special and geometrical arrangement of functional groups.
- Conduct the most common reactions like addition, substitution, oxidation, reduction etc., on large scale.

**UNIT I:**
Polar effects – Inductive effect, electrometric effect, resonance, hyper conjugation, steric hindrance, and aromaticity – examples. (9h)

**UNIT II:**
Electrophilic reactions: a) Friedel-Craft reaction b) Riemer- Teimenn Reaction c) Backmann rearrangement.
Nucleophilic reactions : a) Aldol condensation b) Perkin Reaction c) Benzoin condensation.(10h)

**UNIT – III:**
Stereo isomerism; Optical isomerism; Symmetry and chirality; Optical isomerism in lactic acid and tartaric acid; Sequence rules; Enantiomers, diastereomers; Geometrical Isomerism; E-Z system of nomenclature, conformational analysis of ethane and Cyclohexane. (12h)

**UNIT.IV**
Some Reagents of Synthetic importance:
Preparation and applications of Aluminium Chloride, N-Bromosuccinamide (NBS), Diazomethane, Dicyclo hexyl carbodiimide(DCC), Potassium tertiary butoxide and Grignard reagent. (12h)

**UNIT.V:**
Some Useful Reactions in Organic Synthesis:
i). Protection of functional groups: Hydroxyl, Carbonyl and amino groups
ii). Oxidation: Oxidation of alcohols and carbonyl compounds with suitable examples
iii). Reduction: Reduction of double and triple bonds and carbonyl compounds with suitable examples. (12h)

**TEXT BOOKS:**
1. Text book of Organic Chemistry – Morrsion and Boyd.
2. Organic Reaction Mechanisms by VK Ahulwalia and RK Parashar
3. Vogels Text Book of Qualitative Organic Analysis.

**References:**
1. Reaction mechanism – Peter Skyes.
2. Text book of Organic Chemistry – P.L. Soni.
3. Organic Chemistry Vol- I-IL. Finar.
4. Reactions and Reagents – O.P. Agrawal.
5. A TEXT BOOKS of Organic Chemistry- Bahl and ArunBahl, S. Chand company, New Delhi
6. Polymer Science and Technology- Hema Singh, Acme Learning, New Delhi

**COURSE OUTCOMES:**
**After completion of the course student shall be able to**

- Analyze the mechanism of organic chemical reaction which are essential to synthesis new organic compounds in drug and pharmaceutical industries
- carry out a chemical processes industrially for the manufacture of drugs and pharmaceuticals, Comprehension on basic reactions, reagents and their applications.
- Illustrate the electronic behaviour of organic molecules, their special and geometrical arrangement of functional groups.

- Explain the reaction mechanisms for different types of reactions.
- Conduct the most common reactions like addition, substitution, oxidation, reduction etc., on large scale.

**II B.TECH II SEMESTER**

**2. 20A40801 PROCESS HEAT TRANSFER**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

- To demonstrate different modes of heat transfer
- To describe formulae for steady/ unsteady rate of heat transfer by conduction for rectangular, cylindrical and spherical geometries
- To teach how to estimate the heat transfer coefficients for different flow geometries
- To explain the working and design of double pipe, shell and tube heat exchangers and evaporators
- To impart knowledge on the phenomenon of radiation, radiation shields and estimation of emissivity.

**UNIT -I**

**Introduction:** Nature of heat flow, conduction, convection, natural and forced convection, radiation.
**Heat transfer by conduction in Solids:** Fourier's law, thermal conductivity, steady state conduction in plane wall & composite walls, compound resistances in series, heat flow through a cylinder, conduction in spheres.
**Unsteady state heat conduction:** Equation for one-dimensional conduction, Semi-infinite solid.

**UNIT- II**

**Principles of heat flow in fluids:** Typical heat exchange equipment, counter current and parallel current flows, energy balances, rate of heat transfer, overall heat transfer coefficient, electrical analogy, critical radius of insulation, logarithmic mean temperature difference, variable overall coefficient, multi-pass exchangers, individual heat transfer coefficients, resistance form of overall coefficient, fouling factors, classification of individual heat transfer coefficients, magnitudes of heat transfer coefficients, effective coefficients for unsteady-state heat transfer.

**UNIT- III**

**Heat Transfer to Fluids without Phase change:** Regimes of heat transfer in fluids, thermal boundary layer, heat transfer by forced convection in flow, heat transfer by forced convection in turbulent flow, the transfer of heat by turbulent eddies and analogy between transfer of momentum and heat, heat transfer to liquid metals, heating and cooling of fluids in forced convection outside tubes.

**UNIT -IV**

**Natural convection:** Natural convection to air from vertical shapes and horizontal planes, effect of natural convection in laminar-flow heat transfer.

**Heat transfer to fluids with phase change:** Heat transfer from condensing vapors, heat transfer to boiling liquids.

**Radiation:** Introduction, properties and definitions, black body radiation, real surfaces and the Gray body, absorption of radiation by opaque solids, radiation between surfaces, radiation Shielding, radiation to semi-transparent materials, combined heat transfer by conduction, convection and radiation.

**UNIT- V**

**Heat exchange equipment:** General design of heat exchange equipment, heat exchangers, condensers, boilers and calendrias, extended surface equipment, heat transfer in agitated vessels, scraped surface heat exchangers, heat transfer in packed beds, heat exchanger effectiveness (NTU method)

**Evaporators:** Evaporators, performance of tubular evaporators, capacity and economy, multipleeffect evaporators, methods of feeding, vapor recompression

**TEXT BOOK:**

1. Unit Operations of Chemical Engineering, 6th ed., W.L. McCabe, J.C. Smith and P. Harriot, McGraw-Hill, New York, 2001

**REFERENCES:**

1. Process Heat Transfer, D.Q. Kern, Tata McGraw-Hill, New Delhi, 1997.
2. Heat Transfer, 4th ed., J.P. Holman, McGraw-Hill, New York, 1976.
3. Chemical Engineering, Volume-I, J. Coulson and R.F. Richardson, Pergamon Press

**COURSE OUCOMES:**

At the end of the course the student will be able to

- Determine individual and overall heat transfer coefficients in laminar and turbulent flow conditions.
- Design of heat exchange equipment such as double pipe heat exchanger, shell and tube heat exchanger used in chemical industry.
- Estimate the performance (capacity, economy) of a given single/multiple effect evaporator.
- Calculate heat transfer coefficient in forced convection and natural convection.

Analyze radiation heat transfer between different surfaces

**II B.TECH II SEMESTER**

## 3. 20A40802 CHEMICAL ENGINEERING THERMODYNAMICS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

To introduce the concepts of chemical potential, partial properties, property relations for ideal gases, fugacity excess properties and to develop the theoretical foundation for applications of thermodynamics to gas mixtures and liquid solutions and to perform the phase equilibrium calculations using simple models for VLE, Gamma/Phi approach and equation of state approach.

**UNIT I**

**Solution Thermodynamics:** Theory, Fundamental property relation, chemical potential as a criterion for phase equilibrium, partial properties, ideal gas mixtures, fugacity and fugacity coefficient for pure species, fugacity and fugacity coefficient for species in solutions, generalized correlations for Fugacity coefficient, The ideal solutions, excess properties.

**UNIT II**

**Solution Thermodynamics:** Applications: The liquid phase properties from VLE data, models for the excess Gibbs energy, property changes of mixing

**VLE at low to moderate pressures:** The nature of equilibrium, the phase rule, Duhems theorem, VLE: Qualitative behaviour, the gamma /Phi formulation of VLE, Dew point and bubble point calculations, flash calculations, solute (1)/solvent (2) systems

**UNIT III**

**Thermodynamic Properties and VLE from Equations of State:** properties of fluids from the virial equations of state, properties of fluids from cubic equations of state, fluid properties from correlations of the Pitzer type, VLE from cubic equations of state

**Topics in Phase Equilibria:** Equilibrium and stability, Liquid-Liquid Equilibrium (LLE), Vapor-Liquid–Liquid Equilibrium (VLLE), Solid-Liquid Equilibrium (SLE), Solid Vapor Equilibrium (SVE).

**UNIT IV**

**Chemical Reaction Equilibria:** The reaction coordinate, application equilibrium criterion to chemical reactions, The standard Gibb's energy change and the equilibrium constant, effect of temperature on equilibrium constants, relation of equilibrium constants to composition, equilibrium conversion for single reactions, Phase rule and Duhem's theorem for reacting systems.

**UNIT V**

**Introduction to Molecular Thermodynamics :** Molecular Theory of Fluids, Second Virial Coefficients from Potential Functions, Internal Energy of Ideal Gases: Microscopic view, Thermodynamic Properties and Statistical Mechanics ,Hydrogen Bonding and Charge-Transfer Complexing ,Behavior of Excess Properties ,Molecular Basis for Mixture Behavior, VLE by Molecular Simulation.

**TEXT BOOK:**

1. Introduction to Chemical Engineering Thermodynamics, 6$^{th}$ ed., J.M. Smith, H.C. Van Ness and M.M. Abbott, Tata McGraw-Hill, New Delhi, 2003.

**REFERENCE:**

1. Chemical Engineering Thermodynamics, Pradeep Ahuja, PHI Learning Pvt. Ltd., New Delhi, 2009
2. A Text Book of Chemical Engineering Thermodynamics, K.V. Narayanan, PHI Learning Pvt. Ltd., New Delhi, 2001.

**II B.TECH II SEMESTER**

## 4. 20A40803 INSTRUMENTATION AND PROCESS CONTROL

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

- Describe the various elements of instruments, measurement of temperature, pressure and level in process industries.
- Define the basics of process control and develop transfer function models for dynamic processes.
- Drawthe block diagrams and analyse process stability

**UNIT- I**

Elements of instruments, static and dynamic characteristics, basic concepts of first order type instruments, mercury in glass thermometer, bimetallic thermometer, pressure spring thermometer. Industrial thermocouples, thermocouple wires, thermo couple wells. Head, density and specific gravity, direct measurement of liquid level, pressure measurement in open vessels, level measurements in pressure vessels. Pressure vacuum and head: liquid column manometers, measuring elements for gauge pressure and vacuum, indicating elements for pressure gauges, measurement of absolute pressure, measuring pressure in corrosive liquids.

**UNIT- II**

Introduction to process dynamics and control: Laplace transforms, Inverse Laplace transform, Response of First Order Systems. Physical examples of first order systems- Liquid level, mixing process, R- C circuit. Linearization. Response of first order systems in series- interacting and non- interacting systems, second order systems, transportation lag.

**UNIT- III**

Control system: Components of a control system, Servo Vs regulator problem, development of block diagram. Controllers and final control elements: Control valve and its construction, PD, PI, PID controllers. Stability: Concept of Stability, Stability criterion, Routh test for stability.

**UNIT- IV**

Root locus: concept of root locus, rules for plotting the root locus diagram. Introduction to frequency response: Substitution rule, Bode diagrams Control systems design by frequency response: Bode stability criterion, Gain and Phase margins.

**UNIT- V**

Controller tuning: Tuning of P, PD, PI, PID controllers, Ziegler- Nichols technique, Cohen and Coon rules. Advanced control strategies: Cascade control, feed forward control, ratio control, Smith predictor.

**TEXT BOOKS:**

1. Industrial instrumentation by Donald P.Eckman, Wiley eastern, 1950.

2. Process Systems Analysis and Control, 2nd ed., D.R. Coughanowr, McGraw-Hill, 1991

**REFERENCES:**

1. Chemical Process Control, G. Stephanopoulos, PHI Learning Pvt. Ltd., New Delhi, 2010 2. Process Control, B.W. Bequette, PHI Learning Pvt. Ltd., New Delhi, 2010

**Common to Civil, Mech, CHEM**

| Course Code | | L | T | P | C |
|---|---|---|---|---|---|
| 20A49101a | MANAGERIAL ECONOMICS AND FINANCIAL ANALYSIS | 3 | 0 | 0 | 3 |

**Pre-requisite** **Semester -IV**

## Course Objectives:

The objectives of this course are:

| | |
|---|---|
| 1. | To inculcate the basic knowledge of micro economics and financial accounting |
| 2. | To make the students learn how demand is estimated for different products, input-output relationship for optimizing production and cost |
| 3. | To know the various types of Market Structures & pricing methods and its strategies |
| 4. | To give an overview on investment appraisal methods to promote the students to learn how to plan long-term investment decisions. |
| 5. | To provide fundamental skills on Accounting and to explain the process of preparing Financial statements |

**UNIT – I**

**Managerial Economics**

Introduction – Nature, meaning, significance, functions and advantages. Demand-Concept, Function, Law of Demand – DemandElasticity- Types – Measurement. Demand Forecasting- Factors governing Forecasting, Methods. Managerial Economics and Financial Accounting and Management.

**LEARNING OUTCOMES:** At the end of the Unit, the learners will be able to

State the Nature of Managerial Economics and its importance

- Understand the concept of demand andits determinants
- Analyze the Elasticity and degree of elasticity
- EvaluateDemand forecasting methods
- Design the process of demand estimation for different types of demand

**UNIT - II**

**Production and Cost Analysis**

Introduction – Nature, meaning, significance, functions and advantages. Production Function– Least-cost combination–Shortrun and longrun Production Function- Isoquants andIsocosts, MRTS - Cobb-Douglas Production Function - Laws of Returns - Internal and External Economies of scale. Cost&Break-Even Analysis - Cost concepts and Cost behavior- Break-Even Analysis (BEA) - Determination of Break-Even Point (Simple Problems)-Managerial significance and limitations of Break-Even Analysis.

**UNIT - III**

**Business Organizations and Markets**

Introduction – Nature, meaning, significance, functions and advantages.Forms of Business Organizations- Sole Proprietary - Partnership - Joint Stock Companies - Public Sector Enterprises.Types of Markets - Perfect and Imperfect Competition - Features of Perfect Competition – Monopoly-Monopolistic Competition–Oligopoly-Price-Output Determination - Pricing Methods and Strategies.

**UNIT - IV**

**Capital Budgeting**

Introduction – Nature, meaning, significance, functions and advantages. Typesof Working Capital,Components, Sources of Short-term and Long-term Capital, Estimating Working capital requirements. Capital Budgeting– Features, Proposals,Methods and Evaluation. Projects – Pay Back Method, Accounting Rate of Return (ARR) Net Present Value (NPV) Internal Rate Return (IRR) Method (sample problems)

**UNIT - V**

**Financial Accounting and Analysis**

Introduction – Nature, meaning, significance, functions and advantages. Concepts and Conventions-Double-Entry Book Keeping, Journal, Ledger, Trial Balance- Final Accounts (Trading Account, Profit and Loss Account and Balance Sheet with simple adjustments). ***Financial Analysis -*** Analysis and Interpretation of Liquidity Ratios, Activity Ratios, and Capital structure Ratios and Profitability.

**Textbooks:**

1. Varshney&Maheswari: Managerial Economics, Sultan Chand, 2013.
2. Aryasri: Business Economics and Financial Analysis, 4/e, MGH, 2019

**Reference Books:**

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR**

**COLLEGE OF ENGINEERING (Autonomous), ANANTHAPURAMU**

**B.Tech (R-20 Chemical Engineering)**

**Common to Civil, Mech, CHEM**

| Course Code | | L | T | P | C |
|---|---|---|---|---|---|
| **20A49101b** | **ENTREPRENEURSHIP& INCUBATION** | 3 | 0 | 0 | 3 |

| **COURSE OBJECTIVES:** The objective of this course is | |
|---|---|
| 1 | To make the student understand about Entrepreneurship |
| 2 | To enable the student in knowing various sources of generating new ideas in setting up ofnew enterprise |
| 3 | To facilitate the student in knowing various sources of finance in starting up of a business |
| 4 | To impart knowledge about various government sources which provide financial assistance to entrepreneurs/ women entrepreneurs |
| 5 | To encourage the student in creating and designing business plans |

| **COURSE OUTCOMES:** At the end of the course, students will be able to | |
|---|---|
| CO1 | Define the Concepts related to the Entrepreneurship and Incubators |
| CO2 | Understand the concept of Entrepreneurship and challenges in the world of competition. |
| CO3 | Apply the Knowledge in generating ideas for New Ventures. |
| CO4 | Analyze various sources of finance and subsidies to entrepreneur/women Entrepreneurs. |
| CO5 | Evaluate the role of central government and state government in promoting Entrepreneurship. |
| CO6 | Create and design business plan structure through incubations. |

**UNIT-I: Entrepreneurship**

Introduction-Nature, meaning, significance, functions and advantages. concept, characteristics-knowledge and skills requirement - process - Factors supporting entrepreneurship - Differences between Entrepreneur and Intrapreneur - entrepreneurial mindset and personality - Recent trends.

**LEARNING OUTCOMES**

At the end if the Unit, the learners will be able to

- Understand theconcept of Entrepreneur and Entrepreneurship in India
- Analyzerecent trends in Entrepreneurship across the globe
- Develop a creative mind set and personality in starting a business.

**UNIT-II: Women Entrepreneurship**

Introduction – Nature, meaning, significance, functions and advantages. Growth of women entrepreneurship in India. - Issues & Challenges - Entrepreneurial motivations.Entrepreneurship Development and Government. Role, of Central and State Government - incentives, subsidies and grants – Export-oriented Units - Fiscal and Tax concessions.

**LEARNING OUTCOMES**

At the end of the Unit, the learners will be able to

- Understand the role of government in promoting women entrepreneurship
- Analyze the role of export-oriented units
- Evaluate the tax concessions available for Women entrepreneurs

**UNIT-III:Product Development**

Introduction – Nature, meaning, significance, functions and advantages. Startup Initiatives - Generating business/ Service idea – Sources and methods –Identifying opportunities - Feasibility study - Market feasibility, technical/operational feasibility, Financial feasibility. Developing business plan, Preparing project report, Presenting business plan to investors.

**LEARNING OUTCOMES**

At the end if the Unit, the learners will be able to

- Analyze the sources of new methods in generating business idea
- Evaluate market feasibility, financial feasibility and technical feasibility
- Design and draw business plansinproject preparation and prepare project reports

**UNIT-IV:Startups**

Introduction – Nature, meaning, significance, functions and advantages. Fundamentals of Business Incubation - Principles and good practices of business incubation- Process of business incubation and the business incubator and how they operate and influence theType/benefits of incubators - Corporate/educational / institutional incubators - Broader business incubation environment - Pre-Incubation and Post - Incubation process - Idea lab, Business plan structure -Value proposition

**LEARNING OUTCOMES**

At the end of the Unit, the learners will be able to:

- Understand the importance of business incubation

- Apply brilliant ideas in the process of business incubation
- Analyze the process of business incubation/incubators.
- Design their own business incubation/incubators as viable-business unit.

**UNIT-V: Finance**

Introduction – Nature, meaning, significance, functions and advantages. Sources - Long term and Short term - Institutional Finance – Commercial Banks, SFC's and NBFC's in India, Role in small and medium business - Entrepreneurship development programs in India - The entrepreneurial journey- Institutions supporting entrepreneurship development.

**LEARNING OUTCOMES**

At the end of the Unit, the learners will be able to

- Understand the various sources of finance in Starting the new venture
- Analyze the role of banks and other financial institutions in promoting entrepreneurship in India
- Evaluatethe need and importance of MSMEs in the growth of country

**TEXT BOOKS**

1. D F Kuratko and T V Rao, **Entrepreneurship** - A South-Asian Perspective – Cengage Learning, 2012. (For PPT, Case Solutions Faculty may visit :login.cengage.com)

2 .Nandan H, Fundamentals of Entrepreneurship, PHI, 2013

## REFERENCES

1.Vasant Desai,Small Scale Industries and Entrepreneurship, Himalaya Publishing 2012.

2. Rajeev Roy Entrepreneurship, 2nd Edition, Oxford, 2012.

3.B.JanakiramandM.Rizwana|| Entrepreneurship Development: Text & Cases, Excel Books, 2011.

4.Stuart Read, Effectual Entrepreneurship, Routledge, 2013.

**E-RESOURCES**

1. Entrepreneurship-Through-the-Lens-of-enture Capital

2.http://www.onlinevideolecture.com/?course=mba-programs&subject=entrepreneurship

3.http://nptel.ac.in/courses/122106032/Pdf/7_4.pd

4.http://freevideolectures.com/Course/3514/Economics-/-Management-/-Entrepreneurhip/50

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR**

**COLLEGE OF ENGINEERING (Autonomous), ANANTHAPURAMU**
**B.Tech (R-20 Chemical Engineering)**
**Common to Civil, Mech, CHEM**

| Course Code | | L | T | P | C |
|---|---|---|---|---|---|
| 20A49101c | BUSINESS ETHICS AND CORPORATE GOVERNANCE | 3 | 0 | 0 | 3 |

**Pre-requisite** **Semester -IV**

## Course Objectives:

The objectives of this course are:

| | |
|---|---|
| 1. | To make the student understand the principles of business ethics |
| 2. | To enable them in knowing the ethics in management |
| 3. | To facilitate the student's role in corporate culture |
| 4. | To impart knowledge about the fair-trade practices |
| 5. | To encourage the student in creating knowing about the corporate governance |

**UNIT – I**

**ETHICS**

Introduction – Meaning – Nature, Scope, significance, Loyalty, and ethical behavior - Value systems - Business Ethics,Types, Characteristics, Factors, Contradictions and Ethical Practices inManagement- Corporate Social Responsibility – Issues of Management – Crisis Management.

**UNIT - II**

**ETHICS IN MANAGEMENT**

Introduction Ethics in production, finance, Human Resource Management and, Marketing Management - Technology Ethics and Professional ethics - The Ethical Value System – Universalism, Utilitarianism, Distributive Justice, Social Contracts, Individual Freedom of Choice, Professional Codes; Culture and Ethics – Ethical Values in different Cultures, Culture and Individual Ethics.

**UNIT - III**

**CORPORATE CULTURE**

Introduction, Meaning,definition,Nature, Scope, Functions,andsignificance–
Cross cultural issues in Ethics - - Emotional Honesty – Virtue of humility – Promote happiness – karma yoga – proactive – flexibility and purity of mind. The Ethical Value System – Universalism, Utilitarianism, Distributive

Justice, Social Contracts, Individual Freedom of Choice, Professional Codes; Culture and Ethics –

Ethical Values in different Cultures, Culture and Individual Ethics.

**UNIT - IV**

**LEGAL FRAME WORK**

Law and Ethics, Agencies enforcing Ethical Business Behavior, Legal Impact– Environmental Protection, Fair Trade Practices,legal Compliances, Safeguarding Health and wellbeing of Customers.

**UNIT - V**

**CORPORATE GOVERNANCE**

Introduction, meaning – scope Nature - Issues, need, corporate governance code, transparency & disclosure, role of auditors, board of directors and shareholders. Global issues, accounting and regulatory frame work, corporate scams, committees in India and abroad, corporate social responsibility. of BoDs composition, Cadbury Committee - various committees - reports - Benefits and Limitations

**Textbooks:**


1. Murthy CSV: Business Ethics and Corporate Governance, HPH
2. Bholananth Dutta, S.K. Podder – Corporation Governance, VBH.


**Reference Books:**


1.Dr. K. Nirmala, KarunakaraReddy: Business Ethics and Corporate Governance, HPH

2. H.R.Machiraju: Corporate Governance

3. K. Venkataramana, Corporate Governance, SHBP.

4. N.M.Khandelwal : Indian Ethos and Values for Managers

**II B.TECH II SEMESTER**

**5. 20A40804 PROCESS HEAT TRANSFER LAB**

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 3 | 1.5 |

**COURSE OBJECTIVE:** This lab will provide practical knowledge on various heat transfer process and equipment like heat exchangers and evaporators.

**List of Experiments:**

1. Determination of total thermal resistance and thermal conductivity of composite wall.
   Major equipment - Composite wall Assembly
2. Determination of thermal conductivity of a metal rod.
   Major equipment - Thermal Conductivity apparatus
3. Determination of natural convective heat transfer coefficient for a vertical tube.
   Major equipment - Natural convection heat transfer apparatus
4. Determination of critical heat flux point for pool boiling of water.
   Major equipment- Pool boiling apparatus
5. Determination of forced convective heat transfer coefficient for air flowing through a pipe
   Major equipment – Forced convection heat transfer apparatus
6. Determination of overall heat transfer coefficient in double pipe heat exchanger.
   Major equipment - Double pipe heat exchanger apparatus
7. Determination of heat transfer coefficient for a helical coil in an agitated vessel.
   Major equipment – Helical coil in a agitated vessel.
8. Study of the temperature distribution along the length of a pin-fin under natural and forced convection conditions
   Major equipment - Pin fin apparatus
9. Estimation of un-steady state film heat transfer coefficient between the medium in which the body is cooled.
   Major equipment - Heat transfer coefficient determination apparatus
10. Determination of Stefan – Boltzmann constant.
    Major equipment - Stefan Boltzmann apparatus
11. Determination of emissivity of a given plate at various temperatures.
    Major equipment - Emissivity determination apparatus

**II B.TECH II SEMESTER**

## 6. 20A40805 ORGANIC CHEMISTRY LAB

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 3 | 1.5 |

**COURSE OBJECTIVES:**

This course aims to provide the student to

- Detailed organic structure analysis
- The planning and implementation of advanced organic reactions
- Understand the major concepts, theoretical and experimental principles.

**ORGANIC CHEMISTRY LAB:**

1. Criteria of Purity of Solid and Liquid, Determination of Melting Point & Boiling Point. Detecting Nitrogen, Sulphur, and Halogens in Organic Compounds.
2. Identification of an Unknown Substance from the following classes of Organic Compounds, Alcohols, Phenols, Aldehydes, Ketenes, Carbohydrates and Carboxylic acids.
3. Preparation of Aspririn
4. Preparation of Paracetamol
5. Preparation of Acetanilide
6. Preparation of Sulphonic acid
7. Preparation of derivatives for Aldehydes and Amines.
8. Beckman Rearrangement (Preparation of Benzanilide from Benzophenoneoxime).
9. Determination of strength of a Glycine Solution.
10. Estimation of an Aldehyde.

**TEXT BOOKS:**

1. Text book of Organic Chemistry – Morrsion and Boyd.
2. Organic Reaction Mechanisms by VK Ahulwalia and RK Parashar
3. Vogels Text Book of Qualitative Organic Analysis.

**REFERENCES:**


1. Reaction mechanism – Peter Skyes.
2. Text book of Organic Chemistry – P.L. Soni.
3. Organic Chemistry Vol- I-IL. Finar.
4. Reactions and Reagents – O.P. Agrawal.
5. A TEXT BOOKS of Organic Chemistry- Bahl and ArunBahl, S. Chand company, New Delhi
6. Polymer Science and Technology- Hema Singh, Acme Learning, New Delhi


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**II B.TECH II SEMESTER**

## 7. INSTRUMENTATION AND PROCESS CONTROL LAB

20A40806

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 3 | 1.5 |

**COURSE OBJECTIVES:**

1. Study about process dynamics and various forms of mathematical models to express them
2. Determine the time lag for first and second order systems.
3. Emphasize theoretical concepts of open and close loop runs on liquid level and liquid temperature.

List of Experiments:

1. Calibration and determination of time lag of various first and second order instruments Major equipment - First order instrument like Mercury-in-Glass thermometer and Overall second order instrument like Mercury-in-Glass thermometer in a thermal well
2. Experiments with single tank system. Single tank - Step Response Single tank - Impulse Response
3. Experiments with two tank system with interaction. Interacting Tanks – Step Response Interacting Tanks – Impulse Response
4. Experiments with two tank system without interaction. Non Interacting Tanks – Step Response Non Interacting Tanks – Impulse Response
5. Level control trainer Major equipment - Level control trainer set up with computer
6. Temperature control trainer Major equipment - Temperature control trainer with computer
7. Experiments on proportional, reset, rate mode of control etc. Major equipment – PID control apparatus
8. Control valve characteristics Major equipment – Control valve set up
9. Estimation of damping coefficient for U-tube manometer Major equipment - U-tube manometer.

**II B.TECH II SEMESTER**

## 8. SKILL ORIENTED COURSE-II
## (INDUSTRIAL SAFETY AND HAZARD MANAGEMENT)

**20A40807**

| L | T | P | C |
|---|---|---|---|
| 1 | 0 | 2 | 2 |

**COURSE OBJECTIVES:**

- Have awareness of different hazards in process industries
- Classification of hazards and their identifications
- Precautions in chemical storage and handling
- Learn risk analysis techniques and quantify them
- Learn emergency management plans

**Unit – I**

Introduction, Factors Contributing to the Costs of Accidents, List of some Notable accidents in the process industry/selected case histories, some common features of high cost accidents, reasons for high priority towards safety.

**Unit – II**

Material hazards1: Introduction Hazardous substances-categories, Toxicity, Radiation, Flammability, Ignition, Fires and explosions.

**Unit – III**

Material hazards 2: Fire balls, Fire damage, run away chemical reaction, incompatible materials, material safety and data sheets

Process and plant Hazards: Hazards of pressure, causes of over pressures, flow deviations, effects of leakages/releases, hazards of temperatures.

**Unit – IV**

Hazard analysis: process safety management, process hazards analysis, hazards analysis methods, check list, preliminary hazard analysis, what-if / check list, hazard and operability analysis, FMEA, Fault tree analysis, cause and consequence analysis.

**Unit – V**

Preventive and protective measures: Safety options, process safety approaches, inherent safety and design, plant layout, inherent security, explosion prevention and protection, personal protective systems, plant modifications and management change, relief valves and rupture discs, breather vents for storage tanks, explosions vents, flame arresters, flare systems

**TEXT BOOKS:**

1. Chemical process industry safety by K S N Raju, Mc-Graw Hill education (India) Pvt.Ltd,2014
2. Chemical process Safety by Crowl, 2014

**REFERENCES:**

1. Chemical process safety by Sanders, 5$^{th}$ ed, 2013

**II B.TECH II SEMESTER**

**9. 20A49102 MANDATORY NON-CREDIT COURSE-III**
**(DESIGN THINKING FOR INNOVATION)**

| L | T | P | C |
|---|---|---|---|
| 2 | 1 | 0 | 0 |

**COURSE OBJECTIVES:**

The objective of this course is to familiarize students with design thinking process as a tool for breakthrough innovation. It aims to equip students with design thinking skills and ignite the minds to create innovative ideas, develop solutions for real-time problems.

**UNIT - I**

**Introduction to Design Thinking**

Introduction to elements and principles of Design, basics of design-dot, line, shape, form as fundamental design components. Principles of design. Introduction to design thinking, history of Design Thinking, New materials in Industry.

**UNIT - II**

**Design Thinking Process**

Design thinking process (empathize, analyze, idea & prototype), implementing the process in driving inventions, design thinking in social innovations. Tools of design thinking - person, costumer, journey map, brain storming, product development

**Activity:** Every student presents their idea in three minutes, Every student can present design process in the form of flow diagram or flow chart etc. Every student should explain about product development.

**UNIT - III**

**Innovation**

Art of innovation, Difference between innovation and creativity, role of creativity and innovation in organizations. Creativity to Innovation. Teams for innovation, Measuring the impact and value of creativity.

**Activity:** Debate on innovation and creativity, Flow and planning from idea to innovation, Debate on value-based innovation.

**UNIT - IV**

**Product Design**

Problem formation, introduction to product design, Product strategies, Product value, Product planning, product specifications. Innovation towards product design Case studies.

**Activity:** Importance of modelling, how to set specifications, Explaining their own product design.

**UNIT - V**

**Design Thinking in Business Processes**

Design Thinking applied in Business & Strategic Innovation, Design Thinking principles that redefine business – Business challenges: Growth, Predictability, Change, Maintaining Relevance, Extreme competition, Standardization. Design thinking to meet corporate needs. Design thinking for Startups. Defining and testing Business Models and Business Cases. Developing & testing prototypes.

**Activity:** How to market our own product, About maintenance, Relibility and plan for startup.

**TEXT BOOKS:**

1. Change by design, Tim Brown, Harper Bollins (2009)
2. Design Thinking for Strategic Innovation, Idris Mootee, 2013, John Wiley & Sons.

**REFERENCES:**

1. Design Thinking in the Classroom by David Lee, Ulysses press
2. Design the Future, by Shrrutin N Shetty, Norton Press
3. Universal principles of design- William Lidwell, Kritinaholden, Jill Butter.
4. The era of open innovation – Chesbrough.H

**Online Learning Resources:**

https://nptel.ac.in/courses/110/106/110106124/
https://nptel.ac.in/courses/109/104/109104109/
https://swayam.gov.in/nd1_noc19_mg60/preview

**Course Outcomes :**

- Define the concepts related to design thinking.
- Explain the fundamentals of Design Thinking and innovation
- Apply the design thinking techniques for solving problems in various sectors.
- Analyse to work in a multidisciplinary environment
- Evaluate the value of creativity
- Formulate specific problem statements of real time issues

**10. 20A49901 NSS/NCC/NSO Activities**

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 2 | 0 |

III-I

| | | | | | |
|---|---|---|---|---|---|
| **Course Code** | **1. CHEMICAL REACTION** | **L** | **T** | **P** | **C** |
| **20A50801** | **ENGINEERING** | **3** | **0** | **0** | **3** |
| **Pre-requisite** | **Semester - V** | | | | |

Course Objectives:

- To explain the temperature dependency of rate of reaction as per Arrhenius law, Collision theory and Transition State theory.
- To teach how to determine kinetics of a chemical reaction both at constant and variable volume from the experimental data using integral, differential and method of fractional lives.
- To inform how to obtain the rate law for a non-elementary chemical reaction from a given mechanism
- To describe the designing of reactors for conducting homogenous reactions under isothermal conditions.
- Learn the importance of RTD and the compartmental models for modelling of non-ideal flow reacting vessels.
- Calculate the conversions based on segregated flow model, dispersion model and tanks-in-series models.

Course Outcomes (CO):

At the end of the course, the student will be able to:

| | |
|---|---|
| CO1 | Understand the various factors for selection of the chemical reactors for a particular process and rate law for both elementary and non – elementary reactions. |
| CO2 | Analyse and interpret experimental data from batch reactors and determine the order of simple chemical reactions using integral and differential method of analysis |
| CO3 | Able to Distinguish ideal reactor types (batch, CSTR and PFR) and apply quantitative methods to design the size of reactors for simple chemical reaction schemes. |
| CO4 | Design of an optimal ideal reactor through multiple reactions for yield or selectivity, and evaluate the reactor performance for reactors when the temperature is not uniform within the reactor |
| CO5 | Ability to Understand the importance of RTD and the compartmental models for modelling of Non – Ideal flow reacting vessels and evaluate the conversions based on segregated flow model, dispersion model and tanks – in – series models. |

**Course Articulation Matrix**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | | 1 | 2 | 1 | 2 | 1 | | 2 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO2 | 3 | 3 | 3 | 2 | | 1 | 1 | 1 | 1 | 1 | | 2 |
| CO3 | 2 | 3 | 3 | 2 | | 1 | 2 | 1 | 1 | 1 | | 1 |
| CO4 | 3 | 2 | 3 | 1 | | 1 | 1 | 1 | 2 | 1 | | 3 |
| CO5 | 2 | 3 | 1 | 1 | | 1 | 2 | 1 | 2 | 1 | | 2 |

**UNIT - I**

**Overview of chemical reaction engineering**-classification of reactions, variables affecting the rate of reaction definition of reaction rate, kinetics of homogenous reactions- concentration dependent term of rate equation, Temperature dependent term of rate equation, searching for a mechanism, predictability of reaction rate from theory.

**Interpretation of batch reactor data- constant volume batch reactor**:- Analysis of total pressure data obtained in a constant-volume system, the conversion, Integral method of analysis of data– general procedure, irreversible unimolecular type first order reactions, irreversible bimolecular type second order reactions, irreversible trimolecular type third order reactions, empirical reactions of nth order, zero-order reactions, overall order of irreversible reactions from the half-life, fractional life method, irreversible reactions in parallel, homogenous catalysed reactions, autocatalytic reactions, irreversible reactions in series.

**UNIT - II**

**Constant volume batch reactor**– first order reversible reactions, second order reversible reactions, reversible reactions in general, reactions of shifting order, Differential method of analysis of data. Varying volume batch reactor–differential method of analysis, integral method of analysis, zero order, first order, second order, nth order reactions, temperature and reaction rate, the search for a rate equation

**UNIT - III**

**Introduction to reactor design**- general discussion, symbols and relationship between $C_A$ and $X_A$. Ideal reactors for a single reaction- Ideal batch reactor, Steady-state mixed flow reactor, Steady-state plug reactors.

**Design for single reactions**- Size comparison of single reactors, Multiple- reactor systems, Recycle reactor, Autocatalytic reactions.

**UNIT - IV**

**Design for parallel reactions**- introduction to multiple reactions, qualitative discussion about product distribution, quantitative treatment of product distribution and of reactor size.

**Multiple reactions**-Irreversible first order reactions in series, quantitative discussion about product distribution, quantitative treatment, plug flow or batch reactor, quantitative treatment, mixed flow reactor, first-order followed by zero-order reaction, zero order followed by first order reaction.

**UNIT - V**

**Basics of non-ideal flow**: E, the exit age distribution function of fluid, the RTD, conversion in non-ideal flow reactors, diagnosing reactors (qualitative discussion only).

**The dispersion model**: axial dispersion, correlations for axial dispersion, chemical reaction and dispersion.

**The tanks in series model**: Pulse response experiments and the RTD, chemical conversion. The convection model for laminar flow- the convective model and its RTD, chemical conversion in laminar flow reactors

**Earliness of mixing, segregation and RTD**: Self-mixing of a single fluid, mixing of two miscible fluids.

**Textbooks**:

1. Chemical Reaction Engineering, 3rd ed., O. Levenspiel, John Wiely& Sons, 1999.

**Reference Books**:

1. Elements of Chemical Reaction Engineering, 2nd ed., H.S. Fogler, PHI Learning Pvt. Ltd., New Delhi, 2010.
2. Chemical Engineering Kinetics, 3rd ed., J.M. Smith, McGraw-Hill, New York, 1981.


Online Learning Resources:

| Course Code | MASS TRANSFER | L | T | P | C |
|---|---|---|---|---|---|
| 20A50802 | OPERATIONS - I | 3 | 0 | 0 | 3 |
| Pre-requisite | Semester - V | | | | |

Course Objectives:

- To impart the basic concepts of molecular diffusion, mass transfer coefficients and analysis of different mass transfer processes.
- To discuss the fundamental concepts of mass transfer principles and their applications to real engineering problems.
- To introduce the mass transfer rates and Fick's Law of diffusion.
- To describe convective mass transfer rates and mass transfer coefficients.
- To appraise different types of equipment and their operation for gas-liquid separations.
- To explain the design of mass transfer equipment for absorption, stripping, drying and humidification.

Course Outcomes (CO):

At the end of the course, the student will be able to:

| | |
|---|---|
| CO1 | Identify diffusion phenomena in various chemical processes. |
| CO2 | Determine diffusivity coefficient in gases, liquids and solids. |
| CO3 | Calculate mass transfer coefficients at interfaces of multiphase mass transfer systems |
| CO4 | Design equipment for gas-liquid mass transfer operations. |
| CO5 | Interpret and design driers, humidifiers |

**Course Articulation Matrix**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |
| CO6 | | | | | | | | | | | | |

**UNIT - I**

**The Mass Transfer Operations**: Classification of the Mass-Transfer Operations, Choice of Separation Method, Methods of Conducting the Mass-Transfer Operations, Design Principles, Unit Systems

**Molecular Diffusion in Fluids**: Molecular Diffusion, Equation of Continuity, binary solutions, Steady State Molecular Diffusion in Fluids at Rest and in Laminar Flow, estimation of diffusivity of gases and liquids, Momentum and Heat Transfer in Laminar flow
Diffusion:Diffusion in Solids, Fick's Diffusion, Unsteady State Diffusion, Types of Solid Diffusion, diffusion through polymers, diffusion through crystalline solids, Diffusion through

porous solids & hydrodynamic flow of gases.

**UNIT - II**

**Mass Transfer Coefficients**: Mass Transfer Coefficients, Mass Transfer Coefficients in Laminar Flow (Explanation of equations only and no derivation), Mass Transfer Coefficients in Turbulent Flow, eddy diffusion, Film Theory, Penetration theory, Surface-renewal Theory, Combination Film-Surface-renewal theory, Surface-Stretch Theory, Mass, Heat and Momentum Transfer Analogies, Turbulent Flow in Circular Pipes. Mass transfer data for simple situations.

Inter Phase Mass Transfer: Concept of Equilibrium, Diffusion between Phases, Material Balances in steady state co-current and counter current stage processes, Stages, Cascades, Kremser – Brown equation.

**UNIT - III**

**Equipment For Gas-Liquid Operations**: Gas Dispersed, Sparged vessels (Bubble Columns) Mechanical agitated equipments(Brief description),Tray towers, General characteristics, Sieve design for absorption and distillation (Qualitative Treatment), Different types of Tray Efficiencies, Liquid Dispersed venturi Scrubbers, Wetted-Wall Towers, Packed Towers Counter current flow of Liquid & Gas through packing, Mass transfer coefficients for packed towers, End effects and Axial Mixing Tray tower vs Packed towers.

**UNIT - IV**

**Absorption And Stripping**: Absorption equilibrium, ideal and non-ideal solutions, selection of a solvent for absorption, one component transferred: material balances. Determination of number of Plates (Graphical), Absorption Factor, estimation of number of plates by Kremser Brown equation, Continuous contact equipment; HETP, Absorption of one component, Determination of number of Transfer Units (NTU) and Height of the Continuous Absorber, overall coefficients and transfer units, dilute solutions, overall height of transfer units.

**UNIT - V**

**Humidification Operations**: Vapor-Pressure Curve, Definitions, Psychometric Charts, Enthalpy of gas-vapor Mixtures, Humidification and Dehumidification, Operating lines and Design of Packed Humidifiers.

**Drying:** Equilibrium, Definitions, Drying Conditions- Rate of Batch Drying under constant drying conditions, Mechanisms of batch drying, drying time through circulation drying.

Classification of Drying Operations: Batch and Continuous Drying Equipment.

**Textbooks**:

1. Mass transfer operations by R.E. Treybal, 3rd ed. Mc Graw Hill, 1980.
2. Separation process C.J King, Tata Mc Graw Hill
3. Principles of Mass Transfer and Separation Processes by B K Dutta, Printice Hall of India Pvt Limited, New Delhi

**Reference Books**:

1. Diffusion mass transfer in fluid system by E. L. Cussler.
2. Transport processes and unit operations by Christie J. Geankoplis
3. Separation Process Principles, J D Seader and E. J. Henley, John Wiley & Sons, Inc,

New York

Online Learning Resources:

| Course Code | CHEMICAL PROCESS EQUIPMENT DESIGN | L | T | P | C |
|---|---|---|---|---|---|
| 20A50803 | | 3 | 0 | 0 | 3 |
| Pre-requisite | Semester - V | | | | |

**Course Objectives**

Chemical process plants include a number of important equipment such as reactors, distillation columns, absorbers, heat exchangers, evaporators, crystallizers, etc. Design of such equipment should be carried out a priori to set-up a process plant and thus, it is the basic step in a chemical process. The present course enables one to learn about the complete process design of Heat Exchanger, Condenser, Reboiler, Crystallizer, Evaporator, Packed column and Distillation column.

**Prerequisites:** Basic knowledge of chemical process calculations, momentum, heat and mass transfer.

**Course Outcomes (Students will be able to……)**

1. Understand the use of basic concepts of science and engineering.
2. Use design concepts for designing process equipment.

| | |
|---|---|
| CO1 | Mechanical design of pressure vessels |
| CO2 | Process design of separation equipment's for distillation, absorption, stripping, liquid-liquid extraction, adsorption. |
| CO3 | Selection of piping materials, pumps, compressors,fans and blowers, vacuum system equipment, turbines, and expanders. |
| CO4 | Design of material handling equipment like piping system,pumps, compressors, turbines and expanders |
| CO5 | Design ofkey heat exchanger types like heat exchangers, Double pipe and multiple double pipe, shell and tube heat exchanger etc. |

**Course Articulation Matrix**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |
| CO6 | | | | | | | | | | | | |

**UNIT - I**

Introduction to Process Equipment Design, basic definition of designing, its constraints, necessity of this course and different equipment to be designed, classification of heat exchangers based on different factors, Working of different heat exchangers such as double pipe exchanger, shell and tube exchanger, plate heat exchanger, extended surface heat exchanger, air cooled heat exchanger, storage type exchanger,

Basic design parameters for designing of heat exchangers such as overall heat transfer coefficient, dirt factor and mean temperature difference, Basic parameters for design of heat exchangers such as Ft correction factor, allocation of fluids and acceptable limits of pressure drop and velocity Design steps of double pipe heat exchanger

**UNIT - II**

Types of shell and tube heat exchangers, respective merits and demerits, front and rear heads of this exchanger, comparison of types, Different types of tubes, methods to decide suitable diameter

and length of tubes, tube arrangement and passes in shell and tube exchanger, different standards available for shells, bundle diameter, shell diameter, types of shell, baffles, tie rods and spacers.
Design of shell and tube exchanger using Kern's method and Bell's method.

**UNIT - III**

Uses of condensers, types of shell and tube condensers, Design of condenser.
Utility of reboiler and its classification, detailed construction and heat transfer mechanism in kettle type and thermosiphon reboilers, design of kettle type and thermosiphon reboilers, forced circulation reboilers, comparison of different types of reboilers

**UNIT - IV**

Definition of Evaporation, its application and necessity, Performance of evaporators, Basic parts of evaporator, types of evaporators, Material and energy balance in an evaporator, boiling point rise, detailed working of triple effect evaporator system, Governing equations for design of multiple effect evaporator system, Badger McCabe method, Design of evaporators using Newton Raphson method, vertical and horizontal vapour liquid separators.
Definition of Crystallization, different shapes of crystals, applications of crystallizers, supersaturation, solid-liquid phase equilibrium, solubility curve, nucleation and crystal growth, working of crystallizer, important facts of design considerations of crystallizer, steps involved in design of crystallizer

**UNIT - V**

Packed column and its utility, Selection of packed and plate columns considering different factors, different components of packed column, few factors for packing, Different types of random packing, structured packing, respective features, determination of height of transfer unit, estimation of column diameter, column internals such as packing support, liquid distributers, hold down plate.

Distillation column, its process, different reflux ratio, design of binary system using McCabe-Thiele method, design of multi-component distillation column using Lewis-Matheson method, Hengstebeck's method and Erbar-Maddox method. Plate efficiency, O'Connell and AIChE methods, Plate contactors, details of sieve plate, bubble cap plate and valve plate, respective merits and demerits, selection of plate, liquid flow pattern and downcomer, operating range of parameters for plate of distillation column, design of plate considering different factors.

**Textbooks**:

**Books and references**

1. Backhurst, J. R. and Harker J. H.,"Coulson and Richardson Chemical Engineering", Vol. II, 5th Ed., 2002, Butterworth-Heinemann.
2. Sinnott, R.K., "Coulson and Richardson's Chemical Engineering Series: Chemical Engineering Design", Vol. VI, 4th Ed., 2005, Elsevier Butterworth-Heinemann.
3. Serth, R.W., "Process Heat Transfer: Principles and Applications" 2007, Elsevier Ltd.

**Online Resources**

**Process Equipment Design** By Prof. Shabina Khanam, IIT Roorkee under NPTEL Program (https://youtu.be/d2-D8dTrEWM)

**Professional Elective Course - I**

| | | | | | |
|---|---|---|---|---|---|
| **Course Code** | **PE1. ENVIRONMENTAL** | **L** | **T** | **P** | **C** |
| **20A50804a** | **ENGINEERING** | **3** | **0** | **0** | **3** |
| **Pre-requisite** | **Semester - V** | | | | |

Course Objectives:

1. To illustrate the importance of Environment and society to engineering professional students
2. To impart the causes and preventive measures against soil, water, air and noise pollution
3. Describe the preventive methods of different types of pollution

Course Outcomes (CO):
At the end of the course, the student will be able to:

| | |
|---|---|
| CO1 | Understandimportanceofenvironmentanddifferenttypesofpollution. |
| CO2 | Explaincausesandpreventivemeasuresagainstairpollution. |
| CO3 | Describecausesandpreventivemeasuresagainstwaterpollution. |
| CO4 | Describecausesandpreventivemeasuresagainstsoilpollution. |
| CO5 | Explaincausesandpreventivemeasuresagainstnoisepollution. |

**Course Articulation Matrix**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |
| CO6 | | | | | | | | | | | | |

**UNIT - I**

**ManandEnvironment**:Overview(socio-economicstructure&occupationalexposures)–ScopeofEnvironmentalEngineering–pollutionproblemsduetourbanization&industrialization

**UNIT – II**

Air pollution Sampling and Measurement: Ambient air sampling, Stack sampling and Analysis of Sulphur Dioxide, Nitrogen Oxides and Particulate matter.

**UNIT – III**

Air Pollution Control Methods and Equipment: Control methods, Source correction methods, Cleaning of gaseous effluents, Particulate emission control, Selection of a particulate collector and Control of Gaseous emissions

Control of Specific Gaseous Pollutants: Control of Sulphur dioxide, Control of Nitrogen Oxides, Carbon Monoxide and Hydrocarbons.

**UNIT – IV**

Water Pollution: Water resources, Origin of waste water, Types of Water Pollutants and their effects, Water Pollution Laws and Standards.

Waste Water Sampling, Analysis and Treatment: Sampling, Methods of Analysis, Determination of Organic Matter, Inorganic Matter and Physical Characteristics, Primary, Secondary, Advanced Waste Water Treatment and Recovery of Materials from Process Effluents.

**UNIT - V**

Solid waste Management: Sources and Classification, Public health aspects, Disposal methods and Potential methods of disposal.

Hazardous Waste Management: Definition, Sources, Classification, Hazardous Waste Management Strategy, treatment methods and Disposal methods.

Textbooks:

1. *Environmental Pollution Control Engineering by C.S.Rao, 2nd edition, New Age International Ltd (2006)*
2. Kormondy- concept of Ecology, Concept of Ecology Prentice-Hall of India, N.Delhi
3. Odum - FundamentalofEcology
4. J.Turk&A.Turk - EnvironmentalScience
5. D.Lal - WaterSupply&WasteWater
6. Dix - EnvironmentalPollution

References:

1. *Air pollution by M.N.Rao, H.V.N. Rao, Tata McGraw Hill (2007)*

Online Learning Resources:

| | | | | | |
|---|---|---|---|---|---|
| | **Professional Elective Course -I** | | | | |
| **Course Code** | **PE2. PROCESS MODELING &** | **L** | **T** | **P** | **C** |
| **20A50804b** | **SIMULATION** | **3** | **0** | **0** | **3** |
| **Pre-requisite** | **Semester - V** | | | | |

Course Objectives:

- Learn to develop mathematical model for problems.
- To impart knowledge on modelling of various equipment and their simulation using different numerical techniques.
- Formulate a chemical engineering problem as a mathematical model, and select an appropriate solution method.
- Understand the computational requirements of various solution options and use this understanding in the selection of the solution method
- Formulate and solve process design problems, based on fundamental analysis and using mathematical models of chemical processes

Course Outcomes (CO):

At the end of the course, the student will be able to:

| | |
|---|---|
| CO1 | Understand the stages involved in the development of a process model. |
| CO2 | Formulate a chemical engineering problem as a mathematical model from basic engineering principles |
| CO3 | Identify the appropriate numerical solutions for solving the models. |
| CO4 | Understand various techniques for solving ODEs and PDEs and solve the developed models. |
| CO5 | Simulating the chemical engineering models developed. |

**Course Articulation Matrix**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |

UNIT - I

**Introduction:** Modelling and simulation, definition, concept and uses of mathematical models, Classification of mathematical models- steady state Vs dynamic models, lumped Vs distributed parameter models, deterministic Vs stochastic models.
Fundamental laws: Principles of formulation, Continuity Equation, Component Continuity Equation, Energy equation, and Equation of motion.

UNIT - II

Examples of mathematical models of reactor systems: Series of isothermal constant hold-up Continuous Stirred Tank Reactors (CSTRs), CSTRs with variable hold-ups, Two heated tanks, gas phase pressurized CSTR, Non-isothermal CSTR.

UNIT - III

Examples of mathematical models of systems: Single component vaporizer, batch reactor, Reactor with mass transfer, ideal binary distillation column, batch distillation with hold-up

UNIT - IV

Empirical model building- Method of least squares, linear, polynomial
Solution of non-linear algebraic equations- Bisection, False position, Newton- Raphson method
Numerical solution of ordinary differential equations- Euler's method, Modified Euler's method, Runge- Kutta $4^{th}$ order method

UNIT - V

Modular approaches to process simulation: Analysis Vs Design mode, sequential modular approach, Simultaneous modular approach, Equation solving approach.
Simulation of chemical processes: Introduction to various simulation software packages in chemical engineering, Simulation of models such as isothermal CSTR, non-isothermal CSTR, and batch reactor

**Textbooks:**


1. William L Luyben, "Process Modeling, Simulation and Control for Chemical Engineers", McGraw Hill Publishing Company, $2^{nd}$ edition, 1990
2. Numerical Methods for Engineers, S.K. Gupta, Wiley Eastern, New Delhi, 1995
3. Process Plant Simulation, B.V.Babu, Oxford University Press, 2004


**Reference Books:**


1. Numerical Methods for Engineers and Scientists, S.S. Rao
2. Introduction to Numerical Methods in Chemical Engineering, P. Ahuja, PHI learning Pvt. Ltd., New Delhi, 2010
1. Process Modeling and Simulation, Amiya K. Jana, 2012.


Online Learning Resources:

## Professional Elective Course - I

| | | | | | |
|---|---|---|---|---|---|
| **Course Code** | **PE3. MATERIAL SCIENCE FOR** | **L** | **T** | **P** | **C** |
| **20A50804c** | **CHEMICAL ENGINEERS** | **3** | **0** | **0** | **3** |
| **Pre-requisite** | **Semester** | | | | |

Course Objectives:
This course will help students to learn about the relationship between structure and properties of materials, application of various classes of materials including metals, ceramics, polymers.

Course Outcomes (CO):
At the end of the course, the student will be able to:

| | |
|---|---|
| CO1 | Understand and identify various crystal systems. Calculation of parameters for simple crystal structures predict the behavior of crystal systems due to imperfections |
| CO2 | Analyze the properties of simple alloys and steels based on their phase diagrams, phase transitions and heat treatment. |
| CO3 | Evaluate the mechanical behavior, failure and strengthening mechanisms of various metals, alloys and plastics |
| CO4 | Ability to apply types of corrosion and illustrate methods to mitigate corrosion and select suitable material for various chemical processes. |
| CO5 | Proper selection of materials for designing various equipment's in a chemical industry |

**Course Articulation Matrix**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |
| CO6 | | | | | | | | | | | | |

**UNIT - I**

**Introduction**: Engineering Materials – Classification – levels of structure.

**Crystal Geometry and Structure Determination**: Space lattice and Unit cell. Bravais lattices, crystal systems with examples. Lattice coordinates, Miller indices, Bravais indices for directions and places: crystalline and non crystalline solids; ionic, covalent and metallic solids; packing efficiency, coordination number; structure determination by Bragg's X-ray diffraction and powder methods.

**UNIT - II**

**Crystal Imperfection**: Point defects, line defects-edge and screw dislocation, Berger's circuit and Berger's vectors, dislocation reaction, dislocation motion, multiplication of dislocations during deformation, role of dislocation on crystal properties; surface defects, dislocation density and stress required to move dislocations

**UNIT - III**

**Basic thermodynamic functions**: phase diagrams and phase transformation: Primary and binary systems-general types with examples; tie line& lever rule, non-equilibrium cooling: phase diagrams of Fe-$Fe_3$-C, Pb-Sn, Cu-Ni systems.

Phase transformations in Fe-$Fe_3$-C steels, Time-Temperature-Transformation (TTT) curves for eutectoid steels and plain carbon steels; effect of alloying elements on properties of steels; types of steels, alloys and other metals used in chemical industry.

**UNIT - IV**

Elastic, an elastic and plastic deformations in solid materials; rubber like elasticity, visco-elastic behaviour (models); shear strength of real and perfect crystals, work hardening mechanisms, cold working, hot working; dynamic recovery, recrystallization, grain growth, grain size and yield stress, Brief description of heat treatment in steels.

**UNIT - V**

**Fracture in ductile and brittle materials, creep**: mechanism of creep and methods to reduce creeping in materials, creep rates and relations. Fatigue-mechanisms and methods to improve fatigue resistance in materials. Composite materials: types; stress-strain relations in composite materials, applications.

**Oxidation and Corrosion**: Mechanisms of oxidation, oxidation resistant materials, principles and types of corrosion, protection against corrosion.

**Textbooks:**

Materials Science and Engineering, 5$^{th}$ed. V. Raghavan, PHI Learning Pvt. Ltd., New Delhi, 2009.

**Reference Books:**

Elements of Materials Science, L.R. Van Vlack,

2. Science of Engineering Materials, vols. 1&2, ManasChanda, McMillan Company of India Ltd.

Online Learning Resources:

| | | | | | |
|---|---|---|---|---|---|
| **Course Code** | **Open Elective Course – I** | **L** | **T** | **P** | **C** |
| **20A50805** | **ENERGY CONVERSION AND STORAGE DEVICES** | **3** | **0** | **0** | **3** |
| **Pre-requisite** | **Common to All Branches** | | | | |

Course Objectives:
1. Understand the fundamentals of fossil energy sources, solar, biomass and electrochemical energy etc
2. Understand the basics of photosynthetic, photocatalytic and photoelectrochemical systems and devices for the efficient energy and fuels production.
3. Learn the principles and operations of electrochemical energy storage devices,

Course Outcomes (CO):
At the end of the course, the student will be able to:

| | |
|---|---|
| CO1 | Understand the need of energyconversion and the various methods of energy storage |
| CO2 | Identify Winds energy as alternateform of energy and to know how itcan be tapped |
| CO3 | Understand the nuclear and bio energy, its mechanism of production and its applications |
| CO4 | Analyse chemical, electrochemical energy storage devices and interpret the conversion efficiencies |
| CO5 | Explain bio gas generation and itsimpact on environment |

**Course Articulation Matrix**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |
| CO6 | | | | | | | | | | | | |

**UNIT - I**

**Outline of the course**. Introduction and scope of energy conversion. World Energy Production and Balance. Motivations for studying future energy systems (e.g. pollution, climate change, energy security).

**UNIT - II**

**Fossil Energy**: Overview of fossil fuel resources and energy contents. Cycle analysis (Rankine, Brayton, combined cycles, cogeneration)
Nuclear Energy: nuclear reaction and energy conversion physics (fission and fusion), nuclear power systems

**UNIT - III**

**Solar-thermal energy**: solar thermal radiation physics, Active and passive solar-thermal

energy collection and conversion systems
**Photoelectric energy**: Photoelectric physics. Solar photovoltaic cell materials and technology
**Wind Energy:** Wind interaction with objects fluid dynamics. Wind harvesting devices and systems

**UNIT - IV**
**Biomass and Waste to Energy**: Potential and resources of biomass and waste energy. Thermal-chemical and bio-chemical conversion methods
Overview of Climate Control, $CO_2$ Sequestration and Energy Sustainability

**UNIT - V**
Basic of Electrochemical energy conversion and storage, Fundamentals of Fuel Cells, Basics of Fusion power, Energy Storage Technologies, Mechanical storage, Chemical storage, Electrical storage

**Textbooks**:
Energy Systems Engineering, F.M. Vanek, L.D Albright, and LargusAngenent, Second Edition, McGraw-Hill, Inc., 2012,

**Reference Books**:
- Angèle Reinders, Pierre Verlinden, Wilfried van Sark, Alexandre Freundlich, Photovoltaic Solar Energy:From Fundamentals to Applications, JOHN WILEY.
- Alexander P. Kirk, Solar Photovoltaic Cells: Photons to Electricity, ELSEVIER
- Francesco Dalena, Angelo Basile, Claudio Rossi, Bioenergy Systems For The Future: Prospects ForBiofuels And Biohydrogen, 1st Edition, ELSEVIER
- Jean-Marie Tarascon, Patrice Simon, ELECTROCHEMICAL ENERGY STORAGE,
- Electrochemistry by Carl H. Hamann, Andrew Hamnett and Wolf Vielstich, Wiley VCH, 1998.
- Modern Electrochemistry 1. Volume 1 and 2, by J. O'M. Bockris and A. K. N. Reddy, Kluwer Academic,2000.
- Electrochemical Methods, by A. J. Bard and L. R. Faulkner, John Willey, 1980
- John Love and John A. Bryant, Biofuels and Bioenergy, John Wiley
- Anju Dahiya, Bioenergy: Biomass to Biofuels, Elsevier

**Online Learning Resources:**

| Course Code | ENVIRONMENTAL ENGINEERING LAB | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 3 | 1.5 |
| **20A50806** | **Semester - V** | | | | |

Course Objectives:

Course Outcomes (CO):
At the end of the course, the student will be able to:

| | |
|---|---|
| CO1 | Able to analyze the acidity and alkalinity of water sample |
| CO2 | Able to understand the knowledge on pH, hardness, turbidity and solid matter of water sample |
| CO3 | Able to evaluate the, flash and fire point and calorific value of fuel and proximate analysis of coal |
| CO4 | Able to evaluate the PM 2.5 concentration of atmospheric air |
| CO5 | Able to apply the procedures for determination of dissolved oxygen and COD of waste water sample |

**Course Articulation Matrix**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |
| CO6 | | | | | | | | | | | | |

**List of Experiments:**

1. Estimation of chemical and physical parameters of Ground and Surface water:
   $P^H$, TDS & Conductivity, Hardness, Turbidity, Fluoride, Color analysis.
   Pesticide Microbial analysis: e-coli/ total coli forms bacteria
2. Estimation of physical parameters of waste water:
   $P^H$, TDS, Hardness, Turbidity, Alkalinity etc.
3. Estimation of chemical parameters of waste water:
   COD, BOD, TSS
4. Water and waste water treatment:
   Small RO system for treatment of ground water.
   Same above system with UF membrane for turbidity removal and water disinfection.
5. Analysis of Air:
   Estimation of SPM, RSPM, $SO_x$, $NO_x$, CO and ozone in atmospheric air to study air pollution.
7. Fuel cell Test Kit [Energy]
   A small ½ watt to 1 watt fuel cell with water electrolysis kit ($H_2$ and $O_2$ Generation) plus small voltmeter and ammeter for measuring fuel cell performance.
7. Measurement of Flash point, fire point and calorific value of any fuel

References:

Online Learning Resources/Virtual Labs:

| Course Code | CHEMICAL REACTION ENGINEERING LAB | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 3 | 1.5 |
| 20A50807 | Semester | | | | |

Course Objectives:

- Operate lab equipments like CSTR, Batch, PFR reactors.
- Analyze the concentration versus time data and determine the specific rate constant and the order of the reaction.
- Compare theoretical and experimental conversions in a CSTR and PFR.
- Estimate RTD and model parameters in a CSTR, PFR, packed bed and CSTRin-series.

Course Outcomes (CO):
At the end of the course, the student will be able to:

| | |
|---|---|
| CO1 | Determine the specific rate constant and the order of the reaction using the experimental data obtained for CSTR, Batch and PFR. |
| CO2 | Express the temperature dependency of rate of reaction using the experimental data obtained. |
| CO3 | Able to determine space times and volumes of reactors both experimentally and theoretically |
| CO4 | Estimate the mass transfer coefficients in solid-liquid and liquid-liquid systems. |
| CO5 | Obtain RTD from experiment and use the data to estimate model parameters in a CSTR, PFR, packed bed and CSTRs in-series |

**Course Articulation Matrix**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | - | 3 | 3 | - | 2 | - | 2 | - | 2 | - |
| CO2 | 3 | 3 | - | 3 | 3 | - | 2 | - | 2 | - | 2 | - |
| CO3 | 3 | 3 | - | 3 | 3 | - | 2 | - | 2 | - | 2 | - |
| CO4 | 3 | 3 | - | 3 | 3 | - | 2 | - | 2 | - | 2 | - |
| CO5 | | | | | | | | | | | | |

List of Experiments:

1. Determination of the order of a reaction using a batch reactor and analyzing the data by (a) differential method (b) integral method.
2. Determination of the activation energy of a reaction using a batch reactor.
3. To determine the effect of residence time on conversion and to determine the rate constant using a CSTR.
4. To determine the specific reaction rate constant of a reaction of a known order using a batch reactor.
5. To determine the order of the reaction and the rate constant using a tubular reactor.
6. CSTRs in series- comparison of experimental and theoretical values for space times and volumes of reactors.
7. Mass transfer with chemical reaction (solid-liquid system) – determination of mass transfer coefficient.
8. Mass transfer with chemical reaction (liquid-liquid system) – determination of mass transfer coefficient
9. Axial mixing in a packed bed. Determination of RTD and dispersion number for a packed-bed using tracer
10. Determination of RTD and dispersion number in a tubular reactor using a tracer

References:

Online Learning Resources/Virtual Labs:

| Course Code 20A50808 | COMPUTER APPLICATIONS IN CHEMICAL ENGINEERING Semester - V | L | T | P | C |
|---|---|---|---|---|---|
| | | 1 | 0 | 2 | 2 |

Course Objectives:

- 

Course Outcomes (CO):
At the end of the course, the student will be able to:

| | |
|---|---|
| CO1 | Solve the algebraic, simultaneous equations, ODEs and PDEs using the basic mathematical science. |
| CO2 | Apply regression analysis, interpolation, extrapolation, numerical differentiation andnumericalintegration |
| CO3 | Evaluate the properties of Chemical Engineering Unit Operation problems |
| CO4 | Solve initial value problems, boundary value problems using C programming and MATLAB software's. |
| CO5 | Computer applications for chemicalengineeringproblems (either C or MATLAB coding) |

**Course Articulation Matrix**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | - | - | 2 | 3 | 3 | - | - | - | - | - |
| CO2 | 3 | 3 | - | - | 3 | 1 | 3 | - | - | - | - | - |
| CO3 | 3 | 3 | - | - | - | 1 | 3 | - | - | - | - | - |
| CO4 | 3 | 3 | - | - | - | - | 3 | - | - | - | - | - |
| CO5 | | | | | | | | | | | | |

List of Experiments:

Numericalproblemsrequiredtobesolvedusing C Programming andMATLAB.

**Numerical Methods:** Roots of algebraic equations and solution of simultaneous equations.Regression analysis,InterpolationandExtrapolation,Differentiation and NumericalIntegration.Solutionofordinarydifferentialequations,InitialandBoundaryValueProblems.Solutionsofpartial differential equations.

**Applications of Numerical Methods to Chemical Engineering Problems:** Material andEnergyBalance,Fluidflowoperations,Heattransfer,MassTransfer,Thermodynamics,Mechanicaloperations,Predictionofproperties.

1. Programme to determine the roots of Non-linear Algebraic/Transcedental Equation by using Bisection Method
2. Programme to determine the roots of Non-linear Algebraic/Transcedental Equation by using Regula-Falsi Method
3. Programme to determine the roots of Non-linear Algebraic/Transcedental Equation by

using Newton-Raphson Method

4. Programme to perform Regression Analysis to fit a curve with examples
5. Programme to Interpolate the data with and without equal intervals
6. Programme for the Numerical integration by using Trapezoidal and Simpson's Rules
7. Programme for the Solution of Ordinary Differential Equations by using Euler Method
8. Programme for the Solution of Ordinary Differential Equations by using R-K fourth order Method
9. Programme for the Application of Numerical Methods to find the pressure drop in a pipe and terminal velocity & minimum fluidization velocity of a particle in momentum transfer
10. Programme for the Application of Numerical Methods to solve problems involving mechanical unit operations
11. Programme for the Application of Numerical Methods to solve problems involving material and energy balances
12. Programme for the Application of Numerical Methods to solve problems involving chemical engineering thermodynamics such as estimation of bubble point and dew point Temperatures & Pressures
13. Programme for the Application of Numerical Methods to solve problems involving chemical reaction engineering such as solving the rate equations in case of batch reactor, CSTR and PFR

**List of programmes:**

1. MATLAB – Matrices/ Polynomials/ Integral/ Differential/ Plots
2. Data handling and regression using MS-Excel
3. Non-linear algebraic equation
4. Problems on general material balance
5. Numerical Integration- Simpson's 1/3 Rule
6. Ordinary Differential Equation- R-K Method
7. Curve Fitting-Least Square
8. Calculation of Bubble Point and Dew Point for Ideal multi-component system
9. P-xy and T-xy data generation from the given vapor pressure data
10. Flash Vaporization for multi-component system
11. Design of Batch Reactor/ PFR/ CSTR
12. Double pipe heat exchanger (Area, Length and Pressure drop)

**LearningResources:**

**TextBooks:**

1. ComputationalTechniquesforProcessSimulationandAnalysisusingMATLAB,NiketS. Kaisare,Taylor& Francis,CRCpress,2018.
2. *ProblemSolvingwithC++,*WalterSavitch,Pearson,2014,9th Edition.
3. LabManuals

**References:**

1. AppliedNumericalAnalysisusingMATLAB,LaureneV.Fausett,Pearson,2009,2nd Edition.
2. Numerical Methods for Chemical Engineers with MATLAB Applications,AlkisConstantinides,NavidMoustoufi, Prentice Hall,1999.
3. GettingstartedwithMATLAB:Aquickintroductionforscientists&Engineers,RudraPratap,OxfordUniversityPress,2010.

**Online Learning Resources/Virtual Labs:**

https://nptel.ac.in/courses/103/106/103106118/
https://nptel.ac.in/courses/111/102/111102137/

| | | | | | |
|---|---|---|---|---|---|
| **Course Code** | **EVALUATION OF COMMUNITY SERVICE** | **L** | **T** | **P** | **C** |
| **20A50809** | **PROJECT** | | | | **1.5** |
| **Pre-requisite** | **Semester** | | | | |

Course Objectives:

.

Course Outcomes (CO):

UNIT - I

UNIT - II

UNIT - III

UNIT - IV

UNIT - V

Textbooks:

Reference Books:

Online Learning Resources:

Mandatory Non – Credit Course

**Course Code** **INDIAN CONSTITUTION** **L T P C**
**20A55401**
**Pre-requisite** **Common to Civil, MECH & CHEM**

Course Objectives:

1. To Enable the student to understand the importance of constitution
2. To understand the structure of executive, legislature and judiciary
3. To understand philosophy of fundamental rights and duties
4. To understand the autonomous nature of constitutional bodies like Supreme Court and high court controller and auditor general of India and Election Commission of India.

To understand the central-state relation in financial and administrative control

Course Outcomes (CO):
At the end of the course, the student will be able to:

| | |
|---|---|
| CO1 | State the historical background of the constitution making and its importance for building a democratic India. |
| CO2 | Understand the functioning of three wings of the government i.e., executive, legislative and judiciary. |
| CO3 | Demonstrate the value of the fundamental rights and duties for becoming good citizen of India and analyse the decentralization of power between central, state and local self-government |
| CO4 | Appraise the knowledge in strengthening of the constitutional institutions like CAG, Election Commission and UPSC for sustaining democracy |
| CO5 | Develop themselves as responsible citizens and pave way to build a democratic country. |

**Course Articulation Matrix**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |
| CO6 | | | | | | | | | | | | |

**UNIT - I**

**Introduction to Indian Constitution**

Constitution -Meaning of the term - Indian Constitution- Sources and constitutional history - Features– Citizenship – Preamble - Fundamental Rights and Duties - Directive Principles of State Policy.

UNIT - II

**Union Government and its Administration**

Structure of the Indian Union - Federalism - Centre-State relationship – President's Role, power and position - PM and Council of ministers - Cabinet and Central Secretariat –Lok

Sabha - Rajya Sabha - The Supreme Court and High Court - Powers and Functions

UNIT - III

**State Government and its Administration**

Structure of the State Govt. - Governor - Role and Position-CM and Council of Ministers - State Secretariat- Organization Structure and Functions

UNIT - IV

**Local Administration**

District's Administration Head - Role and Importance - Municipalities - Mayor and role of Elected Representatives -CEO of Municipal Corporation Panchayati Raj - Functions– PRI – Zilla Parishath - Elected officials and their roles – CEO, Zilla Parishath - Block level Organizational Hierarchy - (Different departments) - Village level - Role of Elected and Appointed officials - Importance of grass root democracy

UNIT - V

**Local Administration**

District's Administration Head - Role and Importance - Municipalities - Mayor and role of Elected Representatives -CEO of Municipal Corporation Panchayati Raj - Functions– PRI – Zilla Parishath - Elected officials and their roles – CEO, Zilla Parishath - Block level Organizational Hierarchy - (Different departments) - Village level - Role of Elected and Appointed officials - Importance of grass root democracy

Textbooks:

1. Durga Das Basu, Introduction to the Constitution of India, Prentice – Hall of India Pvt. Ltd. New Delhi
2. Subash Kashyap, Indian Constitution, National Book Trust

Reference Books:

1. J.A. Siwach, Dynamics of Indian Government & Politics,
2. H.M.Sreevai, Constitutional Law of India, 4th edition in 3 volumes (Universal Law Publication)
3. J.C. Johari, Indian Government and Politics, Hans India
4. M.V. Pylee, Indian Constitution Durga Das Basu, Human Rights in Constitutional Law, Prentice – Hall of India Pvt. Ltd. New Delhi

Online Learning Resources:

nptel.ac.in/courses/109104074/8
2.nptel.ac.in/courses/109104045/
3.nptel.ac.in/courses/101104065/
4.www.hss.iitb.ac.in/en/lecture-details
5.www.iitb.ac.in/en/event/2nd-lecture-institute-lecture-series-indian-constitution

**JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS):: ANANTHAPURAMU**

**III B. Tech- II Semester**

| **Course Code** | **CHEMICAL PLANT DESIGN & ECONOMICS** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|---|
| **20A60801** | | **3** | **0** | **0** | **3** |
| **Pre-requisite** | **Semester-VI** | | | | |

Course Objectives:

- To familiarize the students about various economic aspects of chemical processes
- Learn basics of Cost estimation, Working Capital and Capital Investment and understand the time value of money
- Learn the importance of Cash flow diagrams and Break-even analysis.
- Study depreciation methods and methods of estimation of profitability of an industry
- Study the procedures adopted for Replacement and Selection from Alternatives.

Course Outcomes (CO):

At the end of the course, the student will be able to:

| | |
|---|---|
| CO1 | *Understand* design considerations, cash flow and various costs involved in process Industries |
| CO2 | *Apply* the knowledge on different types of interest studied &*Predict* the Present worth and annuities |
| CO3 | *Solve* problems on depreciation using various methods as well able to explain types of taxes |
| CO4 | *Analyse* alternative investments, pay out period for an investment and rate of return |
| CO5 | *Evaluate* linear programming problems (LPP) by graphical and algebraic methods |

**Course Articulation Matrix**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |
| CO6 | | | | | | | | | | | | |

UNIT - I

Introduction, Process Design development.General design considerations, Cost and asset accounting.Cash flow for industrial operations, factors effecting investment and production cost, capital investments, estimation of capital investments, cost indices, cost factors in capital investment

UNIT - II

Organizations for presenting capital investments, estimates by compartmentalization, estimation of total product of cost direction, production costs, fixed charges, plant overhead costs, financing.
Interest and investment cost, type interest, nominal and effective interest rates, continuous interest, present worth and discount annuities, cost due interest on investment, source of capital.

UNIT - III
Taxes and insurances, type of taxes: federal income taxes, insurance-types of insurance, self insurance.
Depreciation: types of depreciation, services life, salvage value, present value, methods for determining depreciation, single unit and group depreciation.

UNIT - IV
Profitability: alternative investments and replacements, profitability standards, discounted cash flow, capitalized cost, pay out period,alternative investments, analysis with small investments, increments and replacements.

UNIT - V
Optimum design and design strategy, incremental cost, general procedure for determining optimum condition, comparison of graphical and analytical methods, optimum production rates, semi continuous cyclic operation, fluid dynamics, mass transfer strategy of linearization

**Textbooks:**
1. Plant Design and Economics for Chemical Engineering, 4$^{th}$ ed., M.S. Peters and K.D. Timmerhaus, McGraw-Hill,1991

**Reference Books:**
1. Process Engineering Economics, Schweyer

Online Learning Resources:

| Course Code | MASS TRANSFER OPERATIONS - II | L | T | P | C |
|---|---|---|---|---|---|
| **2060802** | | **3** | **0** | **0** | **3** |
| **Pre-requisite** | **Semester** | | | | |

Course Objectives:

- To introduce stage wise mass transfer operations, principles of various stage wise contact processes like distillation, extraction and leaching and drying
- To appraise design aspects of the equipment for utilized for distillation, extraction and leaching and drying.
- To coach the importance of VLE for ideal non-ideal systems (miscible and immiscible liquids) in mass transfer operations.
- To enlighten on different types of distillation such as: batch & continuous, flash vaporization, steam distillation and differential distillation.
- To impart distillation column design using McCabe Thiele and Ponchon-Savarit methods.

Course Outcomes (CO):

At the end of the course, the student will be able to:

| | |
|---|---|
| CO1 | Remember the stage wise contact processes absorption; distillation, extraction and leaching that are used in separation processes in industries. |
| CO2 | Understand the underlying principles related separation processes in industries |
| CO3 | Apply for various mass transfer operations mentioned above to equipment's |
| CO4 | Analyse these separation processes for specific purposes by using the experience obtained while conducting experiments in laboratory |
| CO5 | Design and debug any problems emanating in equipment used in industries for the above operations |

**Course Articulation Matrix**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |
| CO6 | | | | | | | | | | | | |

**UNIT - I**

Distillation: Fields of applications, VLE for miscible liquids, immiscible liquids, steam distillation, Positive and negative deviations from ideality, enthalpy-concentration diagrams, flash vaporization and differential distillation for binary and multi component mixtures, Batch distillation with Reflux.

**UNIT - II**

Continuous rectification-binary systems, multistage tray towers –method of Mc Cabe and Thiele, enriching section, stripping section, feed introduction, total reflux, minimum and optimum reflux ratios, use of open steam, types of condensers, partial condensers, effect of cold reflux, multiple feeds, tray efficiencies, continuous-contact equipment (packed towers)
Multistage (tray) towers –the method of Ponchon and Savarit, the enriching and stripping sections, feed tray location, total reflux, minimum and optimum reflux ratios, types of reboilers, use of open steam, condenser and reflux accumulators, Azeotropic distillation, extractive distillation, comparison of Azeotropic and extractive distillation.

**UNIT - III**
Liquid-Liquid operations: fields of usefulness, liquid-liquid equilibrium, equilateral triangular co-ordinates, choice of solvent, stage wise contact, multistage cross-current extraction, Multi stage counter current without reflux
Multi stage counter current with reflux, Differential (continuous contact) extractors, spray towers, packed towers, mechanically agitated counter-current extractors, centrifugal extractors, dilute solutions, super critical fluid extraction, fractional extraction.

**UNIT - IV**
Leaching: Fields of applications, preparation of solid for leaching, types of leaching, leaching equilibrium, single stage and multi stage leaching calculations, constant under flow conditions, equipment for leaching operation.

**UNIT - V**
Adsorption: Adsorption, types of adsorptions, nature of adsorbents, adsorption equilibrium, single gases and vapors, Adsorption Hysteresis, effect of temperature, Heat of adsorption, vapor and gas mixtures: One component adsorbed, Effect of change of temperature or pressure. Liquids, Adsorption of solute from dilute solution, The Freundlich equation, Adsorption from concentrated solutions, adsorption operations, stage wise operation, application of Freundlich equation to single and Multistage adsorption (cross current & counter current).
Fluidized and teeter beds, continuous contact, steady state moving bed adsorbers, unsteady state–fixed bed adsorbers, adsorption wave, elution, pressure swing and vacuum swing adsorption (qualitative treatment), ion-exchange: principles of ion exchange, techniques and applications.

**Textbooks:**
1. Mass transfer operations by R.E. Treybal, 3rd ed. Mc Graw Hill, 1980.

**Reference Books:**
1. Principles of Mass Transfer and Separation Processes by B K Dutta, Printice Hall of India Pvt Limited, New Delhi
2. Transport processes and unit operations by Christie J. Geankoplis
3. Separation Process Principles, J D Seader and E. J. Henley, John Wiley & Sons, Inc, New York

Online Learning Resources:

| **Course Code** | **TRANSPORT PHENOMENA** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|---|
| **20A60803** | | **3** | **0** | **0** | **3** |
| **Pre-requisite** | **Semester-VI** | | | | |

Fluid Mechanics for Chemical Engineers, Process heat transfer, Mass Transfer operations- I & II and Chemical Reaction Engineering

Course Objectives:

- Different types of fluids, their flow characteristics and different mathematical models applied to actual situations
- Mechanism of fluids in motion under different conditions.

Course Outcomes (CO):
At the end of the course, the student will be able to:

| | |
|---|---|
| CO1 | Understand the chemical and physical transport processes and their mechanisms. |
| CO2 | Analyze different fluid flow characteristics and different mathematical models applied to actual situations. |
| CO3 | Evaluate heat, mass and momentum transfer problems. |
| CO4 | Analyze industrial problems along with appropriate approximations and boundary conditions |
| CO5 | Design steady and time dependent solutions along with their limitations |

**Course Articulation Matrix**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |

**UNIT - I**

Viscosity and the mechanisms of momentum transfer: Newton's law of viscosity (molecular momentum transport), generalization of Newton's law of viscosity, pressure and temperature dependence of viscosity, molecular theory of the viscosity of gases at low density, molecular theory of the viscosity of liquids. Thermal conductivity and the mechanisms of energy transport: Fourier's law of heat conduction (molecular energy transport), temperature and pressure dependence of thermal conductivity, and theory of thermal conductivity of gases at low density. Diffusivity and the mechanisms of mass transport: Fick's law of binary diffusion (molecular mass transport), temperature and pressure dependence of diffusivities, theory of diffusion in gases at low density.

**UNIT - II**

Shell momentum balances and velocity distributions in laminar flow: shell momentum balances and boundary conditions, flow of a falling film, flow through a circular tube, flow through annulus, flow of two adjacent immiscible fluids, creeping flow around a sphere.

**UNIT - III**

Shell energy balances and temperature distributions in solids and laminar flow: shell energy balances; boundary conditions, heat conduction with an electrical heat source, heat conduction with a nuclear heat source, heat conduction with a viscous heat source, heat conduction with a chemical heat source, heat conduction through composite walls, heat conduction in a cooling fin, forced convection, free convection.

**UNIT - IV**

Concentration distributions in solids and laminar flow: shell mass balances; boundary conditions, diffusion through a stagnant gas film, diffusion with a heterogeneous chemical reaction, diffusion with a homogeneous chemical reaction, diffusion into a falling liquid film (gas absorption), diffusion into a falling liquid film (solid dissolution), diffusion and chemical reaction inside a porous catalyst.

**UNIT - V**

The equations of change: Derivation of the equation of continuity in Rectangular and Polar coordinates, the equation of motion, the equation of energy, the equation of continuity of a component in multi component mixture (in rectangular coordinates only) the equations of change in terms of the substantial derivative. Use of equations of change to solve one dimensional steady state problems of momentum, heat and component transfer, Introduction to Turbulent transport, Time smoothing of equation change.

**Textbooks:**

At the end of the course, the student will be able to:

1. Derive equations of continuity in rectangular and polar coordinates
2. Develop equation of motion, energy and component continuity for rectangular coordinate system.
3. Solve one dimensional steady state problems of momentum, heat and mass transfer using equations of change
4. Formulate time smoothing of equations of change for turbulent transport.

**Reference Books:**


1. Transport phenomena for engineers by L. Theodore, International text book company, U.S.A.1971.
2. Transport processes and unit operations by C.J. Geankoplis, PHI, 3$^{rd}$ed. 1997.
3. Fundamental of heat, momentum and mass transfer, Welty, Wicks and Wilson, John Wiley.


Online Learning Resources:

**Professional Elective Course -II**

| | | | | | |
|---|---|---|---|---|---|
| **Course Code** | **PE1. FLUIDIZATION ENGINEERING** | **L** | **T** | **P** | **C** |
| **20A60804a** | | **3** | **0** | **0** | **3** |
| **Pre-requisite** | **Semester-VI** | | | | |

Course Objectives:

Course Outcomes (CO):
At the end of the course, the student will be able to:

| | |
|---|---|
| CO1 | Understand the basic knowledge on fluidization engineering and industrial applications of fluidization |
| CO2 | Implement the knowledge on mapping of regimes of fluidization |
| CO3 | Derivebubble formation in both dense and fluidized beds by various models |
| CO4 | Relate high velocity fluidization and Derive minimum fluidization mass velocity and pressure drop equation for minimum fluidization. |
| CO5 | Estimation of gas interchange coefficients. |

**Course Articulation Matrix**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |

UNIT - I

**Introduction:** The phenomenon of fluidization; liquid like behavior of a fluidized bed; Comparison with other contacting methods; Advantages and disadvantages of fluidized beds.
**Industrial applications of fluidized beds:** Coal gasification; gasoline from other petroleum fractions; Gasoline from natural and synthesis gases; Heat exchange; Coating of metal objects with plastics; Drying of solids; Synthesis of phthalic anhydride; Acrylonitrile; Polymerization of olefins; FCCU; Fluidized combustion of coal; incineration of solid waste; Activation of carbon; gasification of waste; bio-fluidization.

UNIT - II

**Fluidization and mapping of regimes:** Minimum fluidization velocity; Pressure drop vs. velocity diagram; effect of temperature and pressure on fluidization; Geldart classification of particles; terminal velocity of particles, Transport disengaging height; turbulent fluidization; pneumatic transport of solids; fast fluidization; solid circulation systems; Voidage diagram; Mapping of regimes of fluidization.

UNIT - III

**Bubbles in dense bed:** Single rising bubbles; Davidson model for gas flow at bubbles; Evaluation of models for gas flow at bubbles.
**Bubbling Fluidized beds:** Experimental findings; Estimation of bed Voidages; Physical models: simple two-phase model; K-L model.

UNIT - IV

**High velocity Fluidization:** Turbulent fluidized bed; Fast fluidization pressure drop in turbulent and fast fluidization.
**Solids Movement, Mixing, Segregation and staging:** Vertical movement of solids; Horizontal movement of solids; Staging of fluidized beds.

UNIT - V

**Gas Dispersion and Gas interchange in Bubbling Beds:** Dispersion of gas in beds; Gas interchange between bubble and emulsion; Estimation of gas interchange coefficients.
**Particle to Gas Mass Transfer:** Experimental interpolation of mass transfer coefficients; Heat transfer; Experimental heat transfer from the bubbling bed model.

Textbooks:

1. Fluidization Engineering by Kunil, Diazo and Octave Levenspiel, John Weiley& Sons Inc, Newyork, 1969.
2. Fluidization Engineering by J.R. Howard, Adam Heilgar.

Reference Books:

Online Learning Resources:

Professional Elective Course - II

| | | | | | |
|---|---|---|---|---|---|
| **Course Code** | **PE2. NUMERICAL METHODS IN CHEMICAL** | **L** | **T** | **P** | **C** |
| **20A60804b** | **ENGINEERING** | **3** | **0** | **0** | **3** |
| **Pre-requisite** | **Semester-VI** | | | | |

Course Objectives:

- To instruct the concept of Matrices in solving linear algebraic equations
- To elucidate the different numerical methods to solve nonlinear algebraic equations
- To disseminate the use of different numerical techniques for carrying out numerical integration and numerical differentiation.
- To introduce curve fitting using method of least squares
- To teach different methods to solve ordinary differential equations.

To explain the importance of numerical methods to solve chemical engineering problems.

Course Outcomes (CO):

At the end of the course, the student will be able to:

| | |
|---|---|
| CO1 | Able to solve nonlinear algebraic quations |
| CO2 | Able to perform Regression Analysis and interpolation |
| CO3 | Able to use numerical integration and differentiation techniques |
| CO4 | Able to solve ordinary differential equations |
| CO5 | Able to solve partial differential equations |

**Course Articulation Matrix**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |

UNIT - I

Elementary row transformations - Rank, Eigen Values, Solution of system of linear equations by Gauss elimination and Gauss Jordan, Gauss-Seidel and LU decomposition methods.

UNIT - II

**Solution of Nonlinear Algebraic Equations**: Introduction, Bisection method, Newton-Raphson, Regula-Falsi and Secant method. Chemical engineering problems involving solution of linear and Non-linear algebraic equations.

UNIT - III

**Regression Analysis**: Introduction, least squares curve-fitting methods, Newton's forward formulae, Newton's backward formulae. Interpolation Polynomial, Lagrangian Interpolation (Unequal Intervals), cubic spline interpolation

UNIT - IV

**Numerical differentiation:** Three-point Lagrangian formulae.

**Numerical Integration:** Trapezoidal rule, Simpson's 1/3 and 3/8 rules, integration with unequal segments, Chemical engineering problems involving numerical differentiation and integration.

UNIT - V

**Solution of ordinary Differential Equations-** Introduction to ordinary Differential Equations, Initial and boundary value problems, Euler method, modified Euler, Runge-Kutta $4^{th}$ order method, Predictor Corrector method, Milne's method, Chemical engineering problems involving single, and a system of ODEs.

**Introduction to Partial Differential Equations**: elliptic, parabolic and hyperbolic equations and their applications in chemical engineering.

Textbooks:

1. Numerical methods for Engineers, S.K. Gupta, New Age International (P) Limited, Publishers, 1998
2. Introductory Methods of Numerical Analysis, S.S. Sastry, PHI publisher.

Reference Books:

1. Mathematical methods in Chemical Engineering, S. Puspavanam, Prentice Hall of India PHI,1998 ISBN 81-203-1262-7
2. Mathematical methods in Chemical and environmental
3. Engineering, Ajay K. Roy, Thomson Learning, 2000 ISBN 981-240-375-2
4. Engineering Mathematics, Volume - II, E. Rukmangadachari& E. Keshava Reddy, Pearson Publisher.
5. Engineering Mathematics, Volume - II, by G.S.S.Raju, CENGAGE publisher.
6. Mathematical Methods by T.K.V. Iyengar, B.Krishna Gandhi, S.Ranganatham and M.V.S.S.N.Prasad, S. Chand publication.
7. Higher Engineering Mathematics, by B.V.Ramana, Mc Graw Hill publishers.
8. Advanced Engineering Mathematics, by Erwin Kreyszig, Wiley India.

Online Learning Resources:

Professional Elective Course - II

| | | | | | |
|---|---|---|---|---|---|
| **Course Code** | **PE3. SOLID – FLUID REACTIONS** | **L** | **T** | **P** | **C** |
| **20A60804c** | | **3** | **0** | **0** | **0** |
| **Pre-requisite** | **Semester** | | | | |

Course Objectives:

- Knowledge of rate law given the rate controlling step in catalytic reactions, internal and external diffusion effects.
- Learn the factors influencing catalyst decay, the role of pore diffusion on catalyst activity rate.
- Shrinking core model for spherical particles of unchanging size and design the fluid-solid reactors.

Course Outcomes (CO):

At the end of the course, the student will be able to:

| | |
|---|---|
| CO1 | Understand the reactor performance for reactors when the temperature is not uniform within the reactor |
| CO2 | Analyze the rate law and the rate controlling step in catalytic reactions, internal and external diffusion effects. |
| CO3 | Understand the factors influencing catalyst decay |
| CO4 | Evaluate the role of pore diffusion on catalyst activity rate. |
| CO5 | Able to design the fluid – solid reactors and analyse the changing and unchanging size |

**Course Articulation Matrix**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |

UNIT - I

**Temperature and Pressure effects**- single reactions- heats of reaction from thermodynamics, heats of reaction and temperature, equilibrium constants from thermodynamics, equilibrium conversion, general graphical design procedure, optimum temperature progression, heat effects, adiabatic operations, non-adiabatic operations, comments and extensions. Exothermic reactions in mixed flow reactors-A special problem, multiple reactions.

UNIT - II

**Temperature and Pressure effects**- optimum temperature progression, heat effects, adiabatic operations, non-adiabatic operations, comments and extensions. Exothermic reactions in mixed flow reactors-A special problem, multiple reactions.

UNIT - III

**Catalysis and Catalytic reactors**: catalysts, steps in catalytic reactions, synthesizing a rate law, mechanism and rate limiting step.

**Heterogeneous reactions**: Introduction to Solid catalyzed reactions: The rate equation for Surface Kinetics- Pore diffusion resistance combined with surface kinetics, porous catalyst particles, heat effects during reaction, Performance equations for reactors containing porous catalyst particles.

UNIT - IV

**Solid catalyzed reactions**- Experimental methods for finding rates. Deactivating catalysts-mechanisms of catalyst deactivation, the rate and performance equations.

UNIT - V

**Fluid-fluid reactions**: kinetics- the rate equation.

**Fluid-particle reactions**: kinetics- selection of a model, shrinking core model for spherical particles of unchanging size, rate of reaction for shrinking spherical particles, extensions, determination of rate controlling step

Textbooks:

Reference Books:

Online Learning Resources:

**Open Elective Course - II**

| | | | | | | |
|---|---|---|---|---|---|---|
| **Course Code** | **OE2. GREEN TECHNOLOGY** | | **L** | **T** | **P** | **C** |
| **20A60805** | | | **3** | **0** | **0** | **3** |
| **Pre-requisite** | **Common to All Branches** | **Semester** | | | | |

Course Objectives:

Course Outcomes (CO):
At the end of the course, the student will be able to:

| | |
|---|---|
| CO1 | Understand the basic knowledge of environmental issues and estimate the risk |
| CO2 | Evaluate the exposures |
| CO3 | To discuss the type of wastes and emissions that drive the environmental impacts |
| CO4 | Estimation of the environmental properties, persistence, ecosystem risk, |
| CO5 | To present approaches and methodologies for evaluating and improving the environmental performance of chemical processes and chemical products. |

**Course Articulation Matrix**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |

UNIT - I
**An introduction to environmental issues**: Role of chemical processes and chemical products, Global environmental issues, Air and water quality issues, Ecology.
**Risk concept**: Description of risk, Risk assessment concept, Dose-response, Exposure assessment.

UNIT - II
**Evaluating exposures:** Occupational exposures: recognition, evaluation, control, Exposure assessment for chemicals in the ambient environment, Designing safer chemicals.
**Green chemistry**:Green chemistry methodologies, Optimization based frameworks for the design of green chemical synthesis pathway.

UNIT - III
**Evaluating environmental fate:** Chemical and physical property estimation, estimating environmental persistence, estimating ecosystem risk, classifying environmental risk based on chemical structure.

UNIT - IV

**Life-cycle concepts**: Life-cycle assessment, Life-cycle impact assessment

UNIT - V

Material flows in chemical manufacturing, Assessing opportunities for waste exchanges and by-product synergies.

**Textbooks:**

SHONNARD, DALLEN, D. Green Engineering: Environmentally Conscious Design of Chemical Processes.

**Reference Books:**

Online Learning Resources:

| Course Code | MASS TRANSFER OPERATIONS LABORATORY | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 3 | 1.5 |
| **20A60806** | | **Semester** | | | |

Course Objectives:

Course Outcomes (CO):
At the end of the course, the student will be able to:

| | |
|---|---|
| CO1 | Able to calculate diffusivity coefficients for different systems |
| CO2 | Able to evaluate Mass transfer coefficients for different systems |
| CO3 | Able to calculate Tie line data for VLE, LLE, systems |
| CO4 | Able to perform adsorption studies |
| CO5 | Able to understand drying characteristics |

**Course Articulation Matrix**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |

List of Experiments:

1. Estimation of diffusivity coefficients for vapor in gas
2. Estimation of solid diffusion coefficient in air
3. Steam distillation
4. Simple distillation
5. Evaluation of HETP in packed towers
6. Vapor Liquid Equilibria
7. Batch Drying
8. Evaluation of Mass transfer coefficients for Surface Evaporation
9. Evaluation of Mass transfer coefficients for Wetted wall column
10. Liquid- Liquid Equilibria (Tie line data)
11. Ternary Liquid Equilibria (binodal curve)
12. Leaching
13. Adsorption studies

References:

1. Principles of Mass Transfer and Separation Processes by B K Dutta, Printice Hall of India Pvt Limited, New Delhi
2. Transport processes and unit operations by Christie J.Geankoplis
3. Separation Process Principles, J D Seader and E. J. Henley, John Wiley & Sons, Inc,. New York
4. Mass transfer operations Laboratory manual by Mr.M.kalyan kumar, lambert publications, June 2019.

Online Learning Resources/Virtual Labs:

| Course Code | CHEMICAL PROCESS EQUIPMENT DESIGN & DRAWING LABORATORY | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 3 | 1.5 |
| 20A60807 | Semester | | | | |

Course Objectives:

Course Outcomes (CO):
At the end of the course, the student will be able to:

| | |
|---|---|
| CO1 | Design and use the data to draw a pressure vessel |
| CO2 | Design and use the data to draw a standard vertical short tube evaporator |
| CO3 | Design and use the data to draw a sieve tray type distillation column |
| CO4 | Design and use the data to draw a reaction vessel with a plane jacket |
| CO5 | Sketch memory diagrams pertaining to attachments, supports and internal parts of heat exchangers, tall vessels and reaction vessel. |
| CO6 | Sketch memory diagrams pertaining to attachments, supports, and internal parts of pressure vessels, distillation column and packed column |

**Course Articulation Matrix**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |
| CO6 | | | | | | | | | | | | |

List of Experiments:
References:

Online Learning Resources/Virtual Labs:

| Course Code 20A60808 | CHEMICAL PROCESS SIMULATION LAB Semester | L 0 | T 0 | P 3 | C 1.5 |
|---|---|---|---|---|---|

Course Objectives:

Course Outcomes (CO):
At the end of the course, the student will be able to:

| | | |
|---|---|---|
| CO1 | Able to understand the fundamentals of process simulation | |
| CO2 | Able to solve Initial value problems (IVP) | |
| CO3 | Able to solve Boundary value problems (BVP) | |
| CO4 | Able to simulate CSTR, PFR and Batch reactors | |
| CO5 | Able to simulate Distillation column, vaporizer etc | |

**Course Articulation Matrix**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |

List of Experiments:

1. Simulation of Initial Value Problem (Ex: Gravity Flow tank).
2. Simulation of Boundary Value Problem (Ex: Tubular Reactor with axial Diffusion)
3. Simulation of Three CSTRs in series – open and Closed loop
4. Simulation of Control system design for a Non isothermal CSTR
5. Simulation of Binary Distillation column
6. Simulation of Batch Reactor isothermal and Non isothermal – closed loop
7. Simulation of Interacting and Non interacting System- two tank liquid level
8. Simulation of Plug flow reactor
9. Non linear Regression: Fitting a catalytic rate model
10. Constrained Optimization using Matlab
11. Stability analysis using Bode diagrams for control systems
12. Dynamic modeling of Single Component Vaporizer

References:

Online Learning Resources/Virtual Labs:

**Skill Oriented Course -**

**Semester-VI**

| **Course Code** | **Soft Skills** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|---|
| **20A65502** | | **1** | **0** | **2** | **2** |
| **Pre-requisite** | | | | | |

Common to CIVIL,MECH, CHEM

Course Objectives:

- ➢ To encourage all round development of the students by focusing on soft skills
- ➢ To make the students aware of critical thinking and problem-solving skills
- ➢ To develop leadership skills and organizational skills through group activities
- ➢ To function effectively with heterogeneous teams

Course Outcomes (CO):

By the end of the program students should be able to

- Define various elements of effective communicative skills
- Understanding people using emotional intelligence
- apply critical thinking skills in problem solving
- analyse the needs of an organization for team building
- Assess the situation and take necessary decisions as a leader
- Creating a productive work place atmosphere using social and work-life skills ensuring personal and emotional well-being

| UNIT – I | **Soft Skills & Communication Skills** | Lecture Hrs |
|---|---|---|

Introduction, meaning, significance of soft skills – definition, significance, types of communication skills - Intrapersonal & Inter-personal skills - Verbal and Non-verbal Communication

**Activities:**

**Intrapersonal Skills**- Narration about self- strengths and weaknesses- clarity of thought – self- expression – articulating with felicity

(The facilitator can guide the participants before the activity citing examples from the lives of the great, anecdotes and literary sources)

**Inter personal Skills**- Group Discussion – Debate – Team Tasks - Book and film Reviews by groups - Group leader presenting views (non- controversial and secular) on contemporary issues or on a given topic.

**Verbal Communication**- Oral Presentations- Extempore- brief addresses and speeches- convincing- negotiating- agreeing and disagreeing with professional grace.

**Non-verbal communication** – Public speaking – Mock interviews – presentations with an objective to identify non- verbal clues and remedy the lapses on observation

UNIT – II **Critical Thinking** Lecture Hrs

Active Listening – Observation – Curiosity – Introspection – Analytical Thinking – Open-mindedness – Creative Thinking

**Activities**

:

Gathering information and statistics on a topic - sequencing – assorting – reasoning – critiquing issues –placing the problem – finding the root cause - seeking viable solution – judging with rationale – evaluating the views of others - Case Study, Story Analysis

UNIT – III **Problem Solving & Decision Making** Lecture Hrs

Meaning & features of Problem Solving – Managing Conflict – Conflict resolution –

Methods of decision making – Effective decision making in teams – Methods & Styles

**Activities:**

Placing a problem which involves conflict of interests, choice and views – formulating the problem – exploring solutions by proper reasoning – Discussion on important professional, career and organizational decisions and initiate debate on the appropriateness of the decision.

Case Study & Group Discussion

UNIT – IV **Emotional Intelligence & Stress Management** Lecture Hrs

Managing Emotions – Thinking before Reacting – Empathy for Others – Self-awareness – Self-Regulation – Stress factors – Controlling Stress – Tips

**Activities**:

Providing situations for the participants to express emotions such as happiness, enthusiasm, gratitude, sympathy, and confidence, compassion in the form of written or oral presentations.

Providing opportunities for the participants to narrate certain crisis and stress –ridden situations caused by failure, anger, jealousy, resentment and frustration in the form of written and oral presentation, Organizing Debates

UNIT – V **Leadership Skills** Lecture Hrs

Team-Building – Decision-Making – Accountability – Planning – Public Speaking – Motivation – Risk-Taking - Team Building - Time Management

**Activities**

Forming group with a consensus among the participants- choosing a leader- encouraging the group members to express views on leadership- democratic attitude- sense of sacrifice – sense of adjustment – vision – accommodating nature- eliciting views on successes and failures of leadership using the past knowledge and experience of the participants, Public Speaking, Activities on Time Management, Motivation, Decision Making , Group discussion etc.

**NOTE-:**

1. The facilitator can guide the participants before the activity citing examples from the lives of the great, anecdotes, epics, scriptures, autobiographies and literary sources which bear true relevance to the prescribed skill.

2. Case studies may be given wherever feasible for example for Decision Making- The decision of King Lear or for good Leadership – Mahendar Singh Dhoni etc.

Textbooks:

1. Personality Development and Soft Skills (English, Paperback, Mitra Barun K.)Publisher : Oxford University Press; Pap/Cdr edition (July 22, 2012)
2. Personality Development and Soft Skills: Preparing for Tomorrow, Dr Shikha KapoorPublisher : I K International Publishing House; 0 edition (February 28, 2018)

**1.** Reference Books:

1.Soft skills: personality development for life success by prashantsharma,

BPB publications 2018.

**2.** Soft Skills By Alex K. Published by S.Chand

**3.** Soft Skills: An Integrated Approach to Maximise Personality Gajendra

Singh Chauhan, Sangeetha Sharma Published by Wiley.

**4.** Communication Skills and Soft Skills (Hardcover, A. Sharma) Publisher: Yking books

**5.** SOFT SKILLS for a BIG IMPACT (English, Paperback, RenuShorey)

Publisher: Notion Press

6. Life Skills Paperback English Dr. Rajiv Kumar Jain, Dr. Usha Jain
Publisher : Vayu Education Of India

Online Learning Resources:

1. **https://youtu.be/DUlsNJtg2L8?list=PLLy_2iUCG87CQhELCytvXh0E_y-bOO1_q**
2. **https://youtu.be/xBaLgJZ0t6A?list=PLzf4HHlsQFwJZel_j2PUy0pwjVUgj7KlJ**
3. **https://youtu.be/-Y-R9hDl7lU**
4. **https://youtu.be/gkLsn4ddmTs**
5. **https://youtu.be/2bf9K2rRWwo**
6. **https://youtu.be/FchfE3c2jzc**

**(Mandatory Non-Credit Course)** (CIVIL, ME, CHEM))

**INTELLECTUAL PROPERTY RIGHTS AND PATENTS**

**20A69901**

Course code

| L | T | P | C |
|---|---|---|---|
| 2 | 0 | 0 | 0 |

**CourseObjectives:**

This course introduces the student to the basics of Intellectual Property Rights, Copy Right Laws,

Cyber Laws, Trade Marks and Issues related to Patents. The overall idea of the course is to help and encourage the student for startups and innovations.

**CourseOutcomes:** At the end of the course the students will be able to

UnderstandIPRlaw&Cyberlaw

Discussregistration process,maintenance andlitigations associatedwith trademarks

Illustrate thecopyright law

Enumerate thetrade excretal.

**UNIT I**

Introduction to Intellectual Property Law – Evolutionary past – Intellectual Property Law Basics – Types of Intellectual Property – Innovations and Inventions of Trade related Intellectual Property Rights – Agencies Responsible for Intellectual Property Registration – Infringement – Regulatory – Overuse or Misuse of Intellectual Property Rights – Compliance and Liability Issues.

**UNIT II**

Introduction to Copyrights – Principles of Copyright – Subject Matters of Copyright – Rights Afforded by Copyright Law –Copyright Ownership – Transfer and Duration – Right to Prepare Derivative Works –Rights of Distribution – Rights of performers – Copyright Formalities and Registration–Limitations–Infringement of Copyright –International Copyright Law-Semiconductor Chip Protection Act.

**UNIT III**

IntroductiontoPatentLaw–RightsandLimitations–RightsunderPatentLaw–Patent Requirements

–Ownership and Transfer –Patent Application Process and Granting of Patent –Patent InfringementandLitigation–InternationalPatentLaw–DoublePatenting–PatentSearching–Patent Cooperation Treaty – New developments in Patent Law- Invention Developers and Promoters.

**UNIT IV**

Introduction to Trademark – Trademark Registration Process – Post registration procedures – Trade Mark maintenance – Transfer of rights – Inter parties Proceedings – Infringement – Dilution of Ownership of Trademark– Likelihood of confusion –Trademark claims – Trademarks Litigation – International Trade Mark Law.

**UNIT V**

Introduction to Trade Secrets – Maintaining Trade Secret – Physical Security – Employee Access Limitation – Employee Confidentiality Agreement – Trade Secret Law – Unfair Competition – Trade Secret Litigation – Breach of Contract – Applying State Law. Introduction to Cyber Law – Information Technology Act – Cyber Crime and E-commerce – Data Security – Confidentiality – Privacy – International aspects of Computer and Online Crime.

**Textbooks:**

Deborah E. Bouchoux: "Intellectual Property". Cengage learning, New Delhi

KompalBansal&ParishitBansal "Fundamentals of IPR for Engineers‟ S Publications (Press)

Cyber Law. Texts& Cases, South-Western‟s Special Topics Collections

**References:**

PrabhuddhaGanguli: „Intellectual Property Rights" Tata Mc-Graw–Hill, New Delhi

Richard Stim: "Intellectual Property", Cengage Learning, New Delhi.

R. Radha Krishnan, S. Balasubramanian: "Intellectual Property Rights", Excel Books. New Delhi.

M.Ashok Kumar and Mohd. Iqbal Ali: "Intellectual property Right "Serials Pub

**JNTUA COLLEGE OF ENGINEERING (Autonomous): ANANTAPURAMU**

**B. Tech (CHEM)–IV-I Sem (R20)**

**Professional Elective Course - III**

| | | | | | |
|---|---|---|---|---|---|
| **Course Code** | **PE1. PETROLEUM REFINING &** | **L** | **T** | **P** | **C** |
| **20A70801a** | **PETROCHEMICAL TECHNOLOGY** | **3** | **0** | **0** | **3** |
| **Pre-requisite** | **SemesterVII** | | | | |

Course Objectives:

- Learn the formation, refining of crude oil and products of refinery.
- Understand the means of processing data including thermal properties, important products characteristics.
- Develop skills in drawing neat flow diagrams of different petroleum refining processes
- (cracking/reforming/alkylation/isomerization / hydrocracking etc.,) that are aimed at producing high value/demand products.
- Identify important testing methods for important petroleum products.
- Have idea on Indian standards for major petroleum products

Course Outcomes (CO):
At the end of the course, the student will be able to:

| | |
|---|---|
| CO1 | Able to the overall scenario of quality of crude oil. |
| CO2 | Able to calculate different Petroleum Products and their specifications. |
| CO3 | Able to know the different processes involving for up gradation of petroleum fractions. |
| CO4 | Able to do Thermal & Catalytic cracking processes. |
| CO5 | Able to understand chemicals from ethane, ethylene, and acetylene |

**Course Articulation Matrix**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |

UNIT – I

Origin, formation and composition of petroleum: Origin and formation of petroleum, Reserves and deposits of world, Indian Petroleum Industry. Petroleum processing data: Evaluation of petroleum, thermal properties of petroleum fractions, important products, properties and test methods.

UNIT – II

Fractionation of petroleum: Dehydration and desalting of crudes, heating of crude pipe still heaters, distillation of petroleum, blending of gasoline. Treatment techniques: fraction-impurities, treatment of gasoline, treatment of kerosene, treatment of lubes.

UNIT – III

Thermal and catalytic processes: Cracking, catalytic cracking, catalytic reforming, Naphtha cracking, coking, Hydrogenation processes, Alkylation processes, Isomerization process.

UNIT – IV

Petrochemical Industry – Feed stocks Chemicals from methane: Introduction, production of Methanol, Formaldehyde, Ethylene glycol, PTFE, Methylamines.

UNIT – V

Chemicals from Ethane-Ethylene-Acetylene: Oxidation of ethane, production of Ethylene, Manufacture of Vinyl Chloride monomer, vinyl Acetate manufacture, Ethanol from Ethylene, Acetylene manufacture, Acetaldehyde from Acetylene.

**Textbooks:**

1. Nelson. W.L. “Petroleum refining Engineering”, 4 Edition, Mc Graw Hill, New York, 1969.

2. Rao, B.K.B. “Modern Petroleum Refining Processes”, 4 Edition, Oxford and IBH Publishing, 2002.

**Reference Books:**

1. Goldstine. R.F. “The Petroleum Chemicals Industry”, Taylor and Francis, London, 1967.

2. Gruese. W.S.and Stevens, D.R. “Chemical Technology of Petroleum”, McGraw Hill, 1980.

3 Chauvel. A. and Lefevrev, “Petro Chemicals”, Volume 1 and 2, Gulf Publishing company 1989.

**Online Learning Resources:**

**Professional Elective Course - III**

| | | | | | |
|---|---|---|---|---|---|
| **Course Code** | **PE2. ENERGY ENGINEERING** | **L** | **T** | **P** | **C** |
| **20A70801b** | | **3** | **0** | **0** | **3** |
| **Pre-requisite** | **SemesterVII** | | | | |

Course Objectives:

- To acquaint the student with the conventional energy sources and their utilization.
- To understand the importance of heat recovery and energy conservation methods and energy audit

Course Outcomes (CO):
At the end of the course, the student will be able to:

| | |
|---|---|
| CO1 | Associate the basic energy sources, fuels and their utilization requirements with reference to Indian Scenario |
| CO2 | Estimate steam production cost and its quality |
| CO3 | Describe energy production and storage for solar and wind |
| CO4 | Explain heat recovery from processes and effective utilization of waste heat |
| CO5 | Describe different types of energy audit and energy conversion |

**Course Articulation Matrix**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |

UNIT - I

Sources of energy, types of fuels- energy and relative forms. Calorific value- gross and net value, calculation of calorific value from fuel analysis, experimental determination energy resources present and future energy demands with reference to India.

**Coal:** origin, occurrence, reserves, petrography, classification, ranking, analysis, testing, storage, coal carbonization and by-product recovery, liquefaction of coal, gasification of coal, burning of coal and firing mechanism, burning of pulverized coal.

UNIT - II

**Liquid fuels:** petroleum: origin, occurrence, reserves, composition, classification, characteristics, fractionation, reforming, cracking, petroleum products, specification of

petroleum products, burning of liquid fuels.
Natural gas, coke oven gas, producer gas, water gas, LPG, burning of gaseous fuels, hydrogen (from water) as future fuel, fuel cells, flue gas, analysis: orsat apparatus.

UNIT - III

**Steam Plant:** Run time cycle, boiler plant, steam cost, steam distribution and utilization, combined heat and power systems, energy from biomass and biogas plants, gas purification, solar energy, wind energy, energy storage.

UNIT - IV

Waste heat recovery, sources of waste heat and potential application, various types of heat recovery systems, regenerators, recuperators, waste heat boilers

**Energy conservation:** conservation methods in process industries, theoretical analysis, practical limitations.

UNIT - V

**Energy auditing:** short term, medium-term, long-term schemes, energy conversion, energy index, energy cost, representation of energy consumption, Sankey diagram, energy auditing.

Textbooks:
1. Fuels, Furnaces and Refractories, O.P.Gupta
2. Fuels and Combustion, 3rd ed., Samir Sarkar, Universities Press, 2009

Reference Books:
1. Non-conventional Energy Resources, G.D.Rai, Khanna Publishers
2. Fuel and Energy, Harker and Backhurst, Academic press London 1981
3. Fuel Science- Harker and Allen, Oliver and Boyd, 1972

Online Learning Resources:

**Professional Elective Course - III**

| | | | | | |
|---|---|---|---|---|---|
| **Course Code** | **PE3. BASICS OF NANOTECHNOLOGY** | **L** | **T** | **P** | **C** |
| **20A70801c** | | **3** | **0** | **0** | **3** |
| **Pre-requisite** | **SemesterVII** | | | | |

Course Objectives:

- Basic knowledge of nanotechnology, classification and properties of nanomaterials
- Various methods of synthesis of nanomaterials.
- Applications of nanomaterials

Course Outcomes (CO):
At the end of the course, the student will be able to:

| | |
|---|---|
| CO1 | Understand the importance of nanotechnology and its interdisciplinary nature |
| CO2 | Understand the methods of fabrications and applications of nanomaterials |
| CO3 | Understand the Unique properties of nanomaterials |
| CO4 | Able to analyse different synthesis methodologies of nanoparticles |
| CO5 | Able to distinguish top down and bottom up approaches |

**Course Articulation Matrix**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |

UNIT - I

Introduction:History and Scope, Can Small Things Make a Big Difference? Classification of Nanostructured Materials, Fascinating Nanostructures, Applications of Nanomaterials, Nature: The Best of Nanotechnologist, Challenges and Future Prospects.

UNIT - II

Unique Properties of Nanomaterials: Microstructure and Defects in Nanocrystalline Materials: Dislocations, Twins, stacking faults and voids, Grain Boundaries, triple and disclinations. Effect of Nano-dimensions on Materials Behaviour: Elastic properties, Melting Point, Diffusivity, Grain growth characteristics, Enhanced solid solubility.

UNIT - III

Magnetic Properties: Soft magnetic nanocrystalline alloy, Permanent magnetic nanocrystalline materials, Giant Magnetic Resonance, Electrical Properties, Optical Properties, Thermal Properties and Mechanical Properties.

UNIT - IV

Synthesis Routes: Bottom-up approaches:Physical Vapor Deposition, Inert Gas Condensation, Laser Ablation, Chemical Vapor Deposition, Molecular Beam Epitaxy, Sol-gel method, Self-assembly

UNIT - V

Top-down approaches: Mechanical alloying, Nano-lithography.

Consolidation of Nano powders: Shock wave consolidation, Hot isostatic pressing and Cold isostatic pressing  Spark plasma sintering.

Applications of Nanomaterials:Nano-electronics, Nano sensors, Nano catalysts, Structure and Engineering, Automotive Industry, Water- Treatment and the environment, Nano-medical applications, Textiles, Paints, Energy, Defence and Space Applications

**Textbooks:**

1. Text Book of Nano Science and Nano Technology – B.S. Murthy, P. Shankar, Baldev Raj, B.B. Rath and James Munday, University Press-IIM.
2. Introduction to Nanotechnology – Charles P. Poole, Jr., and Frank J. Owens, Wley India Edition, 2012.

**Reference Books:**

1. Nano: The Essentials by T.Pradeep, Mc Graw- Hill Education.
2. Nanomaterials, Nanotechnologies and Design by Michael F. Ashby, Paulo J. Ferreira and Daniel L.Schodek
3. Transport in Nano structures- David Ferry, Cambridge University press 2000
4. Nanofabrication towards biomedical application: Techniques, tools, Application and impact – Ed. ChallaS.,S. R. Kumar, J. H. Carola.
5. Carbon Nanotubes: Properties and Applications- Michael J. O'Connell.
6. Electron Transport in Mesoscopic systems - S. Dutta, Cambridge University press.

**Online Learning Resources:**

**Professional Elective - IV**

| Course Code | PE1. CORROSION ENGINEERING | L | T | P | C |
|---|---|---|---|---|---|
| 20A70802a | | 3 | 0 | 0 | 3 |
| Pre-requisite | Semester VII | | | | |

Course Objectives:

1. Be introduced to the principles of electrochemistry as well as the essential elements of electrochemical corrosion.
2. Lay a foundation for understanding the forms of corrosion, the mechanisms of corrosion, electrochemical methods.
3. Develop the thermodynamic and kinetic aspects of electrochemistry, including potential-pH
4. (Pourbaix) diagrams, mixed potential theory, and the theory and application of polarization.
5. Design methods for combating corrosion, the principles and methods leading to mitigation of corrosion problems that might occur in engineering practice.

Course Outcomes (CO):
At the end of the course, the student will be able to:

| | |
|---|---|
| CO1 | Understand the electrochemical behaviour of corroding systems |
| CO2 | Classify Various corrosion forms and the mechanisms involved |
| CO3 | Apply the electrochemical aspects of combating eight forms of corrosion |
| CO4 | Design of suitable materials & methods of combat corrosion |
| CO5 | Evaluate the polarization behaviour of corroding systems |

**Course Articulation Matrix**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |

UNIT - I

**Introduction**

Definitions of Corrosion - Overall classification of types of corrosion-Basic electrochemistry – Galvanic and electrolytic cells – Potential measurements - EMF and Galvanic series – Galvanic corrosion and bimetallic contacts – Eh – pH diagrams, Cost of Corrosion, Metallurgical properties influencing corrosion.

UNIT - II

**Forms of Corrosion**

Uniform attack, galvanic, crevice, pitting, inter granular, selective leaching, erosion and stress corrosion – Mechanisms, testing procedures and their protection.

UNIT - III

**Electrode kinetics and polarization phenomena**

Electrode – solution interface – Electrode kinetics and polarization phenomena – Exchange current density – Polarization techniques to measure corrosion rates – Mixed potential theory – Activation and diffusion controlled mixed electrodes.

UNIT - IV

**Methods of corrosion prevention and control**

Design, coatings and inhibition – Cathodic protection – Stray current corrosion – Passivity phenomena and development of corrosion resistant alloys – Anodic control.

UNIT - V

**Industry Approach**

Selection for a given Chemical Engineering Service Environment- Materials for Chemical Engineering Industry to resist the given chemical Environment. -Ferritic, Austenitic steels and stainless steels- Copper and its alloys-Brasses, bronzes, Nickel and its alloys- Monel alloys-materials for a petroleum refinery industry.

**Textbooks:**

1. M. G. Fontana, Corrosion Engineering (Third Edition) McGraw-Hill Book Company.
2. Denny A Jones, Principles and Prevention of Corrosion (second edition), Prentice-Hall, N. J. (1996).

**Reference Books:**

1. H. H. Uhlig and R. W. Revie, Corrosion and Corrosion Control, Wiley (NY) (1985).

**Online Learning Resources:**

**Professional Elective Course - IV**

| | | | | | |
|---|---|---|---|---|---|
| **Course Code** | **PE2. OPTIMIZATION OF CHEMICAL** | **L** | **T** | **P** | **C** |
| **20A70802b** | **PROCESSES** | **3** | **0** | **0** | **3** |
| **Pre-requisite** | **SemesterVII** | | | | |

Course Objectives:

- To learn problem formulation of optimization.
- To realize the numerical methods of un-constrained optimization.
- To learn linear programming and its applications
- To understand the use of genetic algorithms in optimization
- To know the applications of numerical optimization.

Course Outcomes (CO):
At the end of the course, the student will be able to:

| | |
|---|---|
| CO1 | Define, understand and explain the concept of Optimization of Chemical Processes |
| CO2 | Formulate Optimization Problems with given constraints |
| CO3 | Apply and analyse the optimization criterion for solving problems |
| CO4 | Investigate constrained and unconstrained optimization techniques |
| CO5 | Investigate different methods of optimization and to suggest a technique for specific problem |

**Course Articulation Matrix**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |
| CO6 | | | | | | | | | | | | |

UNIT - I

**Nature and organization of optimization problems**: Introduction to optimization, scope and hierarchy of optimization, examples of applications of optimization, essential features of optimization problems, general procedure for solving optimization problems, Optimization of a manufacturing problem with a stepwise procedure, obstacles of optimization, constraints in optimization, examples and formulation of constrained optimization problems.

**Basic concepts of optimization**: Continuity of functions, unimodal versus Multimodal functions. Convex and Concave functions, convex region, Necessary and sufficient conditions for an extremum of an unconstrained function.

UNIT - II

**Optimization of unconstrained single variable functions:** Region elimination methods: Fibonacci search, Golden section search. Polynomial approximation methods- Sequential search

**Methods specifying optimum by a point:** Newton's method, Secant method, Quadratic interpolation, Cubic interpolation. Applications of one- dimensional search methods to chemical engineering problems.

UNIT - III

**Unconstrained multivariable optimization:** Random search methods, grid search, uni-variate search, multivariable Newton's method, steepest descent method, Conjugate search directions, Conjugate gradient method

UNIT - IV

**Optimization of Unit operations:** Optimal pipe diameter, optimizing recovery of waste heat, optimization of multiple effect evaporator, Determination of optimal reflux ratio for staged distillation column, shell and tube heat exchanger.

UNIT - V

**Linear programming and applications:** Basic concepts in linear programming, graphical solution, artificial variable technique, exceptional cases in LPP, non-existing feasible solution, degeneracy, duality in linear programming, dual simplex method, revised simplex method.

**Textbooks:**

1. Optimization of Chemical Processes, T.F. Edgar and D.M. Himmelblau, McGraw-Hill, New York, 2001.
2. Optimization for Engineering Design, Kalyan Moy Deb, PHI Pvt. Ltd., New Delhi, 2000

**Reference Books:**

**Online Learning Resources:**

## Professional Elective Course - IV

| | | | | | |
|---|---|---|---|---|---|
| **Course Code** | **PE3. PHARMACEUTICALS &** | **L** | **T** | **P** | **C** |
| **20A70802c** | **FINE CHEMICALS** | **3** | **0** | **0** | **3** |
| **Pre-requisite** | **SemesterVII** | | | | |

Course Objectives:

Course Outcomes (CO):
At the end of the course, the student will be able to:

| | |
|---|---|
| CO1 | Able to understand the principle of pharmaceuticals and their properties |
| CO2 | Able to understand the principle of fine chemicals and their properties |
| CO3 | Able to analyse the pharmaceuticals like aspirin, penicillin, calcium gluconate |
| CO4 | Able to understand principle of tablet manufacture and granulation equipment's |
| CO5 | Able to understand sterilization process |

**Course Articulation Matrix**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |

UNIT - I
A brief outline of grades of chemicals, sources of impurities in chemicals, principles (without going into details of individual chemicals) of limit test for arsenic, lead, iron, chloride and sulfate in Pharmaceuticals.

UNIT - II
Outlines of Preparation, properties, uses and testing of the following Pharmaceuticals - sulfacetamide, paracetamol, riboflavin, nicotinamide,
Outlines of Preparation, properties, uses and testing of the following fine chemicals - Methyl orange, fluorescence, procaine hydrochloride, paramino salicylic acid, isonicatinic acid hydrazide.

UNIT - III
Manufacture with flowsheets, properties, uses and testing of the following Pharmaceuticals – aspirin, penicillin, calcium gluconate.

UNIT - IV

Manufacture with flowsheets, properties, uses and testing of the following ferric ammonium citrate, pthallic anhydride and phenol fluorobenzene process and benzene sulfate process, other processes in outline only.

UNIT - V

Tablet making and coating, granulation equipments, Preparation of capsules, extraction of crude drugs. Sterilization: introduction, risk factor, methods of sterilization, heat (dry and moist), heating with bactericide, filtration, gaseous sterilization and radiation sterilization, suitable example to be discussed.

Textbooks:

1. Remington's Pharmaceutical Science,16th ed, Mac publishing company, 1980.
2. Industrial Chemicals, 3rd ed., Faith, Kayes and Clark, John Wiley &Sons,. 1965.

Reference Books:

1. Blently's Text Book of Pharmaceutical Chemistry, 8th ed, H A Rawlins,
2. B Tindell and Box,. Oxford University Press, London, 1977

Online Learning Resources:

**Professional Elective Course - V**

| | | | | | |
|---|---|---|---|---|---|
| **Course Code** | **MOOCs course offered by Swayam/ NPTEL** | **L** | **T** | **P** | **C** |
| **20A70803** | | **3** | **0** | **0** | **3** |
| **Pre-requisite** | **SemesterVII** | | | | |

Course Objectives:

Course Outcomes (CO):
At the end of the course, the student will be able to:

| | |
|---|---|
| CO1 | |
| CO2 | |
| CO3 | |
| CO4 | |
| CO5 | |
| CO6 | |

**Course Articulation Matrix**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |
| CO6 | | | | | | | | | | | | |

UNIT - I

UNIT - II

UNIT - III

UNIT - IV

UNIT - V

Textbooks:

Reference Books:

Online Learning Resources:

Common to All Branches

Course Code **MANAGEMENT SCIENCE** L T P C

20A75401a 3 0 0 3

Pre-requisite Semester

COURSE OBJECTIVES: The objectives of this course are

1 To provide fundamental knowledge on Management, Administration, Organization & its concepts.

2 To make the students understand the role of management in Production

3 To impart the concept of HRM in order to have an idea on Recruitment, Selection, Training & Development, job evaluation and Merit rating concepts

4 To create awareness on identify Strategic Management areas & the PERT/CPM for better Project Management

5 To make the students aware of the contemporary issues in management

Course Outcomes (CO): At the end of the course, students will be able to

1 Define the Management, and its Functions

2 Understand the concepts & principles of management and designs of organization in a practical world

3 Apply the knowledge of Work-study principles & Quality Control techniques in industry

4 Analyse the concepts of HRM in Recruitment, Selection and Training & Development.

5 Evaluate PERT/CPM Techniques for projects of an enterprise and estimate time & cost of project & to analyse the business through SWOT.

6 Create Modern technology in management science.

UNIT - I INTRODUCTION TO MANAGEMENT

Management - Concept and meaning - Nature-Functions - Management as a Science and Art and both. Schools of Management Thought - Taylor’s Scientific Theory-Henry Fayol’s principles - Elton Mayo’s Human relations - Systems Theory - Organizational Designs - Line organization - Line & Staff Organization - Functional Organization - Committee form of Organization - Social responsibilities of Management.

LEARNING OUTCOMES: At the end if the Unit, the learners will be able to

- Understand the concept of management and organization
- Analyze the organization chart & structure for an enterprise.
- Apply the concepts & principles of management in real life industry.
- Evaluate and interpret the theories and the modern organization theory.

UNIT - II OPERATIONS MANAGEMENT

Principles and Types of Plant Layout - Methods of Production (Job, batch and Mass Production), - Statistical Quality Control - Materials Management - Objectives - Inventory-Functions - Types, Inventory Techniques - EOQ-ABC Analysis - Purchase Procedure - Marketing Management - Concept - Meaning - Nature- Functions of Marketing - Marketing Mix - Channels of Distribution - Advertisement and Sales Promotion - Marketing Strategies based on Product Life Cycle.

LEARNING OUTCOMES: At the end of the Unit, the learners will be able to

- Understand the core concepts of Management Science and Operations Management
- Apply the knowledge of Quality Control, Work-study principles in real life industry.
- Analyze Marketing Mix Strategies for an enterprise



- Evaluate Materials departments & Determine EOQ
- Create and design advertising and sales promotion

UNIT - III HUMAN RESOURCES MANAGEMENT (HRM)

HRM - Evolution of HRM - Definition and Meaning – Nature - Managerial and Operative functions - - Job Analysis - Human Resource Planning (HRP) – Process of Recruitment & Selection - Training and Development - Performance Appraisal - Methods of Performance Appraisal – Placement -

Employee Induction - Wage and Salary Administration.

LEARNING OUTCOMES: At the end if the Unit, the learners will

- Understand the concepts of HRM in Recruitment, Selection, Training & Development
- Apply Managerial and operative Functions
- Analyze the need of training
- Evaluate performance appraisal
- Design the basic structure of salaries and wages

UNIT - IV STRATEGIC & PROJECT MANAGEMENT

Strategy Definition & Meaning - Vision - Mission - Goals - Steps in Strategy Formulation and

Implementation - SWOT Analysis Project Management - Network Analysis - Programme

Evaluation and Review Technique (PERT) - Critical Path Method (CPM) Identifying Critical Path -

Project Crashing (Simple problems).

LEARNING OUTCOMES: At the end of the Unit, the learners will be able to

- Understand Mission, Objectives, Goals & strategies for an enterprise
- Apply SWOT Analysis to strengthen the project
- Analyze Strategy formulation and implementation
- Evaluate PERT and CPM Techniques
- Creative in completing the projects within given time

UNIT - V Contemporary Issues In Management

The concept of Management Information System (MIS) - Materials Requirement Planning (MRP) -

Customer Relations Management (CRM) - Total Quality Management (TQM) - Six Sigma Concept -

Supply Chain Management (SCM) - Enterprise Resource Planning (ERP) - Business Process

Outsourcing (BPO) - Business Process Re-engineering - knowledge Management.

LEARNING OUTCOMES At the end if the Unit, the learners will be able to

- Understand modern management techniques

- Apply Knowledge in Understanding in modern
- Analyze CRM, MRP, TQM
- Evaluate Six Sigma concept and SCM

Textbooks:

1. A.R Aryasri, Management Science, TMH, 2013
2. Stoner, Freeman, Gilbert, Management, Pearson Education, New Delhi, 2012.

Reference Books:

1. Koontz & Weihrich, Essentials of Management, 6/e, TMH, 2005.
2. Thomas N.Duening & John M.Ivancevich, Management Principles and Guidelines, Biztantra.

R 20 Regulations

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR, A.P. INDIA

3. Kanishka Bedi, Production and Operations Management, Oxford University Press, 2004.
4. Samuel C.Certo, Modern Management, 9/e, PHI, 2005

Online Learning Resources:

www.slideshare.net/jhayabesamis/chapter-1-the-nature-and-concept-of-management-

122625641 ?

www.slideshare.net/vivekpratapsingh14/school-of-management-thoughts ?

https://www.slideshare.net/89ajpaul/organizational-design-anf-structure

https://www.slideshare.net/sujeet2685/plant-layout-46555840#

https://www.slideshare.net/drmadhurverma/materials-38395397

https://www.slideshare.net/ShaliniShetty3/introduction-to-marketing-management-

72210724 ?

https://www.slideshare.net/srinidhiraman/human-resource-management-ppt-43320777

https://www.slideshare.net/wicaksana/training-and-development-33535063

https://www.slideshare.net/ayushijain107/strategic-management-ppt-58012275

| Course Code | BUSINESS ENVIRONMENT | L | T | P | C |
|---|---|---|---|---|---|
| 20A75401b | | 3 | 0 | 0 | 3 |
| Pre-requisite | Semester | | | | |

Course Objectives:

| | |
|---|---|
| 1. | To make the student understand about the business environment |
| 2. | To enable them in knowing the importance of fiscal and monitory policy |
| 3 | To facilitate them in understanding the export policy of the country |
| 4. | To Impart knowledge about the functioning and role of WTO |
| 5. | To Encourage the student in knowing the structure of stock markets |

Course Outcomes (CO): At the end of the course, students will be able to

| | |
|---|---|
| 1. | Define Business Environment and its Importance. |
| 2. | Understand various types of business environment. |
| 3 | Apply the knowledge of Money markets in future investment |
| 4 | Analyze India's Trade Policy |
| 5 | Evaluate fiscal and monitory policy |
| 6 | Develop a personal synthesis and approach for identifying business opportunities |

UNIT - I **Overview of Business Environment**

Introduction – meaning Nature, Scope, significance, functions and advantages. Types - Internal & External, Micro and Macro. Competitive structure of industries - Environmental analysis - advantages & limitations of environmental analysis & Characteristics of business.

**Learning Outcomes: -** After completion of this unit student will

- Understand the concept of Business environment
- Classify various types of business environment
- Evaluate the environmental analysis in business
- Discuss the Characteristics of Business.

UNIT - II **Fiscal Policy**

Introduction – Nature, meaning, significance, functions and advantages. Public Revenues - Public Expenditure - Public debt - Development activities financed by public expenditure - Evaluation of recent fiscal policy of GOI. Highlights of Budget - Monetary Policy - Demand and Supply of Money – RBI - Objectives of monetary and credit policy - Recent trends - Role of Finance Commission.

**Learning Outcomes: -** After completion of this unit student will

- Understand the concept of public revenue and public Expenditure
- Identify the functions of RBI and its role
- Analyze the Monitory policy in India
- Know the recent trends and the role of Finance Commission in the development of our country
- Differentiate between Fiscal and Monitory Policy

UNIT - III **India's Trade Policy**

Introduction – Nature, meaning, significance, functions and advantages. Magnitude and direction of Indian International Trade - Bilateral and Multilateral Trade Agreements - EXIM policy and role of EXIM bank - Balance of Payments– Structure & Major components - Causes for Disequilibrium in Balance of Payments - Correction measures.

**Learning Outcomes: -** After completion of this unit student will

- Understand the role of Indian international trade
- Understand and explain the need for Export and EXIM Policies
- Analyze causes for Disequilibrium and correction measure
- Differentiate between Bilateral and Multilateral Trade Agreements

UNIT - IV **World Trade Organization**

Introduction – Nature, meaning, significance, functions and advantages. Organization and Structure - Role and functions of WTO in promoting world trade - Agreements in the Uruguay Round – TRIPS, TRIMS, and GATT - Disputes Settlement Mechanism - Dumping and Anti-dumping Measures.

**Learning Outcomes: -** After completion of this unit student will

- Understand the role of WTO in trade
- Analyze Agreements on trade by WTO
- Understand the Dispute Settlement Mechanism
- Compare and contrast the Dumping and Anti-dumping Measures.

UNIT - V **Money Markets And Capital Markets**

Introduction – Nature, meaning, significance, functions and advantages. Features and components of Indian financial systems - Objectives, features and structure of money markets and capital markets - Reforms and recent development – SEBI - Stock Exchanges - Investor protection and role of SEBI.

**Learning Outcomes: -** After completion of this unit student will

- Understand the components of Indian financial system
- Know the structure of Money markets and Capital markets
- Analyze the Stock Markets
- Apply the knowledge in future investments
- Understand the role of SEBI in investor protection.

Textbooks:

1. Francis Cherunilam (2009), International Business: Text and Cases, Prentice Hall of India.
2. K. Aswathappa, Essentials of Business Environment: Texts and Cases & Exercises 13th Revised Edition.HPH2016

Reference Books:

1.K. V. Sivayya, V. B. M Das (2009), Indian Industrial Economy, Sultan Chand Publishers, New Delhi, India.
2. Sundaram, Black (2009), International Business Environment Text and Cases, Prentice Hall of India, New Delhi, India.
3. Chari. S. N (2009), International Business, Wiley India.
4.E. Bhattacharya (2009), International Business, Excel Publications, New Delhi.

Online Learning Resources:

| Course Code | ORGANIZATIONAL BEHAVIOUR | L | T | P | C |
|---|---|---|---|---|---|
| 20A75401c | | 3 | 0 | 0 | 3 |
| Pre-requisite | Semester | | | | |

Course Objectives:

| | |
|---|---|
| 1 | **To enable student's comprehension of organizational behavior** |
| 2 | **To offer knowledge to students on self-motivation, leadership and management** |
| 3 | **To facilitate them to become powerful leaders** |
| 4 | **To Impart knowledge about group dynamics** |
| 5 | **To make them understand the importance of change and development** |

**COURSE OUTCOMES:** At the end of the course, students will be able to

| | |
|---|---|
| 1 | Define the Organizational Behavior, its nature and scope |
| 2 | Understand the nature and concept of Organizational behavior |
| 3 | Apply theories of motivation to analyze the performance problems |
| 4 | Analyze the different theories of leadership |
| 5 | Evaluate group dynamics |
| 6 | Develop as powerful leader |

UNIT - I **Introduction**

Meaning, definition, nature, scope and functions - Organizing Process – Making organizing effective - Understanding Individual Behavior – Attitude - Perception - Learning – Personality.

**LEARNING OUTCOMES: -** After completion of this unit student will

- Understand the concept of Organizational Behavior
- Contrast and compare Individual & Group Behavior and attitude
- Evaluate personality types

UNIT - II **Motivation and Leading**

Theories of Motivation - Maslow's Hierarchy of Needs - Hertzberg's Two Factor Theory - Vroom's theory of expectancy - McClelland's theory of needs – Mc Gregor's theory X and theory Y – Adam's equity theory – Locke's goal setting theory – Alderfer's ERG theory - Leadership – research, theories, traits - Leaders Vs Managers.

**LEARNING OUTCOMES: -** After completion of this unit student will

- Understand the concept of Motivation
- Analyze the Theories of motivation
- Explain how employees are motivated according to Maslow's Needs Hierarchy

UNIT - III **Organizational Culture**

Introduction – Meaning, scope, definition, Nature - Organizational Climate - Leadership - Traits Theory–Managerial Grid - Transactional Vs Transformational Leadership - Qualities of good Leader - Conflict Management - Evaluating Leader - Women and Corporate leadership.

**LEARNING OUTCOMES: -** After completion of this unit student will

- Understand the concept of Leadership
- Contrast and compare Trait theory and Managerial Grid
- Distinguish the difference between Transactional and Transformational Leadership
- Evaluate the qualities of good leaders

UNIT - IV **Group Dynamics**

Introduction – Nature, Meaning, scope, definition and functions - Organizational Culture - Changing the Culture – Change Management – Work Stress Management - Organizational management – Managerial implications of organization's change and development

**LEARNING OUTCOMES: -** After completion of this unit student will

- Understand the importance of organizational change and development
- Apply change management in the organization
- Analyze work stress management
- Evaluate Managerial implications of organization

UNIT - V **Organizational Change and Development**

Introduction – Nature, Meaning, scope, definition and functions - Organizational Culture - Changing the Culture – Change Management – Work Stress Management - Organizational management – Managerial implications of organization's change and development

**LEARNING OUTCOMES: -** After completion of this unit student will

- Understand the importance of organizational change and development
- Apply change management in the organization
- Analyze work stress management
- Evaluate Managerial implications of organization

Textbooks:

1. Luthans, Fred, Organisational Behaviour, McGraw-Hill, 12 Th edition 2011 2. P Subba Rao, Organisational Behaviour, Himalya Publishing House 2017

Reference Books:

- McShane, Organizational Behaviour, TMH 2009
- Nelson, Organisational Behaviour, Thomson, 2009.
- Robbins, P.Stephen, Timothy A. Judge, Organisational Behaviour, Pearson 2009.
- Aswathappa, Organisational Behaviour, Himalaya, 2009

## Open Elective Course - III

| | | | | | |
|---|---|---|---|---|---|
| **Course Code** | **INDUSTRIAL POLLUTION CONTROL** | **L** | **T** | **P** | **C** |
| **20A70804** | **ENGINEERING** | **3** | **0** | **0** | **3** |
| **Pre-requisite** | **SemesterVII** | | | | |

Common to All Branches

Course Objectives:

Course Outcomes (CO):
At the end of the course, the student will be able to:

| | |
|---|---|
| CO1 | Understand the different types of wastes generated in an industry, their effects on living and non-living things & environmental regulatory legislations and standards and climate changes. |
| CO2 | Quantify, analyse and treat wastewater |
| CO3 | Apply the different unit operations and unit processes involved in conversion of highly polluted water to potable standards |
| CO4 | Apply the operating principles, design calculations of particulate control devices. |
| CO5 | Estimate the different waste generated from the industries |

**Course Articulation Matrix**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |
| CO6 | | | | | | | | | | | | |

UNIT - I

Types of emissions from chemical industries and effects of environment, environment legislation, Type of pollution, sources of wastewater, Effluent guidelines and standards. Characterization of effluent streams, oxygen demands and their determination (BOD, COD, and TOC), Oxygen sag curve, BOD curve mathematical, controlling of BOD curve, self purification of running streams, sources and characteristics of pollutants in fertilizer, paper and pulp industry, petroleum and petroleum industry.

UNIT - II

General methods of control and removal of sulfur dioxide, oxides of nitrogen and organic vapors from gaseous effluent, treatment of liquid and gaseous effluent in fertilizer industry. Air pollution sampling and measurement: Types of pollutant and sampling and measurement,ambient air sampling: collection of gaseous air pollutants, collection of particulate air pollutants. Stack sampling: sampling system, particulate sampling, and gaseous sampling. Analysis of air pollutants: Sulphur dioxide, nitrogen oxides, carbon monoxide, oxidants and ozones, hydrocarbons, particulate matter

UNIT - III
Air pollution control methods and equipments: Source collection methods: raw material changes, process changes, and equipment modification. Cleaning of gaseous equipments particulate emission control: collection efficiency, control equipment like gravitational settling chambers, Cyclone separators, fabric filters, ESP and their constructional details and design aspects. Scrubbers: wet scrubbers, spray towers, centrifugal scrubbers, packed beds and plate columns, venturi scrubbers, their design aspects. Control of gaseous emissions: absorption by liquids, absorption equipments, adsorption by solids, equipment and the design aspects

UNIT - IV
Introduction to waste water treatment, biological treatment of wastewater, bacterial and bacterial growth curve, aerobic processes, suspended growth processes, activated aerated lagoons and stabilization ponds, attached growth processes, trickling filters, rotary drum filters, anaerobic processes.

UNIT - V
Methods of primary treatments: screening, sedimentation, flotation, neutralization, and methods of tertiary treatment. A brief study of carbon absorption, ion exchange, reverse osmosis, ultra-filtration, chlorination, ozonation, treatment and disposal. Hazardous waste management: nuclear wastes: health and environment effects, sources and disposal methods. Chemical wastes: health and environmental effects, treatment and disposal: treatment and disposal by industry, off site treatment and disposal, treatment practices in various countries. Biomedical wastes: types of wastes and their control.

**Textbooks:**
1. Environmental Pollution and Control Engineering, C. S. Rao – Wiley Eastern Limited, India, New Delhi, 1993.
2. Pollution Control in Process Industries, S.P. Mahajan, Tata McGraw-Hill, New Delhi, 1985.

**Reference Books:**
1. Wastewater Treatment, M. Narayana Rao and A.K.Datta, Oxford and IHB publ. New Delhi.

**Online Learning Resources:**

Open Elective - IV

| | | | | | |
|---|---|---|---|---|---|
| **Course Code** | **SOLID WASTE MANAGEMENT** | **L** | **T** | **P** | **C** |
| **2070805** | | **3** | **0** | **0** | **3** |
| **Pre-requisite** | **SemesterVII** | | | | |

Common to All Branches

Course Objectives:

- Material flow in society and generation of solid waste source
- Clarification of solid waste on characterization of the same
- Understand the sense of onsite handling storage and collection systems including transportation
- Understand processing technologies with mechanical volume reduction and thermal volume reduction corporate land filling, deep well injections.
- Learn to estimate material recovery energy recovery from a given waste data using case standing

Course Outcomes (CO):

At the end of the course, the student will be able to:

| | |
|---|---|
| CO1 | Identify sources and relationship between various functional elements of solid waste management and methods of storage and collection and transport of solid wastes. |
| CO2 | Know the importance of transfer station and suggest suitable methods of solid waste disposal based on the composition of solid waste. |
| CO3 | Suggest suitable methods for the management of plastic and E-wastes |
| CO4 | Identify hazardous wastes and suggest suitable management techniques for radioactive wastes and Bio-medical wastes. |
| CO5 | Adopt the suitable management method for a given industry |

**Course Articulation Matrix**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |

UNIT - I

**Introduction:** Definition, characteristics and perspectives of solid waste. Types of solid waste. Physical and chemical characteristics. Variation of composition and characteristics. Municipal, industrial, special and hazardous wastes.

General aspects Overview of material flow in society. Reduction in raw material usage. Reduction in solid waste generation. Reuse and material recovery. General effects on health and environment. Legislations.

UNIT - II

**Engineered systems:** Typical generation rates. Estimation and factors effecting generation rates. On site handling. Storage and processing. Collection systems and devices. Transfer and transport.

UNIT - III

**Processing Techniques:** Mechanical volume reduction. Thermal volume reduction. Component separation. Land filling and land forming. Deep well injection.

UNIT - IV

**Material recovery:** Mechanical size alteration. Electromagnetic separation. Drying and dewatering. Other material recovery systems. Recovery of biological conversion products. Recovery of thermal conversion products.

**Energy recovery:** Energy recovery systems and efficiency factors. Determination of output and efficiency. Details of energy recovery systems. Combustion incineration and heat recovery. Gasification and pyrolysis. Refuse derived fuels (RDF).

UNIT - V

**Case studies:** Major industries and management methods used in typical industries – Coal fired power stations, textile industry, oil refinery, distillery, sugar industry, and radioactive waste generation units.

**Textbooks:**

1. Howard S. Peavy, Environmental Engineering, McGraw Hill International Edition, 1986.
2. Dutta, Industrial Solid Water Management and Land Filling Practice, Narose Publishing House, 1999.

**Reference Books:**

1. Sastry C.A., Waste Treatment Plants, Narose Publishing House, 1995.
2. Lagrega, Hazardous Waste Management, McGraw Hill, 1994.

**Online Learning Resources:**

**Skill Oriented Course - V**

| | | | | | |
|---|---|---|---|---|---|
| **Course Code** | **APPLICATIONS OF AI & ML IN CHEMICAL** | **L** | **T** | **P** | **C** |
| **20A70806** | **ENGINEERING** | **3** | **0** | **0** | **3** |
| **Pre-requisite** | **SemesterVII** | | | | |

Course Objectives:

- 

Course Outcomes (CO):
At the end of the course, the student will be able to:

| | |
|---|---|
| CO1 | Able to understand Artificial Intelligence (AI) principles to Chemical Engineering |
| CO2 | Able to understand Machine Learning (ML) principles to Chemical Engineering |
| CO3 | Able to understand the principle of Game Theory |
| CO4 | Ablet to use Probability and Bays' Theorem to real problems |
| CO5 | Able to use search techniques |

**Course Articulation Matrix**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |
| CO6 | | | | | | | | | | | | |

UNIT - I

**Introduction to Artificial Intelligence and Problem-Solving Agent**: Problems of AI, AI technique, Tic – Tac – Toe problem. Intelligent Agents, Agents & environment, nature of environment, structure of agents, goal-based agents, utility-based agents, learning agents. Defining the problem as state space search, production system, problem characteristics, and issues in the design of search programs.

UNIT - II

**Search Techniques**: Problem solving agents, searching for solutions; uniform search strategies: breadth first search, depth first search, depth limited search, bidirectional search, comparing uniform search strategies. Heuristic search strategies Greedy best -first search, A* search, AO* search, memory bounded heuristic search: local search algorithms & optimization problems: Hill climbing search, simulated annealing search, local beam search

UNIT - III

**Constraint Satisfaction Problems and Game Theory**: Local search for constraint satisfaction problems. Adversarial search, Games, optimal decisions & strategies in games, the minimax search procedure, alpha-beta pruning, additional refinements, iterative deepening

UNIT - IV

**Knowledge & Reasoning: Statistical Reasoning**: Probability and Bays' Theorem, Certainty Factors and Rule-Base Systems, Bayesian Networks, Dempster-Shafer Theory, Fuzzy Logic. AI for knowledge representation, rule-based knowledge representation, procedural and declarative knowledge, Logic programming, Forward and backward reasoning

UNIT - V

**Introduction to Machine Learning**: Exploring sub-discipline of AI: Machine Learning, Supervised learning, Unsupervised learning, Reinforcement learning, Classification problems, Regression problems, Clustering problems, Introduction to neural networks and deep learning

**Textbooks:**


1. S. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach", Prentice Hall, Third Edition, 2015.
2. Nils J. Nilsson, "Artificial Intelligence: A New Synthesis", 1st Edition, Morgan-Kaufmann, 1998.


**Reference Books:**


1. Elaine Rich, Kevin Knight, & Shivashankar B Nair, "Artificial Intelligence", McGraw Hill, 3rd ed.,2017.
2. Patterson, "Introduction to Artificial Intelligence & Expert Systems", Pearson, 1st ed. 2015.
3. Saroj Kaushik, "Logic &Prolog Programming", New Age International, Ist edition, 2002.
4. Joseph C. Giarratano,Gary D. Riley, "Expert Systems: Principles and Programming", 4th Edition, 2007.


**Online Learning Resources:**

| | | | | | |
|---|---|---|---|---|---|
| **Course Code 20A70807** | **EVALUATION OF INDUSTRY INTERNSHIP** | **L** | **T** | **P** | **C** |
| | **SemesterVII** | | | | |

Course Objectives:

Course Outcomes (CO):

List of Experiments:

References:

Online Learning Resources/Virtual Labs:

| | | |
|---|---|---|
| **Course Code 20A80101** | **FULL INTERNSHIP & PROJECT WORK** | **L T P C** |
| | **SemesterVIII** | |

Course Objectives:

Course Outcomes (CO):

List of Experiments:

References:

Online Learning Resources/Virtual Labs:

| | | | | | |
|---|---|---|---|---|---|
| **Course Code** | **TITLE OF THE COURSE** | **L** | **T** | **P** | **C** |
| | **Semester** | | | | |

Course Objectives:

Course Outcomes (CO):

List of Experiments:

References:

Online Learning Resources/Virtual Labs:

## JNTUA College of Engineering (Autonomous), Ananthapuramu

## Open Elective Course – I Civil

**III B.TECH – I SEMESTER (R20) (common to all branches) - 2020 Admitted Batch**

| Course Code | Experimental Stress Analysis | L | T | P | C |
|---|---|---|---|---|---|
| 20A50105 | | 3 | 0 | 0 | 3 |
| | Semester | V | | | |

Course Objectives:

1. To understand different methods of experimental stress analysis
2. To understand the use of strain gauges for measurement of strain
3. To be exposed to different Non destructive methods of concrete
4. To understand the theory of photo elasticity and its applications in analysis of structures
5. To understand different methods of photo elasticity

Course Outcomes (CO):

1. Understand different methods of experimental stress analysis
2. Understand the use of strain gauges for measurement of strain
3. Expose to different Non destructive methods of concrete
4. Understand the theory of photo elasticity and its applications in analysis of structures
5. Understand different methods of photo elasticity

UNIT - I

**PRINCIPLES OF EXPERIMENTAL APPROACH**:Merits of Experimental Analysis Introduction, uses of experimental stress analysisAdvantages of experimental stress analysis, Different methods –Simplification of problems.

UNIT - II

**STRAIN MEASUREMENT USING STRAIN GAUGES** :Definition of strain and its relation of experimental Determinations Properties of Strain-

Gauge Systems-Types of Strain Gauges –Mechanical, Acoustic and Optical Strain Gauges. Introduction to Electrical strain gauges - Inductance strain gauges – LVDT – Resistance strain gauges – Various types –Gauge factor – Materials of adhesion base.

UNIT - III

**STRAIN ROSSETTES AND NON – DESTRUCTIVE TESTING OF CONCRETE:** Introduction – The three elements Rectangular Rosette – The Delta Rosette Corrections for Transverse Strain Gauge.

Ultrasonic Pulse Velocity method –Application to Concrete. Hammer Test – Application to Concrete.

UNIT - IV

**THEORY OF PHOTOELASTICITY**: Introduction –Temporary Double refraction – The stress Optic Law –Effects of stressed model in a polar scope for various arrangements – Fringe Sharpening. Brewster's Stress Optic law.

UNIT - V

**TWO DIMENSIONAL PHOTOELASTICITY**:Introduction – Isochramic Fringe patterns- Isoclinic Fringe patterns passage of light through plane Polariscope and Circular polariscope Isoclinic Fringe patterns – Compensation techniques – Calibration methods – Separation methods – Scaling Model to prototype Stresses – Materials for photo – Elasticity Properties of Photoelastic Materials.

Textbooks:

1. Experimental stress analysis by J.W.Dally and W.F.Riley, College House Enterprises2005
2. Experimental stress analysis by Dr.SadhuSingh.khanna Publishers 4th edition

Reference Books:

1. Experimental Stress analysis by U.C.Jindal, Pearson Pubilications 2012 edition
2. Experimental Stress Analysis by L.S.Srinath, MC.Graw Hill Company Publishers.

Online Learning Resources:

## Open Elective Course – I EEE

**III B.TECH – I SEMESTER (R20) (common to all branches) - 2020 Admitted Batch**

| **Course Code** | **ELECTRIC VEHICLE ENGINEERING (OE-I) EEE** | | **L** | **T** | **P** | **C** |
|---|---|---|---|---|---|---|
| **20A50205** | | | **3** | **0** | **0** | **3** |
| **Pre-requisite** | AC & DC Machines | **Semester** | **V** | | | |

**Course Objectives:** The student will be able to:

- Understand latest trends in Electric Vehicles; parameters used in EV and types of EVs.
- Analyze various energy sources available to run EV like batteries, fuels cells etc.
- Analyze the dynamics and the propulsion system used in EVs, working of fuel cells, battery charging concept.
- Design a electromechanical system using various control techniques.

**Course Outcomes (CO):** At the end of the course, the student will be able to:

**CO1:** Understand the difference between conventional and latest trends in Electric Vehicles; understand the various parameters used in EV, types of HEVs.

**CO2:**Analyze various energy sources available to run EV like batteries, fuels cells etc.

**CO3:**Analyze the propulsion system of EV, its dynamics and the concept of battery charging.

**CO4:** Design EV system with battery charger using various fundamental concepts.

| **UNIT - I** | **INTRODUCTION TO EV SYSTEMS AND PARAMETERS** | **Lecture Hrs: 10** |
|---|---|---|

Past, Present and Future EV, EV Concept, EV Technology, State-of-the Art EVs, EV configuration, EV system, Fixed and Variable gearing, single and multiple motor drive, in-wheel drives, EV parameters: Weight, size, force and energy, performance parameters.

| **UNIT - II** | **EV AND ENERGY SOURCES** | **Lecture Hrs: 08** |
|---|---|---|

Electro mobility and the environment, history of Electric power trains, carbon emissions from fuels, green houses and pollutants, comparison of conventional, battery, hybrid and fuel cell electric systems

| **UNIT - III** | **EV PROPULSION AND DYNAMICS** | **Lecture Hrs: 10** |
|---|---|---|

Choice of electric propulsion system, block diagram, concept of EV Motors, single and multi motor configurations, fixed and variable geared transmission, In-wheel motor configuration, classification, Electric motors used in current vehicle applications, Recent EV Motors, Vehicle load factors, vehicle acceleration.

| UNIT - IV | FUEL CELLS | Lecture Hrs: 10 |
|---|---|---|
| Introduction of fuel cells, basic operation, model, voltage, power and efficiency, power plant system – characteristics, sizing, Example of fuel cell electric vehicle.<br><br>Introduction to HEV, brake specific fuel consumption, comparison of series, series-parallel hybrid systems, examples | | |
| **UNIT - V** | **BATTERY CHARGING AND VEHICLE CONTROL** | **Lecture Hrs: 10** |
| **Battery charging:** Battery Chemistry, Basic requirements, charger architecture, charger functions, wireless charging, power factor correction.<br><br>**Battery Management System:** Introduction and BMS functionality, Battery pack topology, Voltage, Temperature and Current Sensing.<br><br>**Control:** Introduction, modelling of electro mechanical system, feedback controller design approach, PI controllers designing, torque-loop, speed control loop compensation, acceleration of battery electric vehicle | | |

**Textbooks:** C.C Chan, K.T Chau: Modern Electric Vehicle Technology, Oxford University Press Inc., New York 2001.

1. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.

**Reference Books:**

1. Electric and Hybrid Vehicles Design Fundamentals, Iqbal Husain, CRC Press 2005.
2. Ali Emadi, Advanced Electric Drive Vehicles, CRC Press, 2015.
3. Tom Denton, "Electric and Hybrid Vehicles", TAYLOR & FRANCIS; 2nd edition, CBS PUBLISHERS, 2$^{nd}$ Edition, 2020.
4. MehrdadEhsani, Yimin Gao, Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals", CRC Press, 2010.
5. Bergveld, H.J., Kruijt, W.S., Notten, P.H.L "Battery Management Systems -Design by Modelling" Philips Research Book Series 2002.

**Online Learning Resources:**

1. https://onlinecourses.nptel.ac.in/noc22_ee53/preview

## JNTUA College of Engineering (Autonomous), Ananthapuramu

## Open Elective Course – I Mechanical

**III B.TECH – I SEMESTER (R20) (common to all branches) - 2020 Admitted Batch**

| Subject Code | Title of the Subject | L | T | P | C |
|---|---|---|---|---|---|
| 2050305 | **OPTIMIZATION TECHNIQUES** | 3 | 0 | 0 | 3 |

**Course Objectives:**

To introduce various optimization techniques i.e classical, linear programming,

Transportation problem, simplex algorithm, dynamic programming Constrained and unconstrained optimization techniques for solving and optimizing.

Electrical and electronic engineering circuits design problems in real world situations.

To explain the concept of Dynamic programming and its applications to project

Learn the knowledge to formulate optimization problems

**UNIT - I**

**Classical optimization techniques:** Single variable optimization with and without constraints, multi – variable optimization without constraints, multi – variable optimization with constraints– method of Lagrange multipliers, Kuhn-Tucker conditions.

**UNIT - II**

**Numerical methods for optimization:**Nelder Mead's Simplex search method, Gradient of a function, Steepest descent method, Newton's method, types of penalty methods for handling constraints.

**UNIT - III**

**Genetic algorithm (GA) :** Differences and similarities between conventional and evolutionary algorithms, working principle, reproduction, crossover, mutation, termination criteria, different reproduction and crossover operators, GA for constrained optimization, draw backs of GA,

**Multi-Objective GA:** Pareto's analysis, Non-dominated front, multi – objective GA, Non-dominated sorted GA, convergence criterion, applications of multi-objective problems

**UNIT – IV**

**Genetic Programming (GP):** Principles of genetic programming, terminal sets, functional sets, differences between GA & GP, random population generation, solving differential equations using GP.

**UNIT V**

**Applications of Optimization in Design and Manufacturing systems:** Some typical applications like optimization of path synthesis of a four-bar mechanism, minimization of weight of a cantilever beam and general optimization model of a machining process.

**Course Outcomes**:

After completion of this course, the student will be able to explain the need of optimization of engineering systems understand optimization of electrical and electronics engineering problems

apply classical optimization techniques, linear programming, simplex algorithm,

• transportation problem apply unconstrained optimization and constrained non-linear programming anddynamic programming Formulate optimization problems.

**TEXT BOOKS:**

Optimal design – Jasbir Arora, Mc Graw Hill (International) Publishers

Optimization for Engineering Design – Kalyanmoy Deb, PHI Publishers

Engineering Optimization – S.S.Rao, New Age Publishers

**REFERENCES:**

1.Genetic algorithms in Search, Optimization, and Machine learning – D.E.Goldberg, Addison-Wesley Publishers

Genetic Programming- Koza

Multi objective Genetic algorithms - Kalyanmoy Deb, PHI Publishers

## JNTUA College of Engineering (Autonomous), Ananthapuramu

## Open Elective Course – I ECE

**III B.TECH – I SEMESTER (R20) (common to all branches) - 2020 Admitted Batch**

| | | | | | |
|---|---|---|---|---|---|
| **Course Code** | **BASICS OF ELECTRONICS AND** | **L** | **T** | **P** | **C** |
| **20A50405** | **COMMUNICATION ENGINEERING** | 3 | 0 | 0 | 3 |
| | **Semester** | **V** | | | |

**Pre-requisite**

Applied Physics

**Course Objectives:**

- To study the basic principle, construction and operation of semiconductor devices.
- To learn the real time applications of semiconductor devices.
- To introduce binary number systems, logic gates and digital logic circuits.
- To get an idea about the basic principles of communication systems and their applications.
- To learn the measurement of physical parameters using Sensors and Transducers.

**Course Outcomes (CO):** At the end of this course, the students will be able to

- Understand the basic principle, construction and operation of semiconductor devices.
- Learn the real time applications of semiconductor devices.
- Comprehend the binary number systems, logic gates and digital logic circuits.
- Understand the basic principles of communication systems and their applications.
- Measure the physical parameters using Sensors and Transducers.

**UNIT - I**

**Introduction to Electronics Engineering:** Overview, scope and objective of studying Electronics Engineering. Introduction to semiconductor devices: Bond structure of semiconductors, intrinsic and extrinsic semiconductors; Basic principle and operation of semiconductor devices – diode, bipolar junction transistor, field effect transistors; Introduction to VLSI.

**UNIT - II**

**Applications of semiconductor devices:** Basic concepts of rectifiers, voltage regulators, amplifiers and oscillators; Basic concepts of operational amplifier and their applications.

**UNIT - III**

**Introduction to digital systems:** Binary number system, Boolean algebra, Logic gates, adders, one-bit memory, flip-flops (SR, JK), shift registers, Asynchronous counter.

**UNIT - IV**

**Introduction to Communication Systems:** Elements of a communication system – transmitter and receiver; Signal types in communication; FDM and TDM; Processing of signals for transmission – basic concepts of amplitude and frequency modulation; Examples of telecommunication systems – telephone, radio, television, mobile communication and satellite communication.

**UNIT - V**

**Sensors and Transducers** - Active and passive transducers: Measurement of displacement (Resistance, capacitance, inductance; LVDT) Force (strain gauges) Pressure (piezoelectric transducers) Temperature (resistance thermometers, thermocouples and thermistors), Velocity, Acceleration, Vibration, pH measurement Signal Conditioning Circuits.

**Textbooks:**


1. Millman J, Halkias C.C and Jit S, "Electronic Devices and Circuits", Tata McGraw-Hill, 2nd 2007 Edition.
2. Mano M.M., "Digital Design", Prentice-Hall, 3rd Edition. 2002
3. A.K. Sawhney, "A course in Electrical and Electronics Measurements and Instrumentation", DhanpatRai& Co. 3rd edition Delhi, 2010.
4. Kennedy G. and Davis B., "Electronic Communication Systems", Tata McGraw-Hill, 4th 2008 Edition.


**Reference Books:**


1. Tomasi W., "Advanced Electronic Communication Systems", Pearson/Prentice-Hall, 6th 2004 Edition.
2. Boylstead R.L. and Nashelsky L., "Electronic Devices and Circuit Theory", Pearson, 10th 2009 Edition.

Online Learning Resources:

## JNTUA College of Engineering (Autonomous), Ananthapuramu

## Open Elective Course – I CSE

**III B.TECH – I SEMESTER (R20) (common to all branches) - 2020 Admitted Batch**

### INTRODUCTION TO JAVA PROGRAMMING

**Course Code:20A50505** **Semester V(R20)** **L T P C : 3 0 0 3**

**Course Objectives**:

- To understand object-oriented concepts and problem-solving techniques
- To obtain knowledge about the principles of inheritance and polymorphism
- To implement the concept of packages, interfaces, exception handling and concurrency mechanism.
- To design the GUIs using applets and swing controls.
- To understand the Java Database Connectivity Architecture

**Course Outcomes:**

CO1: Solve real-world problems using OOP techniques.
CO2: Apply code reusability through inheritance, packages and interfaces

CO3: Solve problems using java collection framework and I/O classes.
CO4: Develop applications by using parallel streams for better performance and develop applets for web applications.
CO5: Build GUIs and handle events generated by user interactions and Use the JDBC API to access the database.

UNIT – I: **Introduction**

Introduction to Object Oriented Programming, The History and Evolution of Java, Introduction to Classes, Objects, Methods, Constructors, this keyword, Garbage Collection, Data Types, Variables, Type Conversion and Casting, Arrays, Operators, Control Statements, Method Overloading, Constructor Overloading, Parameter Passing, Recursion, String Class and String handling methods.

UNIT – II: **Inheritance, Packages, Interfaces**

Inheritance: Basics, Using Super, Creating Multilevel hierarchy, Method overriding, Dynamic Method Dispatch, Using Abstract classes, Using final with inheritance, Object class,
Packages: Basics, Finding packages and CLASSPATH, Access Protection, Importing packages.
Interfaces: Definition, Implementing Interfaces, Extending Interfaces, Nested Interfaces, Applying Interfaces, Variables in Interfaces.

UNIT – III: **Exception handling, Stream based I/O**

Exception handling - Fundamentals, Exception types, Uncaught exceptions, using try and catch, multiple catch clauses, nested try statements, throw, throws and finally, built-in exceptions, creating own exception subclasses.

Stream based I/O (java.io) – The Stream classes-Byte streams and Character streams, Reading console Input and Writing Console Output, File class, Reading and Writing Files, Random access file operations, The Console class, Serialization, Enumerations, Autoboxing, Generics.

UNIT – IV: **Multithreading, The Collections Framework**

Multithreading: The Java thread model, Creating threads, Thread priorities, Synchronizing threads, Interthread communication.

The Collections Framework (java.util): Collections overview, Collection Interfaces, The Collectionclasses- Array List, Linked List, Hash Set, Tree Set, Priority Queue, Array Deque. Hashtable, Properties, Stack, Vector, String Tokenizer, Bit Set, Date, Calendar, Random, Formatter, Scanner.

UNIT – V: **Applet, GUI Programming with Swings, Accessing Databases with JDBC**

Applet: Basics, Architecture, Applet Skeleton, requesting repainting, using the status window, passing parameters to applets

GUI Programming with Swings – The origin and design philosophy of swing, components and containers, layout managers, event handling, using a push button, jtextfield, jlabel and image icon, the swing buttons, jtext field, jscrollpane, jlist, jcombobox, trees, jtable, An overview of jmenubar, jmenu and jmenuitem, creating a main menu, show message dialog, show confirmdialog, show input dialog, show option dialog, jdialog, create a modeless dialog.

Accessing Databases with JDBC:

Types of Drivers, JDBC Architecture, JDBC classes and Interfaces, Basic steps in developing JDBC applications, Creating a new database and table with JDBC.

**Textbooks**:


1. Java The complete reference, 9th edition, Herbert Schildt, McGraw Hill Education (India) Pvt. Ltd.
2. Java How to Program, 10th Edition, Paul Dietel, Harvey Dietel, Pearson Education.


**Reference Books:**


1. Understanding Object-Oriented Programming with Java, updated edition, T. Budd, Pearson Education.
2. Core Java Volume – 1 Fundamentals, Cay S. Horstmann, Pearson Education.
3. Java Programming for core and advanced learners, Sagayaraj, Dennis, KarthikandGajalakshmi, University Press
4. Introduction to Java programming, Y. Daniel Liang, Pearson Education

## JNTUA College of Engineering (Autonomous), Ananthapuramu

## Open Elective Course – I Chemical

**III B.TECH – I SEMESTER (R20) (common to all branches) - 2020 Admitted Batch**

| Course Code | | L | T | P | C |
|---|---|---|---|---|---|
| **20A50805** | **ENERGY CONVERSION AND STORAGE DEVICES** | **3** | **0** | **0** | **3** |

**Pre-requisite**

Course Objectives:

4. Understand the fundamentals of fossil energy sources, solar, biomass and electrochemical energy etc
5. Understand the basics of photosynthetic, photocatalytic and photoelectrochemical systems and devices for the efficient energy and fuels production.
6. Learn the principles and operations of electrochemical energy storage devices,

Course Outcomes (CO):

At the end of the course, the student will be able to:

CO1 Understand the need of energyconversion and the various methods of energy storage

CO2 Identify Winds energy as alternateform of energy and to know how itcan be tapped

CO3 Understand the nuclear and bio energy, its mechanism of production and its applications

CO4 Analyse chemical, electrochemical energy storage devices and interpret the conversion efficiencies

CO5 Explain bio gas generation and itsimpact on environment

**Course Articulation Matrix**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |
| CO6 | | | | | | | | | | | | |

**UNIT - I**

**Outline of the course**. Introduction and scope of energy conversion. World Energy Production and Balance. Motivations for studying future energy systems (e.g. pollution, climate change, energy security).

**UNIT - II**

**Fossil Energy**: Overview of fossil fuel resources and energy contents. Cycle analysis (Rankine, Brayton, combined cycles, cogeneration)

Nuclear Energy: nuclear reaction and energy conversion physics (fission and fusion), nuclear power systems

**UNIT - III**

**Solar-thermal energy**: solar thermal radiation physics, Active and passive solar-thermal energy collection and conversion systems

**Photoelectric energy**: Photoelectric physics. Solar photovoltaic cell materials and technology

**Wind Energy:** Wind interaction with objects fluid dynamics. Wind harvesting devices and systems

**UNIT - IV**

**Biomass and Waste to Energy**: Potential and resources of biomass and waste energy. Thermal-chemical and bio-chemical conversion methods

Overview of Climate Control, $CO_2$ Sequestration and Energy Sustainability

**UNIT - V**

Basic of Electrochemical energy conversion and storage, Fundamentals of Fuel Cells, Basics of Fusion power, Energy Storage Technologies, Mechanical storage, Chemical storage, Electrical storage

**Textbooks**:

Energy Systems Engineering, F.M. Vanek, L.D Albright, and LargusAngenent, Second Edition, McGraw-Hill, Inc., 2012,

**Reference Books**:

- AngèleReinders, Pierre Verlinden, Wilfried van Sark, Alexandre Freundlich, Photovoltaic Solar Energy:From Fundamentals to Applications, JOHN WILEY.
- Alexander P. Kirk, Solar Photovoltaic Cells: Photons to Electricity, ELSEVIER
- Francesco Dalena, Angelo Basile, Claudio Rossi, Bioenergy Systems For The Future: Prospects ForBiofuels And Biohydrogen, 1st Edition, ELSEVIER
- Jean-Marie Tarascon, Patrice Simon, ELECTROCHEMICAL ENERGY STORAGE,
- Electrochemistry by Carl H. Hamann, Andrew Hamnett and Wolf Vielstich, Wiley VCH, 1998.
- Modern Electrochemistry 1. Volume 1 and 2, by J. O'M. Bockris and A. K. N. Reddy, Kluwer Academic,2000.
- Electrochemical Methods, by A. J. Bard and L. R. Faulkner, John Willey, 1980
- John Love and John A. Bryant, Biofuels and Bioenergy, John Wiley
- Anju Dahiya, Bioenergy: Biomass to Biofuels, Elsevier

**JNTUA College of Engineering (Autonomous), Ananthapuramu**

**Open Elective Course – I Mathematics**

**III B.TECH – I SEMESTER (R20) (common to all branches) - 2020 Admitted Batch**

| | | | | | | |
|---|---|---|---|---|---|---|
| **Course Code** | **Optimization Methods** | | **L** | **T** | **P** | **C** |
| **20A55101** | **B.Tech III Year (Common for all) Open elective course -1** | | **0** | **3** | **0** | **3** |
| **Pre-requisite** | **--** | **Semester** | **I** | | | |
| | | | | | | |
| Course Objectives: | | | | | | |
| This course enables the students to classify and formulate real-life problem for modeling as optimization problem, solving and applying for decision making. | | | | | | |
| Course Outcomes (CO): Student will be able to | | | | | | |
| • formulate a linear programming problem and solve it by various methods.<br>• give an optimal solution in assignment jobs, give transportation of items from sources to destinations.<br>• identify strategies in a game for optimal profit.<br>• implement project planning. | | | | | | |
| UNIT - I | | | 8 Hrs | | | |
| Introduction to operational research-Linear programming problems (LPP)-Graphical method-Simplex method-Big M Method-Dual simplex method. | | | | | | |
| UNIT - II | | | 8 Hrs | | | |
| Transportation problems- assignment problems-Game theory. | | | | | | |
| UNIT - III | | | 9 Hrs | | | |
| CPM and PERT –Network diagram-Events and activities-Project Planning-Reducing critical events and activities-Critical path calculations. | | | | | | |
| UNIT - IV | | | 8 Hrs | | | |
| Sequencing Problems-Replacement problems-Capital equipment- Discounting costs-Group replacement . | | | | | | |
| UNIT - V | | | 9 Hrs | | | |
| Inventory models-various costs- Deterministic inventory models-Economic lot size-Stochastic inventory models- Single period inventory models with shortage cost. | | | | | | |
| Textbooks: | | | | | | |

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|---|
| **1.** Operations Research , S.D. Sharma.<br>**2.** Operations Research, An Introduction, Hamdy A. Taha, Pearson publishers.<br>**3.** Operations Research, Nita H Shah, Ravi M Gor, HardikSoni, PHI publishers |
| Reference Books: |
| 1. Problems on Operations Research, Er. Premkumargupta, Dr.D.S. Hira, Chand publishers<br>2. Operations Research, CB Gupta, PK Dwivedi, Sunil kumaryadav |
| Online Learning Resources: |
| https://nptel.ac.in/content/storage2/courses/105108127/pdf/Module_1/M1L2slides.pdf<br>https://slideplayer.com/slide/7790901/<br>https://www.ime.unicamp.br/~andreani/MS515/capitulo12.pdf |

**JNTUA College of Engineering (Autonomous), Ananthapuramu**

**Open Elective Course – I Physics**

**III B.TECH – I SEMESTER (R20) (common to all branches) - 2020 Admitted Batch**

| Subject Code | Title of the Subject | L | T | P | C |
|---|---|---|---|---|---|
| 20A55201 | **MATERIALS CHARACTERIZATION TECHNIQUES** | 3 | | - | 3 |

| **COURSE OBJECTIVES** | |
|---|---|
| 1 | To provide an exposure to different characterization techniques. |
| 2 | To explain the basic principles and analysis of different spectroscopic techniques. |
| 3 | To elucidate the basic principle of Scanning electron microscope along with its limitations and applications. |
| 4 | To identify the Resolving power and Magnification of Transmission electron microscope and its applications. |
| 5 | To educate the uses of advanced electric and magnetic instruments for characterization. |
| **COURSE OUTCOMES** | |
| At the end of the course the student will be able | |
| CO1 | To explain the structural analysis by X-ray diffraction. |
| CO2 | To understand the morphology of different materials using SEM and TEM. |
| CO3 | To recognize basic principles of various spectroscopic techniques. |
| CO4 | To apprehend the electric and magnetic properties of the materials. |
| CO5 | To make out which technique has to be used to analyse a material |

**Mapping between Course Outcomes and Programme Outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |

**SYLLABUS**

**Credit: 3** **Hours of teaching: - 45 H**

**UNIT-I** **9H**

**Structure analysis by Powder X-Ray Diffraction**: Introduction, Bragg's law of diffraction, Intensity of Diffracted beams, Factors affecting Diffraction, Intensities, Structure of polycrystalline Aggregates, Determination of crystal structure,Crystallite size by Scherrer and Williamson-Hall (W-H) Methods, Small angle X-ray scattering (SAXS) (in brief).

**UNIT-II** **9H**

**Microscopy technique -1 –Scanning Electron Microscopy (SEM)**

Introduction, Principle, Construction and working principle of Scanning Electron Microscopy, Specimen preparation, Different types of modes used (SecondaryElectron and Backscatter Electron), Advantages, limitations and applications of SEM.

**UNIT-III** **9H**

**Microscopy Technique -2 - Transmission Electron Microscopy (TEM)**: Construction and Working principle, Resolving power and Magnification, Bright and dark fields, Diffraction and image formation, Specimen preparation, Selected Area Diffraction, Applications of Transmission Electron Microscopy,Difference between SEM and TEM, Advantage and Limitations of Transmission Electron Microscopy.

**UNIT-IV** **9H**

**Spectroscopy techniques** – Principle, Experimental arrangement, Analysis and advantages of the spectroscopic techniques – (i) UV-Visible spectroscopy(ii) Raman Spectroscopy, (iii) Fourier Transform infrared (FTIR) spectroscopy, (iv) X-ray photoelectron spectroscopy (XPS).

**UNIT-V** **9H**

**Electrical & Magnetic Characterization techniques:**Electrical Properties analysis techniques (DC conductivity, AC conductivity) Activation Energy, Effect of Magnetic field on the electrical properties (Hall Effect). Magnetization measurement by induction method,Vibrating sample Magnetometer (VSM) and SQUID.

**TEXT BOOKS:**

1. Material Characterization: Introduction to Microscopic and Spectroscopic Methods –Yang

Leng – John Wiley & Sons (Asia) Pvt. Ltd. 2008

2. Hand book of Materials Characterization -by **Sharma** S. K. - S**pringer**

**REFERENCES:**

1. Fundamentals of Molecular Spectroscopy – IV Ed. – Colin Neville BanwellandElaine M.

McCash, Tata McGraw-Hill, 2008.

2. Elements of X-ray diffraction – Bernard Dennis Cullity& Stuart R Stocks, PrenticeHall, 2001 – Science

3. Materials Characterization: Introduction to Microscopic and Spectroscopic Methods-Yang Leng- John Wiley & Sons

4. Characterization of Materials 2nd Edition, 3 Volumes-Kaufmann E N -John Wiley(Bp)

5. Microstructural Characterization of Materials - David Brandon, Wayne D Kalpan,John Wiley & Sons Ltd., 2008.

**NPTEL courses**

https://nptel.ac.in/courses/115/103/115103030/

https://nptel.ac.in/content/syllabus_pdf/113106034.pdf

https://nptel.ac.in/noc/courses/noc19/SEM1/noc19-mm08/

## JNTUA College of Engineering (Autonomous), Ananthapuramu

## Open Elective Course – I H & SS

**III B.TECH – I SEMESTER (R20) (common to all branches) - 2020 Admitted Batch**

**DEPARTMENT OF HUMANITIES & SOCIAL SCIENCES**

| Course Code | E-Business | L | T | P | C |
|---|---|---|---|---|---|
| 20A55401 | | 3 | 0 | 0 | 3 |
| Pre-requisite | | | | | |

Course Objectives:

| | |
|---|---|
| 1. | To provide knowledge on emerging concept on E-Business related aspect. |
| 2. | To understand various electronic markets models which are trending in India |
| 3. | To give detailed information about electronic payment systems net banking. |
| 4. | To exact awareness on internet advertising, market research strategies and supply chain management. |
| 5. | To understand about various internet protocols-security related concept. |

Course Outcomes (CO):

| | |
|---|---|
| 1 | They will be able to identify the priority of E-Commerce in the present globalised world. |
| 2 | Will be able to understand E-market-Models which are practicing by the organization |
| 3. | Will be able to recognize various E-payment systems & importance of net banking. |
| 4. | By knowing E-advertisement, market research strategies, they can identify the importance of customer role. |
| 5. | By understanding about E-security, they can ensure better access control to secure the information |
| 6 | Develop a personal synthesis and approach towards E-Business |

UNIT – I **Electronic Business**

Definition of Electronic Business - Functions of Electronic Commerce (EC) - Advantages of E-Commerce – E-Commerce and E-Business Internet Services Online Shopping-Commerce Opportunities for Industries.

**LEARNING OUTCOMES:-** After completion of this unit student will

- Understand the concept of E-Business
- Contrast and compare E-Commerce E-Business
- Analyze Advantages of E-Commerce
- Evaluate opportunities of E-commerce for industry

UNIT - II **Electronic Markets and Business Models**

E-Shops-E-Malls E-Groceries - Portals - Vertical Portals-Horizontal Portals - Advantages of Portals - Business Models-Business to Business(B2B)-Business to Customers(B2C)-Business to Government(B2G)-Auctions-B2B Portals in India

**LEARNING OUTCOMES:-** After completion of this unit student will

- Understand the concept of business models
- Contrast and compare Vertical portal and Horizontal portals
- Analyze Advantages of portals

- Explain the B2B,B2C and B2G model

UNIT - III **III Electronic Payment Systems**

Digital Payment Requirements-Designing E-payment System- Electronic Fund Transfer (EFT)-Electronic Data Interchange (EDT)-Credit Cards-Debit Cards-E-Cash-Electronic Cheques -Smart Cards-Net Banking-Digital Signature.

**LEARNING OUTCOMES:-** After completion of this unit student will

- Understand the Electronic payment system
- Contrast and compare EFT and EDT
- Analyze debit card and credit card
- Explain the on Digital signature

UNIT - IV **E-Security**

Internet Protocols - Security on the Internet –Network and Website Security – Firewalls – Encryption – Access Control – Secure Electronic transactions.

**LEARNING OUTCOMES:-** After completion of this unit student will

- Understand E-Security
- Contrast and compare security and network
- Analyze Encryption
- Evaluate electronic transitions

UNIT - V **E-Marketing**

Online Marketing – Advantages of Online Marketing – Internet Advertisement – Advertisement Methods – Conducting Online Online Market Research– Data mining and Marketing Research Marketing Strategy On the Web – E-Customer Relationship Management(e-CRM) –E- Supply Chain Management.(e-SCM) –New Trends in Supply Chain Management.

**LEARNING OUTCOMES:-** After completion of this unit student will

- Understand the concept of online marketing
- Analyze advantages of online marketing
- Compare the e-CRM and e-SCM
- Explain the New trends in supply chain management

Textbooks:

1. **E-Commerce by C.S.V Murthy** Himalaya publication house, 2002.
2. **E-Commerce by** P.T.S Joseph, Fourth Edition, Prentice Hall of India 2011

Reference Books:

1. **E-Commerce: by** KamaleshKBajaj,DebjaniNa, Second Edition TataMcGrwHills 2005
2. **E-Commerce E-Management: by Dave Chaffey** – Second Edition, Pearson, 2012.
3. **E-Commerce Fundamentals and Application; by** Henry Chan, Raymond Lee,Tharm Wiley India 2007
4. **E-Commerce: by** S. Jaiswall Galgotia Publication Pvt Ltd 2003.

Online Learning Resources:

## JNTUA College of Engineering (Autonomous), Ananthapuramu
## Open Elective Course – I

**III B.TECH – I SEMESTER (R20) (common to all branches) - 2020 Admitted Batch**
**DEPARTMENT OF CHEMISTRY**

| Subject Code | Title of the Subject | L | T | P | C |
|---|---|---|---|---|---|
| 20A55301 | **CHEMISTRY OF ENERGY MATERIALS** | 2 | 1 | - | 3 |

| **COURSE OBJECTIVES** | |
|---|---|
| 1 | To make the student understand basic electrochemical principles such as standard electrode potentials, emf and applications of electrochemical principles in the design of batteries. |

| | |
|---|---|
| 2 | To understand the basic concepts of processing and limitations of fossil fuels and Fuel cells & their applications. |
| 3 | To impart knowledge to the students about fundamental concepts of hydrogen storage in different materials and liquification method |
| 4 | Necessasity of harnessing alternate energy resources such as solar energy and its basic concepts. |
| 5 | To understand and apply the basics of calculations related to material and energy flow in the processes. |

| COURSE OUTCOMES | |
|---|---|
| CO1 | Solve the problems based on electrode potential,Describe the Galvanic Cell Differentiate between Lead acid and Lithium ion batteries, Illustrate the electrical double layer |
| CO2 | Describe the working Principle of Fuel cell,Explain the efficiency of the fuel cell<br>Discuss about the Basic design of fuel cells,Classify the fuel cell |
| CO3 | Differentiate Chemical and Physical methods of hydrogen storage,Discuss the metal organic frame work, Illustrate the carbon and metal oxide porous structures<br>Describe the liquification methods |
| CO4 | Apply the photo voltaic technology,Demonstrate about solar energy and prospects<br>Illustrate the Solar cells,Discuss about concentrated solar power |
| CO5 | Differentiate between Photo and Photo electrochemical Conversions,Illustrate the photochemical cells, Identify the applications of photochemical reactions, Interpret advantages of photoelectron catalytic conversion |

**Mapping between Course Outcomes and Programme Outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |

## SYLLABUS

**UNIT-1: Electrochemical Systems:** Galvanic cell, standard electrode potential, application of EMF, electrical double layer, dipole moments, polarization, Batteries-Lead-acid and Lithium ion batteries**.-**

**UNIT-2: Fuel Cells:** Fuel cell working principle, Classification of fuel cells, Polymer electrolyte membrane (PEM) fuel cells, Solid-oxide fuel cells (SOFC), Fuel cell efficiency, Basic design of fuel cell,

**UNIT-3: Photo and Photo electrochemical Conversions:** Photochemical cells and applications of photochemical reactions, specificity of photo electrochemical cell, advantage of photoelectron catalytic conversions.

**UNIT-4: Solar Energy:** Solar energy introduction and prospects, photo voltaic (PV) technology, concentrated solar power (CSP), Solar Fuels, Solar cells .

**UNIT-5: Hydrogen Storage:** Hydrogen Storage, Chemical and Physical methods of hydrogen storage, Hydrogen Storage in metal hydrides, metal organic frame works (MOF), Carbon structures, metal oxide porous structures, hydrogel storage by high pressure methods. Liquifaction method.

**References :**


1. Physical chemistry by Ira N. Levine
2. Essentials of Physical Chemistry, Bahl and Bahl and Tuli.
3. Inorganic Chemistry, Silver and Atkins
4. Fuel Cell Hand Book 7$^{th}$ Edition, by US Department of Energy (EG&G technical services and corporation)
5. Hand book of solar energy and applications by Arvind Tiwari and Shyam.
6. Solar energy fundamental, technology and systems by Klaus Jagar et.al.
7. Hydrogen storage by Levine Klebonoff


## JNTUA College of Engineering (Autonomous), Ananthapuramu

## Open Elective Course – II Civil

**III B.TECH – II SEMESTER (R20) (common to all branches) - 2020 Admitted Batch**

| Course Code | Disaster Management | L | T | P | C |
|---|---|---|---|---|---|
| 20A60105 | | 3 | 0 | 0 | 3 |

Course Objectives:

1. To give knowledge types of disasters and stages in disaster rehabilitation process.
2. To make awareness on change in climates and their impacts on occurrence of environmental disasters.

3. To impart knowledge on Consideration of wind and water effects as per codal provisions to withstand disasters.
4. To familiarize the student with the Causes of earthquake and their effects and remedial methods to be adopted for buildings.
5. To illustrate the methodology in Planning and design considerations of various structures constructing in disaster prone areas.

Course Outcomes (CO):

1. About various types of disasters and stages in disaster rehabilitation process.
2. Impact of change in climates and their impacts on occurrence of environmental disasters.
3. Adopting suitable codal provisions to study the effect of wind and water effects on various structures constructed at disaster prone areas.
4. Causes of earthquake and their effects and remedial methods to be adopted for buildings.
5. Adopt suitable Planning and design considerations of various structures constructing in disaster prone areas.

UNIT - I

Brief introduction to different types of natural disaster, Occurrence of disaster in different climatic and geographical regions, hazard (earthquake and cyclone) map of the world and India, Regulations for disaster risk reduction, Post disaster recovery and rehabilitation (socioeconomic consequences)

UNIT - II

Climate change and its impact on tropical cyclone, Nature of cyclonic wind, velocities and pressure, Cyclone effects, Storm surge, Floods, Landslides. Behavior of structures in past cyclones and wind storms, case studies. Cyclonic retrofitting, strengthening of structures and adaptive sustainable reconstruction. Life–line structures such as temporary cyclone shelter.

UNIT - III

Basic wind engineering, aerodynamics of bluff bodies, vortex shedding and associated unsteadiness along and across wind forces. Lab: Wind tunnel testing, its salient features. Introduction to Computational fluid dynamics. General planning/design considerations under wind storms & cyclones; Wind effects on buildings, towers, glass panels etc, & wind resistant features in design. Codal Provisions, design wind speed, pressure coefficients; Coastal zoning regulation for construction & reconstruction phase in the coastal areas, innovative construction material & techniques, traditional construction techniques in coastal areas.

UNIT - IV

Causes of earthquake, plate tectonics, faults, seismic waves; magnitude, intensity, epicenter, energy release and ground motions. Earthquake effects – On ground, soil rupture, liquefaction, landslides. Performance of ground and building in past earthquakes: Behavior of various types of buildings, structures, and collapse patterns; Behavior of Non-structural elements like services, fixtures, mountings- case studies. Seismic retrofitting- Weakness in existing buildings, aging, concepts in repair, restoration and seismic strengthening.

UNIT - V

General Planning and design consideration; Building forms, horizontal and vertical eccentricities, mass and stiffness distribution, soft storey etc.; Seismic effects related to building configuration. Plan and vertical irregularities, redundancy and setbacks. Various

Types and Construction details of: Foundations, soil stabilization, retaining walls, plinth fill, flooring, walls, openings, roofs, terraces, parapets, boundary walls, under-ground – overhead tanks, staircases and isolation of structures; innovative construction material and techniques; Local practices: traditional regional responses; Computational investigation techniques.

Textbooks:

1. Disaster Management by Rajib Shah, Universities Press, India, 2003
2. Disaster Management by R.B. Singh (Ed) Rawat Publication, New Delhi, 2000

Reference Books:

1. Natural disasters. By Abbott, L. P. (2013) 9th Ed. McGraw-Hill.
2. Earthquake Resistant Design of Structures. By Agarwal, P. and Shrikhande, M. (2009). New Delhi : PHI Learning.
3. Mapping Vulnerability: Disasters, Development and People. byBankoff, G., Frerks, G. and Hilhorst, D. (2004). London :Earthscan.
4. Improving Earthquakes and Cyclone Resistance of Structures:Guidelines for the Indian Subcontinent. TERI
5. Disaster Mitigation, preparedness, recovery and Response. By Sinha, P. C. (2006). New Delhi : SBS Publishers.
6. World Bank. (2009). Handbook for Reconstructingafter Natural Disasters.

Online Learning Resources:

## JNTUA College of Engineering (Autonomous), Ananthapuramu

## Open Elective Course – II EEE

**III B.TECH – II SEMESTER (R20) (common to all branches) - 2020 Admitted Batch**

| Course Code | RENEWABLE ENERGY SYSTEMS (OE-II) | | L | T | P | C |
|---|---|---|---|---|---|---|
| 20A60205 | | | 3 | 0 | 0 | 3 |
| Pre-requisite | | Semester | VI | | | |
| | | | | | | |
| **Course Objectives:** To make the students learn about: | | | | | | |
| • Various sources of Energy and the need of Renewable Energy Systems.<br>• The concepts of Solar Radiation, Wind energy and its applications. | | | | | | |

- Operation of Solar thermal and solar PV systems
- The concept of geo thermal energy and its applications, biomass energy, the concept of Ocean energy and fuel cells.

**Course Outcomes (CO):** At the end of the course the student will be able to:

**CO 1** Understand various alternate sources of energy for different suitable application requirements.
**CO 2**Analyze the concepts of solar energy generation strategies and wind energy system
**CO 3** Design Solar and Wind energy systems.
**CO 4** Apply the concepts of Geo Thermal Energy, Ocean Energy, Bio mass and Fuel Cells for generation of power.

| | | |
|---|---|---|
| **UNIT - I** | **SOLAR ENERGY** | Lecture Hrs: 10 |

Solar radiation - beam and diffuse radiation, solar constant, earth sun angles, attenuation and measurement of solar radiation, local solar time, derived solar angles, sunrise, sunset and day length. flat plate collectors, concentrating collectors, storage of solar energy-thermal storage.

| | | |
|---|---|---|
| **UNIT - II** | **PV ENERGY SYSTEMS** | Lecture Hrs: 10 |

Introduction, The PV effect in crystalline silicon basic principles, the film PV, Other PV technologies, Electrical characteristics of silicon PV cells and modules, PV systems for remote power, Grid connected PV systems.

| | | |
|---|---|---|
| **UNIT - III** | **WIND ENERGY** | Lecture Hrs: 10 |

Principle of wind energy conversion; Basic components of wind energy conversion systems; wind mill components, various types and their constructional features; design considerations of horizontal and vertical axis wind machines: analysis of aerodynamic forces acting on wind mill blades and estimation of power output; wind data and site selection considerations.

| | | |
|---|---|---|
| **UNIT - IV** | **GEOTHERMAL ENERGY** | Lecture Hrs: 8 |

Estimation and nature of geothermal energy, geothermal sources and resources like hydrothermal, geo-pressured hot dry rock, magma. Advantages, disadvantages and application of geothermal energy, prospects of geothermal energy in India.

| | | |
|---|---|---|
| **UNIT - V** | **MISCELLANEOUS ENERGY TECHNOLOGIES** | Lecture Hrs: 10 |

Ocean Energy: Tidal Energy-Principle of working, performance and limitations. Wave Energy-Principle of working, performance and limitations.
Bio mass Energy: Biomass conversion technologies, Biogas generation plants, Classification, advantages and disadvantages, constructional details, site selection, digester design consideration
Fuel cell: Principle of working of various types of fuel cells and their working, performance and limitations.

**Text books:**

1. Stephen Peake, "Renewable Energy Power for a Sustainable Future", Oxford International Edition, 2018.
2. G. D. Rai, "Non-Conventional Energy Sources", 4th Edition, Khanna Publishers, 2000.

**Reference Books:**

1. S. P. Sukhatme, "Solar Energy",3rd Edition, Tata Mc Graw Hill Education Pvt. Ltd, 2008.
2. B H Khan , " Non-Conventional Energy Resources", 2nd Edition, Tata Mc Graw Hill Education Pvt Ltd, 2011.

3. S. Hasan Saeed and D.K.Sharma,"Non-Conventional Energy Resources",3rd Edition, S.K.Kataria& Sons, 2012.
4. G. N. Tiwari and M.K.Ghosal, "Renewable Energy Resource: Basic Principles and Applications", Narosa Publishing House, 2004.

**Online Learning Resources:**

1. https://nptel.ac.in/courses/103103206
2. https://nptel.ac.in/courses/108108078

https://www.slideshare.net/fatimahAlkreem/e-businessppt-67935771
https://www.slideshare.net/VikramNani/e-commerce-business-models
https://www.slideshare.net/RiteshGoyal/electronic-payment-system
https://www.slideshare.net/WelingkarDLP/electronic-security
https://www.slideshare.net/Ankitha2404/emarketing-ppt

## JNTUA College of Engineering (Autonomous), Ananthapuramu

## Open Elective Course – II Mechanical

**III B.TECH – II SEMESTER (R20) (common to all branches) - 2020 Admitted Batch**

| Subject Code | Title of the Subject | L | T | P | C |
|---|---|---|---|---|---|
| 20A60305 | **SOLAR ENERGY SYSTEMS** | 3 | 0 | 0 | 3 |

**Course objectives**

Learning the fundamental principles of solar radiation and geographic distribution of solar radiation.

Study of various solar energy technologies with different types of concentrating collectors.

Comparative study of different solar cells with respect to properties and applications of solar cells in nano technology.

Understanding the basics of economics involves in the solar system.

Learning the concepts and designing aspects in thermal power. 6. Study of solar pond and solar stills and their applications.

**UNIT – I**

**SOLAR RADIATION:**

Sources of radiation –sun earth relationship, Solar Time and angles, day length, angle of incidence on tilted surface; Sun path diagram, Solar Radiation: Extraterrestrial Radiation; Effect of earth atmosphere; Estimation of solar radiation on horizontal and tilted surfaces. Geographic Distribution of solar radiation, Phyrellio, pyranometer, equation of time- estimation of average radiation falling on tilled.

**UNIT-II**

**SOLAR ENERGY TECHNOLOGIES:**

Performance analysis of a liquid Flat-plate collector, Total loss coefficient and heat losses: Top loss coefficient, Bottom loss coefficient, Side loss coefficient. Solar concentrating collectors, types of concentrating collectors, Parabolic Dish System, The central power tower system, The Parabolic Trough System, Tracking CPC and Solar Swing, Performance analysis of cylindrical parabolic collector, Compound parabolic concentrator (CPC).

**UNIT-III**

**SOLAR CELLS:**

Solar cell fundamentals, solar cell classification, solar cell, module, panel array construction, maximum power pint trackers(MPPT), solar PV applications, The Recent developments in Solar cells, Role of Nano-Technology in Solar cells.

**UNIT – IV**

**ECONOMICS:**

Discounted Cash Flow-light cycle, coasting of solar system, production function and optimization

**UNIT – V**

**THERMAL POWER:**

The power concepts- design aspects, thermo-chemical reactor.

**SOLAR POND AND SOLAR STILLS:**

Working Principle-Construction-operating difficulties and remedies, Agriculture and Domestic applications: Still, timber drying, crop drying, cooker.

**Course Outcomes :**

Illustrate the fundamental principles of solar radiation and geographic distribution of solar radiation.

Obtaining the performance analysis of liquid flat plate collector and cylindrical parabolic collector.

Developing solar cells in the field of nano technology.

Calculating the cash flow and costs involves in the solar energy systems.

Designing and developing of thermo chemical reactor with respect to thermal power.

**Reference Books:**

Solar Energy Thermal Process Diffice and Beckman
Solar Heating and Cooling by Kreith and Kreider
Solar Energy Utilization by G.D.Rai
Solar Energy Utilization by G.D.Rai , Khanna Publishers.
Renewable Energy Sources and Emerging Technologies- By D.P. Kothari, PHI Pub.,
Applied Solar Energy by Meinel and Meinel
Non-Conventional Energy Resources by B.H . Khan, Tata McGraw Hill
Energy Resources Utilization and Technologies ByAnjaneyulu, BS Pub.

## JNTUA College of Engineering (Autonomous), Ananthapuramu

## Open Elective Course – II ECE

**III B.TECH – II SEMESTER (R20) (common to all branches) - 2020 Admitted Batch**

| Course Code | BASICS OF INTEGRATED CIRCUITS APPLICATIONS | L | T | P | C |
|---|---|---|---|---|---|
| 20A60405 | | 3 | 0 | 0 | 3 |

**\Pre-requisite**

Basics of Electronics and Communication Engineering

**Course Objectives:**

- To introduce the basic building blocks of linear & digital integrated circuits.
- To learn the linear and non - linear applications of operational amplifiers.
- To introduce the theory and applications of 555 and PLL.

- To learn the theory of ADC and DAC
- To understand different families of digital integrated circuits and their characteristics.

**Course Outcomes (CO):** At the end of this course, the students will be able to

- Understand the basic concepts of Op -AMPs, characteristics and specifications.
- Design circuits using operational amplifiers for various applications.
- Develop, apply and analyze circuits for advanced applications using Op-Amps, PLL, VCO and Analog multipliers.
- Understand different families of digital integrated circuits and their characteristics
- Design various and sequential circuits using digital ICs.

**UNIT - I**

**Operational Amplifier**: Ideal and Practical Op-Amp, Op-Amp Characteristics, DC and AC Characteristics, Features of 741 Op-Amp, Modes of Operation - Inverting, Non-Inverting, Differential, Instrumentation Amplifier, AC Amplifier, Differentiators and Integrators, Comparators, Schmitt Trigger, Introduction to Voltage Regulators, Features of 723 Regulator, Three Terminal Voltage Regulators.

**UNIT - II**

**Op-Amp, IC-555 & IC 565 Applications:** Introduction to Active Filters, Characteristics of Band pass, Band reject and All Pass Filters, Analysis of 1st order LPF & HPF Butterworth Filters, Waveform Generators – Triangular, Sawtooth, Square Wave, IC555 Timer - Functional Diagram, Monostable and Astable Operations, Applications, IC565 PLL - Block Schematic, Description of Individual Blocks, Applications.

**UNIT - III**

**Data Converters**: Introduction, Basic DAC techniques, Different types of DACs-Weighted resistor DAC, R-2R ladder DAC, Inverted R-2R DAC, Different Types of ADCs - Parallel Comparator Type ADC, Counter Type ADC, Successive Approximation ADC and Dual Slope ADC, DAC and ADC Specifications.

**UNIT - IV**

**Digital Integrated Circuits**: Classification of Integrated Circuits, Comparison of Various Logic Families, CMOS Transmission Gate, IC interfacing- TTL Driving CMOS & CMOS Driving TTL

**Combinational Logic ICs** – Specifications and Applications of TTL-74XX & CMOS 40XX Series ICs - Code Converters, Decoders, Demultiplexers, LED & LCD Decoders with Drivers, Encoders, Priority Encoders, Multiplexers, Demultiplexers, Priority Generators/Checkers, Parallel Binary Adder/Subtractor, Magnitude Comparators.

**UNIT - V**

**Sequential Logic ICs and Memories:** Familiarity with commonly available 74XX & CMOS 40XX Series ICs – All Types of Flip-flops, Synchronous Counters, Decade Counters, Shift Registers. Memories - ROM Architecture, Types of ROMS & Applications, RAM Architecture, Static & Dynamic RAMs.

**Textbooks:**

1. Ramakanth A. Gayakwad, “Op-Amps & Linear ICs”, PHI, 2003.
2. Floyd and Jain, “Digital Fundamentals”, Pearson Education, 8th Edition, 2005.

**Reference Books:**

1. D. Roy Chowdhury, “Linear Integrated Circuits”, New Age International (p) Ltd, Second Edition, 2003.
2. James M. Fiore, “Op Amps and Linear Integrated Circuits-Concepts and Applications”, Cengage Learning/ Jaico, 2009.
3. K.Lal Kishore, “Operational Amplifiers with Linear Integrated Circuits”, Pearson, 2009.
4. John. F. Wakerly, “Digital Design Principles and Practices”, Pearson, Third Edition, 2005.

Online Learning Resources:

## JNTUA College of Engineering (Autonomous), Ananthapuramu

## Open Elective Course – II CSE

**III B.TECH – II SEMESTER (R20) (common to all branches) - 2020 Admitted Batch**

## Introduction to Linux Programming

**Course Code:20A60505** **L T P C : 3 0 0 3**

**Course Objectives**:

- To study the commands according to user requirements.
- To utilize Shell scripts to perform the given task.
- To enable writing own programs in UNIX.
- To know AWK programs.

**Course Outcomes:**

CO1: Develop text data processing applications using Unix commands and filters.

CO2: Design and develop text based user interface components

CO3: Understand user management, network management and backup utilities

CO4: Use the system calls for file management

CO5: Understands the Concept of Process Threads and File Structure.

**UNIT-I: Introduction,Unix File System,Unix Commands**

Operating System, History of UNIX, Overview and Features of Unix System,Structure of Unix System, Unix Environment. **Unix File System**: Introduction of Files, Organization of File Systems, Accessing File Systems, Structure of File Systems. **Unix Commands**: Basic Commands, Advanced Unix Commands: File Access Permissions, Pipe Operator, cut, paste, wc, sort, head, tail, diff, cmp, uniq, comm, time, Conversions between DOS and Unix, man.

**UNIT-II: File management and Compression Techniques,Manipulating Processes and Signals**
Managing and Compressing Files, Computer Devices, Disk related Commands, Compression and Uncompressing Files, Important Unix System Files, Shell Variables, Export of Local and Global Shell Variables.

**Manipulating Processes and Signals**: Process Basics, Processes States and Transitions, Zombie Process, Context switching, Threads, ps-status of Process.

**UNIT-III: System calls**

Introduction, File-related System calls (open, create, read, write, lseek), File-related System calls (close, mknod, link and unlink, access, and chown, chmod), Directory Handling System calls (mkdir, rmdir, chdir, opendir, readdir, telldir, closedir), Process related System calls ( exec, fork, wait,exit).

**Editors in Unix**: introduction, Stream editor, Emacs Editor.

**UNIT-IV: AWK Script,Burne Shell**

AWK Command, print, printf, Displaying Content of Specified Patterns, Comparison Operators, Compound Expressions, Arithmetic Operators, Begin and end Sections, User-defined Variables, if else Statement, Built-in Variables, Changing Input Filed Separator, Functions, Loops, Getting Input from User, Search and Substitute Functions, Copying results into Another file.

**Bourne Shell**: Introduction, beginning Bourne Shell Scripting, Writing Shell Scripts, Command Line Parameters, read, for Loop, While Loop, if Statement, Bourne Shell Commands.

**UNIT-V: InterprocessCommunicaation, Unix System Administration and Networking**

Interprocess Communication, Synchronization, Filters.

**Unix System Administration and Networking**: Unix Booting Procedure,Mounting Unix File System, Unmounting Unix File System, Managing User Accounts, Networking Tools, mail Command, Distributed File System, Firewalls, Backup and Restore.

**TEXT BOOKS**

1. "UNIX and SHELL Programming", B.M. HARWANI, OXFORD UNIVERSITY PRESS.

**REFERENCES**

1. "UNIX and Linux System Administration Handbook", Evi Nemeth, Garth Snyder, Trent R. Hein and Ben Whaley, PHI

## JNTUA College of Engineering (Autonomous), Ananthapuramu

## Open Elective Course – II Chemical

**III B.TECH – II SEMESTER (R20) (common to all branches) - 2020 Admitted Batch**

| Course Code | OE2. GREEN TECHNOLOGY | L | T | P | C |
|---|---|---|---|---|---|
| 20A60805 | | 3 | 0 | 0 | 3 |

**Pre-requisite**

Course Objectives:

Course Outcomes (CO):

At the end of the course, the student will be able to:

| | |
|---|---|
| CO1 | Understand the basic knowledge of environmental issues and estimate the risk |
| CO2 | Evaluate the exposures |
| CO3 | To discuss the type of wastes and emissions that drive the environmental impacts |
| CO4 | Estimation of the environmental properties, persistence, ecosystem risk, |

CO5 To present approaches and methodologies for evaluating and improving the environmental performance of chemical processes and chemical products.

**Course Articulation Matrix**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |

UNIT - I

**An introduction to environmental issues**: Role of chemical processes and chemical products, Global environmental issues, Air and water quality issues, Ecology.

**Risk concept**: Description of risk, Risk assessment concept, Dose-response, Exposure assessment.

UNIT - II

**Evaluating exposures:** Occupational exposures: recognition, evaluation, control, Exposure assessment for chemicals in the ambient environment, Designing safer chemicals.

**Green chemistry**:Green chemistry methodologies, Optimization based frameworks for the design of green chemical synthesis pathway.

UNIT - III

**Evaluating environmental fate:** Chemical and physical property estimation, estimating environmental persistence, estimating ecosystem risk, classifying environmental risk based on chemical structure.

UNIT - IV

**Life-cycle concepts**: Life-cycle assessment, Life-cycle impact assessment

UNIT - V

Material flows in chemical manufacturing, Assessing opportunities for waste exchanges and by-product synergies.

**Textbooks:**

SHONNARD, DALLEN, D. Green Engineering: Environmentally Conscious Design of Chemical Processes.

**Reference Books:**

Online Learning Resources:

## JNTUA College of Engineering (Autonomous), Ananthapuramu

## Open Elective Course – II

**III B.TECH – II SEMESTER (R20) (common to all branches) - 2020 Admitted Batch**

**DEPARTMENT OF MATHEMATICS**

<table>
<tr><td>Course Code</td><td rowspan="2" colspan="2">Mathematical Modelling & Simulation<br>(Common for CIVIL,MECH&CHEM)</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>20A65101</td><td>0</td><td>3</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite</td><td></td><td>Semester</td><td colspan="4">II</td></tr>
<tr><td colspan="7"></td></tr>
<tr><td colspan="7">Course Objectives:</td></tr>
<tr><td colspan="7">This course focuses on what is needed to build simulation software environments, and not just building simulations using preexisting packages.</td></tr>
<tr><td colspan="7">Course Outcomes (CO): Student will be able to</td></tr>
<tr><td colspan="7">• understand basic Model Forms.<br>• understand basic Simulation Approaches.<br>• evaluate handling Stepped and Event-based Time in Simulations.<br>• distinguish Discrete versus Continuous Modeling.<br>• apply Numerical Techniques.<br>• calculate Sources and Propagation of Error.</td></tr>
<tr><td>UNIT - I</td><td colspan="2"></td><td colspan="4">8 Hrs</td></tr>
<tr><td colspan="7">Simulation Basics-Handling Stepped and Event-based Time in Simulations-Discrete versus Continuous Modelling-Numerical Techniques-Sources and Propagation of Error</td></tr>
</table>

| UNIT - II | | 9 Hrs |
|---|---|---|
| Dynamical, Finite State, and Complex Model Simulations-Graph or Network Transitions Based Simulations-Actor Based Simulations-Mesh Based Simulations-Hybrid Simulations | | |
| UNIT - III | | 8 Hrs |
| Converting to Parallel and Distributed Simulations-Partitioning the Data-Partitioning the Algorithms-Handling Inter-partition Dependencies | | |
| UNIT - IV | | 8 Hrs |
| Probability and Statistics for Simulations and Analysis-Introduction to Queues and Random Noise-Random Variates Generation-Sensitivity Analysis | | |
| UNIT - V | | 9 Hrs |
| Simulations Results Analysis and Viewing Tools-Display Forms: Tables, Graphs, and Multidimensional Visualization-Terminals, X and MS Windows, and Web Interfaces-Validation of Model Results. | | |
| Textbooks: | | |
| 1. Mathematical modeling, JN Kapur, Newage publishers<br>2. Mathematical Modeling and Simulation: Introduction for Scientists and Engineers<br>by Kai Velten, Wiley Publishers | | |
| Reference Books: | | |
| 1. Introduction to Mathematical Modeling and Computer Simulations<br>By Vladimir Mityushev,WojciechNawalaniecNataliaRylko Published by Chapman and Hall/CRC. | | |
| Online Learning Resources: | | |
| http://www.cse.chalmers.se/~dag/docs/matmodReport6.pdf<br>https://www.slideshare.net/arupparia/introduction-to-mathematical-modelling-42588379<br>https://www.slideshare.net/mailrenuka/simulation-for-queuing-problems-using-random-numbers | | |

## JNTUA College of Engineering (Autonomous), Ananthapuramu

### Open Elective Course – II

**III B.TECH – II SEMESTER (R20) (common to all branches) - 2020 Admitted Batch**

**DEPARTMENT OF MATHEMATICS**

<table>
<tr><td>Course Code</td><td rowspan="2" colspan="2">Wavelet transforms and its Applications (Common for EEE&ECE)</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>20A65102</td><td>0</td><td>3</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite</td><td>Fourier Series</td><td>Semester</td><td colspan="4">II</td></tr>
<tr><td colspan="7"></td></tr>
<tr><td colspan="7">Course Objectives:</td></tr>
<tr><td colspan="7">This course provides the students to understand Wavelet transforms and its applications.</td></tr>
<tr><td colspan="7">Course Outcomes (CO): Student will be able to</td></tr>
<tr><td colspan="7"><ul><li>understand wavelets and wavelet expansion systems.</li><li>illustrate the multi resolution analysis ad scaling functions.</li><li>form fine scale to coarse scale analysis.</li><li>find the lattices and lifting.</li><li>perform numerical complexity of discrete wavelet transforms.</li><li>find the frames and tight frames using Fourier series.</li></ul></td></tr>
<tr><td>UNIT - I</td><td colspan="2">Wavelets</td><td colspan="4">9 Hrs</td></tr>
<tr><td colspan="7">Wavelets and Wavelet Expansion Systems - Wavelet Expansion- Wavelet Transform- Wavelet System- More Specific Characteristics of Wavelet Systems - Haar Scaling Functions and Wavelets -effectiveness of Wavelet Analysis -The Discrete Wavelet Transform The Discrete-Time and Continuous Wavelet Transforms.</td></tr>
<tr><td>UNIT - II</td><td colspan="2">A Multiresolution Formulation of Wavelet Systems</td><td colspan="4">8 Hrs</td></tr>
</table>

| | | |
|---|---|---|
| Signal Spaces -The Scaling Function -Multiresolution Analysis - The Wavelet Functions - The Discrete Wavelet Transform- A Parseval's Theorem - Display of the Discrete Wavelet Transform and the Wavelet Expansion. | | |
| UNIT - III | Filter Banks and the Discrete Wavelet Transform | 9 Hrs |
| Analysis - From Fine Scale to Coarse Scale- Filtering and Down-Sampling or Decimating -Synthesis - From Coarse Scale to Fine Scale -Filtering and Up-Sampling or Stretching - Input Coefficients - Lattices and Lifting - -Different Points of View. | | |
| UNIT - IV | Time-Frequency and Complexity | 9 Hrs |
| Multiresolution versus Time-Frequency Analysis- Periodic versus Nonperiodic Discrete Wavelet Transforms -The Discrete Wavelet Transform versus the Discrete-Time Wavelet Transform- Numerical Complexity of the Discrete Wavelet Transform. | | |
| UNIT - V | Bases and Matrix Examples | 8 Hrs |
| Bases, Orthogonal Bases, and Biorthogonal Bases -Matrix Examples - Fourier Series Example - Sine Expansion Example - Frames and Tight Frames - Matrix Examples -Sine Expansion as a Tight Frame Example. | | |
| Textbooks: | | |
| 1. C. Sidney Burrus, Ramesh A. Gopinath, “Introduction to Wavelets and Wavelets Transforms”,Prentice Hall, (1997).<br>2. James S. Walker, “A Primer on Wavelets and their Scientific Applications”, CRC Press, (1999). | | |
| Reference Books: | | |
| 1. Raghuveer Rao, “Wavelet Transforms”, Pearson Education, Asia. | | |
| Online Learning Resources: | | |
| https://www.slideshare.net/RajEndiran1/introduction-to-wavelet-transform-51504915 | | |

# JNTUA College of Engineering (Autonomous), Ananthapuramu

## Open Elective Course – II

**III B.TECH – II SEMESTER (R20) (common to all branches) - 2020 Admitted Batch**

**DEPARTMENT OF MATHEMATICS**

<table>
<tr><td>Course Code</td><td colspan="2" rowspan="2">Statistical Methods for Data Science<br>CSE (Data Science)</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>20A65103</td><td></td><td>3</td><td></td><td>3</td></tr>
<tr><td>Pre-requisite</td><td></td><td>Semester</td><td colspan="4">II</td></tr>
<tr><td colspan="7"></td></tr>
<tr><td colspan="7">Course Objectives:</td></tr>
<tr><td colspan="7">This course aims at providing knowledge on basic concepts of Statistics, Estimation and testing of hypotheses for large and small samples.</td></tr>
<tr><td colspan="7">Course Outcomes (CO): Student will be able to</td></tr>
<tr><td colspan="7">• Understand the basic concepts of Statistics<br>• Analyze data and draw conclusion about collection of data under study using Point estimation<br>• Analyze data and draw conclusion about collection of data under study using Interval estimation<br>• Analyzing the tests and types of errors for large samples<br>• Apply testing of hypothesis for small samples.</td></tr>
<tr><td>UNIT - I</td><td colspan="2">Basic Concepts</td><td colspan="4">9 Hrs</td></tr>
<tr><td colspan="7">Population, sample, parameter and statistic; characteristics of a good estimator; Consistency – Invariance property of Consistent estimator, Sufficient condition for consistency; Unbiasedness; Sufficiency – Factorization Theorem – Minimal sufficiency; Efficiency – Most efficient estimator, likelihood equivalence, Uniformly minimum variance unbiased estimator,applications of Lehmann-Scheffe's Theorem, Rao - Blackwell Theorem and applications</td></tr>
<tr><td>UNIT - II</td><td colspan="2">Point Estimation</td><td colspan="4">8 Hrs</td></tr>
<tr><td colspan="7">Point Estimation- Estimator, Estimate, Methods of point estimation – Maximum likelihood method (the asymptotic properties of ML estimators are not included), Large sample properties of ML estimator(without proof)- applications , Method of moments, method of least squares, method of minimum chi-square and modified minimum chi-square-Asymptotic Maximum Likelihood Estimation and applications.</td></tr>
<tr><td>UNIT - III</td><td colspan="2">Interval Estimation</td><td colspan="4">8 Hrs</td></tr>
</table>

| | | |
|---|---|---|
| Confidence limits and confidence coefficient; Duality between acceptance region of a test and a confidence interval; Construction of confidence intervals for population proportion (small and large samples) and between two population proportions(large samples); Confidence intervals for mean and variance of a normal population; Difference between the mean and ratio of two normal populations. | | |
| **UNIT - IV** | **Testing of hypotheses** | **9 Hrs** |
| Types of errors, power of a test, most powerful tests; Neyman-Pearson Fundamental Lemma and its applications; Notion of Uniformly most powerful tests; Likelihood Ratio tests: Description and property of LR tests - Application to standard distributions. | | |
| **UNIT - V** | **Small sample tests** | **9 Hrs** |
| Student's t-test, test for a population mean, equality of two population means, paired t-test, F-test for equality of two population variances,CRD,RBD,LSD; Chi-square test for goodness of fit and test for independence of attributes, $\chi 2$ test for testing variance of a normal distribution<br>Sign test, Signed rank test, Median test, Mann-Whitney test, Run test and One sample Kolmogorov –Smirnov test ,Kruskal – Wallis H test(Description, properties and applications only). | | |
| **Textbooks:** | | |
| 1. Manoj Kumar Srivastava and Namita Srivastava, Statistical Inference – Testing of<br>Hypotheses, Prentice Hall of India, 2014.<br>2. Robert V Hogg, Elliot A Tannis and Dale L.Zimmerman, Probability and Statistical Inference,9th edition,Pearson publishers,2013. | | |
| **Reference Books:** | | |
| 1. S.P.Gupta, Statistical Methods, 33rd Edition, Sultan Chand & Sons.<br>2. Miller and John E Freund, Probability and Statistics for Engineers, 5th Edition. | | |
| **Online Learning Resources:** | | |
| 1. https://www.statstutor.ac.uk/resources/uploaded/1introduction3.pdf<br>2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2996198/ | | |

## JNTUA College of Engineering (Autonomous), Ananthapuramu

## Open Elective Course – II

**III B.TECH – II SEMESTER (R20) (common to all branches) - 2020 Admitted Batch**

## PHYSICS OF ELECTRONIC MATERIALS AND DEVICES

**COURSE OBJECTIVES**

1 To impart the fundamental knowledge on various materials, their properties and

**Applications.**

2 To provide insight into various semiconducting materials and their properties.

3 To elucidate the characteristic behavior of various semiconductor devices.

4 To provide the basics of dielectric and piezoelectric materials and their properties.

5 To explain different categories of magnetic materials, mechanism and their advanced applications.

**COURSE OUTCOMES**

At the end of the course the student will be able

CO1 To understand the fundamentals of various materials.

CO2 To exploit the physics of semiconducting materials

CO3 To familiarize with the working principles of semiconductor-based devices.

CO4 To understand the behavior of dielectric and piezoelectric materials.

CO5 To make use of the magnetic materials for advanced applications.

### Mapping between Course Outcomes and Programme Outcomes

PO1 PO2 PO3 PO4 PO5 PO6 PO7 PO8 PO9 PO10 PO11 PO12

CO1

CO2

CO3

CO4

CO5

**SYLLABUS** **Credit: 3 Hours of teaching: - 45 H**

UNIT-1 Fundamentals of Materials Science: 9H

Introduction, Phase rule, Phase Diagram, Elementary idea of Nucleation and Growth, Methods of crystal growth. Basic idea of point, line and planar defects.Concept of thin films, preparation of thin films, Deposition of thin film using sputtering methods (RF and glow discharge).

UNIT-2: Semiconductors: 9H

Introduction, charge carriers in semiconductors, effective mass, Diffusion and drift, Diffusion and recombination, Diffusion length. The Fermi level & Fermi-Dirac distribution, Electron and Hole in quantum well, Change of electron-hole concentration- Qualitative analysis, Temperature dependency of carrier concentration, Conductivity and mobility, Effects of temperature and doping on mobility, High field effects.

UNIT-3: Physics of Semiconductor Devices: 9H

Introduction, Band structure, PN junctions and their typical characteristics under equilibrium.and under bias, Construction and working principles of: Light emitting diodes, Heterojunctions, Transistors, FET and MOSFETs.

UNIT-4: Dielectric Materials and their Applications: 9H

Introduction, Dielectric properties, Electronic polarizability and susceptibility, Dielectric constant and frequency dependence of polarization, Dielectric strength and dielectric loss, Piezoelectric properties- Ferroelectricity-Applications.

UNIT-5: Magnetic Materials and their Applications: 9H

Introduction, Magnetism & various contributions to para and dia magnetism, Ferro and Ferri magnetism and ferrites, Concepts of Spin waves and Magnons, Anti-ferromagnetism, Domains and domain walls, Coercive force, Hysteresis, Nano-magnetism, Super-paramagnetism – Properties and applications.

**Text Books**

1. Principles of Electronic Materials and Devices-S.O. Kasap, McGraw-Hill Education (India) Pvt. Ltd.,3rd edition, 2007.

2. Electronic Components and Materials- Grover and Jamwal, DhanpatRai and Co.

**Reference Books:**

1. Solid State Electronic Devices -B.G. Streetman and S. Banerjee, PHI Learning,6th edition

2. Electronic Materials Science- Eugene A. Irene, , Wiley, 2005

3. An Introduction to Electronic Materials for Engineers-Wei Gao, Zhengwei Li, Nigel Sammes, World Scientific Publishing Co. Pvt. Ltd., , 2nd Edition,2011

4. A First Course In Material Science- by Raghvan, McGraw Hill Pub.

5. The Science and Engineering of materials- Donald R.Askeland,Chapman& Hall Pub.

6. Electrical Engineering Materials-by A.J. Dekker, PHI Pub

NPTEL courses links

https://nptel.ac.in/courses/113/106/113106062/

https://onlinecourses.nptel.ac.in/noc20_mm02/preview

https://nptel.ac.in/noc/courses/noc17/SEM1/noc17-mm07

## JNTUA College of Engineering (Autonomous), Ananthapuramu

## Open Elective Course – II H& SS

**III B.TECH – II SEMESTER (R20) (common to all branches) - 2020 Admitted Batch**

| **Course Code** | **Academic Writing and Public Speaking** | | **L** | **T** | **P** | **C** |
|---|---|---|---|---|---|---|
| **20A65501** | | | **3** | **0** | **0** | **3** |
| **Pre-requisite** | | | | | | |
| | | | | | | |
| Course Objectives: | | | | | | |

- To encourage all round development of the students by focusing on writing skills
- To make the students aware of non-verbal skills
- To develop analytical skills

<table>
<tr><td colspan="3">➢ To deliver effective public speeches</td></tr>
<tr><td colspan="3">Course Outcomes (CO):</td></tr>
<tr><td colspan="3">By the end of the program students will be able to<ul><li>Define various elements of Academic Writing</li><li>Understand how to paraphrase sources and avoid plagiarism</li><li>Demonstrate the knowledge in writing a Research paper</li><li>Analyse different types of essays</li><li>Assess the speeches of others and know the positive strengths of speakers</li><li>Build confidence in giving an impactful presentation to the audience</li></ul></td></tr>
<tr><td>UNIT - I</td><td>Introduction to Academic Writing</td><td>Lecture Hrs</td></tr>
<tr><td colspan="3">Introduction to Academic Writing – Essential Features of Academic Writing – Courtesy – Clarity – Conciseness – Correctness – Coherence – Completeness – Types – Descriptive, Analytical, Persuasive, Critical writing</td></tr>
<tr><td>UNIT - II</td><td>Academic Journal Article</td><td>Lecture Hrs</td></tr>
<tr><td colspan="3">Art of condensation- summarizing and paraphrasing - Abstract Writing, writing Project Proposal, writing application for internship, Technical/Research/Journal Paper Writing – Conference Paper writing - Editing, Proof Reading - Plagiarism</td></tr>
<tr><td>UNIT - III</td><td>Essay & Writing Reviews</td><td>Lecture Hrs</td></tr>
<tr><td colspan="3">Compare and Contrast – Argumentative Essay – Exploratory Essay – Features and Analysis of Sample Essays – Writing Book Report, Summarizing, Book/film Review-</td></tr>
<tr><td>UNIT - IV</td><td>Public Speaking</td><td>Lecture Hrs</td></tr>
<tr><td colspan="3">Introduction, Nature, characteristics, significance of Public Speaking – Presentation – 4 Ps of Presentation – Stage Dynamics – Answering Strategies –Analysis of Impactful Speeches-Speeches for Academic events</td></tr>
<tr><td>UNIT - V</td><td>Public Speaking and Non-Verbal Delivery</td><td>Lecture Hrs</td></tr>
<tr><td colspan="3">Body Language – Kinesics – Oculesics – Proxemics – Haptics – Paralanguage</td></tr>
<tr><td colspan="3">Textbooks:</td></tr>
<tr><td colspan="3"><ol start="3"><li>Critical Thinking, Academic Writing and Presentation Skills: Mg University Edition Paperback – 1 January 2010 Pearson Education; First edition (1 January 2010)</li><li>A Course In Academic Writing Paperback – 1 January 2017Publisher : The Orient Blackswan; Second edition (1 January 2017)</li></ol></td></tr>
<tr><td colspan="3">Reference Books:<ol><li>A Handbook For Academic Writing and Composition Paperback – 1 January 2014</li></ol></td></tr>
</table>

| |
|---|
| by Nzanmongi Jasmine PattonPublisher : Pinnacle Learning; 1st edition (1 January 2014)<br>2. Critical Thinking, Academic Writing and Presentation Skills: Mg University Edition Paperback – 1 January 2010Publisher : Pearson Education; First edition (1 January 2010) by Marilyn Anderson (Author)<br>3. Effective Academic Writing Second Edition: 1: Student Book: The Paragraph Paperback – Student Edition, 9 June 2014 by Alice Savage (Author), MasoudShafiei (Author)Publisher : Oxford University Press; Student, Workbook edition (9 June 2014)<br>4. A Course In Academic Writing Paperback – 1 January 2017 by Renu Gupta (Author) Publisher : The Orient Blackswan; Second edition (1 January 2017) |
| Online Learning Resources: |
| 1. https://youtu.be/NNhTIT81nH8<br>2. phttps://www.youtube.com/watch?v=478ccrWKY-A<br>3. https://www.youtube.com/watch?v=nzGo5ZC1gMw<br>4. https://www.youtube.com/watch?v=Qve0ZBmJMh4 |

## JNTUA College of Engineering (Autonomous), Ananthapuramu

## Open Elective Course – II

**III B.TECH – II SEMESTER (R20) (common to all branches) - 2020 Admitted Batch**

**DEPARTMENT OF CHEMISTRY**

| Subject Code | Title of the Subject | L | T | P | C |
|---|---|---|---|---|---|
| | **CHEMISTRY OF POLYMERS AND ITS APPLICATIONS** | 2 | 1 | - | 3 |

| COURSE OBJECTIVES | |
|---|---|
| 1 | To understand the basic principles of polymers |
| 2 | To synthesize the different polymeric materials and their characterization by |

| | |
|---|---|
| | various instrumental methods. |
| 3 | To impart knowledge to the students about fundamental concepts of Hydro gels of polymer networks, surface phenomenon by micelles |
| 4 | To enumerate the applications of polymers in engineering |

| COURSE OUTCOMES | |
|---|---|
| CO1 | Classify the polymers, Explain polymerization mechanism, Differentiate addition, condensation polymerizations, Describe measurement of molecular weight of polymer |
| CO2 | Differentiate Bulk, solution, Suspension and emulsion polymerization, Describe fibers and elastomers, Identify the thermosetting and thermo polymers, Characterize the properties of polymers by IR, NMR, XRD etc. |
| CO3 | Describe the properties and applications of polymers, Interpret the properties of cellulose, lignin, starch, rosin, latex etc., Discuss the special plastics of PES, PAES, PEEK etc., Explain modified cellulosics |
| CO4 | Identify types of polymer networks, Describe methods involve in hydrogel preparation, Explain applications of hydrogels in drug delivery, Demonstrate the advanced drug delivery systems and controlled release |
| CO5 | Demonstrate electrical phenomena at interfaces including electrokinetics, miselles, reverse micelles etc., Explain photoelectron spectroscopy, Discuss ESCA and Auger spectroscopy to the study of surfaces, Differentiate micelles and reverse micelles |

**Mapping between Course Outcomes and Programme Outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |

## SYLLABUS

**Unit – I: Polymers-Basics and Characterization :-**

Basic concepts: monomers, repeating units, degree of polymerization, linear, branched and network polymers, classification of polymers, Polymerization: addition, condensation, co polymerization and coordination. Average molecular weight concepts: number, weight and viscosity average molecular weights, polydispersity and molecular weight distribution. Measurement of molecular weight: end group, viscosity, light scattering, osmotic and ultracentrifugation methods, analysis and testing of polymers.

**Unit – II: Synthetic Polymers**

Addition and condensation polymerization processes – Bulk, Solution, Suspension and Emulsion polymerization. Preparation and significance, classification of polymers based on physical properties, Thermoplastics, Thermosetting plastics, Fibers and elastomers, General Applications. Preparation of Polymers based on different types of monomers, Olefin polymers, Diene polymers, nylons, Urea - formaldehyde, phenol – formaldehyde. Melamine Epoxy and Ion exchange resins. Characterization of polymers by IR, NMR, XRD

**Unit – III : Natural Polymers & Modified cellulosics**

Natural Polymers: Chemical & Physical structure, properties, source, important chemical modifications, applications of polymers such as cellulose, lignin, starch, rosin, shellac, latexes, vegetable oils and gums, proteins. Modified cellulosics: Cellulose esters and ethers such as Ethyl cellulose, CMC, HPMC, cellulose acetals, Liquid crystalline polymers; specialty plastics- PES, PAES, PEEK, PEA.

**Unit-IV: Hydrogels of Polymer networks and Drug delivery**

Definitions of Hydrogel, polymer networks, Types of polymer networks, Methods involved in hydrogel preparation, Classification, Properties of hydrogels, Applications of hydrogels in drug delivery.

Introduction to drug systems including, drug development, regulation, absorption and disposition, routes of administration and dosage forms. Advanced drug delivery systems and controlled release.

**Unit – V: Surface phenomena**

Surface tension, adsorption on solids, electrical phenomena at interfaces including electrokinetics, micelles, reverse micelles, solubilization. Application of photoelectron spectroscopy, ESCA and Auger spectroscopy to the study of surfaces.

**References :**

1. A Text book of Polymer science, Billmayer
2. Organic polymer Chemistry, K.J.Saunders, Chapman and Hall
3. Advanced Organic Chemistry, B.Miller, Prentice Hall
4. Polymer Chemistry – G.S.Mishra
5. Polymer Chemistry – Gowarikar
6. Physical Chemistry –Galston
7. Drug Delivery- Ashim K. Misra

## JNTUA College of Engineering (Autonomous), Ananthapuramu

## Open Elective Course – III CIVIL

**IV B.TECH – I SEMESTER (R20) (common to all branches) - 2020 Admitted Batch**

| Course Code | Building Technology for Engineers | L | T | P | C |
|---|---|---|---|---|---|
| 20A70104 | | 3 | 0 | 0 | 3 |

**Course Objectives :**

1. To make the student familiar with varioustypes of Buildings and its components
2. To teach the students about general requirements of building regarding safety and transportation
3. To impart knowledge on various special requirements of buildings regarding ventilation, insulation acoustics, etc,.
4. To make the student familiar with the concepts of various Prefabrication systems.
5. To Teach the students about various construction equipments used in building.

**Course Outcomes:**

By the end of this course the student will be able to

1. Classify various types of buildings and its components.
2. Understand the general requirements of building regarding safety and transportation.

3. Understand the Special requirements of buildings regarding ventilation, insulation acoustics, etc,.
4. Familiarize with the concepts of various Prefabrication systems.
5. Understand various construction equipments used in building.

**UNIT-1**

**Building planning:** Types of Buildings — components, definitions, economy and design, Principles and aspects of building planning, Definitions and importance of Grouping and circulation; Lighting and ventilation; Sustainability and Green Buildings.

**UNIT-**II

**General requirements:** Requirements for safety against fire, termite, damping, earthquakes, Vertical transportation in building — planning of vertical transportation, Stairs, different forms of stairs, Other modes of vertical transportation.

**UNIT-**III

**Special Requirements:** Air conditioning — process and classification of air conditioning, Dehumidification. Systems of air-conditioning, ventilation, functional requirements of ventilation. Thermal insulation. Acoustics, effect of noise, properties of noise and its measurements, Principles of acoustics of building. Sound insulation.

UNIT-IV

**Prefabrication systems:** Prefabricated walls, openings, cupboards, shelves etc., planning and modules and sizes of components in prefabrication. Plumbing services — water supply system, maintenance of building pipe line, Sanitary fittings, Design of building drainage.

UNIT-V

**Construction Equipment:** Introduction and Planning for construction Equipment, Earthmoving and Excavating equipment, Pile driving equipment, Lifting and Concreting Equipment.

<u>Learning Resources:</u>

Text Books:

1. Building Construction, Punmia B. C., Jain A.J., and Jain A.J., Laxmi Publication, 2016, Eleventh Edition.
2. The Text book for Building Construction, Arora S. P., and Bindra S. P., Dhanpat Rai Pubications, 2010.

Reference Books:

1. Building Construction, Varghese P.C., PHI Learning Pvt. Ltd., 2017, 2nd Edition.
2. Construction Planning, Equipment and Methods, Robert P., Clifford J. S., and Aviad S., McGrawHiII Education, 2010

## JNTUA College of Engineering (Autonomous), Ananthapuramu

## Open Elective Course – III EEE

**IV B.TECH – I SEMESTER (R20) (common to all branches) - 2020 Admitted Batch**

<table>
<tr><td>Course Code</td><td colspan="2" rowspan="2">BATTERY MANAGEMENT SYSTEMS<br>(OE-III)</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>20A70204</td><td>3</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td>Pre-requisite</td><td>Basic Electrical Engineering</td><td>Semester</td><td colspan="4">VI</td></tr>
<tr><td colspan="7">Course Objectives: To make the students learn about:</td></tr>
<tr><td colspan="7">• Understand the role of battery management system and the requirements of BMS.<br>• Interpret the concept associated with battery charging / discharging process<br>• Analyze various parameters of battery and battery pack<br>• Design the model of battery pack</td></tr>
<tr><td colspan="7">Course Outcomes (CO): After completion of this course, student will be able to</td></tr>
<tr><td colspan="7">CO1: Understand and remember the basic concepts and terminologies of Cells and Batteries, charging, discharging methods, concept of cell balancing.<br><br>CO2:Analyze BMS functionality, various sensors used, control techniques, Sate of Charge estimation, cell total energy and cell total power.<br><br>CO3: Apply the equivalent circuits, physical models, empirical modelling of BMS.<br><br>CO4: Design of Battery management system considering various parameters and through simulation.</td></tr>
</table>

| UNIT - I | INTRODUCTION | Lecture Hrs: 14 |
|---|---|---|
| Introduction to Battery Management System, Cells & Batteries, Nominal voltage and capacity, C rate, Energy and power, Cells connected in series, Cells connected in parallel, Electrochemical and lithium-ion cells, Rechargeable cell, Charging and Discharging Process, Overcharge and Undercharge, Modes of Charging | | |
| **UNIT - II** | **BATTERY MANAGEMENT SYSTEM** | Lecture Hrs: 14 |
| Introduction and BMS functionality, Battery pack topology, BMS Functionality, Voltage Sensing, Temperature Sensing, Current Sensing, BMS Functionality, High-voltage contactor control, Isolation sensing, Thermal control, Protection, Communication Interface, Range estimation, State-of charge estimation, Cell total energy and cell total power | | |
| **UNIT - III** | **BATTERY STATE OF CHARGE AND STATE OF HEALTH ESTIMATION** | Lecture Hrs: 12 |
| Battery state of charge estimation (SOC), voltage-based methods to estimate SOC, Model-based state estimation, Battery Health Estimation, Lithium-ion aging: Negative electrode, Lithium ion aging: Positive electrode, Cell Balancing, Causes of imbalance, Circuits for balancing | | |
| **UNIT - IV** | **MODELLING AND SIMULATION** | Lecture Hrs: 12 |
| Equivalent-circuit models (ECMs), Physics-based models (PBMs), Empirical modelling approach, Physics-based modelling approach, Simulating an electric vehicle, Vehicle range calculations, Simulating constant power and voltage, Simulating battery packs | | |
| **UNIT - V** | **DESIGN OF BATTERY MANAGEMENT SYSTEMS** | Lecture Hrs: 12 |
| Design principles of battery BMS, Effect of distance, load, and force on battery life and BMS, energy balancing with multi-battery system | | |
| **Textbooks:** | | |
| 1. Plett, Gregory L. Battery management systems, Volume I: Battery modelling. Artech House, 2015.<br>2. Plett, Gregory L. Battery management systems, Volume II: Equivalent-circuit methods. Artech House, 2015. | | |
| **Reference Books:** | | |
| 1. Bergveld, H.J., Kruijt, W.S., Notten, P.H.L "Battery Management Systems -Design by Modelling" Philips Research Book Series 2002.<br>2. Davide Andrea," Battery Management Systems for Large Lithium-ion Battery Packs" Artech House, 2010<br>3. Pop, Valer, et al. Battery management systems: Accurate state-of-charge indication for battery-powered applications. Vol. 9. Springer Science & Business Media, 2008.<br>4. RuiXiong, "Battery management Algorithm for Electric Vehicles", China Machine Press, Springer,2020.<br>5. Bergveid, Krujit, Notten, " Battery Management Systems: Design by Modelling", Philips Research Book Series, Kluwer Academic Publishers. | | |

| **Online Learning Resources:** |
|---|
| 1. https://www.coursera.org/learn/battery-management-systems |

## JNTUA College of Engineering (Autonomous), Ananthapuramu

## Open Elective Course – III

**IV B.TECH – I SEMESTER (R20) (common to all branches) - 2020 Admitted Batch**

**DEPARTMENT OF MECHANICAL ENGINEERING**

| Subject Code | Title of the Subject | L | T | P | C |
|---|---|---|---|---|---|
| 20A70304 | **MODERN MANUFACTURING METHODS** | 3 | 0 | 0 | 3 |

**Course Objectives:**

To learn the importance and basics of unconventional machining.
To understand the rapid prototyping processes.

To have the knowledge of different micro machining methods
To understand the working principles of various Non-traditional machining methods.

To learn about Non-traditional forming processes.

**UNIT-I**

Need for Modern Manufacturing Methods: Non-traditional machining methods and rapid prototyping methods - their relevance for precision and lean manufacturing. Classification of non-traditional processes - their selection for processing of different materials and the range of applications.

Introduction to rapid prototyping - Classification of rapid prototyping methods - sterolithography, fused deposition methods - materials, principle of prototyping and various applications.

**UNIT-II**

Ultrasonic machining – Elements of the process, mechanics of material removal, process parameters, applications and limitations, Abrasive jet, Water jet and abrasive water jet machining: Basic mechanics of material removal, descriptive of equipment, process variables, applications and limitations.

**UNIT-III**

Electro –Chemical Processes: Fundamentals of electro chemical machining, electrochemical grinding, metal removal rate in ECM, Tooling, process variables, applications, economic aspects of ECM.

Chemical Machining: Fundamentals of chemical machining- Principle of material removal- maskants – etchants- process variables, advantages and applications.

**UNIT-IV**

Thermal Metal Removal Processes: Basic principle of spark erosion (EDM), Wire cut EDM, and Electric Discharge Grinding processes - Mechanics of machining, process parameters, selection of tool electrode and dielectric fluids, choice of parameters for improved surface finish and machining accuracy - Applications of different processes and their limitations.

Plasma Machining: Principle of material removal, description of process and equipment, process variables, scope of applications and the process limitations.

**UNIT-V**

Electron Beam Machining: Generation and control of electron beam for machining, theory of electron beam machining, comparison of thermal and non-thermal processes - process mechanics, parameters, applications and limitations.

Laser Beam Machining: Process description, Mechanism of material removal, process parameters, capabilities and limitations, features of machining, applications and limitations.

**Course Outcomes:**

At the end of this course the student should be able to understand

- Technical aspects of precision machining.
- Applications of rapid prototyping technologies.
- Tool selection for non traditional processes.
- Knowledge of economic aspects of Non traditional processes.
- Fabrication of microelectronic devices.

**TEXT BOOKS:**

- Manufacturing processes for engineering materials by SeropeKalpakjian and Steven R Schmid, 5edn, Pearson Pub.
- Advanced machining processes, VK Jain, Allied publishers.

**REFERENCE:**

- New Technology , Bhattacharya A, The Institution of Engineers, India 1984
- Manufacturing Technology, Kalpakzian, Pearson
- Modern Machining Process, Pandey P.C. and Shah H.S., TMH.

## JNTUA College of Engineering (Autonomous), Ananthapuramu
## Open Elective Course – III

**IV B.TECH – I SEMESTER (R20) (common to all branches) - 2020 Admitted Batch**
**DEPARTMENT OF Electronic & Communication Engineering**

| Course Code | DIGITAL ELECTRONICS | L | T | P | C |
|---|---|---|---|---|---|
| 20A70404 | | 3 | 0 | 0 | 3 |
| Pre-requisite | Semester | VII | | | |

Basics of Electronics and Communication Engineering

**Course Objectives:**

- To learn simplification methods for minimizing Boolean functions and their realization using logic gates.
- To understand and design various combinational logic circuits like adders and code converters.
- To know the design of various combinational circuits useful to implement logic functions.
- To study the design of sequential logic circuits in synchronous and asynchronous modes.
- To introduce programmable logic devices.

**Course Outcomes (CO):** At the end of this course, the students will be able to

- Learn simplification methods for minimizing Boolean functions and their realization using logic gates.
- Understand and design various combinational logic circuits like adders and code converters.
- Know the design of various combinational circuits useful to implement logic functions.
- Gain knowledge on the design of sequential logic circuits in synchronous and asynchronous modes.
- Understand the operation and uses of programmable logic devices.

**UNIT - I**

**Logic Simplification and Combinational Logic Design**: Review of Boolean Algebra and De Morgan's Theorem, SOP & POS forms, Canonical forms, Introduction to Logic Gates, Ex-OR, Ex-NOR operations, Minimization of Switching Functions: Karnaugh map method, Quine –McCluskey Tabular Minimization Method. Logic function realization: AND-OR, OR-AND and NAND/NOR realizations.

**UNIT - II**

**Introduction to Combinational Design 1**: Binary Adders, Subtractors and BCD adder, Code converters - Binary to Gray, Gray to Binary, BCD to excess3, BCD to Seven Segment display.

**UNIT - III**

**Combinational Logic Design 2:** Decoders (3 to 8, octal to decimal), Encoders, Priority Encoders, Multiplexers, Demultiplexers, Comparators, Implementations of Logic Functions using Decoders and Multiplexers.

**UNIT - IV**

**Sequential Logic Design**: Latches, Flipflops, S-R, D, T, JK and Master-Slave JK FF, Edge triggered FF, flipflop conversions, set up and hold times, Ripple and Synchronous counters, Shift registers.

**UNIT - V**

**Programmable Logic Devices:**ROM, Programmable Logic Devices (PLDs), Introduction to logic families and their comparisons.

**Textbooks:**


1. Digital Design, M. Morris Mano & Michel D. Ciletti, 5th Edition, Pearson Education, 1999.
2. Switching theory and Finite Automata Theory, ZviKohavi and Nirah K. Jha, 2nd Edition, Tata McGraw Hill, 2005.


**Reference Books:**


1. Fundamentals of Logic Design, Charles H Roth, Jr., 5th Edition, Brooks/coleCengage Learning, 2004.
2. Digital & State Machine Design, Comer, 3rd Edition, OXFORD.


Online Learning Resources:

## JNTUA College of Engineering (Autonomous), Ananthapuramu

## Open Elective Course – III

**IV B.TECH – I SEMESTER (R20) (common to all branches) - 2020 Admitted Batch**

**DEPARTMENT OF Compute Science & Engineering**

**Cyber Security**

**Course Code:20A70504** **L T P C : 3 0 0 3**

**Course Objectives:**

- To introduce the concepts of Java.
- To Practice object-oriented programs and build java applications.
- To implement java programs for establishing interfaces.
- To implement sample programs for developing reusable software components.
- To establish database connectivity in java and implement GUI applications.

**Course Outcomes:**

CO1: Recognize the Java programming environment.
CO2: Select appropriate programming constructs to solve a problem.
CO3: Develop efficient programs using multithreading.
CO4: Design reliable programs using Java exception handling features.
**CO5:** Extend the programming functionality supported by Java.

**UNIT-I: Cybercrime**

Cybercrime and information security, Cybercriminals, Classifications of cybercrimes, Need for Cyberlaws in Indian context, Legal perspectives of cybercrime, Indian perspective of cybercrimes, Cybercrime and the Indian ITA 2000, Positive aspects and weak areas of ITA 2000, Amendments made in Indian ITA 2000 for admissibility of e- records, Amendments to the Indian IT Act, Global perspective on cybercrimes, Intellectual property in cyberspace, Ethical dimension of cybercrimes.

**UNIT-II: Cyber Offenses**

Cybercrime and information security, Cybercriminals, Classifications of cybercrimes, Need for Cyberlaws in Indian context, Legal perspectives of cybercrime, Indian perspective of cybercrimes, Cybercrime and the Indian ITA 2000, Positive aspects and weak areas of ITA 2000, Amendments made in Indian ITA 2000 for admissibility of e- records, Amendments to the Indian IT Act, Global perspective on cybercrimes, Intellectual property in cyberspace, Ethical dimension of cybercrimes.

**UNIT-III: Cybercrime in Mobile and Wireless Devices**

Proliferation of mobile and wireless devices, Trends in mobility, Credit card frauds in mobile and wireless computing era, Security challenges posed by mobile devices, Registry settings for mobile devices, Authentication service security, Attacks on mobile/cell phones, Security implications of mobile devices for organizations, Organizational measures for handling mobile devices related security issues.

**UNIT-VI: Tools and Methods Used in Cybercrime**

Proxy servers and anonymizers, Password cracking, Keyloggers and spywares, Virus and worms, Trojan horses and backdoors, Steganography, DoS and DDoS attacks, SQL Injection, Buffer Overflow, Attacks on wireless networks

**UNIT-V: Cyber Forensics, Cybercrime in Real-World**

Forensics of Computer and Handheld Devices: Cyber forensics, Cyber forensics and digital evidence, Forensics analysis of e-mail, Forensics and social networking sites, Forensics of handheld devices – Smartphone forensics, EnCase, Device Seizure, MOBIL edit.

Cybercrime examples, mini-cases, online scams: Real-life examples - Official website of Maharashtra Government hacked, Indian banks lose millions of rupees, Game source code stolen; Mini-cases - Indian Case of online gambling, Indian case of intellectual property crime; Online scams - Cheque cashing scam, Charity scams.

**References:**


1. K. A. Navas, “Electronics Lab Manual”, Volume I, PHI, 5th Edition, 2015, ISBN:9788120351424
2. Cyril Prasanna Raj P., “CMOS digital circuit design manual”, Volume 1, MSEC E-publication, Edition 2016

## JNTUA College of Engineering (Autonomous), Ananthapuramu

## Open Elective Course – III

**IV B.TECH – I SEMESTER (R20) (common to all branches) - 2020 Admitted Batch**

**DEPARTMENT OF Chemical Engineering**

| Course Code | INDUSTRIAL POLLUTION CONTROL ENGINEERING | L | T | P | C |
|---|---|---|---|---|---|
| 20A70804 | | 3 | 0 | 0 | 3 |

**Pre-requisite**

Course Objectives:

Course Outcomes (CO):

At the end of the course, the student will be able to:

| | |
|---|---|
| CO1 | Understand the different types of wastes generated in an industry, their effects on living and non-living things & environmental regulatory legislations and standards and climate changes. |
| CO2 | Quantify, analyse and treat wastewater |
| CO3 | Apply the different unit operations and unit processes involved in conversion of highly polluted water to potable standards |
| CO4 | Apply the operating principles, design calculations of particulate control devices. |
| CO5 | Estimate the different waste generated from the industries |

**Course Articulation Matrix**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |
| CO6 | | | | | | | | | | | | |

UNIT - I

Types of emissions from chemical industries and effects of environment, environment legislation, Type of pollution, sources of wastewater, Effluent guidelines and standards. Characterization of effluent streams, oxygen demands and their determination (BOD, COD, and TOC), Oxygen sag curve, BOD curve mathematical, controlling of BOD curve, self purification of running streams, sources and characteristics of pollutants in fertilizer, paper and pulp industry, petroleum and petroleum industry.

UNIT - II

General methods of control and removal of sulfur dioxide, oxides of nitrogen and organic vapors from gaseous effluent, treatment of liquid and gaseous effluent in fertilizer industry. Air pollution sampling and measurement: Types of pollutant and sampling and measurement,ambient air sampling: collection of gaseous air pollutants, collection of particulate air pollutants. Stack sampling: sampling system, particulate sampling, and gaseous sampling. Analysis of air pollutants: Sulphur dioxide, nitrogen oxides, carbon monoxide, oxidants and ozones, hydrocarbons, particulate matter

UNIT - III

Air pollution control methods and equipments: Source collection methods: raw material changes, process changes, and equipment modification. Cleaning of gaseous equipments particulate emission control: collection efficiency, control equipment like gravitational settling chambers, Cyclone separators, fabric filters, ESP and their constructional details and design aspects. Scrubbers: wet scrubbers, spray towers, centrifugal scrubbers, packed beds and plate columns, venturi scrubbers, their design aspects. Control of gaseous emissions: absorption by liquids, absorption equipments, adsorption by solids, equipment and the design aspects

UNIT - IV

Introduction to waste water treatment, biological treatment of wastewater, bacterial and bacterial growth curve, aerobic processes, suspended growth processes, activated aerated lagoons and stabilization ponds, attached growth processes, trickling filters, rotary drum filters, anaerobic processes.

UNIT - V

Methods of primary treatments: screening, sedimentation, flotation, neutralization, and methods of tertiary treatment. A brief study of carbon absorption, ion exchange, reverse osmosis, ultra-filtration, chlorination, ozonation, treatment and disposal. Hazardous waste management: nuclear wastes: health and environment effects, sources and disposal methods. Chemical wastes: health and environmental effects, treatment and disposal: treatment and disposal by industry, off site treatment and disposal, treatment practices in various countries. Biomedical wastes: types of wastes and their control.

**Textbooks:**

1. Environmental Pollution and Control Engineering, C. S. Rao – Wiley Eastern Limited, India, New Delhi, 1993.

2. Pollution Control in Process Industries, S.P. Mahajan, Tata McGraw-Hill, New Delhi, 1985.

**Reference Books:**

1. Wastewater Treatment, M. Narayana Rao and A.K.Datta, Oxford and IHB publ. New Delhi.

**Online Learning Resources:**

## JNTUA College of Engineering (Autonomous), Ananthapuramu

## Open Elective Course – III

**IV B.TECH – I SEMESTER (R20) (common to all branches) - 2020 Admitted Batch**

## DEPARTMENT OF MATHEMATICS

<table>
<tr><td>Course Code</td><td colspan="2" rowspan="2">Numerical Methods for Engineers<br>(Common for all Branches)</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>20A75101</td><td>0</td><td>3</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite</td><td>---</td><td></td><td colspan="4"></td></tr>
<tr><td colspan="7"></td></tr>
<tr><td colspan="7">Course Objectives:</td></tr>
<tr><td colspan="7">This course aims at providing the student with the knowledge on various numerical methods for solving equations, interpolating the polynomials, evaluation of integral</td></tr>
</table>

| | | |
|---|---|---|
| equations and solution of differential equations. | | |
| Course Outcomes (CO): Student will be able to | | |
| • apply numerical methods to solve algebraic and transcendental equations.<br>• understand fitting of several kinds of curves.<br>• derive interpolating polynomials using interpolation formulae.<br>• Solve differential and integral equations numerically. | | |
| UNIT - I | **Solution of Algebraic & Transcendental Equations:** | 8 Hrs |
| Introduction-Bisection method-Iterative method-Regula falsi method-Newton Raphson method. System of Algebraic equations: Gauss Jordan method-Gauss Siedal method. | | |
| UNIT - II | **Curve Fitting** | 8 Hrs |
| Principle of Least squares- Fitting of curves- Fitting of linear, quadratic and exponential curves. | | |
| UNIT - III | **Interpolation** | 9 Hrs |
| Finite differences-Newton's forward and backward interpolation formulae – Lagrange's formulae. Gauss forward and backward formula, Stirling's formula, Bessel's formula | | |
| UNIT - IV | **Numerical Integration** | 8 Hrs |
| Numerical Integration: Trapezoidal rule – Simpson's 1/3 Rule – Simpson's 3/8 Rule | | |
| UNIT - V | **Solution of Initial value problems to Ordinary differential equations** | 9 Hrs |
| Numerical solution of Ordinary Differential equations: Solution by Taylor's series-Picard's Method of successive Approximations-Modified Euler's Method-Runge-Kutta Methods. | | |
| Textbooks: | | |
| 4. Higher Engineering Mathematics, B.S.Grewal, Khanna publishers.<br>5. Probability and Statistics for Engineers and Scientists, Ronald E. Walpole,PNIE.<br>6. Advanced Engineering Mathematics, by Erwin Kreyszig, Wiley India | | |
| Reference Books: | | |
| 3. Higher Engineering Mathematics, by B.V.Ramana, Mc Graw Hill publishers.<br>4. Advanced Engineering Mathematics, by Alan Jeffrey, Elsevier. | | |
| Online Learning Resources: | | |

https://slideplayer.com/slide/8588078/

**JNTUA College of Engineering (Autonomous), Ananthapuramu**

**Open Elective Course – III**

**IV B.TECH – I SEMESTER (R20) (common to all branches) - 2020 Admitted Batch**

**DEPARTMENT OF Physics**

| Subject Code | Title of the Subject | L | T | P | C |
|---|---|---|---|---|---|
| 20A75201 | **SMART MATERIALS AND DEVICES** | 3 | | - | 3 |

| **COURSE OBJECTIVES** | |
|---|---|
| 1 | To provide exposure to smart materials and their engineering applications. |
| 2 | To impart knowledge on the basics and phenomenon behind the working of smart materials |
| 3 | To explain theproperties exhibited by smart materials |
| 4 | To educate various techniques used to synthesize and characterize smart materials |

| | |
|---|---|
| 5 | To identify the required smart material for distinct applications/devices |
| **COURSE OUTCOMES** | |
| At the end of the course the student will be able | |
| CO1 | To recognize the need of smart materials |
| CO2 | To understand the working principles of smart materials |
| CO3 | To know different techniques used to synthesize and characterize smart materials |
| CO4 | To exploit the properties of smart materials |
| CO5 | To make use of smart materials for different applications |

**Mapping between Course Outcomes and Programme Outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |

## SYLLABUS

**Credit: 3** **Hours of teaching: - 45 H**

**UNITI : Introduction to Smart Materials**: 9H

Historical account of the discovery and development of smart materials, Two phases: Austenite and Martensite, Temperature induced phase changes, Shape memory effect, Pseudoelasticity, One-way shape memory effect, Two-way shape memory effect.

**UNIT II: Properties of Smart Materials**: 9H

Physical principles of optical, Electrical, Dielectric, Piezoelectric, Ferroelectric, Pyroelectric and Magnetic properties of smart materials.

**UNIT III: Synthesis of Smart materials**: 9H

Solid state reaction technique, Chemical route: Chemical vapour deposition, Sol-gel technique, Hydrothermal method,Co-precipitaiton.Green synthesis, Mechanical alloying and Thin film deposition techniques: Chemical etching, Spray pyrolysis.

**UNIT IV: Characterization Techniques**: 9H

X-ray diffraction, Raman spectroscopy (RS), Fourier-transform infrared reflection (FTIR), UV-Visible spectroscopy, Scanning electron microscopy (SEM), Transmission electron microscopy, Atomic force microscopy (AFM) and Differential Scanning Calorimetry (DSC).

**UNIT V:Smart Materials and Devices:** 9H

Characteristics of shape memory alloys, Magnetostrictive, Optoelectronic, Piezoelectric, Metamaterials, Electro-rheological and Magneto-rheological materials and Composite materials.

Devices based on smart materials: Sensors & Actuators, MEMS and intelligent devices, Future scope of the smart materials.

**Text Books:**

1.Encyclopaediaof Smart Materials- Mel Schwartz, John Wiley & Sons, Inc.2002

2. Smart Materials and Structures - M. V. Gandhi and B.S. Thompson, Champman and Hall, 1992

**Texts/References:**

1. Smart Materials and Technologies- M. Addington and D. L. Schodek, , Elsevier, 2005.

2. Characterization and Application of smart Materials -R. Rai, Synthesis, , Nova Science, 2011.

3. Electroceramics: Materials, Properties, Applications -A.J. Moulson and J.M. Herbert, , 2$^{nd}$ Edn., John Wiley & Sons, 2003.

4. Piezoelectric Sensorics: Force, Strain, Pressure, Acceleration and Acoustic 1. Emission Sensors, Materials and Amplifiers,G.Gautschi, Springer, 2002.

5. Optical Metamaterials: Fundamentals and Applications-W. Cai and V. Shalaev, ,springer,2010.

6. Smart Materials and Structures - P. L Reece, New Research, Nova Science, 2007

**NPTEL courses links**

https://nptel.ac.in/courses/112/104/112104173/
https://nptel.ac.in/courses/112/104/112104251/
https://nptel.ac.in/content/storage2/courses/112104173/Mod_1_smart_mat_lec_1.pdf

**JNTUA College of Engineering (Autonomous), Ananthapuramu**

**Open Elective Course – III**

**IV B.TECH – I SEMESTER (R20) (common to all branches) - 2020 Admitted Batch**

**DEPARTMENT OF H &SS**

<table>
<tr><td>Course Code</td><td colspan="2" rowspan="2">Employability Skills</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>20A75501</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite</td><td></td><td>Semester-VII</td><td colspan="4"></td></tr>
<tr><td colspan="7"></td></tr>
<tr><td colspan="7">Course Objectives:</td></tr>
<tr><td colspan="7">➢ To encourage all round development of the students by focusing on productive skills<br>➢ To make the students aware of Goal setting and writing skills<br>➢ To enable them to know the importance of presentation skills in achieving desired goals.<br>➢ To help them develop organizational skills through group activities<br>To function effectively with heterogeneous teams</td></tr>
<tr><td colspan="7">Course Outcomes (CO):</td></tr>
<tr><td colspan="7">CO1: Define goals and try to achieve them<br>CO2: Understand the significance of self-management<br>CO3: Apply the knowledge of writing skills in preparing eye-catchy resumes<br>CO4: Analyse various forms of Presentation skills<br>CO5: Judge the group behaviour<br>CO6: Develop skills required for employability.</td></tr>
<tr><td>UNIT - I</td><td colspan="2">Goal Setting and Self-Management</td><td colspan="4">Lecture Hrs</td></tr>
<tr><td colspan="7">Definition, importance, types of Goal Setting – SMART Goal Setting – Motivation – Intrinsic and Extrinsic Motivation – Self-Management - Knowing about self – SWOT Analysis</td></tr>
<tr><td>UNIT - II</td><td colspan="2">Writing Skills</td><td colspan="4">Lecture Hrs</td></tr>
<tr><td colspan="7">Definition, significance, types of writing skills – Resume writing, E-Mail writing, Cover Letters, - E-Mail Etiquettes</td></tr>
<tr><td>UNIT - III</td><td colspan="2">Technical Presentation Skills</td><td colspan="4">Lecture Hrs</td></tr>
<tr><td colspan="7">Nature, meaning & significance of Presentation Skills – Planning, Preparation, Presentation, Stage Dynamics – PPT & Poster Presentation</td></tr>
<tr><td>UNIT - IV</td><td colspan="2">Group Presentation Skills</td><td colspan="4">Lecture Hrs</td></tr>
</table>

| | | |
|---|---|---|
| Body Language – Group Behaviour - Team Dynamics – Leadership Skills – Personality Manifestation- Group Discussion | | |
| UNIT - V | Job Cracking Skills | Lecture Hrs |
| Nature, characteristics, importance & types of Interviews – Job Interviews – Skills for success - Answering Strategies – Mock Interviews | | |
| Textbooks: | | |
| • 1. Soft Skills & Employability Skills (English, Paperback, SABINA PILLAI, AGNA FERNANDEZ)Publisher: Cambridge<br>2.Personality Development and Soft Skills (English, Paperback, MitraBarun K.) | | |
| Reference Books: | | |
| 1. Learning How To Fly - Life Lessons for the Youth (English, Paperback, Kalam Abdul A. P. J.), Rupa& Co<br>2. Personality Development and Soft Skills - Preparing for Tomorrow 1 Edition (English, Paperback, Shikha Kapoor)Publisher: Dreamtech Press<br>3. Skills for Employability - Skills for Employability with 0 Disc (English, Paperback, Dr. M. Sen Gupta)Publisher: Innovative Publication | | |
| Online Learning Resources: | | |
| 7. https://youtu.be/gkLsn4ddmTs<br>8. https://youtu.be/2bf9K2rRWwo<br>9. https://youtu.be/FchfE3c2jzc<br>10. https://youtu.be/xBaLgJZ0t6A?list=PLzf4HHlsQFwJZel_j2PUy0pwjVUgj7KlJ | | |

**JNTUA College of Engineering (Autonomous), Ananthapuramu**

**Open Elective Course – III**

**IV B.TECH – I SEMESTER (R20) (common to all branches) - 2020 Admitted Batch**

**DEPARTMENT OF Chemistry**

| Subject Code | Title of the Subject | L | T | P | C |
|---|---|---|---|---|---|
| 20A75301 | **GREEN CHEMISTRY AND CATALYSIS FOR SUSTAINABLE ENVIRONMENT** | 2 | 1 | - | 3 |

| COURSE OBJECTIVES | |
|---|---|
| 1 | Learn an interdisciplinary approach to the scientific and societal issues arising from industrial chemical production, including the facets of chemistry and environmental health sciences that can be integrated to promote green chemistry and the redesign of chemicals, industrial processes and products. |
| 2 | Understand the use of alternatives |

| | |
|---|---|
| | assessments that combine chemical, environmental health, regulatory, and business considerations to develop safer products. |

| COURSE OUTCOMES | |
|---|---|
| CO1 | Apply the Green chemistry Principles for day to day life as well as synthesis, Describe the sustainable development and green chemistry, Explain economic and un-economic reactions, Demonstrate Polymer recycling. |
| CO2 | Explain Heterogeneous catalyst and its applications in Chemical and Pharmaceutical Industries, Differentiate Homogeneous and Heterogeneous catalysis, Identify the importance of Bio and Photo Catalysis, Discuss Transition metal and Phase transfer Catalysis |
| CO3 | Demonstrate Organic solvents and importance of solvent free systems, Discuss Super critical carbondioxide, Explain Super critical water and water as a reaction solvent, Interpret Ionic Liquids as Catalyst and Solvent |
| CO4 | Describe importance of Biomass and Solar Power, Illustrate Sonochemistry and Green Chemistry, Apply Green Chemistry for Sustainable Development , Discuss the importance of Renewable resources |
| CO5 | Discuss green Chemistry Principles for practicing Green nano synthesis, Illustrate Microwave Assisted Synthesis, Differentiate Hydrothermal and Reflux synthesis, Demonstrate Green Chemistry applications of Inorganic nanomaterials |

**Mapping between Course Outcomes and Programme Outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |

**SYLLABUS**

**UNIT 1: PRINCIPLES AND CONCEPTS OF GREEN CHEMISTRY**

Introduction, Green chemistry Principles, sustainable development and green chemistry, atom economy, atom economic: Rearrangement and addition reactions and un-economic reactions: Substitution, elimination and Wittig reactions, Reducing Toxicity. Waste - problems and Prevention: Design for degradation, Polymer recycling.

**UNIT 2: CATALYSIS AND GREEN CHEMISTRY**

Introduction to catalysis, Heterogeneous catalysts: Basics of Heterogeneous Catalysis, Zeolites and the Bulk Chemical Industry, Heterogeneous Catalysis in the Fine Chemical and Pharmaceutical Industries, Catalytic Converters, Homogeneous catalysis: Transition Metal Catalysts with Phosphine Ligands, Greener Lewis Acids, Asymmetric Catalysis, Heterogeneous and Homogenous catalysts, Phase transfer catalysis: Hazard Reduction, C–C Bond Formation, Oxidation Using Hydrogen Peroxide, Bio-catalysis and photo-catalysis with examples,

**UNIT 3: ORGANIC SOLVENTS: ENVIRONMENTALLY BENIGN SOLUTIONS**

Organic solvents and volatile organic compounds, solvent free systems, supercritical fluids: Super critical carbondioxide, super critical water and water as a reaction solvent: water based coatings, Ionic liquids as catalyst and solvent.

**UNIT 4: EMERGING GREENER TECHNOLOGIES**

Biomass as renewable resource, Energy: Fossil Fuels, Energy from Biomass, Solar Power, Other Forms of Renewable Energy, Fuel Cells, Chemicals from Renewable Feedstocks, Chemicals from Fatty Acids, Polymers from Renewable Resources, Some Other Chemicals from Natural Resources, Alternative Economies: The Syngas Economy, The Biorefinery, Design for energy efficiency, Industrial applications of alternative environmentally benign catalytic systems for carrying out the important reactions such as selective oxidation, reduction and C-C bond formations (specific reactions)

**UNIT 5: ALTERNATIVE ENERGY SOURCES**

Photo redox catalysis, single electron transfer reactions (SET), Advantages and Challenges Faced by Photochemical Processes, Examples of Photochemical Reactions, Chemistry Using Microwaves: Microwave Heating, Microwave-assisted Reactions, Sonochemistry: Sonochemistry and Green Chemistry, Electrochemical Synthesis: Examples of Electrochemical Synthesis.

**Text Books :**


1. M. Lancaster, Green Chemistry an introductory text, Royal Society of Chemistry, 2002.

2. Paul T. Anastas and John C. Warner, Green Chemistry Theory and Practice, 4th Edition,

Oxford University Press, USA

**References :**

1. Green Chemistry for Environmental Sustainability, First Edition, Sanjay K. Sharma and Ackmez Mudhoo, CRC Press, 2010.
2. Edited by Alvise Perosa and Maurizio Selva , Hand Book of Green chemistry Volume 8:

Green Nanoscience, wiley-VCH, 2013.

# JNTUA College of Engineering (Autonomous), Ananthapuramu

## Open Elective Course – IV

**IV B.TECH – I SEMESTER (R20) (common to all branches) - 2020 Admitted Batch**

**DEPARTMENT OF Civil Engineering**

| | | L | T | P | C |
|---|---|---|---|---|---|
| **20A70105** | **Environmental Impact Assessment** | **3** | **0** | **0** | **3** |

Course Objectives:
1. To impart knowledge on different concepts of Environmental Impact Assessment.
2. To teach procedures of risk assessment.
3. To teach the EIA methodologies and the criterion for selection of EIA methods.
4. To teach the procedures for environmental clearances and audit.
5. To know the impact quantification of various projects on the environment.

Course Outcomes (CO):
1. To prepare EMP, EIS, and EIA report.
2. To identify the risks and impacts of a project.
3. To choose an appropriate EIA methodology.
4. To evaluation the EIA report.
5. To Estimate the cost benefit ratio of a project.

UNIT - I

Concepts and methodologies of EIA :Initial environmental Examination, Elements of EIA, - Factors affecting E-I-A Impact evaluation and analysis, preparation of Environmental Base map, Classification of environmental parameters- Criteria for the selection of EIA Methodology, E I A methods, Ad-hoc methods, matrix methods, Network method Environmental Media Quality Index method, overlay methods and cost/benefit Analysis.

UNIT - II

Impact of Developmental Activities and Land Use :Introduction and Methodology for the assessment of soil and ground water, Delineation of study area, Identification of actives. Procurement of relevant soil quality, Impact prediction, Assessment of Impact significance, Identification and Incorporation of mitigation measures. E I A in surface water, Air and Biological environment: Methodology for the assessment of Impacts on surface water environment, Air pollution sources, Generalized approach for assessment of Air pollution Impact.

UNIT - III

Assessment of Impact on Vegetation, Wildlife and Risk Assessment :Introduction - Assessment of Impact of development Activities on Vegetation and wildlife, environmental Impact of Deforestation – Causes and effects of deforestation - Risk assessment and treatment of uncertainty-key stages in performing an Environmental Risk Assessment- Advantages of Environmental Risk Assessment

UNIT - IV Environmental audit

Introduction - Environmental Audit & Environmental legislation objectives of Environmental Audit, Types of environmental Audit, Audit protocol, stages of Environmental Audit, onsite activities, evaluation of Audit data and preparation of Audit report.

UNIT - V Environmental Acts and Notifications

The Environmental protection Act, The water preservation Act, The Air (Prevention &Control of pollution Act), Wild life Act - Provisions in the EIA notification, procedure for environmental clearance, procedure for conducting environmental impact assessment report- Evaluation of EIA report. Environmental legislation objectives, evaluation of Audit data and preparation of Audit report. Post Audit activities, Concept of ISO and ISO 14000.

Textbooks:

1. Environmental Impact Assessment, by Canter Larry W., McGraw-Hill education Edi (1996)
2. Environmental Impact Assessment Methodologies, by Y. Anjaneyulu, B. S. Publication, Hyderabad 2nd edition 2011

Reference Books:

1. Environmental Engineering, by Peavy, H. S, Rowe, D. R, Tchobanoglous, G.Mc-Graw Hill International Editions, New York 1985
2. Environmental Science and Engineering, by J. Glynn and Gary W. Hein Ke, Prentice Hall Publishers
3. Environmental Science and Engineering, by Suresh K. Dhaneja, S.K., Katania& Sons Publication, New Delhi.
4. Environmental Pollution and Control, by H. S. Bhatia, Galgotia Publication (P) Ltd, Delhi.

Online Learning Resources:

https://nptel.ac.in/courses/124107160

## JNTUA College of Engineering (Autonomous), Ananthapuramu
## Open Elective Course – IV

**IV B.TECH – I SEMESTER (R20) (common to all branches) - 2020 Admitted Batch**

DEPARTMENT OF Electrical & Electronic & Engineering

| | | L | T | P | C |
|---|---|---|---|---|---|
| **Course Code** | **IoT APPLICATIONS IN ELECTRICAL ENGINEERING (OE-IV)** | **L** | **T** | **P** | **C** |
| **20A70205** | | **3** | **0** | **0** | **3** |
| **Pre-requisite** | | | | | |

**Course Objectives:** To make the students learn about:

- Basics of Internet of Things and Micro Electro Mechanical Systems (MEMS) fundamentals in design and fabrication process.
- The concept of motion less and motion detectors in IoT applications.
- Applications of IoT in smart grid.
- The concept of Internet of Energy for various applications.

**Course Outcomes (CO):** After completing the course, the student should be able to do the following:

**CO 1** Understand the concept of IoT in Electrical Engineering.
**CO 2**Analyze various types of motionless sensors and various types of motion detectors
**CO 3** Apply various applications of IoT in smart grid.
**CO 4** Design future working environment with Energy internet.

| **UNIT - I** | **SENSORS** | Lecture Hrs: 10 |
|---|---|---|

Definitions, Terminology, Classification, Temperature sensors, Thermoresistive, Resistance, temperature detectors, Silicon resistive thermistors, Semiconductor, Piezoelectric, Humidity and moisture sensors. Capacitive, Electrical conductivity, Thermal conductivity, time domain reflectometer, Pressure and Force sensors: Piezoresistive, Capacitive, force, strain and tactile sensors, Strain gauge, Piezoelectric

| **UNIT - II** | **OCCUPANCY AND MOTION DETECTORS** | Lecture Hrs: 10 |
|---|---|---|

Capacitive occupancy, Inductive and magnetic, potentiometric - Position, displacement and level sensors, Potentiometric, Capacitive, Inductive, magnetic velocity and acceleration sensors, Capacitive, Piezoresistive, piezoelectric cables, Flow sensors, Electromagnetic, Acoustic sensors - Resistive microphones, Piezoelectric, Photo resistors

| **UNIT - III** | **MEMS** | Lecture Hrs: 10 |
|---|---|---|

Basic concepts of MEMS design, Beam/diaphragm mechanics, electrostatic actuation and fabrication, Process design of MEMS based sensors and actuators, Touch sensor, Pressure sensor, RF MEMS switches, Electric and Magnetic field sensors

| **UNIT - IV** | **IoT FOR SMART GRID** | Lecture Hrs: 8 |
|---|---|---|

Driving factors, Generation level, Transmission level, Distribution level, Applications, Metering and

| monitoring applications, Standardization and interoperability, Smart home | | |
|---|---|---|
| **UNIT - V** | **INTERNET of ENERGY (IoE)** | Lecture Hrs: 10 |
| Concept of Internet of Energy, Evaluation of IoE concept, Vision and motivation of IoE, Architecture, Energy routines, information sensing and processing issues, Energy internet as smart grid . | | |

**Textbooks:**

1. Jon S. Wilson, Sensor Technology Hand book, Newnes Publisher, 2004
2. Tai Ran Hsu, MEMS and Microsystems: Design and manufacture, 1st Edition, Mc Grawhill Education, 2017
3. ErsanKabalci and YasinKabalci, From Smart grid to Internet of Energy, 1st Edition, Academic Press, 2019

**Reference Books:**

1. Raj Kumar Buyya and Amir VahidDastjerdi, Internet of Things: Principles and Paradigms, Kindle Edition, Morgan Kaufmann Publisher, 2016
2. Yen Kheng Tan and Mark Wong, Energy Harvesting Systems for IoT Applications: Generation, Storage and Power Management, 1st Edition, CRC Press, 2019
3. RMD SundaramShriram, K. Vasudevan and Abhishek S. Nagarajan, Internet of Things, Wiley, 2019

**Online Learning Resources:**

1. https://onlinecourses.nptel.ac.in/noc22_cs96/preview
2. https://nptel.ac.in/courses/108108123
3. https://nptel.ac.in/courses/108108179

## JNTUA College of Engineering (Autonomous), Ananthapuramu

## Open Elective Course – IV

**IV B.TECH – I SEMESTER (R20) (common to all branches) - 2020 Admitted Batch**

DEPARTMENT OF Mechanical Engineering

| Subject Code | Title of the Subject | L | T | P | C |
|---|---|---|---|---|---|
| 20A70305 | **MATERIAL HANDLING EQUIPMENTS** | 3 | 0 | 0 | 3 |

**Course Objectives:**

To understand how the knowledge of materials management can be an advantage to logistics and supply chain operations.

To sensitize the students on the materials management functions – Planning, Purchase, Controlling, Storing, Handling, Packaging, Shipping and Distributing, and Standardizing.

To realize the importance of materials both in product and service.

planning/ production and plant layouts, studying about strategies of material handling and equipments, and selection of site locations.

It also aims to explore the layout planning by computer applications following different algorithms.

**UNIT-I**

**Overview of Material Handling**: Principles of Material Handling, Principal groups of Material Handling equipment – General Characteristics and application of Material Handling Equipment, Modern trends in material handling.

**UNIT-II**

**Lifting Equipments**: Hoist- Components of Hoist – Load Handling attachments hooks, grabs and clamps – Grabbing attachments for bulk material – Wire ropes and chains.

**UNIT-II**

**Lifting tackle pulleys for gain of force and speed**: Tension in drop parts – Drums, Shears and sprockets – Arresting gear and brakes – Block brakes, Band brakes, thrust brakes – Safety and hand cranks. Principle operation of EOT, Gantry and jib cranes Hoisting Mechanisms, Travelling mechanisms, lifting mechanisms – Slewing Mechanisms – Elevators and lifts.

**UNIT-IV**

**CONVEYORS:** Types - description -applications of Belt conveyors, apron conveyors and escalators Pneumatic conveyors, Screw conveyors and vibratory conveyors

**UNIT-V**

**ELEVATORS:** Bucket elevators: Loading and bucket arrangements - Cage elevators - shaft way, guides, counter weights, hoisting machine, safety devices - Design of fork lift trucks.

**Course Outcomes :**

The students will be able to select appropriate location for establishing industrial plants by applying the concepts of location selection.

The students will be able to plan and design plant and production layouts through basic strategies and with computer applications.

The students will be able to identify and analyse the problems in the existing layout/ material handling system and shall be able to the optimize the layout/ material handling system

The students will be able to develop algorithms for new planning layouts for typical applications in the industries and Suggesting appropriate material handling strategies in the industries.

The students will be able to design of fork lift trucks.

**REFERENCES**

Rudenko, N., Materials handling equipment, ELnvee Publishers, 1970.

Spivakovsy, A.O. and Dyachkov, V.K., Conveying Machines, Volumes I and II, MIR Publishers, 1985.

Alexandrov, M., Materials Handling Equipments, MIR Publishers, 1981.

Boltzharol, A., Materials Handling Handbook, The Ronald Press Company, 1958.

P.S.G. Tech., “Design Data Book”, KalaikathirAchchagam, Coimbatore, 2003.

Lingaiah. K. and Narayana Iyengar, “Machine Design Data Hand Book”, Vol. 1 & 2, Suma Publishers,

Bangalore, 1983

## JNTUA College of Engineering (Autonomous), Ananthapuramu

## Open Elective Course – IV

**IV B.TECH – I SEMESTER (R20) (common to all branches) - 2020 Admitted Batch**

DEPARTMENT OF Electronics & Communication Engineering

| Course Code | PRINCIPLES OF DIGITAL SIGNAL | L | T | P | C |
|---|---|---|---|---|---|
| 20A70405 | PROCESSING | 3 | 0 | 0 | 3 |

**Pre-requisite**
Basics of Electronics and Communication Engineering

**Course Objectives:**
- To understand the frequency domain analysis of discrete time signals.
- To learn the properties of discrete Fourier series and Fourier transforms.
- To design &analyzeIIR digital filters from analog filters.
- To know various structures used in implementation of FIR digital filters.
- To grasp the importance and applications of Multirate Digital signal processing.

**Course Outcomes (CO):** At the end of this course, the students will be able to
- Articulate the frequency domain analysis of discrete time signals.
- Understand the properties of discrete Fourier series and Fourier transforms.
- Design &analyzeIIR digital filters from analog filters.
- Design various structures used in implementation of FIR digital filters.
- Summarize the importance and applications of Multirate Digital signal processing.

**UNIT - I**
**Introduction to Digital Signal Processing:** Discrete time signals & sequences, Classification of Discrete time systems, stability of LTI systems, LTI system Properties. Solution of Linear constant coefficient difference equations, frequency domain representation of discrete time signals and systems. Review of Z-transforms.

**UNIT - II**
**Discrete Fourier Series and Fourier Transforms:** Properties of discrete Fourier series, DFS representation of periodic sequences, Discrete Fourier transforms: Properties of DFT, linear filtering methods based on DFT, Fast Fourier transforms (FFT) - Radix-2 decimation in time and decimation in frequency FFT Algorithms, Inverse FFT.

**UNIT - III**
**Design of IIR Digital Filters and Realizations:** Analog filter approximations – Butter worth and Chebyshev, Design of IIR Digital filters from analog filters, Design Examples, Analog and Digital frequency transformations. Basic structures of IIR systems, Transposed forms.

**UNIT - IV**
**Design of FIR Digital Filters and Realizations:** Characteristics of FIR Digital Filters, frequency response. Design of FIR digital filters using window techniques and frequency sampling techniques, comparison of IIR & FIR filters, basic structures of FIR systems.

**UNIT - V**
**DSP Applications:** Introduction to programmable DSPs, Multirate signal processing: Decimation, Interpolation, Sampling rate conversion by a rational factor; Adaptive filters: Introduction, Basic principles of Forward Linear Predictive filter and applications such as system identification, echo cancellation, equalization of channels, and beam forming using block diagram representation study only.

**Textbooks:**

1. John G. Proakis and Dimitris G. Manolakis, "Digital Signal Processing, Principles, Algorithmsand Applications", Pearson Education, 2007.
2. A.V. Oppenheim and R.W. Schaffer, "Discrete Time Signal Processing", PHI.

**Reference Books:**

1. Andreas Antoniou, "Digital Signal Processing", TATA McGraw Hill, 2006
2. MH Hayes, "Digital Signal Processing", Schaum's Outline series, TATA Mc-Graw Hill, 2007.
3. Robert J. Schilling and Sandra L. Harris, "Fundamentals of Digital Signal Processing using MATLAB", Thomson, 2007.
4. B. Venkataramani and M. Bhaskar, "Digital Signal Processors – Architecture, Programming and Applications", TATA McGraw Hill, 2002.

Online Learning Resources:

## JNTUA College of Engineering (Autonomous), Ananthapuramu

## Open Elective Course – IV

**IV B.TECH – I SEMESTER (R20) (common to all branches) - 2020 Admitted Batch**

DEPARTMENT OF Computer Science & Engineering

### Introduction to Database Management Systems

**Course Code:20A70505** **L T P C : 3 0 0 3**

Course Objectives:

- To introduce the concept of Internet of Things.
- To Practice programs and build real time applications.
- Students will be explored to the interconnection and integration of the physical world.
- Students will gain practical experience in the development of Cloud-based IoT systems.

- To get knowledge on cloud platforms

Course Outcomes (CO):

CO1: Design reliable real time applications using microcontrollers and microprocessors .
CO2: Extend the programming functionality and design new modules.
CO3: Able to design & develop IOT Devices.

**UNIT-I: Introduction**

Introduction to database systems; Characteristics of databases, File system V/s Database system, Users of Database

system, approaches to building a database, data models, database management system, Data Independence, DBMS

system architecture, challenges in building a DBMS, various components of a DBMS

Introduction to database systems; Characteristics of databases, File system V/s Database system, Users of Database

system, approaches to building a database, data models, database management system, Data Independence, DBMS

system architecture, challenges in building a DBMS, various components of a DBMS

Introduction to database systems; Characteristics of databases, File system V/s Database system, Users of Database

system, approaches to building a database, data models, database management system, Data Independence, DBMSsystem architecture, challenges in building a DBMS, various components of a DBMS

Introduction to database systems; Characteristics of databases, File system V/s Database system, Users of Database

system, approaches to building a database, data models, database management system, Data Independence, DBMS

system architecture, challenges in building a DBMS, various components of a DBMS.

Introduction to database systems; Characteristics of databases, File system V/s Database system, Users of Database

system, approaches to building a database, data models, database management system, Data Independence,DBMS system architecture, challenges in building a DBMS, various components of a DBMS.

Introduction to database systems; Characteristics of databases, File system V/s Database system, Users of Database system, approaches to building a database, data models, database management system, Data Independence, DBMSsystem architecture, challenges in building a DBMS, various components of a DBMS.

Introduction to database systems, Characteristics of databases, File system V/s Database system, Users of Database system, approaches to building a database, data models, database management system, Data Independence, DBMS system architecture, challenges in building a DBMS, various components of a DBMS.

**UNIT-II: E/R Model**

Conceptual Data Modeling – motivation, entities, entity types, various types of attributes, relationships, relationship

types, Entity set types, Participation constraints, E/R diagram notation, Extended E/R Model, Examples

Conceptual Data Modeling – motivation, entities, entity types, various types of attributes, relationships, relationship

types, Entity set types, Participation constraints, E/R diagram notation, Extended E/R Model, Examples

Conceptual Data Modeling - motivation, entities, entity types, various types of attributes, relationships, relationship types, Entity set types, Participation constraints, E/R diagram notation, Extended E/R Model, Examples.

**UNIT-III: Relational Data Model**

Concepts of relations, schema-instance distinction, keys, referential integrity & foreign keys, converting the database specification in ER notation to the relational schema, Relational algebra operators: selection, projection, cross product, various types of joins, division, set operations, example queries, tuple relational calculus, domain relational calculus, Fundamentals of SQL.

**UNIT-VI: Relational Database Design**

Importance of a good schema design, problems encountered with bad schema designs, motivation for normal forms, dependency theory - functional dependencies, Armstrong's axioms for FD's, closure of a set of FD's, minimal covers, Normalization, Normal Forms - INF, 2NF, 3NF and BCNF, decompositions and desirable properties of them, multi valued dependencies and 4NF, join dependencies and 5NF, Concept of Denormalization.

**UNIT-V: Transaction Processing,Data Storage & Indexing**

Transaction processing and Error recovery-Concepts of transaction processing, ACID properties, concurrency control, Serializability, locking based protocols, Timestamp based protocols, recovery and logging methods.

Data Storage and Indexes - File organizations, primary, secondary index structures, various index structures - hasb based, dynamic hashing techniques, multi-level indexes, B and B-trees.

**References:**

3. K. A. Navas, “Electronics Lab Manual”, Volume I, PHI, 5th Edition, 2015, ISBN:9788120351424
4. Cyril Prasanna Raj P., “CMOS digital circuit design manual”, Volume 1, MSEC E-publication, Edition 2016

## JNTUA College of Engineering (Autonomous), Ananthapuramu
## Open Elective Course – IV

**IV B.TECH – I SEMESTER (R20) (common to all branches) - 2020 Admitted Batch**

DEPARTMENT OF Chemical Engineering

| **Course Code** | **SOLID WASTE MANAGEMENT** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|---|
| **20A70805** | | **3** | **0** | **0** | **3** |

**Pre-requisite**

Course Objectives:

- Material flow in society and generation of solid waste source
- Clarification of solid waste on characterization of the same
- Understand the sense of onsite handling storage and collection systems including transportation
- Understand processing technologies with mechanical volume reduction and thermal volume reduction corporate land filling, deep well injections.
- Learn to estimate material recovery energy recovery from a given waste data using case standing

Course Outcomes (CO):

At the end of the course, the student will be able to:

| | |
|---|---|
| CO1 | Identify sources and relationship between various functional elements of solid waste management and methods of storage and collection and transport of solid wastes. |
| CO2 | Know the importance of transfer station and suggest suitable methods of solid waste disposal based on the composition of solid waste. |
| CO3 | Suggest suitable methods for the management of plastic and E-wastes |
| CO4 | Identify hazardous wastes and suggest suitable management techniques for radioactive wastes and Bio-medical wastes. |
| CO5 | Adopt the suitable management method for a given industry |

**Course Articulation Matrix**

| Course Outcomes | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |

UNIT - I

**Introduction:** Definition, characteristics and perspectives of solid waste. Types of solid waste. Physical and chemical characteristics. Variation of composition and characteristics. Municipal, industrial, special and hazardous wastes.

General aspects Overview of material flow in society. Reduction in raw material usage. Reduction in solid waste generation. Reuse and material recovery. General effects on health and environment. Legislations

UNIT - II

**Engineered systems:** Typical generation rates. Estimation and factors effecting generation rates. On site handling. Storage and processing. Collection systems and devices. Transfer and transport.

UNIT - III

**Processing Techniques:** Mechanical volume reduction. Thermal volume reduction. Component separation. Land filling and land forming. Deep well injection.

UNIT - IV

**Material recovery:** Mechanical size alteration. Electromagnetic separation. Drying and dewatering. Other material recovery systems. Recovery of biological conversion products. Recovery of thermal conversion products.

**Energy recovery:** Energy recovery systems and efficiency factors. Determination of output and efficiency. Details of energy recovery systems. Combustion incineration and heat recovery. Gasification and pyrolysis. Refuse derived fuels (RDF).

UNIT - V

**Case studies:** Major industries and management methods used in typical industries – Coal fired power stations, textile industry, oil refinery, distillery, sugar industry, and radioactive waste generation units.

**Textbooks:**

3. Howard S. Peavy, Environmental Engineering, McGraw Hill International Edition, 1986.
4. Dutta, Industrial Solid Water Management and Land Filling Practice, Narose Publishing House, 1999.

**Reference Books:**

3. Sastry C.A., Waste Treatment Plants, Narose Publishing House, 1995.
4. Lagrega, Hazardous Waste Management, McGraw Hill, 1994.

**Online Learning Resources:**

## DEPARTMENT OF MATHEMATICS

| Course Code | Number theory and its Applications | | L | T | P | C |
|---|---|---|---|---|---|---|
| **20A75102** | | | **0** | **3** | **0** | **3** |
| **Pre-requisite** | ----- | **Semester** | **I** | | | |

Course Objectives:

This course enables the students to learn the concepts of number theory and its applications to information security.

Course Outcomes (CO): Student will be able to

- understand number theory and its properties.
- understand principles on congruences
- develop the knowledge to apply various applications
- develop various encryption methods and its applications.

| UNIT - I | **Integers, Greatest common divisors and prime Factorization** | 8 Hrs |
|---|---|---|

The well-ordering property-Divisibility-Representation of integers-Computer operations with integers-Prime numbers-Greatest common divisors-The Euclidean algorithm -The fundamental theorem of arithmetic-Factorization of integers and the Fermat numbers-Linear Diophantine equations

| UNIT - II | **Congruences** | 8 Hrs |
|---|---|---|

Introduction to congruences -Linear congruences-The Chinese remainder theorem-Systems of linear congruences

| UNIT - III | **Applications of Congruences** | 9 Hrs |
|---|---|---|

Divisibility tests-The perpetual calendar-Round-robin tournaments-Computer file storage and hashing functions. Wilson's theorem and Fermat's little theorem-Pseudo primes- Euler's theorem- Euler's p hi-function- The sum and number of divisors- Perfect numbers and Mersenne primes.

| UNIT - IV | **Finite fields & Primality, factoring** | 8 Hrs |
|---|---|---|

Finite fields- quadratic residues and reciprocity-Pseudo primes-rho method-fermat factorization and factor bases.

| UNIT - V | **Cryptology** | 9 Hrs |
|---|---|---|

| |
|---|
| Basic terminology-complexity theorem-Character ciphers-Block ciphers-Exponentiation ciphers- Public-key cryptography-Discrete logarithm-Knapsack ciphers- RSA algorithm-Some applications to computer science. |
| Textbooks: |
| 1. Elementary number theory and its applications, Kenneth H Rosen, AT & T Information systems & Bell laboratories.<br>2. A course in Number theory & Cryptography, Neal Koblitz, Springer. |
| Reference Books: |
| **1.** An Introduction To The Theory Of Numbers, Herbert S. Zuckerman, Hugh L. Montgomery, Ivan Niven, wiley publishers<br>2. Introduction to Analytic number theory-Tom M Apostol, springer<br>**3.** Elementary number theory, VK Krishnan, Universities press |
| Online Learning Resources: |
| https://www.slideshare.net/ItishreeDash3/a-study-on-number-theory-and-its-applications |

**JNTUA College of Engineering (Autonomous), Ananthapuramu**

**Open Elective Course – IV**

**IV B.TECH – I SEMESTER (R20) (common to all branches) - 2020 Admitted Batch**

**DEPARTMENT OF Physics**

| Subject Code | Title of the Subject | L | T | P | C |
|---|---|---|---|---|---|
| 20A75202 | **SENSORS AND ACTUATORS FOR ENGINEERING** | 3 | | - | 3 |

| | | | | | |
|---|---|---|---|---|---|
| | **APPLICATIONS** | | | | |

| **COURSE OBJECTIVES** | |
|---|---|
| 1 | To provide exposure to various kinds of sensors and actuators and their engineering applications. |
| 2 | To impart knowledge on the basic laws and phenomenon behind the working of sensors and actuators |
| 3 | To explain the operating principles of various sensors and actuators |
| 4 | To educate the fabrication of sensors |
| 5 | To explain the required sensor and actuator for interdisciplinary application |
| **COURSE OUTCOMES** | |
| At the end of the course the student will be able | |
| CO1 | To recognize the need of sensors and actuators |
| CO2 | To understand working principles of various sensors and actuators |
| CO3 | To identify different type of sensors and actuators used in real life applications |
| CO4 | To exploit basics in common methods for converting a physical parameter into an electrical quantity |
| CO5 | To make use of sensors and actuators for different applications |

**<u>Mapping between Course Outcomes and Programme Outcomes</u>**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |

## SYLLABUS

**Credits: 3** **Hours of teaching:- 45 H**

**UNIT – I: Introduction to Sensors and Actuators 9H**

**Sensors**: Types of sensors:temperature, pressure, strain, active and passive sensors, General characteristics of sensors (Principles only), Materials used and their fabrication process: Deposition:ChemicalVapor Deposition, Pattern: photolithography and Etching: Dry and WetEtching.

**Actuators:** Functional diagram of actuators, Types of actuators and their basic principle of working: Hydraulic, Pneumatic, Mechanical, Electrical, Magnetic, Electromagnetic, Piezo-electric and Piezo-resistive actuators, Applications of Actuators.

**UNIT –II: Temperature and Mechanical Sensors** **9H**

**Temperature Sensors**: Types of temperature sensors and their basic principle of working: Thermo-resistive sensors: Thermistors, Resistance temperature sensors, Silicon resistive sensors, Thermo-electric sensors: Thermocouples, PN junction temperature sensors

**Mechanical Sensors**: Types of Mechanical sensors and their basic principle of working: Force sensors: Strain gauges, Tactile sensors, Pressure sensors: Semiconductor, Piezoresistive, capacitive, Variable Reluctance Sensor (VRP).

**UNIT –III: Optical and Acoustic Sensors** **9H**

**Optical Sensors**: Basic principle and working of: Photodiodes, Phototransistors and Photo-resistors based sensors, Photomultipliers, Infrared sensors:thermal, Passive Infra Red, Fiber based sensors and Thermopiles

**Acoustic Sensors**: Principle and working of Ultrasonic sensors, Piezo-electric resonators, Microphones.

**UNIT –IV: Magnetic, Electromagnetic Sensors and Actuators** **9H**

Motors as actuators (linear, rotational, stepping motors), magnetic valves, inductive sensors (LVDT, RVDT, and Proximity), Hall Effect sensors, Magneto-resistive sensors, Magneto-strictive sensors and actuators, Voice coil actuators (speakers and speaker-like actuators).

**UNIT –V: Chemical and Radiation Sensors** **9H**

**Chemical Sensors**: Principle and working of Electro-chemical, Thermo-chemical, Gas, pH, Humidity and moisture sensors.

**Radiation Sensors**: Principle and working of Ionization detectors, Scintillation detectors, Geiger-Muller counters, Semiconductor radiation detectors and Microwave sensors (resonant, reflection, transmission)

**Text Books:**

1. Sensors and Actuators – Clarence W. de Silva, CRC Press, 2nd Edition, 2015
2. Sensors and Actuators, D.A.Hall and C.E.Millar, CRC Press, 1999

**Reference Books:**

1.Sensors and Transducers- D.Patranabhis, Prentice Hall of India (Pvt) Ltd. 2003
2. Measurement, Instrumentation, and Sensors Handbook-John G.Webster, CRC press 1999
3. Sensors – A Comprehensive Sensors- Henry Bolte, John Wiley.
4. Handbook of modern sensors, Springer, Stefan Johann Rupitsch.
5. Principles of Industrial Instrumentation By D. Patranabhis

**NPTEL courses links**

https://onlinecourses.nptel.ac.in/noc21_ee32/preview

## JNTUA College of Engineering (Autonomous), Ananthapuramu
## Open Elective Course – IV
**IV B.TECH – I SEMESTER (R20) (common to all branches) - 2020 Admitted Batch**

**DEPARTMENT OF H & SS**

| Subject Code | Title of the Subject | L | T | P | C |
|---|---|---|---|---|---|
| 20A79102 | English Literary Spectrum | 3 | | 0 | 3 |

| COURSE OBJECTIVES | |
|---|---|
| 1 | To develop aesthetic sense to appreciate the beauty of life |
| 2 | To introduce to Elizabethan drama and be able to appreciate the nuances of humour |
| 3 | To familiarize with Victorian novel and industrialization |
| 4 | To expose to the historical significance of ideas of different periods |
| 5 | To give exposure to the vicissitudes of life through short stories |

| COURSE OUTCOMES | |
|---|---|
| CO1 | Awareness to lead a life of quality than quantity |
| CO2 | Able to understand humour and Elizabethan culture |
| CO3 | Enable to appreciate human relations in this mechanized world |
| CO4 | Tolerant and receptive to different ideas |
| CO5 | Be imaginative and understanding of human aspirations |

## Mapping between Course Outcomes and Programme Outcomes

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |

## SYLLABUS

UNIT I: Poetry

1. Ode to a Grecian Urn- John Keats
2. To a Skylark- P.B.Shelley
3. Satan's Speech from Paradise Lost Book I- 140-170 lines- John Milton
4. My Last Duchess- Robert Browning

UNIT II: Drama

1. Twelfth Night- William Shakespeare
   a) Elizabethan theatre
   b) Shakespearean tragedy
   c) Shakespearean Comedy
   d) Themes of Shakespearean Dramas

UNIT III: Novel

1. Hard Times- Charles Dickens

a) Rise of the English Novel
b) Victorian Novel
c) Utilitarianism
d) Humanism

UNIT IV: Prose

1. Of Studies – Francis Bacon
2. On Seeing People Off- A.G.Gardiner
3. Sweetness and Light- Mathew Arnold
4. I too have a Dream- Martin Luther King Junior

UNIT V: Short Stories

1. The Last Leaf- O.Henry
2. Useless Beauty- Guy de Maupassant
3. After the Dance – Leo Tolstoy
4. The Selfish Giant- Oscar Wilde

**Text Books:**

*The Oxford Book of English Verse* by Christopher Ricks (Editor)

*Twelfth Night* (2010 edition): Oxford School Shakespeare (Oxford School Shakespeare Series)

*Dickens Charles, Hard Times* (Penguin Classics)

*The Art of the Personal Essay: An Anthology from the Classical Era to the Present,* Anchor Books Publication

**References:**
Legois and Cazamian, *A History of English Literature*

## JNTUA College of Engineering (Autonomous), Ananthapuramu
## Open Elective Course – IV
### IV B.TECH – I SEMESTER (R20) (common to all branches) - 2020 Admitted Batch
### DEPARTMENT OF Chemistry

| Subject Code | Title of the Subject | L | T | P | C |
|---|---|---|---|---|---|
| 20A75302 | **CHEMISTRY OF NANOMATERIALS AND APPLICATIONS** | 2 | 1 | - | 3 |

| COURSE OBJECTIVES | |
|---|---|
| 1 | To understand synthetic principles of Nanomaterials by various methods |
| 2 | And also characterisae the synthetic nanomaterials by various instrumental methods |
| 3 | To enumerate the applications of nanomaterials in engineering |

| COURSE OUTCOMES | |
|---|---|
| CO1 | Classify the nanostructure materials, Describe scope of nano science and technology, Explain different synthetic methods of nano materials, Identify the synthetic methods of nanomaterial which is suitable for preparation of particular material |
| CO2 | Describe the top down approach, Explain aerosol synthesis and plasma arc technique, Differentiate chemical vapour deposition method and electrodeposition method, Discuss about high energy ball milling. |

| | |
|---|---|
| CO3 | Discuss different technique for characterization of nanomaterial, Explain electron microscopy techniques for characterization of nanomaterial, Describe BET method for surface area analysis, Apply different spectroscopic techniques for characterization |
| CO4 | Explain synthesis and properties and applications of nanaomaterials, Discuss about fullerenes and carbon nanotubes, Differentiate nanomagnetic materials and thermoelectric materials, Describe liquid crystals |
| CO5 | Illustrate applications of nanaomaterials, Discuss the magnetic applications of nanomaterials, list the applications of non-linear optical materials, Describe the applications fullerenes, carbon nanotubes |

**<u>Mapping between Course Outcomes and Programme Outcomes</u>**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | |

## SYLLABUS

**Unit – I**

**Basics and Characterization of Nanomaterials :** Introduction**,** Scope of nanoscience and nanotecnology, nanoscience in nature, classification of nanostructured materials, importance of nano materials.

**Unit – II**

**Synthesis of nanomaterials :** Top-Down approach**,** Inert gas condensation, arc discharge method, aerosol synthesis, plasma arc technique, ion sputtering, laser ablation, laser pyrolysis, and chemical vapour deposition method, electrodeposition method, high energy ball milling method.

Synthetic Methods**:** Bottom-Up approach**:-** Sol-gel synthesis, microemulsions or reverse micelles, co-precipitation method, solvothermal synthesis, hydrothermal synthesis, microwave heating synthesis and sonochemical synthesis.

**UNIT-III**

**Techniques for characterization:** Diffraction technique, spectroscopy techniques, electron microscopy techniques for the characterization of nanomaterilas, BET method for surface area analysis, dynamic light scattering for particle size determination-

**UNIT-IV**

**Studies of Nano-structured Materials:** Synthesis, properties and applications of the following nanomaterials, fullerenes, carbon nanotubes, core-shell nanoparticles, nanoshells, self- assembled monolayers, and monolayer protected metal nanoparticles, nanocrystalline materials, magnetic nanoparticles and important properties in relation to nanomagnetic materials, thermoelectric materials, non-linear optical materials and liquid crystals.

**UNIT-V**

**Engineering Applications of Nanomaterials :** Applications of Nano Particle, nano rods of nano wires, Fullerenes, carbon nano tubes, Graphines nanoparticles and other applications of nonmaterials and uses.

**TEXT BOOKS:**

1. **NANO: The Essentials:** T Pradeep, MaGraw-Hill, 2007.
2. **Textbook of Nanoscience and nanotechnology:** B S Murty, P Shankar, Baldev Rai, BB Rath and James Murday, Univ. Press, 2012.

**REFERENCE BOOKS:**

1. Concepts of Nanochemistry; Ludovico Cademrtiri and Geoffrey A. Ozin & Geoffrey A. Ozin, Wiley-VCH, 2011.
2. **Nanostructures & Nanomaterials; Synthesis, Properties & Applications:** Guozhong Cao, Imperial College Press, 2007.
3. **Nanomaterials Chemistry**, C. N. R. Rao, Achim Muller, K.Cheetham, Wiley-VCH, 2007.