# *TWO YEAR COURSE STRUCTURE*

## *FOR*

# *M.TECH –CAD/CAM*

## *w.e.f.*

# *2013-2014 ADMITTED BATCH*


**DEPARTMENT OF MECHANICALENGINEERING**

**COLLEGE OF ENGINEERING (AUTONOMOUS) :: PULIVENDULA**

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR**

**PULIVENDULA – 516390, Y.S.R. (DIST), ANDHRA PRADESH, INDIA**

# JNTUA COLLEGE OF ENGINEERING (Autonomous) PULIVENDULA

**Course structure for I M.TECH.CAD/CAM(Regular) with effective from 2013-2014**

**I Year I Semestar**

| S.No. | Course Code | Subject Name | Theory/Tutorial | Drawing/Lab | Credits |
|---|---|---|---|---|---|
| 1 | 13D04101 | FINITE ELEMENT METHODS | 4 | - | 4 |
| 3 | 13D04102 | COMPUTATIONAL METHODS | 4 | - | 4 |
| 2 | 13D04107 | GEOMETRIC MODELING | 4 | - | 4 |
| | 13D04103 | ADVANCES IN MANUFACTURING TECHNOLOGY (Elective-1) | 4 | - | |
| | 13D04110 | QUALITY ENGINEERING AND MANUFACTURING (ELECTIVE-1) | | | 4 |
| 4 | 13D04111 | COMPUTATIONAL FLUID DYNAMICS (ELECTIVE-1) | | | |
| | 13D04104 | COMPUTER INTEGRATED MANUFACTURING(Elective-2) | 4 | - | |
| | 13D04105 | PRODUCT ENGINEERING (ELECTIVE-2) | | - | 4 |
| 5 | 13D04106 | COMPUTER AIDED PROCESS PLANNING (ELECTIVE-2) | | - | |
| 6 | 13D04108 | MODELING LAB | | 3 | 2 |
| 7 | 13D04109 | FINITE ELEMENT ANALYSIS LAB | | 3 | 2 |
| | **Total** | | **20** | **6** | **24** |
| | **Total contact periods/week : 26** | | | | |
| | **Total Credits : 24** | | | | |

**I Year II Semestar**

| S.No. | Course Code | Subject Name | Theory/Tutorial | Drawing/Lab | Credits |
|---|---|---|---|---|---|
| 2 | 13D04201 | ADVANCED OPTIMIZATION TECHNIQUES | 4 | - | 4 |
| 3 | 13D04202 | ROBOTICS | 4 | - | 4 |
| 1 | 13D04203 | CNC TECHNOLOGY & PROGRAMMING | 4 | - | 4 |
| | 13D04204 | RAPID PROTOTYPING (ELECTIVE-1) | | - | |
| 4 | 13D04205 | MECHATRONICS (ELECTIVE-1) | 4 | | 4 |
| | 13D04206 | HYDRAULIC AND PNEUMATIC CIRCUIT DESIGN (ELECTIVE-1) | | | |
| | 13D04207 | COMPUTER GRAPHICS (ELECTIVE-2) | | - | |
| 5 | 13D04208 | ARTIFICIAL INTELLIGENCE & EXPERT SYSTEMS (ELECTIVE-2) | 4 | - | 4 |
| | 13D04209 | MECHANICS AND MANUFACTURING METHODS OF COMPOSITES (ELECTIVE-2) | | - | |
| 6 | 13D04210 | AUTOMATION LAB | | 3 | 2 |
| 7 | 13D04211 | CNC LAB | | 3 | 2 |
| | Total | | **20** | **6** | **24** |
| | Total contact periods/week : 26 | | | | |
| | Total Credits : 24 | | | | |

## JNTUA COLLEGE OF ENGINEERING (Autonomous)PULIVENDULA

## CAD/CAM I-ISEMESTER

## FINITE ELEMENT METHODS

***Course Objectives**:*

- *To equip the students with the Finite Element Analysis fundamentals.*
- *To enable the students to formulate the design problems into FEA.*
- *To introduce basic aspects of finite element technology, including domain discretization, polynomial interpolation, application of boundary conditions, assembly of global arrays, and solution of the resulting algebraic systems.*

**UNIT - I**

**Formulation Techniques:** Methodology, Engineering problems and governing differential equations, finite elements. Variational methods-potential energy method, Raleigh Ritz method, strong and weak forms, Galerkin and weighted residual methods, calculus of variations, Essential and natural boundary conditions.

**UNIT – II**

**One-dimensional finite element methods:** Bar elements, temperature effects.Element matrices, assembling of global stiffness matrix, Application of boundary conditions, Elimination and penalty approaches, solution for displacements, reaction, stresses, temperature effects, Quadratic Element, Heat transfer problems: One-dimensional, conduction and convection problems. Examples: - one dimensional fin,

**UNIT – III**

**Trusses:** Element matrices, assembling of global stiffness matrix, solution for displacements, reaction, stresses, temperature effects- 1D problems only.

**Beams and Frames:** Element matrices, assembling of global stiffness matrix, solution for displacements, reaction, stresses- 1D problems only.

**UNIT - IV**

**Two dimensional problems:** CST, LST, four node and eight node rectangular elements, Lagrange basis for triangles and rectangles, serendipity interpolation functions. Axisymmetric Problems:Axisymmetric formulations, Element matrices, boundary conditions. Heat Transfer problems: Conduction and convection, examples: - two-dimensional fin.

**UNIT – V**

**Finite elements in Structural Dynamics:** Dynamic equations, Eigen value problems, and their solution methods, simple problems.

**Convergence:** Requirements for convergence, h-refinement and p-refinement, complete and incomplete interpolation functions, Pascal's triangle.

**TEXT BOOK**:

1 Ashok D. Belegundu, Tirupathi R. Chandrupatla, Introduction to Finite Elements in Engineering, PHI Learning, 2009.

2 Singiresu S Rao, The Finite Element Method in Engineering, Elsevier, 2012.

3 Daryl L. Logan, A First Course in the Finite Element Method, Cl-engineering, 2010

**REFERENCES:**

1.J.N. Reddy, Finite element method in Heat transfer and fluid dynamics, CRC press,1994
2. Zienckiwicz O.C. & R. L. Taylor, Finite Element Method, McGraw-Hill,1983.
3. J. N. Oden, Finite Element of Nonlinear continua, McGraw-Hill, New York, 1971
4. K. J. Bathe, Finite element procedures, Prentice-Hall, 1996

***Course Outcomes:***

*Upon completing this course, the students will be able to:*

- *Identify mathematical model for solution of common engineering problems.*
- *Formulate simple problems into finite elements.*
- *Solve structural, thermal, dynamic problems.*
- *Use professional-level finite element software to solve engineering problems in Solidmechanics, heat transfer and Dynamics.*
- *Derive element matrix equation by different methods by applying basic laws inmechanics and integration by parts.*

## CAD/CAM I-ISEMESTER

# COMPUTATIONAL METHODS

***Course Objectives:***

- *To develop mathematical models of lower level engineering problems.*
- *To learn how to calculate, quantify, and minimize errors, concept of significant digits and how errors are related to correct number of significant digits.*
- *Students will learn how to solve nonlinear equations numerically*
- *Students will be introduced to fundamental matrix algebra concepts and shown how to solve simultaneous linear equations numerically*
- *Students will learn how to numerically integrate continuous and discrete functions.*
- *Students will learn how to numerically solve ordinary differential equations that are initial value or boundary value problems.*

**UNIT – I**

**Numerical Solutions of Linear & Non Linear Equations:** System of Linear Equations– Iterative methods – Relaxation methods – System of non-linear equations –Method of Iteration, Newton Raphson method- computer programs

**Numerical integration:** Newton-Cotes integration formulas – Simpson's rules, Gaussian quadrature. Adaptive integration

**UNIT – II**

**Boundary value problems:** Finite Difference Method, Cubic Spline Method &Shooting method

**Numerical solutions of partial differential equations:** Laplace's equations – Jocobi's Method, Gauss Seidel Method & ADI method. Finite element method- Rayleligh-Ritz Method &Galerkin's Method.

**UNIT – III**

**Parabolic partial differential equations:** Explicit method – Crank-Nickelson method – Derivative boundary condition – Stability and convergence criteria – Finite element for heat flow – computer programs.

**UNIT – IV**

**Hyperbolic partial differential equations:** Solving wave equation by finite differences-stability of numerical method –method of characteristics-wave equation in two space dimensions-computer programs.

**UNIT – V**

**Curve fitting and approximation of functions:** Least square approximation fitting of non-linear curves by least squares –regression analysis- multiple linear regression, non linear regression - computer programs.

**Optimization:**

One dimensional unconstrained optimization, multidimensional unconstrained optimization – direct methods and gradient search methods, constrained optimization.

**TEXT BOOKS:**

1. Steven C.Chapra, Raymond P.Canale "Numerical Methods for Engineers" Tata Mc-Graw hill
2.Introductory Methods of Numerical Analysis, S.S. Sastry, PHI Publication, 5th Edition(2012).
3.Douglas J..Faires,RichedBurden"Numericalmethods"Brooks/cole publishing company,1998.Second edition.

**REFERENCES:**

1.Wardcheney&David Kincaid "Numerical mathematics and computing"Brooks/cole publishing company1999,fourth edition.
2.RileyK.F.M.P.Hobson&BenceS.J,"mathematical methods for physics and engineering"Cambridge university press,1999.

***Course Outcomes:***

*After completion of this course the student should be:*

- *Understand the concept and steps of problem solving - mathematical modeling, solution and implementation.*
- *Solve the boundary value problems also Familiarity with statistics and linear algebra.*
- *Apply advanced mathematics through multivariate calculus and differential equations.*
- *An ability to design and conduct experiments, as well as to analyze and interpret data.*
- *An ability to design a system, component, or process to meet desired needs.*
- *An ability to identify, formulates, and solve engineering problems.*

## CAD/CAM I-ISEMESTER

# GEOMETRIC MODELING

***Course Objectives:***

- *To Learn advanced concepts of feature based modeling and parametric modeling*
- *To understand the mathematical basis for geometric modeling of curves and surfaces and their relationship with computer graphics.*
- *To understand the methods of representation of wireframe, surface, and solid modeling systems.*
- *To Consider data associativity concepts of CAD/CAE integration; Be familiar with interoperability and data transfer techniques between design and analysis software systems.*

**Unit - I**

**Introduction:** Definition, Explicit and implicit equations, parametric equations.

**Unit - II**

**Cubic Splines:** Algebraic and geometric form of cubic spline, tangent vectors, parametric space of a curve, blending functions, four point form, reparametrization, truncating and subdividing of curves.

**Cubic Splines:** Graphic construction and interpretation, composite pc curves.

**Unit - III**

**Bezier Curves:** Bernstein basis, equations of Bezier curves, properties, derivatives.

**B-Spline Curves:** B-Spline basis, equations, knot vectors, properties, and derivatives.

**Unit – IV**

**Surfaces:** Bicubic surfaces, Coon's surfaces, Bezier surfaces, B-Spline surfaces, surfaces of revolutions, Sweep surfaces, ruled surfaces, tabulated cylinder, bilinear surfaces, Gaussian curvature.

**Unit – V**

**Solids:** Tricubic solid, Algebraic and geometric form.

**Solid modeling concepts:** Wire frames, Boundary representation, Half space modeling, spatial cell, cell decomposition, classification problem.

**TEXT BOOKS:**

1. CAD/CAM by Ibrahim Zeid, Tata McGraw Hill.
2. Elements of Computer Graphics by Roger & Adams, Tata McGraw Hill.

**REFERENCES:**

1. Geometric Modeling by Micheal E. Mortenson, McGraw Hill Publishers
2. Computer Aided Design and Manufacturing, K.Lalit Narayan, K.Mallikarjuna Rao, MMM Sarcar, PHI Publishers

***Course Outcomes:*** *Upon completing this course, the students will be able to:*

- *Represent curves and surfaces using parametric equations*
- *Define and relate the basic concepts, tools, and algorithms in geometric modeling and digital surface processing*
- *Critically analyze and assess current research on surface representations and geometric modeling with the intent to apply the proposed methods in your own work*
  *Define the methods of representation of wireframe, surface, and solid modeling systems.*

## CAD/CAM I-ISEMESTER

## ADVANCES IN MANUFACTURING TECHNOLOGY

***Course Objectives**:*

- *To understand the basic principles of welding processes.*
- *To understand the fundamentals of unconventional machining methods.*
- *To develop the students ability to apply modern machining methods on welding*
- *To introduce the students of various types of welding and their performance characteristics.*

**UNIT - I**

**Welding Processes:** Fusion and Solid State Welding Process, Automation in Welding, Design aspects of welds, Weldability of Aluminium alloys, Titanium alloys and High strength low alloy steels, Non destructive testing of Welds, Residual Stresses and Distortion in Weldments.

**UNIT - II**

**Un-conventional Machining Methods-I:**

Abrasive jet machining - Elements of the process, mechanics of metal removal process parameters, economic considerations, applications and limitations, recent developments.

Ultrasonic machining:Elements of the process, machining parameters, effect of parameters on surface finish and metal removal rate, mechanics of metal removal process parameters, economic considerations, applications and limitations.

**UNIT - III**

**Un-conventional Machining Methods-II:**

Electro-Chemical Processes:Fundamentals of electro chemical machining, metal removal rate in ECM, Tool design, Surface finish and accuracy economics aspects of ECM.

Wire EDM Process: General Principle and applications of Wire EDM, Mechanics of metal removal, Process parameters, and selection of tool electrode and dielectric fluids, methods surface finish and machining accuracy.

**UNIT - IV**

**Un-conventional Machining Methods-III:**

Electron Beam Machining: Generation and control of electron beam for machining, theory of electron beam machining, principle, advantages, and limitations, comparison of thermal and non-thermal processes.

Plasma Arc Machining: Principle, machining parameters, effect of machining parameters on surface finish and metal removal rate, applications, limitations

Laser Beam Machining:Principle, effect of machining parameters on surface finish, applications, and limitations.

**UNIT - V**

**Surface Processing Operations:** Plating and Related Processes, Conversion Coatings, Physical Vapor Deposition, Chemical Vapor Deposition, Organic Coatings, Porcelain Enameling and other Ceramic coatings, Thermal and Mechanical Coating Processes.

**TEXT BOOKS:**

1. Manufacturing Technology - P. N. Rao, TMH Publishers
2. Fundamentals of Modern Manufacturing- Mikell P. Groover, John Wiley & Sons Publishers
3. Modern Machining Process- P.C Pandey and H.S Shan, Tata McGraw - Hill Education (1980)
4. Manufacturing Engineering and technology – SeropeKalpakjian& Stephen Schmid

**REFERENCES:**

1.Production Technology - R.K Jain, Khanna publishers (2011)
2.Manufacturing Science - Amitabha Ghosh, Asok Kumar Mallik, East West press
3.Welding Technology - R.S, Parmar, Khanna Publishers (2013)
4.Introduction to Nanotechnology - Poole and Owens, Wiley (2003).

***Course Outcomes**:*

*Upon completing this course, the students will be able to:*

- *Understand the principles of welding processes*
- *Acquire working knowledge on unconventional machining methods*
- *Describe the principle and fundamentals of welding*
- *Familiar with the various applications of welding*

## CAD/CAM I-ISEMESTER

# COMPUTATIONAL FLUID DYNAMICS

***Course Objectives:***

- *To develop an understanding for the major theories, approaches and methodologies used in CFD.*
- *To build up the skills in the actual implementation of CFD methods (e.g. boundary conditions, turbulence modeling etc.) in using commercial CFD codes.*
- *To gain experience in the application of CFD analysis to real engineering designs.*
- *To provide students with the necessary skills to use commercial Computational Fluid Dynamics packages and to carry out research in the area of Computational Fluid Dynamics.*

**UNIT - I**

**INTRODUCTION:** Finite difference method, finite volume method, finite element method, governing equations and boundary conditions, Derivation of finite difference equations.

**Solution methods:** Solution methods of elliptical equations — finite difference formulations, interactive solution methods, direct method with Gaussian elimination. Parabolic equations-explicit schemes and Von Neumann stability analysis, implicit schemes, alternating direction implicit schemes, approximate factorization, fractional step methods, direct method with tridiagonal matrix algorithm.

**UNIT – II**

Hyperbolic equations: explicit schemes and Von Neumann stability analysis, implicit schemes, multi step methods, nonlinear problems, second order one-dimensional wave equations. Burgers equations: Explicit and implicit schemes, Runge-Kutta method.

**UNIT - III**

**FORMULATIONS OF INCOMPRESSIBLE VISCOUS FLOWS:** Formulations of incompressible viscous flows by finite difference methods, pressure correction methods, vortex methods.

**Treatment of compressible flows:** potential equation, Euler equations, Navier-stokes system of equations, flow field-dependent variation methods, boundary conditions, example problems.

**UNIT - IV**

**FINITE VOLUME METHOD**: Finite volume method via finite difference method, formulations for two and three-dimensional problems.

**UNIT** - **V**

**STANDARD VARIATIONAL METHODS:** Linear fluid flow problems, steady state problems, Transient problems.

**TEXT BOOK:**

1. Computational fluid dynamics/ T. J. C'hung/ Cambridge University press,2002.

2. Computational Fluid Dynamics: Basics with applications/John D. Anderson/ Mc Graw Hill.

**REFERENCES:**

1. Text book of fluid dynamics/ Frank Choriton/ CBS Publishers & distributors, 1985

2. Numerical heat transfer and fluid flow / Suhas V. Patankar/ Hemashava Publishers corporation& Mc Graw Hill.

3. Computational Fluid Flow and Heat Transfer/ Muralidaran/ Narosa Publications

4. Fundamentals of Computational Fluid Dynamics/Tapan K. Sengupta / Universities Press.

5. Introduction to Theoretical and Computational Fluid Dynamics/C. Pozrikidis /Oxford

***Course outcomes:***

After completion of this course the student should be:

- Familiar with the differential equations for flow phenomena and numerical methods for their solutions.
- Able to use and develop flow simulation software for the most important classes of flows in engineering and science.
- Able to critically analyze different mathematical models and computational methods for flow simulations.

## CAD/CAM I-ISEMESTER

## QUALITY ENGINEERING AND MANUFACTURING (9D04104C)

***Course Objectives:***

- *To know the importance of quality in manufacturing industries*
- *To understand the steps involved in Design of Experiments and ANOVA*
- *To know how to apply ANOVA & DOE to develop a new manufacturing process.*
- *To know about the different standardization methods for manufacturing.*
- *To Understand and apply the principles of math, science, and engineering in design and manufacturing related activities.*

**UNIT-I**

**Quality value and Engineering:** An overall quality system, Quality Engineering in Production Design, Loss function and quality level**:** Derivation and use of Quadratile Loss Function, Economic Consequences of tightening tolerances as a means to improve quality, Evaluations and Types of Tolerances (N-type-, S-type and L-type)

**UNIT-II**

**Tolerance Design and Tolerancing**: Functional limits, tolerance design for N-type, L-type and S-type characteristics, Tolerance Allocation for multiple components.

**Parameter and tolerance design:** Introduction to parameter design, Signal to Noise ratios, Parameter Design Strategy, Introduction to Tolerance Design, tolerance design using the loss function, identification of tolerance design factors.

**UNIT-III**

**Design of Experiments:** Introduction, Task aids and Responsibilities for DOE process steps, DOE process steps description.

**Analysis of variance (ANOVA):** no-WAY anova, One-way ANOVA, two-way ANOVA, Critique of F-test, ANOVA for four level factors, multiple level factors.

**UNIT-IV**

**Orthogonal Arrays:** Typical test strategies, Better Test Strategies, Efficient Test Strategies, Conducting and Analyzing an experiment.

**Interpolation of experimental results:** Interpretation methods, Percent Contribution, Estimating the Mean.

**UNIT-V**

**ISO-9000** Quality system, BDRE,6-sigma, Taguchi Methods, Bench Marking, Quality Circles-Brain Storming-Fishbone Diagram-Problem Analysis.

**TEXT BOOKS:**

1. Taguchi techniques for quality engineering/Philip J.Ross / McGraw Hill Intl. 2nd Edition, 1995.

**REFERENCES:**

1. Quality Engineering in Production systems/G.Taguchi, A.Elasayed et al/Mc.Graw Hill Intl. Edition, 1989.
2. Taguchi methods explained: Practical steps to Robust Design/PapanP.Bagchi/Prentice Hall Ind. Pvt. Ltd. New Delhi.

***Course Outcomes:***

After completion of the course, the students will be able to:

- *Understanding of time and motion study, work sampling, and process flow charting*
- *Critically observe manufacturing operations.*
- *Produce short technical reports individually and in teams.*
- *Contribute to the profitable growth of manufacturing businesses.*
- *Maintain high standards of professional and ethical responsibility.*
- *To design and conduct experiments, as well as to analyze and interpret data.*
- *To use the techniques, skills, and modern engineering tools necessary for engineering.*

## CAD/CAM I-ISEMESTER

# COMPUTER INTEGRATED MANUFACTURING

***Course Objectives:***

- *To develop an understanding of the role of computer in manufacturing*
- *To introduce hardware and software components for soft automation.*
- *To provide an in-depth understanding of control of manufacturing, automated material handling, storage and retrieval systems.*
- *To take up case studies on FMS and CIM systems*

**UNIT-I**

**INTRODUCTION**

Objectives of a manufacturing system –indentifying business opportunities and problems classification production systems- linking manufacturing strategy and systems- analysis of manufacturing operations

**UNIT-II**

**COMPUTER AIDED PLANNING AND CONTROL**

Production planning and control-cost planning and control-inventory management- Material requirements planning (MRP)- shop floor control-Factory data collection system – Automatic identification system-barcode technology – automated data collection system.

**UNIT-III**

**COMPUTER MONITORING**

Types of production monitoring systems- structure model of manufacturing process- process control & strategies- direct digital control- supervisory computer control – computer in QC – contact inspection methods, non-contact inspection method – computer –aided testing – integration of CAQC with CAD/CAM.

**UNIT-IV**

**INTEGRATED MANUFACTURING SYSTEM**

Definition – application – features – types of manufacturing systems-machine tools- materials handling system – computer control system – DNC systems manufacturing cell Flexible manufacturing systems (FMS) –the FMS concept – transfer systems – head changing FMS – variable mission manufacturing system benefits. Rapid prototyping – Artificial Intelligence and Expert system in CIM.

**UNIT-V**

**MATERIAL HANDLING IN MANUFATURING SYSTEM**

Material handling function, Types of material handling equipment, AGV systems, Automated Storage/ Retrieval systems, Interfacing handling and storage with manufacturing .

**Text Books:**

1. Groover, M.P., “Automation, Production system and CIM”, Prentice – Hall of India, 1998.
2. Davis Bedworth, “ Computer Integrated Desingn and Manufacturing”, TMH, New Delhi,

**Reference:**

1. YoremKoren, “ Computer Integrated Manufacturing”, McGraw Hill,1983
2. Ranky, Paul G., “Comuter Integrated Manufaturing”, Prentice Hall International
3. R.W.Yeomamas, A.Choudary and P.J.W.Ten Hagen, “Desingn rules for a CIM system”,
4. PN RAO , “ CAD/CAM”, (PHI)
5. CSP Rao – CAD/CAM

***Course Outcomes:***

*After completion of the course, the students will be able to:*

- *Apply the principles of operation of automated material handling, storage, and retrieval systems (ASRS) and implement them in production..*
- *Implement group technology concepts in production to facilitate cellular and flexible manufacturing.*
- *Take appropriate strategy to gradually migrate from conventional manufacturing to FMS and CIM*

## CAD/CAM I-ISEMESTER

## PRODUCT ENGINEERING

***Course Objectives***

- *To Design products creatively while applying engineering design principles*
- *To Apply principles of human factors, ethics and environmental factorsin product design*
- *To Work in groups or individually in their pursuit of innovative product design*
- *To implement value design for optimum product cost.*

**UNIT - I**

**Introduction:** Design philosophy-steps in design process-general design rules for manufacturability-basic principles of designing for economical production-creativity in design.
**Materials:** Selection of materials for design-developments in material technology-criteria for material selection-material selection interrelationship with process selection-process selection charts.

**UNIT - II**

**Machining processes:** Overview of various machining processes-general design rules for machining-dimensional tolerance and surface roughness-Design for machining – ease – redesigning of components for machining ease with suitable examples. General design recommendations for machined parts.

**UNIT - III**

**Metal casting:** Appraisal of various casting processes, selection of casting process,-general design considerations for casting-casting tolerance-use of solidification, simulation in casting design-product design rules for sand casting.
**Metal joining:** Appraisal of various welding processes, factors in design of weldments – general design guidelines-pre and post treatment of welds-effects of thermal stresses in weld joints-design of brazed joints.

**UNIT – IV**

**Forging:** Design factors for forging – closed die forging design – parting lines of dies – drop forging die design – general design recommendations.
**Extrusion & Sheet metal work:** Design guide lines extruded sections-design principles for punching, blanking, bending, deep drawing-Keeler Goodman forging line diagram – component design for blanking.

**UNIT- V**

**Plastics:** Visco elastic and creep behavior in plastics-design guidelines for plastic components-design considerations for injection moulding – design guidelines for machining and joining of plastics.

**TEXT BOOKS:**

1. Design for manufacture, John cobert, Adisson Wesley. 1995
2. Product Design For Manufacture And Assembly, 2nd Edition, Geoffrey Boothroyd,Book World Enterprises (2002) Book World Enterprises (2002)

**REFERENCES:**

1. ASM Hand book Vol.20
2. Engineering Design by George E.Dieter

***Course Outcomes***

- *Ability to apply knowledge of basic science and engineering fundamentals*
- *Ability to undertake problem identification, formulation and solution*
- *Understanding of the principles of sustainable design and development*

*Understanding of professional and ethical responsibilities and commitment to them*

**CAD/CAM I-ISEMESTER**

# COMPUTER AIDED PROCESS PLANNING

***Course Objectives:***

- *To help the students develop an understanding of the underlying knowledge and related methods of Computer Aided Process Planning, and*
- *To equip the students with the skills required in carrying out the process planning (PP) function within a computer integrated manufacturing environment.*
- *To introduce group technology and concurrent engineering, and develop skill in the developing automated process plans using variant and generative approaches*

**Unit - I**

**Introduction to CAPP:** Information requirement for process planning system, Role of process planning, advantages of conventional process planning over CAPP, Structure of Automated process planning system, feature recognition, methods.

**Unit - II**

**Generative CAPP system:** Importance, principle of Generative CAPP system, automation of logical decisions, Knowledge based systems, Inference Engine, implementation, benefits.

**Retrieval CAPP system:** Significance, group technology, structure, relative advantages, implementation, and applications.

**Unit - III**

**Selection of manufacturing sequence:** Significance, alternative manufacturing processes, reduction of total set-up cost for a particular sequence, quantitative methods for optimal selection, examples.

**Unit –IV**

**Determination of machining parameters:** reasons for optimal selection of machining parameters, effect of parameters on production rate, cost and surface quality, different approaches, advantages of mathematical approach over conventional approach, solving optimization models of machining processes.

**Determination of manufacturing tolerances:** design tolerances, manufacturing tolerances, methods of tolerance allocation,sequential approach**,** integration of design and manufacturing tolerances, advantages of integrated approach over sequential approach.

**Unit –V**

**Generation of tool path:** Simulation of machining processes,NC tool path generation, graphical implementation, determination of optimal index positions for executing fixed sequence, quantitative methods.

**Implementation techniques for CAPP:** MIPLAN system, Computer programming languages for CAPP, criteria for selecting a CAPP system and benefits of CAPP. Computer integrated planning systems, and Capacity planning system.

**Text Books:**

1.Automation , Production systems and Computer Integrated Manufacturing System – MikellP.Groover

2.Computer Aided Design and Manufacturing – Dr.Sadhu Singh.

3.Computer Aided Engineering – David Bedworth

**Reference:**

1. CAD/CAM By CSP Rao.
2. CAD/CAM by PN Rao.

***Course Outcomes:***

After completion of the course, the students will be able to:

- ***Describe*** *the process planning functions, the role of process planning in manufacturing, the characteristics of traditional and Computer Aided Process Planning (CAPP) systems, and the structure of typical CAPP systems from a holistic prospective.*
- ***Identify*** *the process capabilities, such as process parameters, process boundaries, process performance and process cost in the areas of manufacturing.*
- ***Apply*** *group technology, geometric coding systems, electronic product information representation methods, and process data representation methods to encode part and process information within machining or electronic products manufacturing environment.*
- ***Implement*** *Manual and Computer Aided Process Planning systems in consideration of process planning criteria, and industrial considerations.*

## CAD/CAM I-ISEMESTER

## MODELLING LAB

***Course Objectives:***

- *To train the students with CAD packages.*
- *To impart the 2D and 3D modeling skills to the students.*
- *To import and export different IGES files from one software to another*

1.Generation of the following curves using "C" language

a) Bezier curves
b) Splines
c) B-Splines.

2.Generation of the following surfaces using "C" language

a) Bezier surfaces
b) B-Splines surfaces

3. Generation of solids using "C"

a) Constructive solid geometry
b) Boundary representation

4. Typical tasks of Modeling using PRO/E, IDEAS, CATIA solid modeling packages

a) Surface modeling
b) Solid Modeling
c) Drafting
d) Assembly

***Course Outcomes:***

- *Students will be able to design different parts of mechanical equipments*
- *Students will be able to apply their skills in various designing and Manufacturing Industries.*

**CAD/CAM I-ISEMESTER**

## FINITE ELEMENT ANALYSIS LAB

***Course Objectives***

- *To use the commercial Finite Element packages to build Finite Element models and solve a selected range of engineering problems.*
- *To validate a Finite Element model using a range of techniques.*
- *To communicate effectively in writing to report (both textually and graphically) the method used, the implementation and the numerical results obtained.*
- *To discuss the accuracy of the Finite Element solutions.*

FE Analysis using ANSYS Package for different structures that can be descretized with 1-D,2-D & 3-D elements to perform the following analysis:

1. Static Analysis
    a. Stress analysis of 2D truss.
    b. Stress analysis of a plate with a circular hole and L-Bracket – 2D and 3D
    c. Stress analysis of beams (cantilever, simply supported & fixed ends)
    d. Stress analysis of an axi-symmetric component

2. Thermal Analysis
    a. Conductive heat transfer analysis of a 2D and 3D components
    b. Convective heat transfer analysis of a 2D component
    c. Coupled field analysis of a component
3. Modal Analysis
    a. mode frequency analysis of a 2D component
    b. mode frequency analysis of beams (cantilever, simply supported, Fixed ends)
4. Transient analysis
    a. Transient analysis of a cantilever beam

***Course outcomes***

- *Ability to solve engineering problems using the commercial software's like ANSYS, SIMUFACT, ABAQUS, SIMULIA.*

**CAD/CAM I-IISEMESTER**

# ADVANCED OPTIMIZATION TECHNIQUES

***Course Objectives***

- *The classical optimization techniques are useful in finding the optimum solution for constrained or unconstrained maxima or minima of continuous and differentiable functions.*
- *These methods lead to a set of nonlinear simultaneous equations that may be difficult to solve. These methods of optimization are discussed.*

**UNIT - I**

**Linear programming:** Two-phase simplex method, Big-M method, duality, interpretation, applications.

**Assignment problem**: Hungarian's algorithm, applications, unbalanced problems, traveling salesman problem.

**UNIT - II**

**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.

**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,

**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**

**Introduction To Artificial Neural Networks** : Introduction, Artificial Neural Networks, Historical Development of Neural Networks, Biological Neural Networks, Comparison Between Brain and the Computer, Comparison Between Artificial and Biological Neural Networks. Applications of neural networks. Brief Introduction to Multilayer Perceptron networks, Back Propagation Network (BPN). Solving Optimization Problems, Solving Simultaneous Linear Equation, Solving Traveling Salesman Problems using Hopfield Networks.

**Text Books:**

1. Optimal design – Jasbir Arora, Mc Graw Hill (International) Publishers
2. Optimization for Engineering Design – Kalyanmoy Deb, PHI Publishers
3. Engineering Optimization – S.S.Rao, New Age Publishers

**References:**

1.Genetic algorithms in Search, Optimization, and Machine learning – D.E.Goldberg, Addison-Wesley Publishers
2. Genetic Programming- Koza
3. Multi objective Genetic algorithms - Kalyanmoy Deb, PHI Publishers
4. Artificial Neural Networks B. Yagna Narayana, PHI
5. Introduction to Artificial Neural Systems - J.M.Zurada, Jaico Publishers, 3rd Edition.
6. Introduction to Neural Networks Using MATLAB 6.0 - S.N. Shivanandam, S. Sumati, S. N. Deepa, TMH.

***Course Outcomes***

*Upon successful completion of this course, the student will be able to understand:*

- *Basic theoretical principles in optimization;*
- *Formulation of optimization models;*
- *Solution methods in optimization;*
- *Methods of sensitivity analysis and post processing of results*
- *Applications to a wide range of engineering problems*

**CAD/CAM I-IISEMESTER**

# ROBOTICS

***Course objectives:***

- *To design, develop and complete robotic activities and challenges*
- *This courses aims at providing the student the fundamental knowledge of the various sub-disciplines such as kinematics, dynamics, controls, sensors, actuators, etc. It is aimed to provide adequate background in both analysis and design of robots.*

**Unit – I**

**Fundamentals of Robots:** Introduction, definition, classification and history of robotics, robot characteristics and precision of motion, advantages, disadvantages and applications of robots. Introduction to matrix representation of a point in a space a vector in space, a frame in space, Homogeneous transformation matrices, representation of a pure translation, pure rotation about an axis.

**Unit – II**

**Kinematics of robot:** Forward and inverse kinematics of robots- forward and inverse kinematic equations for position and orientation,Denavit-Hartenberg(D-H) representation of forward kinematic equations of robots, The inverse kinematic of robots, Degeneracy and Dexterity, simple problems with D-H representation.

**Differential motions and Velocities:** Introduction, differential relationship, Jacobian, differential motions of a frame-translations, rotation, rotating about a general axis, differential transformations of a frame. Differential changes between frames, differential motions of a robot and its hand frame, calculation of Jacobian, relation between Jacobian and the differential operator, Inverse Jacobian.

**Unit – III**

**Dynamic analysis and forces:** Introduction, Lagrangian mechanics, Effective moments of inertia, dynamic equations for multi-degree of freedom robots-kinetic enrgy,potential energy, the Lagrangian – Eulers and Newton-Eulers equations of motion.

**Unit – IV**

**Trajectory planning:** Introduction, path Vs trajectory, basics of trajectory planning, joint space trajectory planning-third order polynomial trajectory planning, fifth order polynomial trajectory planning, Cartesian-space trajectories.

**Unit – V**

**Robot sensors:** Introduction, sensor characteristics, Position sensors- Velocity sensors-accelerating sensors, touch and tactile sensors, force and pressure sensors-piezoelectric, force sensing resistor, strain gauges, Torque sensors, light and infrared sensors, proximity sensors, sniff sensors.

Robot Vision: Introduction, the sensing and digitizing function in Machine Vision, image processing and analysis, Training and vision system vision application in robots.

**Text Books:**

1. Introduction to Robotics – Analysis, System, Applications by Saeed B. Niku, PHI Publications

2. Industrial Robotics – Mikell P. Groover& Mitchell Weiss, Roger N. Nagel,NicholasG.Odrey – Mc Graw Hill, 1986

**References:**

1. Robot Modeling and Kinematics – RachidManseur, Firewall Media Publishers (An imprint of Laxmi Publications Pvt. Ltd., New Delhi)

2 Robot Analysis and Control - H. Asada and J.J.E. Slotine John Willey & Sons.

3. Fundamentals of Robotics: Analysis and control, Robert J. Schilling, Prentice Hall, 1990.

4. A robot Engineering text book – Mohsen shahinpoor, Harper & Row Publishers,1987

5. Introduction to Robotics: Mechanics and Control, John.J.Craig, Addison- Wesley, 1999

6. Robotics: Control, sensing, vision, and intelligence – K.S. FU, R.C. Gonzalez and C.S.G Lee. Mc Graw Hill, 1987.

7. Modeling and control of Robot manipulators, L. sciavicco and b. Siciliano, Springer (second edition) 2000.

8.ROBOTICS ( Fundamental concepts and analysis)ASHITAVA GHOSAL.Oxford university

***Course outcomes:***

*By studying this course, students will be*

- *Familiar with the history, concept development and key components of robotics technologies.*
- *Understand basic mathematic manipulations of spatial coordinate representation and transformation.*
- *Understand and able to solve basic robot forward and inverse kinematics problems.*
- *Understand and able to solve basic robotic dynamics, path planning and control problems.*
- *Able to undertake practical robotics experiments that demonstrate the above skills.*

## CAD/CAM I-IISEMESTER

# CNC TECHNOLOGY &PROGRAMMING

***Course Objectives***

- *To get brief idea about Fundamentals and concepts of CNC machining centers, NC machines*
- *To get fundamentals and concepts in Maintenance and Trouble shootingof CNC& NC machine tools.*
- *To state the objectives, advantages, and special requirements concerning CNC, NC & DNC use.*
- *To Identify the different media used to input and store CNC programs.*

**UNIT – I**

**Introduction to CNC Machine tools:** Evolution of Computerized control in manufacturing, Components, Working principle of CNC, DNC and Machining centers.

**UNIT – II**

**Constructional features of CNC machine tools:** Introduction, Spindle drives, Transmission belting, axes feed drives, Slide ways, Ball screws.

**Accessories:** Work tables, Spindles, Spindle heads, Beds and Columns, Tooling – Automatic Tool changer (ATC).

**UNIT – III**

**Electro-magnetic analogue position transducers:** Principle, advantages, characterstics, Synchros, Synchro-Resolvers, Inductos, Laser interferometer.

**Control Systems and interface:** Open and closed loop systems, Micro processor based CNC systems, block diagram of typical CNC system, description of hard ware and soft interpolation systems, Standard and optional features of CNC control systems.

**UNIT – IV**

**NC part programing :**Introduction, NC coordinate system, Manual Part Programming, Codes and concepts, types of tape farmats.

**APT programming:** APT language structure, APT geometry, Definition of point, time, vector, circle, plane, patterns and matrices. APT motion commands: setup commands, point-to point motion commands, continuous path motion commands, post processor commands, control commands, Macro subroutines, Part programming preparation for typical examples.

**UNIT – V**

**Economics and Maintenance of CNC machine tools:** Introduction, factors influencing selection of CNC machines, Cost of operation of CNC machines, Maintenance features of CNC machines, Preventive maintenance, Documentation, Spare parts, Training in Maintenance.

**Text Books:**

1. Computer Control of Manufacturing systems -Y.Koren – Khanna publications
2.Computer Numerical Control Machines – Hans B.Keif and T. Frederick Waters Macmillan/McGraw Hill
3. CAD/CAM – CSP Rao - Sciethech publications

**References:**

1.Computer Numerical Control Machines – Dr.RadhaKrishnanan, New Central Book Agency
2.CNC Machines – B.S. Aditahn and Pabla
3.CNC Machining technology – Smith &Graham.T Springer – Verlag
4.Computer Numerical Machine tools - G.E. Thyer, NEWNES
5.CAD/CAM – PN Rao
6. Introduction to CNC – James V.Valentine&Josophgoldenberg
7. CAD/CAM – M.P.Groover&E.W.Zimmers

***Course outcomes***

*Upon completing this course, Students will be able to:*

- *Understand fundamentals of NC/CNC*
- *Learn and Write NC Part Programming*
- *Learn NC Programming through CAD/CAM*
- *Learn Tooling for NC/CNC*
- *Understand machines like Chucking and Turning Centres,MachiningCentres*

*Learn Maintenance and Trouble Shooting of CNC Machine Tools*

## CAD/CAM I-IISEMESTER

# MECHATRONICS

***Course Objectives:***

- *To understand the technologies behind modern mechatronic systems.*
- *To provide methodological fundamentals for the development of fully automated system.*
- *To teach students how to develop a robotic or automated system project focusing on the hardware and software integration, and*
- *To apply the acquired knowledge for developing a mechatronic system.*

**UNIT – I**

**Introduction:** Definition of Mechatronics products, design considerations and trade offs. Overview of Mechtronic products.Intelligent machine Vs Automatic machine economic and social justification.

**UNIT – II**

**Motion Control:** Control parameters and system objectives, Mechanical Configurations, Popular control system configurations. S-curve, motor/load inertia matching, design with linear slides.

**Motion Control algorithms:** Significance of feed forward control loops, shortfalls, fundamentals concepts of adaptive and fuzzy – control. Fuzzy logic compensatory control of transformation and deformation non- linearity's.

**UNIT – III**

**Architecture of intelligent machines:** Introduction to Microprocessor and programmable logic controls and identification of systems. System design classification, motion control aspects in design.

**UNIT – IV**

**Manufacturing data bases:** Data base management system, CAD/CAM data bases, graphic data base, introduction to object oriented concepts, objects oriented model language interface, procedures and methods in creation, edition and manipulation of data.

**UNIT – V**

**Machine vision:** Feature and pattern recognition methods, concepts of perception and cognition in decision-making, human-Machine and machine- Machine inter facing devices and strategy.

**Text books:**

1."Designing intelligent machines", open university, London.MichelB.Histand and david G. Alciatore.

2.Introduction to Mechatronics and Measurement systems, Tata Mc Graw Hill.

3.C.W.desilva, Control sensors and actuators, Prentice Hall.

***Course Outcomes***

*Upon successful completion of this unit, the student will be able to:*

- *Define the discipline of mechatronics.*
- *Identify examples of mechatronic systems that are encountered in real life.*
- *Identify the components of a typical mechatronic system.*

## CAD/CAM I-IISEMESTER

# RAPID PROTOTYPING

### *Course Objectives*

*This subject provides students with*

- *An understanding of the various rapid prototyping, rapid tooling, and reverse engineering technologies.*
- *The knowledge to select appropriate technologies for product development purposes.*
- *To provide students considering research in this area with an advanced course in which they are exposed to state of the art research that helps them develop novel concepts of their own.*

**Unit-I**

**Introduction:** Need - Development of RP system, RP Process chain, Impact of Rapid Prototyping on Product Development, Virtual Prototyping, Classification of RP system, Benefits and Applications

**Stereo Lithography System(SLA):** Apparatus, Principle, Process parameter, Process details, Data Preparation, Data files and machine details, Advantages, Limitations and Applications.

**Unit II**

**Fusion Decomposition Modeling:** Principle, Process Parameter, Path generation, Applications.

**Solid Ground Curing:** Principle of Operation, Machine details, Products and Applications,

**Laminated Object Manufacturing**: Principle of Operation, LOM materials, Process details, Applications.

**Unit –III**

**Concepts Modelers:** Principle, Thermal Jet Printer, Sander's Model Market, 3-D printer, Selective Laser sintering (SLS), Object Quadra system.Laser Engineering Net Shaping (lens)

**Unit –IV**

**Rapid Tooling:** Indirect Rapid tooling- Silicon rubber tooling- Aluminum filled epoxy tooling Spray metal tooling, Cast kriksite, 3Q keltool, etc, Direct Rapid Tooling Direct. AIM, Quick cast process, Copper polyamide, Rapid Tool, DMILS, Prometal, Sand casting tooling, Laminate tooling soft, Tooling vs. hard tooling.

**Software for RP:** STL files, Overview of Solid view, Magics, Imics, Magic Communication, etc. Internet based software, Collaboration tools.

**Unit V**

**Rapid Manufacturing Process Optimization:** Factors influencing accuracy, Data preparation error, Part building error, Error in finishing, Influence of build orientation.

**Allied Process:** Vacuum casting, surface digitizing, Surface generation from point cloud, Surface modification- Data transfer to solid models.

**TEXT BOOKS:**

1. Chua Chee Kai, Leong Kah Fai, Chu Sing Lim, Rapid Prototyping: Principles and Applications inManufacturing, World Scientific, 2010
2. Paul F.Jacobs – **" stereo lithography and other RP & M Technologies"**, SME, NY 1996
3. Flham D.T &Dinjoy S.S **– " Rapid Manufacturing "** Verlog London 2001
4. Lament wood, **"Rapid automated "** , Indus Press New York.
5. RafiqNoorani,Rapid Prototyping: Principles and Applications in Manufacturing, John Wiley & Sons, 2006

***Course outcomes***

*Upon completion of the subject, students will be able to*

- *Apply the basic principles of rapid prototyping (RP), rapid tooling (RT), and reverse engineering (RE) technologies to product development;*
- *Decipher the limitations of RP, RT, and RE technologies for product development;*
- *Realize the application of RP, RT, and RE technologies for product development.*

## CAD/CAM I-IISEMESTER

# HYDRAULIC AND PNEUMATIC CIRCUITS

***Course Objectives:***

- *This course provides specialized instruction in maintaining and troubleshooting Hydraulic and Pneumatic systems.*
- *Explain the operation of the main elements of an industrial hydraulic and pneumatic system.*

**Unit-I**

**Oil Hydraulic Systems:** Hydraulic power generators – selection and specification of pumps, pump characteristics.

**Hydraulic Actuators**: Hydraulic and rotary actuators – selection, specification and characteristics.

**Unit-II**

**Control and Regulation Elements**: Pressure – direction and flow control valves – relief valves, non return and safety valves- actuation systems.

**Unit-III**

**Hydraulic Circuits:** Reciprocation, quick return, sequencing circuits- accumulator circuits- industrial circuits – press circuits – hydraulic milling machine – grinding, planning, copying, forklift, earth mover circuits – design and selection of components – safety and emergency mandrels.

**Unit-IV**

**Pneumatic Systems and Circuits:** Pneumatic fundamentals- control elements position and pressure sensing – logic circuits- switching circuits- fringe condition modules and their integration – sequential circuits- cascade methods – mapping methods- step counter method – compound circuit design- combination circuit design.

**Unit-V**

**Installation, Maintenance and Special Circuits:** Pneumatic equipments- selection of components- design calculations- applications – fault finding equipments- hydro pneumatic circuits – use of microprocessors for sequencing – PLC- Low cost automation- robotic circuits.

**Reference Books**

1. Antony Espossito, “Fluid power with Applications”, prentice Hall, 1980
2. DudleytA.Pease and John J.Pippenger, “Basic fluid power”, Prentice Hall, 1987
3. Andrew Parr, “Hydraulics and Pneumatics”, (HB), Jaico Publishing House, 1999
4. Bolton. W. “Pneumatic and Hydraulic systems”, Butterworth – Heinneman, 1997

**Web References:**

1. *http://www.pneumatics.com*
2. *http://www.fluidpower.com.tw*

***Course outcomes:***

*Upon completion, the student should be able to:*

- *Define basic fluid power terms and units.*
- *Identify Hydraulic and Pneumatic graphic symbols.*
- *Describe fluid power components.*
- *Calculate basic operations for sizing hydraulic and pneumatic components.*
- *Perform basic fluid power maintenance procedures.*

## CAD/CAM I-IISEMESTER

## ARTIFICIAL INTELLIGENCE & EXPERT SYSTEMS

***Course objectives***

- *To get brief idea about fundamentals and concept of artificial intelligence.*
- *Find appropriate idealizations for converting real world problems into AI search problems formulated using the appropriate search algorithm.*
- *Given a real world supervised learning problem, choose and implement appropriate learning algorithms such as decision trees, support vector machines, and boosting.*

**Unit-I**

**Artificial Intelligence :** Introduction, definition, underlying assumption, Important of Al, Al & related fields State space representation, defining a problem, production systems and its characteristic, search and control strategies –Introduction, preliminary concepts, examples of Search , problems.

**Unit-II**

**Uniformed or preliminary Concept:** Examples of search problems, Uniformed or Blind Search, Informed Search, Or Graphs, Heuristic Search techniques- Generate and Test, Hill climbing, Best first search, Problem reduction, Constraint satisfaction, Means- Ends Analysis.

**Knowledge Representation Issues:** Representations and Mapping, Approaches, Issues in Kr, Types of knowledge procedural Vs Declarative, Logic programming, Forward Vs Backward reasoning, Matching, Non monotonic reasoning and it logic.

**Unit-III**

**Use of Predicate Logic:** Representing simple facts, Instance and is a relationships, Syntax and Semantics for Propositional logic, FOPL, and properties of Wffs, conversion to casual form, Resolution, Natural deduction

**Statistical and Probabilistic Reasoning:** Symbolic reasoning under uncertainly, Probability and Bayes theorem, Certainty factors and Rule based systems, Bayesian Networks, Dempster-Shafer Theory, Fuzzy Logic

**Unit-IV**

**Expert Systems:** Introduction, Structure and uses, Representing and using domain knowledge, Expert System Shells.Pattern recognition, introduction, Recognition and classification process, learning classification patterns, recognizing and understanding speech.

**Introduction to Knowledge Acquisition:** Types of learning, General learning model, and performance measures.

**Unit-V**

**Typical Expert Systems:** MYCIN, Variants of MYCIN, PROSPECTOR DENDRAL, PRUFF etc.

**Introduction to Machine Learning:**Perceptons, Checker Playing examples,Learning, Automata, Genetic Algorithms, Intelligent Editors.

**TEXT BOOKS**


1. Elaine Rich & Kevin Knight**, " Artificial Intelligence"** , M/H 1983
2. WendryB.Ranch**, "Artificial Intelligence in Business"**, Science & Industry – Vol -II application, Ph 1985.
3. Waterman, D.A., Addison, **"A Guide to Expert System" –** Wesley inc. 1986.
4. Hayes, Roth, Waterman, **"Building expert system"** D.A (ed), AW 1983.
5. S.M. and Kulliknowske, **"Designing Expert System"**, Weis, London Champion Hull 1984.


***Course outcomes***

*Upon completing this course, students will be able to:*

- *The student will learn the basics of the theory and practice of Artificial Intelligence as a discipline about intelligent agents capable of deciding what to do, and do it.*
- *The student will learn to apply knowledge representation techniques and problem solving strategies to common AI applications.*
- *The student will design simple software to experiment with various AI concepts and analyze results.*

*The student will build self-learning and research skills to be able to tackle a topic of interest on his/her own or as part of a team.*

**CAD/CAM I-IISEMESTER**

# MECHANICS AND MANUFACTURING METHODS OF COMPOSITES

***Course objectives***

- *Introduce modern composite materials and their applications to students.*
- *Build proper background for stress and strength analysis in the design of composite materials and structures.*

**Unit – I**

**Basic concepts and characteristics:**Geometric and Physical definitions, natural and man-made composites, Aerospace and structural applications, types and classification of composites,
**Reinforcements:**Fibres- Glass, Silica, Kevlar, carbon, boron, silicon carbide, and born carbide fibres. Particulate composites, Polymer composites, Thermoplastics, Thermosetts, Metal matrix and ceramic composites.

**Unit – II**

**Micromechanics:** Unidirectional composites, constituent materials and properties, elastic properties of a lamina, properties of typical composite materials, laminate characteristics and configurations. Characterization of composite properties.
**Coordinate transformations:** Hooke's law for different types of materials, Hooke's law for two dimensional unidirectional lamina, Transformation of stress and strain, Numerical examples of stress strain transformation, Graphic interpretation of stress – strain relations. Off - axis, stiffness modulus, off - axis compliance.

**Unit – III**

**Elastic behavior of unidirectional composites**: Elastic constants of lamina, relation ship between engineering constants and reduced stiffness and compliances, analysis of laminated composites, constitutive relations.

**Unit – IV**

**Strength of unidirectional lamina:** Micro mechanics of failure, Failure mechanisms, Strength of an orthotropic lamina, Strength of a lamina under tension and shear maximum stress and strain criteria, application to design. The failure envelope, first ply failure, free-edge effects.Micro mechanical predictions of elastic constants.

**Unit – V**

**Analysis of laminated composite plates**

Introduction, thin plate theory, specially orthotropic plate, cross and angle ply laminated plates, problems using thin plate theory.
**Manufacturing methods:** Autoclave, tape production, moulding methods, filament winding, man layup, pultrusion, RTM.

**Text Books:**

1. R. M. Jones, Mechanics of Composite Materials, Mc Graw Hill Company, New York,1975.
2. Engineering Mechanics of Composite Materials by Isaac and M.Daniel, Oxford University Press, 1994.

**References:**

1. B. D. Agarwal and L. J. Broutman, Analysis and performance of fibre Composites, Wiley-Interscience, New York, 1980.
2. L. R. Calcote, Analysis of Laminated Composite Structures, Van NostrandRainfold, New York, 1969.

***Course outcomes***

*Upon completing the course the student can be able to:*

- *Teach students to perform mathematical analyses of conventional and non-traditional manufacturing processes.*
- *Demonstrate the ability to break down manufacturing processes for analysis.*
- *Demonstrate the ability to identify known and unknown parameters including initial and boundary conditions for major manufacturing processes.*

## CAD/CAM I-IISEMESTER

# COMPUTER GRAPHICS

***Course objectives***

- *Know and be able to use the underlying algorithms, mathematical concepts, supporting computer graphics. These include but are not limited to:Composite 3D homogeneous matrices for translation, rotation, and scaling transformations. Plane, surface normals, cross and dot products. Hidden surface detection / removal. Scene graphs, display lists.*
- *Know and be able to select among models for lighting/shading: Color, ambient light; distant and light with sources; Phong reflection model; and shading (flat, smooth, Gourand, Phong).*

**Unit - I**

**Introduction to computer graphics:** Color CRT raster scan monitors, plasma display & liquid crystal display monitors, computer input devices, hard copy devices.

**Unit - II**

**Raster scan graphics:** Line drawing algorithms – DDA &Bresenham algorithms, circle generation, general function rasterization, displaying lines, characters and polygons.

**Filling algorithms:** polygon filling, edge fill algorithm, seed fill algorithm, fundamentals of antialiasing and half toning.

**Unit - III**

**Line CLIPPING:** Simple visibility algorithm, Cohen-Sutherland subdivision line clipping algorithm, mid point sub division algorithm.

**Polygon clipping:** polygon clipping, reentrant polygon clipping – Sutherland – Hodgeman algorithm, character clipping, 3D- clipping.

**Unit - IV**

**Transformations:** Cartesian and homogeneous coordinate systems two dimensional and three dimensional transformations – scaling, rotation, Shearing, Zooming, viewing transformation, reflection, rotation about an axis, concatenation.

**Unit - V**

**Rendering:** Hidden line removal algorithms, surface removal algorithms, painters, Warnock, Z-buffer algorithm.

**Shading algorithms:** Constant intensity algorithm, Phong's shading algorithm, gourand shading algorithm, Comparison of shading algorithms.

**Text Books:**

1.Procedural elements for computer graphics-D.F.Rogers, Tata McGraw-Hill.
2.Computer Graphics-Donald Hearn & M.P. Bakers.
3.Computer graphics-Harrington.
4.Interactive computer graphics – New mann&Sprowl

***Course outcomes***

*Upon completing this course,*

- *Students will demonstrate an understanding of contemporary graphics hardware.*
- *Students will create interactive graphics applications in C++ using one or more graphics application programming interfaces.*
- *Students will write program functions to implement graphics primitives.*
- *Students will write programs that demonstrate geometrical transformations.*
- *Students will demonstrate an understanding of the use of object hierarchy in graphics applications.*

## CAD/CAM I-IISEMESTER

# AUTOMATION LAB

***Course objectives***

- *To get the idea about the working principle of Aristo Robot*
- *To know the working of automation studio software*
- *To design the hydraulic and pneumatic circuits by using automation studio software*
- *To design the automated manufacturing systems by using workspace software.*

1. Pick and place robot programming by using Aristo Robot.
2. Simulation of a Manufacturing System by using WORKSPACE software.
3. Simulation of automation system by using WORKSPACE software.
4. Simulation of Linear and Rotary actuators by using AUTOMATION STUDIO software.
5. Simulation of hydraulic circuits by using AUTOMATION STUDIO software.
   - 5.1 Quick return Mechanism circuit.
   - 5.2 Sequencing circuits like hydraulic milling, grinding, shaping machines.
6. Simulation of Pneumatic circuits by AUTOMATION STUDIO software.
   - 6.1 Simulation of Cascade Method
   - 6.2 Simulation of Mapping method
   - 6.3 Simulation of step counter method

***Course outcomes***

*Upon successful completion students should be able to:*

- *Demonstrate the pick and place Aristo Robot.*
- *Demonstrate the working of workspace software.*
- *Check the circuit designs whether working properly or not by using Automation studio software.*

## CAD/CAM I-IISEMESTER

# CNC Lab

***Course objectives***

- *To get practical knowledge on manual part programming of CNC lathe machine by using G codes and M codes.*
- *To get practical knowledge on manual part programming of CNC milling and drilling machine by using G codes and M codes.*
- *To get the practical knowledge on APT language*

1. Manual part programming (using G and M codes) in CNC Lathe Machine
   1.1 Part programming for linear interpolation, circular interpolation, chamfering and grooving.
   1.2 Part programming by using standard canned cycles for turning, facing, taper turning and thread cutting.
2. Manual part programming (using G and M codes) in CNC Milling Machine
   2.1 Part programming for linear interpolation, circular interpolation and contour motions.
   2.2 Part programming involving canned cycles for drilling peak drilling and boring.
3. *APT* (*Automatically Programmed Tools*) *language in CNC Milling and Lathe machine*

***Course outcomes***

*Upon successful completion students should be able to:*

- *Use an understanding of General and Machine (G & M) code to generate or edit a program which will operate a CNC Lathe.*
- *Apply mathematical methods to calculate Cartesian coordinates*

# *TWO YEAR COURSE STRUCTURE*

## *FOR*

# *M.TECH – CAD CAM*

## *w.e.f.*

# *2017-2018 ADMITTED BATCH*

# *R-17 REGULATIONS*


**DEPARTMENT OF MECHANICALENGINEERING**

**COLLEGE OF ENGINEERING (AUTONOMOUS) :: PULIVENDULA**

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR**

**PULIVENDULA – 516390, Y.S.R. (DIST), ANDHRA PRADESH, INDIA**

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR
COLLEGE OF ENGINEERING (Autonomous) PULIVENDULA – 516 390 (A. P.)

***Academic regulations for M. Tech. (Regular) program***
***with effect from academic year 2017-18***

## 1. ELIGIBILITY FOR ADMISSION:

Admission to the above program shall be made subject to the eligibility, qualification and specialization prescribed by the University for each Program from time to time.

i. Admission shall be made either on the basis of merit/rank obtained by the qualifying candidates in GATE/PGECET or otherwise specified, whichever is relevant.

## 2. AWARD OF M.TECH. DEGREE:

A student will be declared eligible for the award of the M. Tech. degree if he/she fulfills the following academic regulations:

i. He/she has pursued a course of study for not less than four semesters and not more than eight semesters.
ii. Students, who fail to fulfill all the academic requirements for the award of the degree within eight semesters from the year of their admission, shall forfeit their seat in the course and their seat shall stand cancelled.
iii. Register for 68 credits and secure all 68 credits

## 3. COURSES OFFERED:

| s.no. | Department | Specialization |
|---|---|---|
| 01. | Electrical & Electronics Engineering (EEE) | *Electrical Power Systems (EPS)* |
| 02. | Mechanical Engineering (ME) | *Computer Aided Design & Computer Aided Manufacturing (CAD&CAM)* |
| 03. | Electronics & Communication Engineering (ECE) | *Digital Electronics & Communication Systems (DECS)* |
| 04. | Computer Science & Engineering (CSE) | *Computer Science & Engineering (CSE)* |

And any other course as approved by the competent authorities from time to time.

## 4. COURSE WORK:

The programs are offered on a Semester basis consisting of four Semesters.

i. The candidates shall undergo ***fivetheory*** and ***two laboratory*** courses in ***each semester*** during the first and second semesters. During the third and fourth semesters the candidates pursue the dissertation in the concerned specialization only. The theme of dissertation should conform to the specialization.
ii. There shall be one comprehensive online examinations conducted by the respective department one at the end of 1st year with 60 objective questions for 60 marks on the subjects studied in the respective years of both semesters. The heads of the respective department are given the responsibility of preparing question paper and conducting the online examination by maintaining confidentiality. A student shall acquire Two credit assigned to the online examination only when he/she secure 40% or more marks. In case, if a student fails in comprehensive online examination, he shall re- register by following a similar procedure adopted for the lab examinations.

iii. There shall be ***two seminars***(*seminar-I, and seminar -II*) related to thesis/dissertation. Out of two seminars related to thesis/dissertation, *seminar-I* shall be conducted in the 3rd semester and the *seminar-II* will be in 4th semester.

iv. A candidate has to either present a paper in any national or international conference organized by AICTE recognized college/institution, or, publish a paper in peer-reviewed journals/Conferences proceedings before the submission of thesis.

v. Only on completion of all the prescribed courses, the candidate will be permitted to submit the thesis/dissertation. Three copies of the thesis / dissertation certified by the concerned supervisor in the prescribed form shall be submitted to the College. Once a student fails to submit the thesis within the stipulated period of four semesters, extension of time up to eight semesters may be permitted by the Principal with recommendation of the College Academic Committee.

vi. The Thesis/Dissertation will be adjudicated by one external examiner from reputed institutions/industry appointed by the competent authority.

vii. If the report of the external examiner is favorable, a viva-voce examination shall be conducted by a board consisting of Head of the department as Chairman, the supervisor and the examiner who adjudicated the thesis/ dissertation. The board shall jointly report the candidate's work as:

A - Excellent
B - Good
C - Satisfactory
D - Unsatisfactory

viii. If the report of the viva-voce is not satisfactory, the candidate will retake the viva-voce examination after three months. If he/she fails to get a satisfactory report at the second viva-voce examination, he/she will not be eligible for the award of the degree unless the candidate is asked to revise and resubmit the thesis/dissertation. The resubmitted copy shall be evaluated by the same board.

## 5. EVALUATION:

The performance of the candidate in each semester program shall be evaluated subject wise, with a maximum of 100 marks for theory and 100 marks for practical examination, on the basis of Internal Evaluation and End Examination.

i. For the theory subjects, 60% of the marks will be for the End Examination and 40% of the marks will be for Internal Evaluation.

Final Internal marks for a total of 40 marks shall be arrived at by considering the marks secured by the student in both the mid examinations with 80% weightage to the better mid exam and 20% to the other. The two midterm examinations shall be held during the semester, one in the middle of the program and the other one during the last week of instruction. **A student shall answer all three questions in 2 hours of time without seeking any choice**.

The following pattern shall be followed in the End-Examination.

a. Five questions shall be set from each of the five units with either/or type for 12 marks each, and the total marks of 60.
b. All the questions have to be answered compulsorily.
c. Each question may consist of one, two or more bits.

ii. For practical subjects, 60 marks shall be for the End Examinations and 40 marks will be for internal evaluation based on the day to day performance. The end semester practical examination shall be conducted by the concerned laboratory teacher and senior expert in the same subject of the department nominated by the Principal.

iii. Comprehensive Online Examination shall be evaluated for 60 marks ad seminar-I and seminar-II shall be evaluated for internal marks of 50 each. There is no external evaluation for them. A candidate has

to secure a minimum of 50% to be declared successful in all the three evaluations. If the candidate fails, he/she has to re-register for Comprehensive Online Examination /seminars. Assessment of these three shall be done by a board consisting of Head of the Department, concerned thesis supervisors, and senior faculty members of the department.

iv. A candidate shall be deemed to have secured the minimum academic requirement in a subject if he secures a minimum of 40% of marks in the End Examination and a minimum aggregate of 50% of the total marks in the End Semester Examination and Internal Evaluation taken together.

v. In case the candidate does not secure the minimum aggregate marks as specified in 5 (iv) he/she has to reappear for the semester examination either the supplementary or regular in that subject or repeat the course as and when next offered or do any other specified subject as may be required. *However the candidate is permitted to appear for two courses per semester only*.

## 6. ATTENDANCE:

A student shall be eligible to appear for end semester examinations if he/she acquires a minimum of 75% of attendance in aggregate of all the subjects in a semester.

i. Condonation of shortage of attendance up to 10% in any subject i.e. from 65% and above and less than 75% may be given by the College Academic Committee.

ii. **Shortage of Attendance below 65% in aggregate shall in NO case be condoned**.

iii. Condonation of shortage of attendance in aggregate up to 10% (65% and above and below 75%) in each semester may be granted by the College Academic Committee.

iv. Students whose shortage of attendance is not condoned in any semester are not eligible to take their external Examination of that class and their registration shall stand cancelled.

v. A student will not be promoted to the next semester unless he/she satisfies the attendance requirements of the present semester, as applicable. They may seek readmission for that semester as and when offered next.

vi. A stipulated fee shall be payable towards condonation of shortage of attendance to the institution.

**7. Grading System is to be introduced**. After each subject is evaluated for 100 marks, the marks obtained in each subject will be converted to a corresponding letter grade as given below, depending on the range in which the marks obtained by the student fall.

**vii. Table – Conversion into Grades and Grade Points assigned**

| Academic performance | Letter Grade | Grade points Assigned |
|---|---|---|
| ≥ 95% | S | 10 |
| ≥90% - < 95% | A++ | 9.5 |
| ≥ 85% - <90% | A+ | 9 |
| ≥80% - <85% | A | 8.5 |
| ≥75% - <80% | B++ | 8 |
| ≥70% - <75% | B+ | 7.5 |
| ≥65% - <70% | B | 7 |
| ≥60% - <65% | C++ | 6.5 |
| ≥55% - <60% | C+ | 6 |
| ≥50% - <55% | C | 5.5 |
| ≥45% -< 50% | D | 5 |
| ≥40%- < 45% | E | 4.5 |
| Below 40% | F(Fail) | 0 |
| Absent | Ab (Absent) | 0 |

i. The following procedure shall be adopted to compute the Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA);

ii. The Semester Grade Point Average (SGPA) is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student, i.e.

$$SGPA = \Sigma (C_i \times G_i) / \Sigma C_i$$

Where, Ci is the number of credits of the $i^{th}$ subject and Gi is the grade point scored by the student in the $i^{th}$ course.

ii. The Cumulative Grade Point Average (CGPA) will be computed in the same manner taking into account all the courses undergone by a student over all the semesters of a program, i.e.

$$CGPA = \Sigma (C_i \times S_i) / \Sigma C_i$$

Where 'Si' is the SGPA of the $i^{th}$ semester and $C_i$ is the total number of credits in that semester.

iii. Both SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

iv. While computing the GPA/CGPA the subjects in which the student is awarded Zero grade points will also be included.

Grade Point: It is a numerical weight allotted to each letter grade on a 10-point scale.
Letter Grade: It is an index of the performance of students in a said course. Grades are denoted by letters S, A, B, C, D, E and F.

## 8. AWARD OF DEGREE AND CLASS:

After a student has satisfied the requirements prescribed for the completion of the program and is eligible for the award of B. Tech. Degree he/she shall be placed in one of the following four classes:

| **Class Awarded** | **CGPA Secured** |
|---|---|
| First Class with Distinction | $\geq 7.5$ |
| First Class | $\geq 6.5 < 7.5$ |
| Second Class | $\geq 5.5 < 6.5$ |
| Pass Class | $\geq 4.0 < 5.5$ |
| | |

(The marks in internal evaluation and external Examination shall be shown separately in the marks memorandum)
Further, CGPA to a maximum of extent of 0.05 shall be added which is just sufficient to effect change of class from pass class to Second class, Second class to First class, First class to First class with distinction for all the courses being offered, without adding any marks to the original marks secured by the students
A candidate shall be eligible for the award of respective degree if he/she satisfies the minimum academic requirements in every subject and secures at least satisfactory report on his/her thesis / dissertation and viva-voce.

## 9. WITHHOLDING OF RESULTS

The result of a candidate shall be withheld if:

i. He/she has not cleared any dues to the Institution / Hostel.
ii. A case of disciplinary action against him/her is pending disposal.

## 10. TRANSITORY REGULATIONS:

Candidates who have discontinued or have been detained for want of attendance or who have failed after having undergone the course are eligible for re-admission to the same or equivalent subjects as and when subjects are offered, subject to the conditions mentioned in 5-(iv) and 2-(ii).

**11. GENERAL:**

The academic regulations should be read as a whole for purpose of any interpretation.

i. The college reserves the right of altering the regulations as and when necessary. The regulations altered may be applicable to all the candidates on rolls.

ii. Wherever the word he, him or his occur, it will also includes she, her, hers.

iii. There shall be no place for transfer of candidate within the constituent colleges of Jawaharlal Nehru Technological University during the entire course of the programme.

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# JNTUA COLLEGE OF ENGINEERING (Autonomous) PULIVENDULA

**Coursestructure for M.Tech. CAD CAM(Regular) with effective from 2017-2018**

**I Year I Semestar**

| S.NO. | COURSE CODE | SUBJECT NAME | THEORY | LAB | CREDITS |
|---|---|---|---|---|---|
| 1 | 17D04101 | FINITE ELEMENT METHODS | 4 | | 4 |
| 2 | 17D04102 | COMPUTATIONAL METHODS | 4 | | 4 |
| 3 | 17D04103 | GEOMETRIC MODELING | 4 | | 4 |
| | 17D04104 | ADVANCES IN MANUFACTURING TECHNOLOGY | 4 | | 4 |
| | 17D04105 | COMPUTER AIDED PROCESS PLANNING | | | |
| 4 | 17D04106 | DESIGN AND ANALYSIS OF EXPERIMENTS | | | |
| | 17D04107 | COMPUTATIONAL FLUID DYNAMICS | 4 | | 4 |
| | 17D04108 | PRODUCT ENGINEERING | 4 | | |
| 5 | 17D04109 | COMPUTER INTEGRATED MANUFACTURING | 4 | | |
| 6 | 17D04110 | MODELING LAB | | 3 | 2 |
| 7 | 17D04111 | FINITE ELEMENT ANALYSIS LAB | | 3 | 2 |
| | **Total** | | **20** | **06** | **24** |
| | **Total contact periods/week : 26** | | | | |
| | **Total Credits : 24** | | | | |

**I Year II Semestar**

| S.NO. | COURSE CODE | SUBJECT NAME | THEORY | LAB | CREDITS |
|---|---|---|---|---|---|
| 1 | 17D04201 | ADVANCED OPTIMIZATION TECHNIQUES | 4 | | 4 |
| 2 | 17D04202 | ROBOTICS | 4 | | 4 |
| 3 | 17D04203 | CNC TECHNOLOGY AND PROGRAMMING | 4 | | 4 |
| 4 | 17D04204 | MECHATRONICS AND MEMS | 4 | | 4 |
| | 17D04205 | ADDITIVE MANUFACTURING | | | |
| | 17D04206 | HYDRAULIC AND PNEUMATIC CIRCUITS | | | |
| 5 | 17D04207 | ARTIFICIAL INTELLIGENCE & EXPERT SYSTEMS | 4 | | 4 |
| | 17D04208 | COMPOSITE MATERIALS | | | |
| | 17D04209 | INTERACTIVE COMPUTER GRAPHICS | | | |
| 6 | 17D04210 | AUTOMATION LAB | | 3 | 2 |
| 7 | 17D04211 | COMPUTER NUMERICAL CONTROL LAB | | 3 | 2 |
| 8 | 17D04212 | COMPREHENSIVE ONLINE EXAMINATION | | | 2 |
| | Total | | **20** | **06** | **26** |
| | Total contact periods/week : 26 | | | | |
| | Total Credits **: 26** | | | | |

**M.Tech (CAD CAM) II Year I Semester**

| S.NO | Course Code | Subject | Maximum Marks | | Total | Min. Marks/ Grades to Pass | Credits |
|---|---|---|---|---|---|---|---|
| | | | Internal | External | | | |
| 1 | 17D04301 | Seminar-I | 50 | - | 50 | 25 | 0 |

**M.Tech (CAD CAM) II Year II Semester**

| S.NO | Course Code | Subject | Maximum Marks | | Total | Min. Marks/ Grades to Pass | Credits |
|---|---|---|---|---|---|---|---|
| | | | Internal | External | | | |
| 1 | 17D04401 | Seminar-II | 50 | - | 50 | 25 | 0 |
| 2 | 17D04402 | **Project Work**<br>Grades : A, B, C, D<br>A - Excellent<br>B - Good<br>C – Satisfactory<br>D - Unsatisfactory | - | - | - | - | 18 |

**JNTUA COLLEGE OF ENGINEERING (Autonomous) PULIVENDULA**

**I M.TECH ISEMESTER**

**FINITE ELEMENT METHODS (17D04101)**

| L | T | P | C |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

***Course Objectives:***

- *To equip the students with the Finite Element Analysis fundamentals.*
- *To enable the students to formulate the design problems into FEA.*
- *To introduce basic aspects of finite element technology, including domain discretization, polynomial interpolation, application of boundary conditions, assembly of global arrays, and solution of the resulting algebraic systems.*

**UNIT - I**

**Mathematical Model and Approximations:** Philosophy and Perspective of FEM, Review of Elasticity, mathematical models for structural problems, Equilibrium of continuum – Differential Formulation, Energy Approach – Integral formulation, Principle of Virtual work – Variational Formulation. Overview of approximate methods for the solution of mathematical methods; Ritz, Rayleigh-Ritz and Galerkin's Method.

**Finite Element Formulation**: Concept of discretisation, Interpolation, Formulation of Finite element characteristic matrices and vectors, Compatibility, Assembly and boundary considerations.

**One-dimensional finite element methods:** Bar elements,Element matrices, assembling of global stiffness matrix, Application of boundary conditions, Elimination and penalty approaches, solution for displacements, reaction, stresses, temperature effects, Quadratic Element.

**UNIT – II**

**Trusses:** Element matrices, assembling of global stiffness matrix, solution for displacements, reaction, stresses, temperature effects - 1D problems only.

**Beams and Frames:** Element matrices, assembling of global stiffness matrix, solution for displacements, reaction, stresses - 1D problems only.

**UNIT – III**

**Two dimensional problems:** Introduction to 2D elements, CST, LST, four node and eight node rectangular elements, Lagrange basis for triangles and rectangles, serendipity interpolation functions. Axisymmetric Problems:Axisymmetric formulations, Element matrices, boundary conditions.

**UNIT - IV**

**FEM in Heat Transfer and Fluid Mechanics problems**: Finite element solution for one dimensional heat conduction with convective boundaries. Formulation of element characteristics and simple numerical problems. Finite element applications in one dimensional potential flows; Formulation based on Potential function and stream function.

**UNIT – V**

**Finite elements in Structural Dynamics:** Dynamic equations, Eigen value problems, and their solution methods, simple problems.

**Convergence:** Requirements for convergence, h-refinement and p-refinement, complete and incomplete interpolation functions, Pascal's triangle.

***Course Outcomes:***

*Upon completing this course, the students will be able to:*

- *Identify mathematical model for solution of common engineering problems.*
- *Formulate simple problems into finite elements.*
- *Solve structural, thermal, dynamic problems.*
- *Use professional-level finite element software to solve engineering problems in Solidmechanics, heat transfer and Dynamics.*

*Derive element matrix equation by different methods by applying basic laws inmechanics and integration by parts.*

**TEXT BOOKS**:

1. Ashok D. Belegundu, Tirupathi R. Chandrupatla, Introduction to Finite Elements in Engineering, PHI Learning, 2009.
2. Daryl L. Logan, A First Course in the Finite Element Method, Cl-engineering, 2010.
3. S.Rajasekaran, Finite Element Analysis in Engineering Design, S.Chand, 2012.

**REFERENCES:**

1. S.Md.Jalaludeen, Finite Element Analysis in Engineering, Anuradha Publications, 2013.
2. J.N. Reddy, An Introduction to the Finite Element Method, McGraw Hill Education Private Limited, 2013.
3. Singiresu S Rao, The Finite Element Method in Engineering, Elsevier, 2012.
4. Zienckiwicz O.C. & R. L. Taylor, Finite Element Method, McGraw-Hill, 1983.
5. K. J. Bathe, Finite element procedures, Prentice-Hall, 1996.
6. Robert.D.Cook, Concepts and applications of Finite Element Analysis, Wiley, 2007.

**I M.TECH ISEMESTER**

## COMPUTATIONAL METHODS(17D04102)

| L | T | P | C |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

**Course Objectives:**

Students will learn

- to solve nonlinear algebraic equations numerically.
- to solve simultaneous linear equations numerically.
- to numerically integrate continuous and discrete functions.
- to numerically solve ordinary and partial differential equations that are initial value or boundary value problems.

**UNIT – I**

**Numerical Solutions of Linear & Non Linear Equations:** System of Linear Equations– Iterative methods –Jacobi's Method,Gauss-Seidal Method, Relaxation methods; Matrix Eigen value Problem. System of non-linear equations –Method of Iteration, Newton-Raphsonmethod

**Unit-II**

**Spline functions:**Introduction: Linear Splines, QuadraticSplines.Cubic Splines: Minimizing Property of Cubic Splines,Numerical differentiation by Cubic Splines Method.

**UNIT – III**

**Boundary value problems:**Finite Difference Method &Shooting method.

**Numerical solutions of partial differential equations:** Laplace's equations -Jacobi's Method, Gauss Seidel Method.

**UNIT – IV**

**Parabolic partial differential equations:** Explicit method – Crank-Nickelson method – Derivative boundary condition – Stability and convergence criteria.

**UNIT – V**

**Hyperbolic partial differential equations:** Solving one dimensional wave equation by finite difference method-stability of numerical method.

**TEXT BOOKS:**

1. Introductory Methods of Numerical Analysis, S.S. Sastry, PHI Publication
2. Higher Engineering Mathematics ; B.S.Grewal; Khanna publications

**REFERENCES:**

1. Steven C.Chapra, Raymond P.Canale "Numerical Methods for Engineers" Tata Mc-Grawhill .
2. Douglas J. Faires, Richard Burden "Numerical Methods" Brooks/Cole publishing company,1998.
3. Numerical Methods for Scientific and Engineering Computation; M.K.Jain, S.R.K.Iyengar, R.K.jain

**Course Outcomes:**

After completion of this course the student should:

- Understand the concept and steps of Numerical methods, solution and implementation.
- Solve the boundary value problems numerically.
- be able to identify, formulate and solve engineering problems.

**I M.TECH ISEMESTER**

## GEOMETRIC MODELING (17D04103)

| L | T | P | C |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

***Course Objectives:***

- *To Learn advanced concepts of feature based modeling and parametric modeling*
- *To understand the mathematical basis for geometric modeling of curves and surfaces and their relationship with computer graphics.*
- *To understand the methods of representation of wireframe, surface, and solid modeling systems.*
- *To Consider data associativity concepts of CAD/CAE integration; Be familiar with interoperability and data transfer techniques between design and analysis software systems.*

**Unit - I**

**Introduction:** Definition, Explicit and implicit equations, parametric equations.

**Unit - II**

**Cubic Splines:** Algebraic and geometric form of cubic spline, tangent vectors, parametric space of a curve, blending functions, four point form, reparametrization, truncating and subdividing of curves, Graphic construction and interpretation, composite pc curves.

**Unit - III**

**Bezier Curves:** Bernstein basis, equations of Bezier curves, properties, derivatives and related problems.

**B-Spline Curves:** B-Spline basis, equations, knot vectors, properties, derivatives and related problems.

**Unit – IV**

**Surfaces:** Bicubic surfaces, Coon's surfaces, Bezier surfaces, B-Spline surfaces, surfaces of revolutions, Sweep surfaces, ruled surfaces, tabulated cylinder, bilinear surfaces, triangular patches, sculptured surface and rational parametric surface.

**Unit – V**

**Solids:** Tricubic solid, Algebraic and geometric form.

**Solid modeling concepts:** Wire frames, Boundary representation, Half space modeling, spatial cell, Constructive Solid Geometry (CSG), Analytical Solid Modelling (ASM).

***Course Outcomes:***

*Upon completing this course, the students will be able to:*

- *Represent curves and surfaces using parametric equations*
- *Define and relate the basic concepts, tools, and algorithms in geometric modeling and digital surface processing*
- *Critically analyze and assess current research on surface representations and geometric modeling with the intent to apply the proposed methods in your own work*

*Define the methods of representation of wireframe, surface, and solid modeling systems.*

**TEXT BOOKS:**

1. Geometric Modeling by Micheal E. Mortenson, McGraw Hill Publishers.
2. CAD/CAM by Ibrahim Zeid, Tata McGraw Hill.
3. 3rd edition CAD/CAM principles and applications by P. N. Rao, McGraw Hill Publishers.

**REFERENCES:**

1. Elements of Computer Graphics by Roger & Adams, Tata McGraw Hill.
2. Computer Aided Design and Manufacturing, K.Lalit Narayan, K.Mallikarjuna Rao, MMM Sarcar, PHI Publishers

**I M.TECH ISEMESTER**

## ADVANCES IN MANUFACTURING TECHNOLOGY (17D04104)

| L | T | P | C |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

***Course Objectives:***

- *To understand the basic principles of welding processes.*
- *To understand the fundamentals of unconventional machining methods.*
- *To develop the students ability to apply modern machining methods on welding*
- *To introduce the students of various types of welding and their performance characteristics.*

**UNIT - I**

**Welding Processes:** Fusion and Solid State Welding Process, Automation in Welding, Design aspects of welds, Weldability of Aluminium alloys, Titanium alloys and High strength low alloy steels, Non destructive testing of Welds, Residual Stresses and Distortion in Weldments.

**UNIT - II**

**Un-conventional Machining Methods-I:**

Abrasive jet machining - Elements of the process, mechanics of metal removal process parameters, economic considerations, applications and limitations, recent developments.

Ultrasonic machining:Elements of the process, machining parameters, effect of parameters on surface finish and metal removal rate, mechanics of metal removal process parameters, economic considerations, applications and limitations.

**UNIT - III**

**Un-conventional Machining Methods-II:**

Electro-Chemical Processes:Fundamentals of electro chemical machining, metal removal rate in ECM, Tool design, Surface finish and accuracy economics aspects of ECM.

Wire EDM Process: General Principle and applications of Wire EDM, Mechanics of metal removal, Process parameters, and selection of tool electrode and dielectric fluids, methods surface finish and machining accuracy.

**UNIT - IV**

**Un-conventional Machining Methods-III:**

Electron Beam Machining: Generation and control of electron beam for machining, theory of electron beam machining, principle, advantages, and limitations, comparison of thermal and non-thermal processes.

Plasma Arc Machining: Principle, machining parameters, effect of machining parameters on surface finish and metal removal rate, applications, limitations

Laser Beam Machining:Principle, effect of machining parameters on surface finish, applications, and limitations.

**UNIT - V**

**Surface Processing Operations:** Plating and Related Processes, Conversion Coatings, Physical Vapor Deposition, Chemical Vapor Deposition, Organic Coatings, Porcelain Enameling and other Ceramic coatings, Thermal and Mechanical Coating Processes.

***Course Outcomes:***

*Upon completing this course, the students will be able to:*

- *Understand the principles of welding processes*
- *Acquire working knowledge on unconventional machining methods*
- *Describe the principle and fundamentals of welding*

*Familiar with the various applications of welding*

**TEXT BOOKS:**

1. Advanced Machining Processes - V.K.Jain, Allied Publishers Private Limited.
2. Fundamentals of Modern Manufacturing- Mikell P. Groover, John Wiley & Sons Publishers
3. Modern Machining Process- P.C Pandey and H.S Shan, Tata McGraw - Hill Education (1980)
4. Unconventional Machining Processes - T.Jagadeesha, I.K Publishers, 2016

**REFERENCES:**

1.Manufacturing Technology - P.N.Rao, McGraw Hill Education Private Limited
2.Manufacturing Science - Amitabha Ghosh, Asok Kumar Mallik, East West press
3.Welding Technology - R.S, Parmar, Khanna Publishers (2013)

**I M.TECH ISEMESTER**

## COMPUTER AIDED PROCESS PLANNING (17D04105)

| L | T | P | C |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

### Course Objective

• To provide the student with an understanding of the importance of process planning role in manufacturing and the application of Computer Aided Process Planning tool in the present manufacturing scenario.

**UNIT IIntroduction**

The Place of Process Planning in the Manufacturing cycle- Process planning and production planning – Process planning and Concurrent Engineering, CAPP.

**UNIT II Part Design Representation**

Design Drafting – Dimensioning – Conventional Toloerencing – Geometric Toloerencing- CAD – input/output devices – Topology – Geometric transformation – Perspective transformation – Data Structure – Geometric modeling for process planning –Group technology coding – The OPITZ system – The MICLASS System.

**UNIT III Process Engineering and Process Planning**

Experienced based planning – Decision table and Decision trees – Process capability analysis – Process planning – Variant process planning – Generative approach – Forward and backward planning, Input format, A1

**UNIT IV Computer Aided Process Planning Systems**

Logical Design of process planning – Implementation considerations- Manufacturing system components, Production Volume, No. of production families- CAM-I, CAPP, MIPLAN, APPAS, AUTOPLAN and PRO, CPPP.

**UNIT VAn Integrated Process Planning Systems**

Totally integrated process planning systems – An Overview – Modulus structure – Data structure – Operation – Report Generation, Expert process planning.

### Course outcomes

Upon completion of this course, the student shall be able to:

- Have a sound knowledge in process planning

Handle computer aided process planning tool

### Textbooks

1. Gideon Halevi and Roland D.Weill, “Principle of process planning”, Alogical approach, chapman & Hall, 1995.
2. C.Elanchezhian and T.SunderSelwin, “Computer aided manufacturing” university science press. 2014.

### References.

1.Tien-Chien-Chang, Richard A.Wysk, “ An Introduction to automated process planning systems”, Prentice Hall 1985.
2. Chang.T.C.,”An Expert Process Planning System”, Prentice Hall, 1985.
3. Nanua Singh,” Systems Approach to Computer Integrated Design and Manufacturing”, John Wiley & Sons, 1996.
4. Rao, “ Computer Aided Manufacturing”, Tata McGraw Hill Publishing Co., 2000.

**I M.TECH ISEMESTER**

## DESIGN AND ANALYSIS OF EXPERIMENTS (17D04106)

| L | T | P | C |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

### *Course Objectives:*

- *To know the importance of quality in manufacturing industries*
- *To understand the steps involved in Design of Experiments and ANOVA*
- *To know how to apply ANOVA & DOE to develop a new manufacturing process.*
- *To know about the different standardization methods for manufacturing.*
- *To Understand and apply the principles of math, science, and engineering in design and manufacturing related activities.*

### UNIT-I

**Quality value and Engineering:** An overall quality system, Quality Engineering in Production Design, Loss function and quality level**:** Derivation and use of Quadratile Loss Function, Economic Consequences of tightening tolerances as a means to improve quality, Evaluations

### UNIT-II

**Tolerance Design and Tolerancing**: Introduction to Tolerances, Types of Tolerances (N-type-, S-type and L-type), Functional limits, tolerance design for N-type, L-type and S-type characteristics, Tolerance Allocation for multiple components.

**Parameter and tolerance design:** Introduction to parameter design, Signal to Noise ratios, Parameter Design Strategy, Introduction to Tolerance Design, tolerance design using the loss function, identification of tolerance design factors.

### UNIT-III

**Design of Experiments:** Introduction, Task aids and Responsibilities for DOE process steps, DOE process steps description.

**Analysis of variance (ANOVA):** no-WAY anova, One-way ANOVA, two-way ANOVA, Critique of F-test, ANOVA for four level factors, multiple level factors.

### UNIT-IV

**Orthogonal Arrays:** Typical test strategies, Better Test Strategies, Efficient Test Strategies, Conducting and Analyzing an experiment.

**Interpolation of experimental results:** Interpretation methods, Percent Contribution, Estimating the Mean.

### UNIT-V

**ISO-9000** Quality system, BDRE,6-sigma, Taguchi Methods, Bench Marking, Quality Circles-Brain Storming-Fishbone Diagram-Problem Analysis.

### *Course Outcomes:*

After completion of the course, the students will be able to:

- *Understanding of time and motion study, work sampling, and process flow charting*
- *Critically observe manufacturing operations.*
- *Produce short technical reports individually and in teams.*
- *Contribute to the profitable growth of manufacturing businesses.*
- *Maintain high standards of professional and ethical responsibility.*
- *To design and conduct experiments, as well as to analyze and interpret data.*

*To use the techniques, skills, and modern engineering tools necessary for engineering.*

### TEXT BOOKS:

1. Taguchi techniques for quality engineering/Philip J.Ross / McGraw Hill Intl. 2nd Edition, 1995.
2. Montgomery DC, Design and Analysis of Experiments, 7th Edition, John Wiley & Sons, NY, 2008.

### REFERENCES:

1. Quality Engineering in Production systems/G.Taguchi, A.Elasayed et al/Mc.Graw Hill Intl. Edition, 1989.
2. Taguchi methods explained: Practical steps to Robust Design/PapanP.Bagchi/Prentice Hall Ind. Pvt. Ltd. New Delhi.

3. Probability And StatisticsDr.B.Krishna Gandhi, Dr. T.K.V. Iyengar, S.Chand Publications.

**I M.TECH ISEMESTER**

## COMPUTATIONAL FLUID DYNAMICS (17D04107)

| L | T | P | C |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

***Course Objectives:***

- *To develop an understanding for the major theories, approaches and methodologies used in CFD.*
- *To build up the skills in the actual implementation of CFD methods (e.g. boundary conditions, turbulence modeling etc.) in using commercial CFD codes.*
- *To gain experience in the application of CFD analysis to real engineering designs.*
- *To provide students with the necessary skills to use commercial Computational Fluid Dynamics packages and to carry out research in the area of Computational Fluid Dynamics.*

**UNIT - I**

**INTRODUCTION:** Finite difference method, finite volume method, finite element method, governing equations and boundary conditions, Derivation of finite difference equations.

**Solution methods:** Solution methods of elliptical equations — finite difference formulations, interactive solution methods, direct method with Gaussian elimination. Parabolic equations-explicit schemes and Von Neumann stability analysis, implicit schemes, alternating direction implicit schemes, approximate factorization, fractional step methods, direct method with tridiagonal matrix algorithm.

**UNIT – II**

Hyperbolic equations: explicit schemes and Von Neumann stability analysis, implicit schemes, multi step methods, nonlinear problems, second order one-dimensional wave equations. Burgers equations: Explicit and implicit schemes, Runge-Kutta method.

**UNIT - III**

**FORMULATIONS OF INCOMPRESSIBLE VISCOUS FLOWS:** Formulations of incompressible viscous flows by finite difference methods, pressure correction methods, vortex methods.

**Treatment of compressible flows:** potential equation, Euler equations, Navier-stokes system of equations, flow field-dependent variation methods, boundary conditions, example problems.

**UNIT - IV**

**FINITE VOLUME METHOD**: Finite volume method via finite difference method, formulations for two and three-dimensional problems.

**UNIT - V**

**STANDARD VARIATIONAL METHODS:** Linear fluid flow problems, steady state problems, Transient problems.

***Course outcomes:***

*After completion of this course the student should be:*

- *Familiar with the differential equations for flow phenomena and numerical methods for their solutions.*
- *Able to use and develop flow simulation software for the most important classes of flows in engineering and science.*

*Able to critically analyze different mathematical models and computational methods for flow simulations.*

**TEXT BOOK:**

1. Computational fluid dynamics/ T. J. C'hung/ Cambridge University press,2002.
2. Computational Fluid Dynamics: Basics with applications/John D. Anderson/ McGraw Hill.

**REFERENCES:**

1. Text book of fluid dynamics/ Frank Choriton/ CBS Publishers & distributors, 1985
2. Numerical heat transfer and fluid flow / Suhas V. Patankar/ Hemashava Publishers corporation&McGraw Hill.
3. Computational Fluid Flow and Heat Transfer/ Muralidaran/ Narosa Publications
4. Fundamentals of Computational Fluid Dynamics/Tapan K. Sengupta / Universities Press.

5. Introduction to Theoretical and Computational Fluid Dynamics/C. Pozrikidis /Oxford.

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## PRODUCT ENGINEERING (17D04108)

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***Course Objectives***

- *To Design products creatively while applying engineering design principles*
- *To Apply principles of human factors, ethics and environmental factorsin product design*
- *To Work in groups or individually in their pursuit of innovative product design*
- *To implement value design for optimum product cost.*

**UNIT - I**

**Introduction:** Design philosophy-steps in design process-general design rules for manufacturability-basic principles of designing for economical production-creativity in design.

**Materials:** Selection of materials for design using Ashby charts - developments in material technology-criteria for material selection-material selection interrelationship with process selection-process selection charts.

**UNIT - II**

**Machining processes:** Overview of various machining processes-general design rules for machining-dimensional tolerance and surface roughness-Design for machining ease – redesigning of components for machining ease with suitable examples, General design recommendations for machined parts.

**UNIT - III**

**Metal casting:** Appraisal of various casting processes, selection of casting process,-general design considerations for casting-casting tolerance-use of simulation in casting design-product design rules for sand casting.

**Metal joining:** Appraisal of various welding processes, factors in design of weldments – general design recommendations for weld strength, general design guidelines for minimizing weld distortion - pre and post treatment of welds - effects of residual stresses in weld joints - design of brazed joints.

**UNIT – IV**

**Forging:** Design factors for forging – parting lines of dies – general design principles for open die and closed die forging – general design recommendations.

**Extrusion & Sheet metal work:** Design guide lines extruded sections-design principles for punching, blanking, bending, deep drawing - Keeler Goodman forming line diagram – component design for blanking.

**UNIT- V**

**Plastics:** Visco elastic and creep behavior in plastics-design guidelines for plastic components-design guidelines for thermosetting plastics and thermoplastics – design guidelines for machining and joining of plastics.

***Course Outcomes***

- *Ability to apply knowledge of basic science and engineering fundamentals*
- *Ability to undertake problem identification, formulation and solution*
- *Understanding of the principles of sustainable design and development*

*Understanding of professional and ethical responsibilities and commitment to them*

**TEXT BOOKS:**

1. Design for manufacturability Handbook, Bralla, Tata McGraw Hill Education. 1998
2. Engineering Design, George E Dieter, Linda C Schmidt, McGraw Hill Education.
3. Production Engineering, P.C.Sharma, S.Chand& Company Ltd.

**REFERENCES:**

1. Product Design and Manufacturing, A.K.Chitale&R.C.Gupta, PHI Learning
2. Manufacturing Technology (Volume – 1), P.N.Rao, McGraw Hill Education
3. Manufacturing Engineering and Technology, SeropeKalpakjian& Steven R. Schmid, Pearson India

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## COMPUTER INTEGRATED MANUFACTURING (17D04109)

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***Course Objectives:***

- *To provide an in-depth understanding of control of manufacturing, automated material handling, storage and retrieval systems.*
- *To take up case studies on FMS and CIM systems*

### UNIT-I

**Manufacturing Automation:** Automated Manufacturing Systems, Computerized Manufacturing Support Systems, Reasons for Automation, Automation Strategies-The USA Principle, Ten Strategies for Automation and Process Improvement, Automation Migration Strategy.

**Automated Flow lines:** System Configurations, Workpart Transfer Mechanisms, Storage Buffers, Control of Production Line, Analysis of Transfer Lines-Transfer Lines with No Internal Parts Storage, Transfer Lines with Internal Storage Buffers.

### UNIT-II

**Manual Assembly Lines:** Assembly Workstations, Work Transport Systems, Line Pacing, Coping With Product Variety, Analysis of Single Model Assembly Lines-Repositioning Losses, The Line Balancing Problem, Line Balancing Algorithms-Largest Candidate Rule, Kilbridge and Wester Method, Ranked Positional Weights Method.

**Automated Assembly Systems:** System Configurations, Parts Delivery at Workstations, Applications, Quantitative Analysis of Assembly Systems- Parts Delivery System at Workstations, Multi-station Assembly machines, Single Station Assembly Machines, Partial Automation.

### UNIT-III

**Automatic Material Handling and Storage systems:** Design Considerations in Material Handling, Material Transport Equipment-Industrial Trucks, Automated Guided Vehicles, Monorails and Other Rail-Guided Vehicles, Conveyors, Cranes and Hoists, Analysis of Vehicle Based Systems, Conveyor Analysis. Automated Storage/Retrieval Systems, Carousel Storage Systems, Engineering Analysis of AS/RS and Carousel Systems.

**Automated Inspection systems:** Overview of Automated Identification Methods, Bar Code Technology, Radio Frequency Identification, Other AIDC Technologies-Mangnetic Stripes, Optical Character Recognition, and Machine Vision.

### UNIT-IV

**Cellular Manufacturing Systems**: Part Families, Parts Classification and Coding, Features of Parts Classification and Coding Systems, Opitz of Parts Classification and Coding Systems, Production Flow Analysis, Composite Part Concept, Machine Cell Design, Applications Of Group Technology, Quantitative analysis of Cellular Manufacturing, Grouping of parts and Machines by Rank Order Clustering, Arranging Machines in a GT Cell.

**Computer Aided Process Planning:** Retrieval CAPP Systems, Generative CAPP Systems, Feature Identification-Algorithms, Graph Based Approach, Attribute Adjacency Graph, Benefits of CAPP.

### UNIT-V

**Flexible Manufacturing Systems:** Flexibility, Types Of FMS-A Dedicated FMS, A Random Order FMS, FMS Components-Workstations, Material Handling and Storage Systems, Computer Control System, Human Recourses, FMS Applications and Benefits

**Computer Integrated Manufacturing:** The Scope of CAD/CAM and CIM, Computerized elements of a CIM System, Components of CIM, Database for CIM, Planning , Scheduling and Analysis of CIM Systems.

***Course Outcomes:***

*After completion of the course, the students will be able to:*

- *Understand the effect of manufacturing automation strategies and derive production metrics.*
- *Analyze automated flow lines and assembly systems, and balance the line.*
- *Design automated material handling and storage systems for a typical production system.*
- *Design a manufacturing cell and cellular manufacturing system.*

*Develop CAPP systems for rotational and prismatic parts.*

**Text Books:**

1. Mikell P Groover, *Automation, production Systems and Computer Integrated Manufacturing,* 3rd Edition, Prentice Hall Inc., New Delhi, 2007.
2. Andrew Kusiak, *Intelligent Manufacturing System,* Prentice Hall Inc., New Jersey, 1992.

**REFERENCE:**

1. Davis Bedworth, " Computer Integrated Design and Manufacturing", TMH, New Delhi,
2. Nanua Singh, *System Approach to Computer Integrated Manufacturing,* Wiley & Sons Inc., 1996.
3. YoremKoren, " Computer Integrated Manufacturing", McGraw Hill,1983.
4. PN RAO , " CAD/CAM", (PHI)
5. CSP Rao – "CAD/CAM", Sciethech publication, 2008.

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## MODELLING LAB (17D04110)

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***Course Objectives:***

- *To train the students with CAD packages.*
- *To impart the 2D and 3D modeling skills to the students.*
- *To import and export different IGES files from one software to another*

1. Generation of the following curves using "C" language

a) Cubic Splines
b) Bezier curves
c) B-Splines.

2. Generation of the following surfaces using "C" language

a) Bezier surfaces
b) B-Spline surfaces

3. Typical tasks of Modeling using PRO/E, IDEAS, CATIA solid modeling packages

a) Sketcher Module
b) Part Module
c) Assembly Module
d) Drafting Module
e) Surface Modelling

***Course Outcomes:***

- *Students will be able to design different parts of mechanical equipments*
- *Students will be able to apply their skills in various designing and Manufacturing Industries.*

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## FINITE ELEMENT ANALYSIS LAB (17D04111)

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***Course Objectives***

- *To use the commercial Finite Element packages to build Finite Element models and solve a selected range of engineering problems.*
- *To validate a Finite Element model using a range of techniques.*
- *To communicate effectively in writing to report (both textually and graphically) the method used, the implementation and the numerical results obtained.*
- *To discuss the accuracy of the Finite Element solutions.*

Finite Element Analysis using ANSYS 14.5 Package for different structures the discretization can be done with 1-D, 2-D & 3-D elements to perform the following analysis:

1. Static Analysis
   a. Stress analysis of 2D truss.
   b. Stress analysis of a plate with a circular hole and L-Bracket – 2D and 3D
   c. Stress analysis of beams (cantilever, simply supported & fixed ends)
   d. Stress analysis of an axi-symmetric component

2. Thermal and Fluid flow Analysis
   a. Conductive heat transfer analysis of a 2D and 3D components
   b. Convective heat transfer analysis of a 2D component
   c. Coupled field analysis of a component
   **d.** Determination of velocity of a fluid and volumetric flow rates for 1-D Fluid flow
   **e.** Determination of velocity of a fluid and volumetric flow rates for 2-D Fluid flow
3. Modal Analysis
   a. mode frequency analysis of a 2D component
   b. mode frequency analysis of beams (cantilever, simply supported, fixed ends)
4. Transient analysis
   a. Transient analysis of a cantilever beam
5. FEM through MAT LAB
   **a.** Introduction to MAT LAB
   **b.** Analysis of 1-dimesional & 2D dimensional truss.
   **c.** Analysis of 1-dimesional & 2D dimensional beam.
   **d.** Analysis of 1-dimesional & 2D dimensional heat conduction.

***Course outcomes***

- *Ability to solve engineering problems using the commercial software's like ANSYS, SIMUFACT, ABAQUS, SIMULIA, MAT LAB.*

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## ADVANCED OPTIMIZATION TECHNIQUES (17D04201)

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***Course Objectives***

- *The classical optimization techniques are useful in finding the optimum solution for constrained or unconstrained maxima or minima of continuous and differentiable functions.*
- *These methods lead to a set of nonlinear simultaneous equations that may be difficult to solve. These methods of optimization are discussed.*

**UNIT - I**

**Linear programming:** Two-phase simplex method, Big-M method, duality, interpretation, applications.

**Assignment problem**: Hungarian's algorithm, applications, unbalanced problems, traveling salesman problem.

**UNIT - II**

**Single variable optimization:**Optimality Criteria, Bracketing Methods, Region Elimination Methods, Point Elimination Method, Gradient Based Methods with and without constraints,

**UNIT - III**

**Multi Variable Optimization:** Optimality Criteria, Unidirectional Search, Direct Search Methods, Gradient Based Methods.

**Constrained Optimization:** Method of Lagrangian multipliers, Kuch – Tucker Conditions, Transformation methods, Sensitivity Analysis, Direct Search for Constrained Minimization, Linearized Search Techniques, Feasible Direction Method, Generalized Reduced Gradient Method, Gradient Projection Method.

**UNIT - IV**

**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,

**UNIT – V**

**Artificial Neural Networks**: Neuron, Nerve Structure and synapse, Artificial Neuron and its model, activation functions, Neural Network architecture: single layer and multilayer feed forward networks, recurrent networks. Back propagation algorithm, factors affecting back propagation training, applications.

***Course Outcomes***

*Upon successful completion of this course, the student will be able to understand:*

- *Basic theoretical principles in optimization;*
- *Formulation of optimization models;*
- *Solution methods in optimization;*
- *Methods of sensitivity analysis and post processing of results*

*Applications to a wide range of engineering problems*

### Text Books:

1. Optimization for Engineering Design – Kalyanmoy Deb, PHI Publishers
2. Engineering Optimization – S.S.Rao, New Age Publishers
3. Artificial Neural Networks B. YagnaNarayana, PHI

### References:

1. Genetic algorithms in Search, Optimization, and Machine learning – D.E.Goldberg, Addison-Wesley Publishers
2. Genetic Programming- Koza
3. Optimal design – JasbirArora, McGraw Hill (International) Publishers
4. Multi objective Genetic algorithms - Kalyanmoy Deb, PHI Publishers
5. Introduction to Artificial Neural Systems - J.M.Zurada, Jaico Publishers, 3rd Edition.
6. Introduction to Neural Networks Using MATLAB 6.0 - S.N. Shivanandam, S. Sumati, S. N. Deepa, TMH.

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## ROBOTICS (17D04202)

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***Course objectives***

- *To design, develop and complete robotic activities and challenges*
- *This course aims at providing the students the fundamental knowledge of the various subscriptions such as kinematics, Dynamics, controls, sensors, actuators, etc.*
- *It is aimed to provide adequate background in both analysis and design of robots.*

**UNIT – I**

**Fundamentals of Robots:** Introduction, history of robotics, definition and classification of robots, control systems and dynamic performance, robot characteristics and precision of motion, Introduction to matrix representation of a point in a space a vector in space, a frame in space, Homogeneous transformation matrices, representation of a pure translation, pure rotation about an axis, combine transformations.

**UNIT – II**

**Kinematics of robot:** Forward and inverse kinematics of robots- forward and inverse kinematic equations for position and orientation, Denavit-Hartenberg(D-H) representation of forward kinematic equations of robots, The inverse kinematic of robots, Degeneracy and Dexterity, simple problems with D-H representation.

**Differential motions and Velocities:** Linear velocity of a rigid body, Relationship between transformation, mapping velocity vector, velocity propagation along links, manipulator Jacobian, Jocobian inverse, Jacobian singularities.

**UNIT – III**

**Dynamic Modeling:** Lagrangian mechanics, two degree of freedom manipulator, Lagrangian - Euler formulation, Newton - Euler formulation, comparison of Lagrangian - Euler and Newton - Euler formulations.

**UNIT – IV**

**Robot sensors:** Introduction, sensor characteristics, Sensors in robotics, tactile sensors, proximity sensors and range sensors, miscellaneous sensors and sensor- based systems, uses of sensors in robotics.

**Robot Vision:** Introduction, the sensing and digitizing function in Machine Vision, image processing and analysis, Training and vision system, robot vision applications in robots.

**UNIT – V**

**Robot programming:** Methods of robot programming, Lead through programming methods, a robotic program as a path in space, motion interpolation, WAIT, SIGNAL, and DELAY commands, Branching, capabilities and limitations of lead through method.

**Robot Languages:** The textual robot languages, generations of robot program languages, Robot languages structure, constants, variables and other data objects, motion commands, end effecter and sensor commands, Computations and operations, program control and subroutines, communications and data processing, monitor mode commands, VAL-II.

***COURSE OUTCOMES***

*By studying this course, students will be*

- *Familiar with the history, concept development and key components of robotics technologies.*
- *Understand basic mathematic manipulation of spatial coordinate representation and transformation.*
- *Understand and able to solve basic robot forward and inverse kinematic problems.*
- *Understand and able to solve robotic dynamics, path planning and control problems.*

*Able to undertake practical robotics experiments that demonstrate the above skills.*

**TEXT BOOKS:**

1. Industrial Robotics – Mikell P. Grooverand Mitchell Weiss, Roger N. Nagel, Nicholas G.Odrey – McGraw Hill, 1986.
2. Robotics and control - R K Mittal and I J nagrath,TataMcGraw Hill 2004.

**REFERENCES:**

1. Robotic Engineering - integrated approach by Richard d Klafter- London: Prentice-Hall- 1989.
2. Introduction to Robotics – Analysis, System, Applications by Saeed B. Niku, PHI Publications
3. Fundamentals of Robotics: Analysis and control, Robert J. Schilling, Prentice Hall, 1990.
4. Robotics for Engineers- yoramkoren, McGraw-Hill, 1985.
5. Introduction to Robotics: Mechanics and Control, John.J.Craig, Addison- Wesley, 1999
6. Robotics: Control, sensing, vision, and intelligence – K.S. FU, R.C. Gonzalez and C.S.G Lee. McGraw Hill, 1987.

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## CNC TECHNOLOGY & PROGRAMMING (17D04203)

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### *Course Objectives*

- *To get brief idea about Fundamentals and concepts of CNC machining centers, NC machines*
- *To get fundamentals and concepts in Maintenance and Trouble shooting of CNC& NC machine tools.*
- *To state the objectives, advantages, and special requirements concerning CNC, NC & DNC use.*
- *To Identify the different media used to input and store CNC programs.*

### UNIT – I

**Introduction to CNC Machine tools:** Evolution of Computerized control in manufacturing, Components, Working principle of CNC, Classification of CNC, DNC and Machining centers and turning centers.

### UNIT – II

**Constructional features of CNC machine tools:** Introduction, Spindle drives, Transmission belting, axes feed drives, Slide ways, Ball screws.

**Accessories:** Work tables, Spindles, Spindle heads, Beds and Columns, Tooling – Automatic Tool changer (ATC), Tool presetting.

### UNIT – III

**Electro-magnetic analogue position transducers:** Principle, advantages, characteristics, Synchros, Synchro-Resolvers, Inductos, Laser interferometer.

**Control Systems and interface:** Open and closed loop systems, Micro processor based CNC systems, block diagram of typical CNC system, description of hard ware and soft interpolation systems, Standard and optional features of CNC control systems.

### UNIT – VI

**NC part programing :**Introduction, NC coordinate system, Manual Part Programming, Codes and concepts, types of tape farmats.

**APT programming:** APT language structure, APT geometry, Definition of point, time, vector, circle, plane, patterns and matrices. APT motion commands: setup commands, point-to point motion commands, continuous path motion commands, post processor commands, control commands, Macro subroutines, Part programming preparation for typical examples.

### UNIT – V

**Economics and Maintenance of CNC machine tools:** Introduction, factors influencing selection of CNC machines, Cost of operation of CNC machines, Maintenance features of CNC machines, Preventive maintenance, Documentation, Spare parts, Training in Maintenance.

### *Course outcomes*

*Upon completing this course, Students will be able to:*

- *Understand fundamentals of NC/CNC*
- *Learn and Write NC Part Programming*
- *Learn NC Programming through CAD/CAM*
- *Learn Tooling for NC/CNC*
- *Understand machines like Chucking and Turning Centers, Machining Centers*

*Learn Maintenance and Trouble Shooting of CNC Machine Tools*

### Text Books:

1. Computer Numerical Control Machines – Dr.RadhaKrishnanan, New Central Book Agency
2. Computer Aided Manufacturing, C.Elanchezhian and T.Sundar Selwyn, University Science Press.
3. Computer Control of Manufacturing systems -Y.Koren – Khanna publications

**References:**

1 Computer Numerical Control Machines – Hans B.Keif and T. Frederick Waters Macmillan/McGraw Hill
2 CNC Machining technology – Smith &Graham.T Springer – Verlag
3 CAD/CAM – CSP Rao - Sciethech publications, 2008.
4 NC machine programming and software design - Chao-HWA Chang Michel A Melkanoff, Prentice Hall.
5 Computer Numerical Machine tools - G.E. Thyer, NEWNES
6 CAD/CAM – PN Rao, Tata McGraw Hill.
7 Introduction to CNC – James V.Valentine&Josophgoldenberg

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## MECHATRONICS AND MEMS (17D04204)

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***Course Objectives:***

- *To understand the technologies behind modern mechatronic systems.*
- *To provide methodological fundamentals for the development of fully automated system.*
- *To teach students how to develop a robotic or automated system project focusing on the hardware and software integration, and*
- *To apply the acquired knowledge for developing a mechatronic system.*

**UNIT – I**

**Introduction:** Definition of Mechatronics, Need for Mechatronics in Industry, Objectives of mechatronics, mechatronics design process, Mechatronics key elements, mechatronics applications – Computer numerical control (CNC) machines, Tool monitoring systems, Flexible manufacturing system (FMS), Industrial Robots, Automatic packaging systems, Automatic inspection systems.

**UNIT – II**

**Sensors:** Static characteristics of sensors, Displacement, Position and Proximity Sensors, Force and torque sensors, Pressure sensors, Flow sensors, Temperature sensors, Acceleration sensors, Level sensors, Light sensors, Smart material sensors, Micro and Nano sensors, Selection criteria for sensors.

**UNIT – III**

**Actuators:** Mechanical, Electrical, Hydraulic and Pneumatic Actuation systems, Characteristics and their limitations, Design of Hydraulic and Pneumatic circuits, Piezoelectric actuators, Shape memory alloys, Selection criteria for actuators.

**UNIT – IV**

**Microprocessors, Microcontrollers and Programmable Logic Controllers:** Architecture of of Microprocessor, Microcontroller and Programmable Logic Controller, PLC Programming using ladder diagrams, logics, latching, sequencing, timers relays and counters, data handling, Analog input/output, selection of -.

**UNIT – V**

**Micro Electro Mechanical Systems (MEMS):** History, Effect of scaling, Fabrication Techniques: Oxidation, Physical Vapor disposition, Chemical Vapor Deposition, Lithography, Etching, Wafer bonding, LIGA, DRIE, Applications: Lab on chip.

***Course Outcomes***

*Upon successful completion of this unit, the student will be able to:*

- *Define the discipline of mechatronics.*
- *Identify examples of mechatronic systems that are encountered in real life.*

*Identify the components of a typical mechatronic system.*

**Text books:**

1. Mechatronics, W.Bolton, Pearson Education
2. Mechatronic System Design, Devadas Shetty and Richard A Kolk, Cengage learning
3. Mechatronics an integrated approach, Clarence W. de Silva, CRC Press
4. Micro Electro Mechanical Systems Design, James J Allen, CRC Press Taylor & Francis group
5. Mechatronics, Ganesh S Hedge, Jones and Bartlett Publishers

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## ADDITIVE MANUFACTURING (17D04205)

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***OBJECTIVE:*** *To educate students with fundamental and advanced knowledge in the field of Additive manufacturing technology and the associated Aerospace, Architecture, Art, Medical and industrial applications.*

### UNIT I

**INTRODUCTION:** Need - Development of AM systems – AM process chain - Impact of AM on Product Development - Virtual Prototyping- Rapid Tooling – RP to AM -Classification of AM processes-Benefits-Applications.

### UNIT II

**REVERSE ENGINEERING AND CAD MODELING:** Basic concept- Digitization techniques – Model reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data requirements – Geometric modelling techniques: Wire frame, surface and solid modelling – data formats - Data interfacing, Part orientation and support generation, Support structure design, Model Slicing, Tool path generation-Software for AM- Case studies.

### UNIT III

**LIQUID BASED AND SOLID BASED ADDITIVE MANUFACTURING SYSTEMS:** Stereolithography Apparatus (SLA): Principle, pre-build process, part-building and post-build processes, photo polymerization of SL resins, part quality and process planning, is recoating issues, materials, advantages, limitations and applications. Solid Ground Curing (SGC): working principle, process, strengths, weaknesses and applications. Fused deposition Modelling (FDM): Principle, details of processes,process variables, types, products, materials and applications. Laminated Object Manufacturing (LOM): Working Principles, details of processes, products, materials, advantages, limitations and applications - Case studies.

### UNIT IV

**POWDER BASED ADDITIVE MANUFACTURING SYSTEMS:** Selective Laser Sintering (SLS): Principle, process, Indirect and direct SLS- powder structures, materials, post processing, surface deviation and accuracy, Applications. Laser Engineered Net Shaping (LENS): Processes, materials, products, advantages, limitations and applications– Case Studies.

### UNIT V

**OTHER ADDITIVE MANUFACTURING SYSTEMS**: Three dimensional Printing (3DP): Principle, basic process, Physics of 3DP, types of printing, process capabilities, material system. Solid based, Liquid based and powder based 3DP systems, strength and weakness, Applications and case studies. Shape Deposition Manufacturing (SDM), Ballastic Particle Manufacturing (BPM), Selective Laser Melting, Electron Beam Melting.

***Course Outcome:***

*On completion of this course, they will learn about a variety of Additive Manufacturing (AM) technologies, their potential to support design and manufacturing, case studies relevant to mass customized manufacturing, and some of the important research challenges associated with AM and its data processing tools.*

### TEXT BOOKS:

1. Gibson, I., Rosen, D.W. and Stucker, B., “Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing”, Springer, 2010.

2. Chua, C.K., Leong K.F. and Lim C.S., “Rapid prototyping: Principles and applications”, second edition, World Scientific Publishers, 2010.

### REFERENCES:

1. Gebhardt, A., “Rapid prototyping”, Hanser Gardener Publications, 2003.

2. Liou, L.W. and Liou, F.W., “Rapid Prototyping and Engineering applications : A tool box for prototype development”, CRC Press, 2011.

3. Kamrani, A.K. and Nasr, E.A., “Rapid Prototyping: Theory and practice”, Springer, 2006.

4. Hilton, P.D. and Jacobs, P.F., Rapid Tooling: Technologies and Industrial Applications, CRC press, 2005.

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## HYDRAULIC AND PNEUMATIC CIRCUITS (17D04206)

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***Course Objectives:***

- *This course provides specialized instruction in maintaining and troubleshooting Hydraulic and Pneumatic systems.*
- *Explain the operation of the main elements of an industrial hydraulic and pneumatic system.*

**UNIT-I**

**Oil Hydraulic Systems:** Hydraulic power generators – selection and specification of pumps, pump characteristics.
**Hydraulic Actuators**: Hydraulic and rotary actuators – selection, specification and characteristics.

**UNIT-II**

**Control and Regulation Elements**: Pressure – direction and flow control valves – relief valves, non return and safety valves- actuation systems.

**UNIT-III**

**Hydraulic Circuits:** Reciprocation, quick return, sequencing circuits- accumulator circuits- industrial circuits – press circuits – hydraulic milling machine – grinding, planning, copying, forklift, earth mover circuits – design and selection of components – safety and emergency mandrels.

**UNIT-IV**

**Pneumatic Systems and Circuits:** Pneumatic fundamentals- control elements position and pressure sensing – logic circuits- switching circuits- fringe condition modules and their integration – sequential circuits- cascade methods – mapping methods- step counter method – compound circuit design- combination circuit design.

**UNIT-V**

**Installation, Maintenance and Special Circuits:** Pneumatic equipments- selection of components- design calculations- applications – fault finding equipments- hydro pneumatic circuits – use of microprocessors for sequencing – PLC- Low cost automation- robotic circuits.

***Course outcomes:***

*Upon completion, the student should be able to:*

- *Define basic fluid power terms and units.*
- *Identify Hydraulic and Pneumatic graphic symbols.*
- *Describe fluid power components.*
- *Calculate basic operations for sizing hydraulic and pneumatic components.*

*Perform basic fluid power maintenance procedures.*

### Text Books

1. R.Sreenivasan "Hydraulic & Pneumatic Controls", McGraw Hill Education (2008).
2. Majumdar "Oil hydraulic systems: Principles and maintenance" TATA McGraw Hill.
3. Bolton. W. “Pneumatic and Hydraulic systems”, Butterworth – Heinneman, 1997.

### Reference Books

1. Antony Espossito, “Fluid power with Applications”, prentice Hall, 1980.
2. DudleytA.Pease and John J.Pippenger, “Basic fluid power”, Prentice Hall, 1987.
3. Andrew Parr, “Hydraulics and Pneumatics”, (HB), Jaico Publishing House, 1999.

### Web References:

1. *http://www.pneumatics.com*
2. *http://www.fluidpower.com.tw*

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## ARTIFICIAL INTELLIGENCE & EXPERT SYSTEMS(17D04207)

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***Course objectives***

- *To get brief idea about fundamentals and concept of artificial intelligence.*
- *Find appropriate idealizations for converting real world problems into AI search problems formulated using the appropriate search algorithm.*

**UNIT-I**

**Artificial Intelligence (A.I.)**: Problem Space, Problem solving, State space, Algorithm's performance and complexity, Search Algorithms, Depth first search method, Breadth first search methods their comparison, A*, AO*, Branch and Bound search techniques, p type, Np complete and Np Hard problems.

**Knowledge Acquisition and Representation:** Manual approach to knowledge Acquisition, Machine Learning approach to Knowledge Acquisition, Semantic nets, Inheritance in Semantic nets, Manipulating monotonic and default inheritance in Semantic nets, Frames, Inheritance in Tangled Frames, Petri nets, Conceptual Dependency, Scripts.

**UNIT-II**

**Learning Systems:** Learning concepts, a simple Learning Algorithm, Nearest Neighbors Algorithm, supervised Learning and unsupervised Learning, Reinforcement Learning, Learning by Inductive Logic Programming, Computational Leaning Theory.

**Expert systems, Expert system applications for CIM:** Introduction to Expert Systems (ES), Personnel Involved in Expert System, Criteria for building an expert system, Architecture of an Expert System, Components of Expert Systems, Inference engines control Strategy, Building an Expert System, Applications in Capacity planning, Facility Location, Inventory Control, Scheduling.

**UNIT-III**

**Knowledge based systems (KBS):** Basic Knowledge based system Architecture, Active Knowledge based systems, Knowledge Development Expert systems, Using Knowledge Distribution in Engineering, A Universal representation Paradigm for Knowledge Base Structuring Methods.

**UNIT-IV**

**Artificial Neural Networks:** Neuron, Nerve structure and synapse, Artificial Neuron and its model, activation functions, Neural network architecture: single layer and multilayer feed forward networks, recurrent networks. Back propagation algorithm, factors affecting back propagation training, applications.

**Fuzzy Logic And Fuzzy Sets**: Fuzzy set Theory, Interval arithmetic, Operations on Fuzzy Sets, Fuzzy Logic Theory, Classical Logic Theory, Fuzzy System Modeling, Fuzzy Control Systems, Adaptive fuzzy Control.

**UNIT-V**

**Applications of Fuzzy Systems and ANNS for selection of Robots:** Health Monitoring Fuzzy Diagnostic Systems, Fuzzy Controller for Robotic Manipulator, Fuzzy Control for Servo Mechanic Systems, ANN for Robotic path Planning, Fault detection and isolation in Robotics.

***Course outcomes***

*Upon completing this course, students will be able to:*

- *The student will learn the basics of the theory and practice of Artificial Intelligence as a discipline about intelligent agents capable of deciding what to do, and do it.*
- *The student will learn to apply knowledge representation techniques and problem solving strategies to common AI applications.*

*The student will design simple software to experiment with various AI concepts and analyze results.*

**TEXT BOOKS:**

1. Andrew Kusiak, Intelligent Manufacturing Systems, Prentice Hall Publications.2005
2. S.M. and Kulliknowske, "Designing Expert System", Weis, London Champion Hull 1984
3. Simons, G. L., Introducing Artificial Intelligence, NCC Pub., 1990.

**REFERENCES:**

1. Andrew Kusiak, Computational Intelligence in Design and Manufacturing, John Wiley and Sons, 2000.
2. Elaine Rich & Kevin Knight, " Artificial Intelligence" , M/H 1983
3. WendryB.Ranch, "Artificial Intelligence in Business", Science & Industry – Vol -II application, Ph 1985.
4. Waterman, D.A., Addison, " A Guide to Expert System" – Wesley inc. 1986.
5. Hayes, Roth, Waterman, "Building expert system" D.A (ed), AW 1983.

**I M.TECH IISEMESTER**

## COMPOSITE MATERIALS (17D04208)

| L | T | P | C |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

***Course objectives***

- *Introduce modern composite materials and their applications to students.*
- *Build proper background for stress and strength analysis in the design of composite materials and structures.*

### UNIT I

### INTRODUCTION TO COMPOSITES

Fundamentals of composites – Definition – classification of composites materials – based on Matrix – based on structure – Advantages and applications of composites - Reinforcement – whiskers – glass fiber – carbon fiber - Aramid fiber – ceramic fiber – Properties and applications

### UNIT II

### POLYMER MATRIX COMPOSITES

Polymers - Polymer matrix materials – PMC processes - hand layup processes – spray up processes – resin transfer moulding – Pultrusion – Filament winding – Auto clave based methods - Injection moulding – sheet moulding compound – properties and applications of PMCs.

### UNIT III

### METAL MATRIX COMPOSITES

Metals - types of metal matrix composites – Metallic Matrices. Processing of MMC – Liquid state processes – solid state processes – Insitu processes. Properties and applications of MMCs.

### UNIT IV

### CERAMIC MATRIX COMPOSITES

Ceramic matrix materials – properties – processing of CMCs –Sintering - Hot pressing – Infiltration – Lanxide process – Insitu chemical reaction techniques – solgel polymer pyrolsis –SHS - Cold isostatic pressing (CIPing) – Hot isostatic pressing(HIPing). Properties and Applications of CCMs.

### UNIT V

### ADVANCES IN COMPOSITES

**Carbon /carbon composites**: Advantages of carbon matrix – limitations of carbon matrix carbon fibre – chemical vapour deposition of carbon on carbon fibre perform. Properties and applications of Carbon-carbon composites. Composites for aerospace applications.

**Biodegradable composites:** Biodegradability, introduction of biocomposites, classification, processing of biocomposites, applications of biocomposites - Mechanical, Biomedical, automobile Engineering.

***Course Outcomes:***

*After completion of the course student can be able to:*

- *Understanding of types, manufacturing processes, and applications of composite materials.*

*Understanding the theory behind Biocomposites.*

### TEXT BOOKS

1. “Composite materials”, Chawla K.K., Springer – Verlag, Second Edition, 1998.
2. “Composite Materials: Engineering and Science”, Mathews F.L. and Rawlings R.D., Chapman and Hall, London, England, 1st edition, 1994.

### REFERENCES

1. “Composite Materials”., H K Shivanand, B V BabuKiran, ASIAN BOOKS, 2011
2. “Fundamentals of Composite Manufacturing”, A.B. Strong, SME, 1989.
3. “Composite materials”, S.C. Sharma, Narosa Publications, 2000.
4. “Hand Book of Bioplastics&Biocomposites for Engineering applications”, Maureen Mitton, John Wiley publications.

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## INTERACTIVE COMPUTER GRAPHICS (17D04209)

| L | T | P | C |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

***Course objectives***

- *Know and be able to use the underlying algorithms, mathematical concepts, supporting computer graphics. These include but are not limited to: Composite 3D homogeneous matrices for translation, rotation, and scaling transformations. Plane, surface normals, cross and dot products. Hidden surface detection / removal. Scene graphs, display lists.*
- *Know and be able to select among models for lighting/shading: Color, ambient light; distant and light with sources; Phong reflection model; and shading (flat, smooth, Gourand, Phong).*

**UNIT - I**

**Introduction to computer graphics:** Color CRT raster scan monitors, plasma display & liquid crystal display monitors, computer input devices, hard copy devices.

**UNIT - II**

**Raster scan graphics:** Line drawing algorithms, DDA &Bresenham's algorithms, circle generating algorithms, DDA, Bresenham's& midpoint circle algorithm and related problems, general function rasterization, displaying lines, characters and polygons.

**UNIT - III**

**Filling algorithms:** polygon filling, filled area primitives, Scan-Line polygon fill algorithm, edge fill algorithm, seed fill algorithm, fundamentals of antialiasing and half toning.

**UNIT - III**

**Line clipping:** Simple visibility algorithm, Cohen-Sutherland line clipping algorithm, midpoint sub division algorithm.

**Polygon clipping:** polygon clipping, Weiler– Atherton polygon clipping, Sutherland – Hodgeman algorithm, character clipping.

**UNIT - IV**

**Transformations:** Cartesian and homogeneous coordinate systems two dimensional and three dimensional transformations – scaling, rotation, Shearing, Zooming, viewing transformation, reflection, rotation about an axis & arbitrary axis, concatenation.

**UNIT - V**

**Rendering:** Hidden line removal algorithms, surface removal algorithms, back face removal algorithm, painters, Warnock, Z-buffer algorithm.

**Shading algorithms:** Constant intensity algorithm, Gouraud shading algorithm, Phong shading algorithm, Fast Phong shading algorithm Comparison of shading algorithms

***COURSE OUTCOMES***

*Upon completing this course,*

- *Students will demonstrate an understanding of contemporary graphics hardware.*
- *Students will create interactive graphics applications in C++ using one or more graphics application programming interfaces.*
- *Students will write program functions to implement graphics primitives.*
- *Students will write programs that demonstrate geometrical transformations.*

*Students will demonstrate an understanding of the use of object hierarchy in graphics applications.*

**TEXT BOOKS:**

1. Computer Graphics-Donald Hearn & M.P. Bakers.
2. Procedural elements for computer graphics-D. F. Rogers, Tata McGraw-Hill.

**REFERENCES:**

1. Interactive computer graphics – New mann&Sprowl
2. Computer graphics-Harrington.
3. CAD/CAM theory and practice, Ibrahim Zeid, 2nd edition, Tata McGraw-Hill.

## AUTOMATION LAB (17D04210)

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

***COURSE OBJECTIVES***

- *To train the students in writing programs for robot movements*
- *To train the students in handling FMS cell for different sequences*
- *To design the hydraulic and pneumatic circuits by using automation studio software*
- *To design the automated manufacturing systems by using workspace software.*

1. **Aristo XT Six axis Robot**
   a. Introduction to Robot programming
   b.Robot programming exercises (Point-to-Point and continuous path task)
2. **WORKSPACE software.**
   a. Simulation of a manufacturing system for increasing production rate.
   b. Simulation of a simple automation system.
3. **AUTOMATION STUDIO software.**

**I.Hydraulic Circuits**

a. Introduction to Automation studio & its control
b. Draw & Simulate the Hydraulic circuit for series & parallel cylinders connection
c. Draw & Simulate Meter-in, Meter-out and hydraulic press and clamping.
d. Sequencing circuits in hydraulics.
e. Synchronizing circuits in hydraulics.

**II. Pneumatic circuits**

a. Sequencing circuits in Pneumatics.
b. Synchronizing circuits in Pneumatics.
c. Design and Simulation of simple pneumatic circuit by using Cascade Method.
d. Design and Simulation of simple pneumatic circuit by using step counter method

**4. Additive manufacturing machine**

a. Introduction to Additive manufacturingMachine.
b. Design and fabrication of simple symmetrical and unsymmetrical components.

***COURSE OUTCOMES***

*Upon successful completion students should be able to:*

- *Demonstrate the pick and place Aristo Robot.*
- *Demonstrate the working of workspace software.*
- *Check the circuit designs whether working properly or not by using Automation studio software.*

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## CNC LAB (17D04211)

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

***Course objectives***

- *To get practical knowledge on manual part programming of CNC lathe machine by using G codes and M codes.*
- *To get practical knowledge on manual part programming of CNC milling and drilling machine by using G codes and M codes.*
- *To get the practical knowledge on APT language.*

1. Manual part programming (using G and M codes) in CNC Lathe Machine
   - 1.1 Part programming for linear interpolation, circular interpolation, chamfering and grooving.
   - 1.2 Part programming by using standard canned cycles for facing, turning, taper turning and thread cutting.
2. Manual part programming (using G and M codes) in CNC Milling Machine
   - 2.1 Part programming for linear interpolation, circular interpolation and contour motions.
   - 2.2 Part programming involving canned cycles for drilling peak drilling and boring.

*3. APT (Automatically Programmed Tools) language in CNC Milling and Lathe machine*

***Course outcomes***

*Upon successful completion students should be able to:*

- *Use an understanding of General and Machine (G & M) code to generate or edit a program which will operate a CNC Lathe.*
- *Apply mathematical methods to calculate Cartesian coordinates*

**DEPARTMENT OF MECHANICAL ENGINEERING**
**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR**
**COLLEGE OF ENGINEERING (AUTONOMOUS), PULIVENDULA**
**YSR(KADAPA) Dist 516 390, (A.P) INDIA.**

## M.TECH: CAD/CAM

## COURSE STRUCTURE

**Semester-I**

| S.No. | Course Code | Course Name | Category | Hours per | | | Credits |
|---|---|---|---|---|---|---|---|
| | | | | L | T | P | |
| 1. | | Geometric Dimensioning and Tolerancing | PC | 3 | 0 | 0 | 3 |
| 2. | | Advanced Finite Element Methods | PC | 3 | 0 | 0 | 3 |
| 3. | | **Professional Elective Course - I**<br>a. Computer Integrated Manufacturing<br>b. Geometric Modeling<br>c. Design of Hydraulic & Pneumatic systems | PE | 3 | 0 | 0 | 3 |
| 4. | | **Professional Elective Course - II**<br>a. Advances in Manufacturing Technology<br>b. Total Quality Management<br>c. Computer Aided process planning | PE | 3 | 0 | 0 | 3 |
| 5. | | Geometric Modelling Laboratory | PC | 0 | 0 | 4 | 2 |
| 6. | | Finite Element Analysis Laboratory | PC | 0 | 0 | 4 | 2 |
| 7. | | Research Methodology and IPR | MC | 2 | 0 | 0 | 2 |
| 8. | | **Audit Course - I** | AC | 2 | 0 | 0 | 0 |
| | | | | | | **Total** | **18** |

**Semester-II**

| S.No. | Course Code | Course Name | Category | Hours per week | | | Credits |
|---|---|---|---|---|---|---|---|
| | | | | L | T | P | |
| 1. | | Advanced Optimization Techniques | PC | 3 | 0 | 0 | 3 |
| 2. | | Industrial Robotics and Expert Systems | PC | 3 | 0 | 0 | 3 |
| 3. | | **Professional Elective Course – III**<br>a. CNC Technology & Programming<br>b. Advanced Composite Materials<br>c. Advanced Mechanism design | PE | 3 | 0 | 0 | 3 |
| 4. | | **Professional Elective Course - IV**<br>a. Mechatronics and MEMS<br>b. Additive Manufacturing<br>c. Design & Analysis of Experiments | PE | 3 | 0 | 0 | 3 |
| 5. | | Process Automation Laboratory | PC | 0 | 0 | 4 | 2 |
| 6. | | CAM Laboratory | PC | 0 | 0 | 4 | 2 |
| 7. | | Technical Seminar | PR | 0 | 0 | 4 | 2 |
| 8. | | **Audit Course - II** | AC | 2 | 0 | 0 | 0 |
| | | | | | | **Total** | **18** |

| Semester-III | | | | | | | |
|---|---|---|---|---|---|---|---|
| S.No. | Course Code | Course Name | Category | Hours per week | | | Credits |
| | | | | L | T | P | |
| 1. | | **Professional Elective Course** - V<br>a. Advanced Tool Design<br>b. Design for Manufacturing<br>c. Automation in Manufacturing | PE | 3 | 0 | 0 | 3 |
| 2. | | Open Elective | OE | 3 | 0 | 0 | 3 |
| 3. | | Co-Curricular Activities | | 0 | 0 | 4 | 2 |
| 4. | | Dissertation Phase – I | PR | 0 | 0 | 20 | 10 |
| | | | | | | **Total** | **18** |

| Semester-IV | | | | | | | |
|---|---|---|---|---|---|---|---|
| S.No. | Course Code | Course Name | Category | Hours per week | | | Credits |
| | | | | L | T | P | |
| 1. | | Dissertation Phase – II | PR | 0 | 0 | 32 | 16 |
| | | | | | | **Total** | **16** |

**Open Elective**

1. Business Analytics.
2. Industrial Safety.
3. Operations Research.
4. Supply Chain Management.
5. Composite Materials.
6. Waste to Energy.
7.Mechatronics.
8.Optimization through Matlab.
9.Automotive Electronics.
10. Rapid Manufacturing.
11. Programming Of Robot And Its Control
12. Industry 4.0.

**Audit course 1 & 2**

1. Disaster Management.
2. Sanskrit for Technical Knowledge.
3. Value Education.
4. Constitution of India.
5. Pedagogy Studies.
6. Stress Management by Yoga.
7. Personality Development through Life Enlightenment Skills.

| Course Code | | GEOMETRIC DIMENSIONING AND TOLERANCING | L | T | P | C |
|---|---|---|---|---|---|---|
| Semester | I | | 3 | 0 | 0 | 3 |

**Course Objectives:**

- Teach the basics of the geometric dimensioning and tolerances.
- Familiar with five groups of GD&T tolerances, form, orientation, location, runout and profile tolerances.
- Introduce tolerances of profiles of lines and surfaces with or without datums.
- Expose the students to various surface roughness parameters and their measurements in two dimensions.
- Understand the concepts of dimensional chains and inspection techniques.

**Course Outcomes (CO):** Student will be able to

- This course systematically introduces the essentials of the language of geometric dimensioning and tolerancing (GD&T) based on ASME standards, as well as the essentials of surface roughness measurements in both 2D and 3D including filtering techniques.
- This course also introduces the related concepts of Vectorial dimensioning and tolerancing, dimensional chains, measurement uncertainty, etc.
- The knowledge gained by the students by learning the above topics will help them to perform very well in their profession as metrologists as well as product designers.

| UNIT - I | **Basic Concepts** | Lecture Hrs: 8 |
|---|---|---|

General terms and definitions of geometrical features - General principle of sizes - System of limits and fits - Inspection of dimensional and geometrical deviations - Datums, datum systems, and selection of datums. Restraining degrees of freedom, DOF, Simulators. Rule #1(Boundary principle) and Rule #2.

| UNIT - II | **Form and Orientation Tolerances** | Lecture Hrs: 10 |
|---|---|---|

Principles of dimensioning - Introduction to geometric dimensioning and tolerancing (GD&T); Form tolerances: types, specifications and interpretations - measurement and evaluation of straightness, flatness and roundness - Orientation tolerances: types, specifications and interpretations, and verification of orientation tolerances. Exercises on each group. RFS, MMC and LMC concepts.

| UNIT - III | **Location, Runout and Profile Tolerances** | Lecture Hrs: 10 |
|---|---|---|

Tolerances of location: types, specifications and interpretations - verification techniques - Tolerances of profiles of lines and surfaces with or without datums - Tolerances of runout - Tolerancing of angles and cones. Exercises on each group. RFS, MMC and LMC concepts.

| UNIT - IV | **Surface Roughness** | Lecture Hrs: 8 |
|---|---|---|

Various parameters and their measurements in two dimensions - filtering and filtering techniques - areal parameters. symbology

| UNIT - V | **Inspection of GD&T call-outs** | Lecture Hrs: 9 |
|---|---|---|

Vectorial dimensioning and tolerancing - Statistical tolerancing of mechanical assemblies - Dimensional chains - Measurement uncertainty - Computer-aided tolerancing and verification. Inspection techniques- conventional and CMM.

**Textbooks:**

1. Drake, P. J., Dimensioning and Tolerance Handbook, McGraw-Hill, Inc., New York. 1999.
2. Meadows, J. D., Geometric Dimensioning and Tolerancing: Applications and Techniques for use in Design, Manufacturing and Inspection, Marcel Dekker, Inc., New York. 1995.
3. Gill, P. S., Geometric Dimensioning and Tolerancing, S. K. Kataria & Sons, New

Delhi.
4. ASME 14.5 - 2009 standards
5. Alex Krulikowski, Fundamentals of geometric dimensionining and tolerancing.
6. James D Meadows, ―Measurement of Geometric Tolerances in Manufacturing.

**Reference Books:**

1. Gupta, I. C., A Textbook of Engineering Metrology, Dhanpat Rai Publications, New Delhi.
2. Galyer, J. F. W. and C. R. Shotbolt, Metrology for Engineers, Cassell Publishers, London.
3. Henzold, G., Handbook of Geometrical Tolerancing: Design, Manufacturing and Inspection, John Wiley & Sons, Chichester.
4. Muralikrishnan, B. and J. Raja, Computational Surface and Roundness Metrology, Springer, USA.
5. Relevant Indian and International Standards.
6. Whitehouse, D. J., Surfaces and their Measurement, Hermes Penton Science, London.

**Online Learning Resources:**

- https://nptel.ac.in/courses/112/106/112106179/
- https://www.youtube.com/watch?v=X_VepJhq_vk
- https://www.youtube.com/watch?v=cjzSXPDBA_Q&t=1s
- https://www.youtube.com/watch?v=-tLq1wXio0U
- https://digitaldefynd.com/best-gdt-courses/

| Course Code | | ADVANCED FINITE ELEMENT METHODS | L | T | P | C |
|---|---|---|---|---|---|---|
| Semester | I | | 3 | 0 | 0 | 3 |

**Course Objectives:**

- To provide the mathematical foundations of the finite element formulation for engineering applications (solids, heat, fluids).
- To expose students to some of the recent trends and research areas in finite elements.

**Course Outcomes (CO):**

Students can able to solve below following problems.

- Students will learn the mathematical formulation of the finite element method and how to apply it to basic (linear) ordinary and partial differential equations.
- Solve 1- D problems. & 2- D Structural & Heat Transfer Problems using FEA
- Solve Trusses & Beams Problems using FEA.
- Formulate & solve structural & dynamics problems.

| UNIT - I | **Formulation Techniques** | Lecture Hrs: 8 |
|---|---|---|

Methodology, Engineering problems and governing differential equations, finite elements, Variational methods-potential energy method, Raleigh Ritz method, strong and weak forms, Galerkin and weighted residual methods, calculus of variations, Essential and natural boundary conditions.

| UNIT - II | **One-dimensional Finite Element Methods** | Lecture Hrs: 10 |
|---|---|---|

Bar elements, temperature effects. Element matrices, assembling of global stiffness matrix, Application of boundary conditions, Elimination and penalty approaches, solution for displacements, reaction, stresses, temperature effects, Quadratic Element, Heat transfer problems: One – dimensional, conduction and convection problems. Examples:- One dimensional fin.

| UNIT - III | **Trusses, Beams and frames - 1D** | Lecture Hrs: 8 |
|---|---|---|

Element matrices, assembling of global stiffness matrix, solution for displacements, reaction, stresses, temperature effects.

Beams and Frames: Element matrices, assembling of global stiffness matrix, solution for displacements, reaction, stresses.

| UNIT - IV | **Two dimensional problems** | Lecture Hrs: 8 |
|---|---|---|

CST, LST, four noded and eight nodded rectangular elements, Lagrange basis for triangles and rectangles, serendipity interpolation functions. Axisymmetric Problems: Axisymmetric formulations, Element matrices, boundary conditions. Heat Transfer problems: Conduction and convection, examples: - two – dimensional fin.

Isoparametric formulation: Concepts, sub parametric, super parametric elements, numerical integration.

| UNIT - V | **Finite elements in Structural Dynamics** | Lecture Hrs: 9 |
|---|---|---|

Dynamic equations, eigen value problems, and their solution methods, simple problems.

Convergence: Requirements for convergence, h-refinement and p-refinement, complete and incomplete interpolation functions, pascal's triangle.

Fracture Mechanics: Formulation of J Integral.

**Textbooks:**

1. T.R.Chandraputla & A.D.Belegundu, Introduction to Finite Elements in Engineering, Pearson Education India; 4th edition - 1st January 2015.
2. J. N. Reddy, D.K. Gartling,The Finite Element Method in Heat Transfer and Fluid Dynamics, Taylor & Francis, 6 April 2010.

**Reference Books:**

1. Zienckiwicz O.C. & R. L. Taylor, Finite Element Method, McGraw-Hill,1983.
2. J. N. Oden, Finite Element of Nonlinear continua, McGraw-Hill, New York, 1971.
3. K. J. Bathe, Finite element procedures, . Prentice-Hall, 1996.
4. Prashant Kumar, Elements of Fracture Mechanics, McGraw Hill Education (India) Private Limited, 2009.
5. Meinhard Kuna, Finite Elements in Fracture Mechanics: Theory - Numerics - Applications, Springer Publications, 2013.

**Online Learning Resources:**

- https://nptel.ac.in/courses/112/104/112104193/
- https://nptel.ac.in/courses/112/104/112104205/
- https://nptel.ac.in/courses/105/105/105105041/
- https://nptel.ac.in/courses/112/106/112106130/
- https://nptel.ac.in/courses/112/103/112103295/

| Course Code | | COMPUTER INTEGRATED MANUFACTURING Professional Elective Course - I | L | T | P | C |
|---|---|---|---|---|---|---|
| Semester | I | | 3 | 0 | 0 | 3 |

**Course Objectives:**

- This course will enable the student
- To gain knowledge about the basic fundamental of CAD.
- To gain knowledge on how computers are integrated at various levels of planning and manufacturing understand computer aided planning and control and computer monitoring.

**Course Outcomes (CO):** Student will be able to

- Understand the importance of product development through CIM. Get knowledge of shop floor control , Computer Integrated Manufacturing and Automation.
- Adopt appropriate material handling and storage in an automated manufacturing environment.
- Incorporate methods of utilization of appropriate features in CAD application enhancing productivity in design

| UNIT - I | **Introduction and NC Machines** | Lecture Hrs:10 |
|---|---|---|

Fundamental concepts in Manufacturing and Automation, Automation Strategies, Economic analysis in production, fundamentals of CAD / CAM, product cycle and CAD/CAM, Automation and CAD/CAM, Scope of CIM, Automated flow lines, Transfer mechanisms, methods of Line balancing.

**Numerical control machines:** Introduction- basic components of an NC system-the NC procedure- NC coordinate system, NC motion control system- application of numerical control- Economics of Numerical control.

| UNIT - II | **NC part programming:** | Lecture Hrs: 8 |
|---|---|---|

Introduction - The Bunch tape in NC - Tape code format - manual part programming. NC programming with manual data input.

| UNIT - III | **Computer controls in NC and Group Technology** | Lecture Hrs: 8 |
|---|---|---|

**Computer controls in NC:** NC controllers' technology - Computer Numerical Control (CNC), Direct Numerical control (DNC).

Adaptive control machining systems. adaptive control optimization system, adaptive control constraint system, applications to machining processes, computer process monitoring, hierarchical structure of computers in manufacturing, and computer process control.

**Group Technology**: Part families, parts classification and coding, production flow analysis, Composite part concept, Machine cell design, benefits of GT.

| UNIT - IV | **CAPP & FMS** | Lecture Hrs: 9 |
|---|---|---|

**Computer aided planning systems:** Approaches to Computer aided Process Planning (CAPP) - Generative and Retrieval CAPP systems, benefits of CAPP, Material Requirement Planning (MRP), mechanism of MRP, benefits, and Capacity Planning.

**Flexible Manufacturing Systems**: Components of FMS, FMS Work stations, Material Handling Systems, and Computer Control system, FMS layout configurations and benefits of FMS.

| UNIT - V | **CAQC** | Lecture Hrs: 8 |
|---|---|---|

**Computer Aided Quality Control.**

Introduction, Total Quality Management (TQM), QC and CIM, Inspection and Testing, Statistical Process Control (SPC), Objectives of CAQC, Role of Computer in QC, Coordinate Measuring Machine, Non-Contact Inspection Methods, Post Process Metrology, Computer Aided Inspection Using Robots, Integrated Computer Aided Inspection Systems, Flexible Inspection System (FIS).

**Textbooks:**

1. Mikel P.Groover, Automation, Production systems and Computer Integrated Manufacturing Systems – Pearson Education; Fourth edition 2016.
2. Radhakrishnan and Subramanian, CAD/CAM/CIM, New Age Publishers, 2007.

**Reference Books:**

1. Mikell P.Groover, and Emory W.Zimmers.Jr., CAD/CAM - PHI Publishers, 1984.
2. K.Lalit Narayan, K.Mallikarjuna Rao, MMM Sarcar, Computer Aided Design and Manufacturing, PHI Publishers, 2008.

**Online Learning Resources:**

- https://en.wikipedia.org/wiki/Computer-integrated_manufacturing
- https://www.techopedia.com/definition/30965/computer-integrated-manufacturing-cim
- https://www.youtube.com/watch?v=_OaBMsUgqgQ
- https://www.youtube.com/watch?v=edplvB_Xvso
- https://nptel.ac.in/courses/112/104/112104289/
- https://www.youtube.com/watch?v=9fqygvj-O2s.

| Course Code | | GEOMETRIC MODELING | L | T | P | C |
|---|---|---|---|---|---|---|
| Semester | I | Professional Elective Course - I | 3 | 0 | 0 | 3 |

**Course Objectives:**

- To Learn advanced concepts of feature based modeling and parametric modeling
- To understand the mathematical basis for geometric modeling of curves and surfaces and their relationship with computer graphics.
- To understand the methods of representation of wireframe, surface, and solid modeling systems.
- To Consider data associativity concepts of CAD/CAE integration; Be familiar with interoperability and data transfer techniques between design and analysis software systems.

**Course Outcomes (CO):** Student will be able to

Upon completing this course, the students will be able to:

- Represent curves and surfaces using parametric equations
- Define and relate the basic concepts, tools, and algorithms in geometric modeling and digital surface processing
- Critically analyze and assess current research on surface representations and geometric modeling with the intent to apply the proposed methods in your own work
- Define the methods of representation of wireframe, surface, and solid modeling systems.

| UNIT - I | **Introduction:** | Lecture Hrs:8 |
|---|---|---|

**Introduction:** Definition, Explicit and implicit equations, parametric equations.

| UNIT - II | **Cubic Splines:** | Lecture Hrs: 8 |
|---|---|---|

**Cubic Splines:** Algebraic and geometric form of cubic spline, tangent vectors, parametric space of a curve, blending functions, four point form, reparametrization, truncating and subdividing of curves, Graphic construction and interpretation, composite pc curves.

| UNIT - III | **Bezier & B-Spline Curves** | Lecture Hrs: 8 |
|---|---|---|

**Bezier Curves:** Bernstein basis, equations of Bezier curves, properties, derivatives and related problems.

**B-Spline Curves:** B-Spline basis, equations, knot vectors, properties, derivatives and related problems.

| UNIT - IV | **Surfaces:** | Lecture Hrs: 9 |
|---|---|---|

**Surfaces:** Bicubic surfaces, Coon's surfaces, Bezier surfaces, B-Spline surfaces, surfaces of revolutions, Sweep surfaces, ruled surfaces, tabulated cylinder, bilinear surfaces, triangular patches, sculptured surface and rational parametric surface.

| UNIT - V | **Solids and Solid modeling concepts:** | Lecture Hrs: 8 |
|---|---|---|

**Solids:** Tricubic solid, Algebraic and geometric form.

**Solid modeling concepts:** Wire frames, Boundary representation, Half space modeling, spatial cell, Constructive Solid Geometry (CSG), Analytical Solid Modelling (ASM).

**Textbooks:**

1. Micheal E. Mortenson, Geometric Modeling, McGraw Hill Publishers, 2013.
2. Ibrahim Zeid, CAD/CAM: Theory and Practice, Tata McGraw Hill, 2010.
3. P. N. Rao, CAD/CAM principles and applications, 3-e, McGraw Hill Publishers, 2017.

**Reference Books:**

1. Rogoer's Adams, Elements of Computer Graphics, Tata McGraw Hill, 1990.
2. K.Lalit Narayan, K.Mallikarjuna Rao, MMM Sarcar, Computer Aided Design and Manufacturing, PHI Publishers, 2008.

**Online Learning Resources:**

- https://www.coursera.org/lecture/interactive-computer-graphics/3-4-flower-modeling-MrexG
- https://www.youtube.com/watch?v=0IgOapAtauM
- https://www.youtube.com/watch?v=tgbXCwjlcaE
- https://www.youtube.com/watch?v=CeOV_tVo970
- https://www.youtube.com/watch?v=hBJ4CLE8k1k
- https://nptel.ac.in/courses/112/102/112102101/

| Course Code | | DESIGN OF HYDRAULIC AND PNEUMATIC SYSTEMS Professional Elective Course – I | L | T | P | C |
|---|---|---|---|---|---|---|
| Semester | I | | 3 | 0 | 0 | 3 |

**Course Objectives:**

- To impart students on the science, use and application of hydraulics and pneumatics as fluid power in Industry.
- Also to impart knowledge on the methodology of basic and advanced design of pneumatics and hydraulics systems.

**Course Outcomes (CO):**

- It helps students to get knowledge on the need, use and application of fluid power and make them familiar to industrial design that lead to automation.

| UNIT - I | **HYDRAULIC POWER GENERATORS & ACTUATORS** | Lecture Hrs: 8 |
|---|---|---|

Hydraulic Power Generators – Types, Selection and specification of pumps, pump characteristics. Actuators - Types, selection and specifications of actuators, characteristics of actuators.

| UNIT - II | **CONTROL AND REGULATION ELEMENTS** | Lecture Hrs: 8 |
|---|---|---|

Pressure - direction and flow control valves - relief valves, non-return and safety valves - valve actuation systems.

| UNIT - III | **HYDRAULIC CIRCUITS** | Lecture Hrs: 10 |
|---|---|---|

Reciprocation, quick return, sequencing, synchronizing circuits - accumulator circuits - industrial circuits - press circuits - hydraulic milling machine - grinding, planning, copying, - forklift, earth mover circuits- design and selection of components - safety and emergency mandrels.

| UNIT - IV | **PNEUMATIC SYSTEMS AND CIRCUITS** | Lecture Hrs: 10 |
|---|---|---|

Pneumatic fundamentals - control elements, position and pressure sensing - logic circuits - switching circuits - fringe conditions modules and these integration - sequential circuits - Design Methods: cascade method - mapping method - step counter method.

| UNIT - V | **INSTALLATION, MAINTENANCE AND SPECIAL CIRCUITS** | Lecture Hrs: 8 |
|---|---|---|

Pneumatic equipments- selection of components - application - fault finding in fluid power systems - hydro pneumatic circuits - use of microprocessors for sequencing - PLC, Low cost automation - Robotic circuits.

**Text Books:**

1. Antony Espossito, “Fluid Power with Applications”, Prentice Hall, 1980.
2. Andrew Parr, “Hydraulic and Pneumatics” (HB), Jaico Publishing House, 1999.

**Reference Books:**

1. Dudleyt, A. Pease and John J. Pippenger, “Basic fluid power”, Prentice Hall, 1987.
2. Bolton. W., “Pneumatic and Hydraulic Systems “, Butterworth –Heinemann, 1997.
3. K.Shanmuga Sundaram, “Hydraulic and Pneumatic Controls: Understanding made Easy" S.Chand & Co Book publishers, New Delhi, 2006 (Reprint 2009).

**Online Learning Resources:**

- Chrome-extension://efaidnbmnnibpcaglefindmkaj/viewer.htms?pdfhrl https%3A%2%2Fwww.iare.ac.in%2Fsites%2Fdefault%2Ffiles%2FDHPS%2520LECTURER%2520NOTES%2520FINAL.pdf&chunk=true.
- chromeextension://efaidnbmnnnibpcajpcglclefindmkaj/viewer.html?pdfurl=https%3A%2F%2Fwww.iare.ac.in%2Fsites%2Fdefault%2Ffiles%2FDHPS%2520PPT%2520%2520FINAL.pdf&chunk=true.
- https://nptel.ac.in/courses/112/105/112105047/
-

| Course Code | | ADVANCES IN MANUFACTURING TECHNOLOGY<br>Professional Elective Course - II | L | T | P | C |
|---|---|---|---|---|---|---|
| Semester | I | | 3 | 0 | 0 | 3 |

**Course Objectives:**

- Provide an integrated, effective and practical platform for create facilities for teaching, training and research & development work for post-graduate studies in various fields of manufacturing technology.
- Link up with national and international colleges/ universities of excellence to impart the education, maintain quality & content of curriculum and award degree certificates in post-Graduation / Doctorates.
- Provide facilities for international and national subject experts to stay, teach and conduct research projects / programmes on mutual exchange and recognition basis.

**Course Outcomes (CO):**

- Analyze technical problems, propose solutions and document with written and oral reports.
- Employ technology for communications, data collection, analysis, simulation and control.
- Use Basic Project management skills, project team work and ethical behavior.
- Machine variety materials using a conversational and CNC lathe, milling machine and grinder.
- Use the basic manufacturing methods, measurements, automation and quality control.

| UNIT - I | **Surface Processing Operations** | Lecture Hrs: 10 |
|---|---|---|

Plating and Related Processes, Conversion Coatings, Physical Vapor Deposition, Chemical Vapor Deposition, Organic Coatings, Porcelain Enameling and other Ceramic coatings, Thermal and Mechanical Coating Processes.

| UNIT - II | **Mechanical Energy Based NTM Process** | Lecture Hrs: 10 |
|---|---|---|

Elements of the process, mechanics of metal removal, process parameters, effect of process parameters on surface finish and metal removal rate, economic considerations, applications and limitations, recent developments in Abrasive Jet Machining, Water Jet Machining, Abrasive Water Jet Machining and Ultrasonic Machining.

| UNIT - III | **Electro – Chemical Energy Based NTM Process** | Lecture Hrs: 8 |
|---|---|---|

**Electro - Chemical Machining**: Fundamentals of electro chemical machining, metal removal rate in ECM, Tool design, Surface finish and accuracy economics aspects of ECM.

**Electro Discharge Machining:** General Principle and applications of EDM, Mechanics of metal removal, Process parameters, selection of tool electrode and dielectric fluids, methods surface finish and machining accuracy, Wire EDM.

| UNIT - IV | **Thermo Electric Based NTM** | Lecture Hrs: 8 |
|---|---|---|

**Electron Beam Machining:** Generation and control of electron beam for machining, theory of electron beam machining, principle, advantages, and limitations, comparison of thermal and non-thermal processes.

**Plasma Arc Machining:** Principle, machining parameters, effect of machining parameters on surface finish and metal removal rate, applications, limitations.

**Laser Beam Machining:** Principle, effect of machining parameters on surface finish, applications and limitations.

| UNIT - V | **Additive Manufacturing** | Lecture Hrs: 8 |
|---|---|---|

**Additive Manufacturing:** Definition, Classification of AM Processes, Steps in AM Process, Fused Deposition Method, Steriolithography, Selective Laser sintering, Laminated Object Manufacturing, and 3D Printing – Working principle, applications and limitations.

**Text Books:**


1. V.K.Jain, Advanced Machining Processes - Allied Publishers Private Limited.
2. Mikell P. Groover, Fundamentals of Modern Manufacturing- John Wiley & Sons Publishers.
3. Serope Kalpakjian and Steven R.Schmid, Manufacturing Engineering and Technology – Pearson.
4. P.C Pandey and H.S Shan, Modern Machining Process- Tata McGraw - Hill Education, 1980.
5. T.Jagadeesha, Unconventional Machining Processes - I.K Publishers, 2016.
6. Gibson, I., Rosen, D.W. and Stucker, B., "Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.


**Reference Books:**


1. P.N.Rao, Manufacturing Technology - McGraw Hill Education Private Limited.
2. Amitabha Ghosh, Asok Kumar Mallik,Manufacturing Science - East West press.


**Online Learning Resources:**

- https://nptel.ac.in/courses/112/107/112107078/
- https://youtu.be/t3y_Ys3LgGM
- https://www.youtube.com/watch?v=E4VZ_rFqpG4&t=1s
- https://youtu.be/-tcaR7oSx_w
- https://youtu.be/Uybg6VDLoRQ
- https://youtu.be/Uybg6VDLoRQ
- https://youtu.be/aWQsEX1TrSI

| Course Code | | TOTAL QUALITY MANAGEMENT | L | T | P | C |
|---|---|---|---|---|---|---|
| Semester | I | Professional Elective Course - II | 3 | 0 | 0 | 3 |

**Course Objectives:**

- Introduce the students, the basic concepts of Total Quality Management.
- Expose with various quality issues in Inspection.
- Gain Knowledge on quality control and its applications to real time.
- Know the extent of customer satisfaction by the application of various quality concepts.
- Understand the importance of Quality standards in Production.

**Course Outcomes (CO):**

At the end of this course, the student will be able to

- Develop an understanding on quality Management philosophies and frameworks
- Adopt TQM methodologies for continuous improvement of quality
- Measure the cost of poor quality, process effectiveness and efficiency to identify areas for improvement
- Apply benchmarking and business process reengineering to improve management processes.
- Determine the set of indications to evaluate performance excellence of an organization.

| UNIT - I | **Introduction** | Lecture Hrs: 10 |
|---|---|---|

Introduction: Definition of Quality, Dimensions of Quality, Definition of Total quality management, Quality Planning, Quality costs – Analysis, Techniques for Quality costs, Basic concepts of Total Quality Management.

| UNIT - II | **Historical Review:** | Lecture Hrs: |
|---|---|---|

**Historical Review:** Quality council, Quality statements, Strategic Planning, Deming Philosophy, Barriers of TQM Implementation, Benefits of TQM, Characteristics of successful quality leader, Contributions of Gurus of TQM, Case studies.

| UNIT - III | **TQM Principles:** | Lecture Hrs: |
|---|---|---|

**TQM Principles:** Customer Satisfaction – Customer Perception of Quality, Customer Complaints, Service Quality, Customer Retention, Employee Involvement – Motivation, Empowerment teams, Continuous Process Improvement – Juran Trilogy, PDSA Cycle, Kaizen, Supplier Partnership – Partnering, sourcing, Supplier Selection, Supplier Rating, Relationship Development, Performance Measures – Basic Concepts, Strategy, Performance Measure Case studies.

| UNIT - IV | **TQM Tools:** | Lecture Hrs: |
|---|---|---|

**TQM Tools:** Benchmarking – Reasons to Benchmark, Benchmarking Process, Quality Function Deployment (QFD) – House of Quality, QFD Process, Benefits, Taguchi Quality Loss Function, Total Productive Maintenance (TPM) – Concept, Improvement Needs, FMEA – Stages of FMEA, The seven tools of quality, Process capability, Concept of Six Sigma, New Seven management tools, Case studies.

| UNIT - V | **Quality Systems:** | Lecture Hrs: |
|---|---|---|

**Quality Systems:** Need for ISO 9000 and Other Quality Systems, ISO 9000: 2000 Quality System – Elements, Implementation of Quality System, Documentation, Quality Auditing, QS 9000, ISO 14000 – Concept, Requirements and Benefits, Case Studies.

**Text Books:**

1. Dale H Besterfield, Total Quality Management, Fourth Edition, Pearson Education, 2015.
2. Subburaj Ramaswamy, Total Quality Management, Tata Mcgraw Hill Publishing Company Ltd., 2005.

3. Joel E.Ross , Total Quality Management, Third Eition, CRC Press, 2017.

**Reference Books:**

1. Narayana V and Sreenivasan N.S, Quality Management – Concepts and Tasks, New Age International, 1996.
2. Robert L.Flood, Beyond TQM, First Edition, John Wiley & Sons Ltd, 1993.
3. Richard S. Leavenworth & Eugene Lodewick Grant, Statistical Quality Control, Seventh Edition, Tata Mcgraw Hill, 2015
4. Samuel Ho , TQM – An Integrated Approach, Kogan Page Ltd, USA, 1995.

**Online Learning Resources:**

- https://www.youtube.com/watch?v=VD6tXadibk0
- https://www.investopedia.com/terms/t/total-quality-management-tqm.asp
- https://blog.capterra.com/what-is-total-quality-management/
- https://nptel.ac.in/courses/110/104/110104080/
- https://onlinecourses.nptel.ac.in/noc21_mg03/preview
- https://nptel.ac.in/courses/110/104/110104085/
- https://nptel.ac.in/noc/courses/noc18/SEM2/noc18-mg39/

| Course Code | | COMPUTER AIDED PROCESS PLANNING | L | T | P | C |
|---|---|---|---|---|---|---|
| Semester | I | Professional Elective Course - II | 3 | 0 | 0 | 3 |

**Course Objectives:**

After studying this unit, you should be able to understand what is process planning and CAPP,

- To know the various steps involved in CAPP.
- To classify the various methods of CAPP.
- To understand the feature recognition in CAP.
- Notable requirements for process planning systems are consistency, accuracy, and ease of application and completeness.

**Course Outcomes (CO):**

At the end of the course, the student will be able to

- Generate the structure of automated process planning system and uses the principle of generative and retrieval CAPP systems for automation.
- Select the manufacturing sequence and explains the reduction of total set up cost for a particular sequence.
- Predict the effect of machining parameters on production rate, cost and surface quality and determines the manufacturing tolerances.
- Explain the generation of tool path and solve optimization models of machining processes.

| UNIT - I | **Introduction to CAPP** | Lecture Hrs: 9 |
|---|---|---|

Information requirement for process planning system, Role of process planning, advantages of conventional process planning over CAPP, Structure of Automated process planning system, feature recognition, methods.

**Generative CAPP system:** Importance, principle of Generative CAPP system, automation of logical decisions, Knowledge based systems, Inference Engine, implementation, benefits.

| UNIT - II | **Retrieval CAPP system** | Lecture Hrs: 8 |
|---|---|---|

Significance, group technology, structure, relative advantages, implementation, and applications

**Selection of manufacturing sequence:** Significance, alternative manufacturing processes, reduction of total set-up cost for a particular sequence, quantitative methods for optimal selection, examples.

| UNIT - III | **Determination of machining parameters** | Lecture Hrs: 10 |
|---|---|---|

reasons for optimal selection of machining parameters, effect of parameters on production rate, cost and surface quality, different approaches, advantages of mathematical approach over conventional approach, solving optimization models of machining processes.

**Determination of manufacturing tolerances:** design tolerances, manufacturing tolerances, methods of tolerance allocation, sequential approach**,** integration of design and manufacturing tolerances, advantages of integrated approach over sequential approach

| UNIT - IV | **Generation of tool path** | Lecture Hrs: 8 |
|---|---|---|

Simulation of machining processes, NC tool path generation, graphical implementation, determination of optimal index positions for executing fixed sequence, quantitative methods.

| UNIT - V | **Implementation techniques for CAPP** | Lecture Hrs: 8 |
|---|---|---|

MIPLAN system, Computer programming languages for CAPP, criteria for selecting a CAPP system and benefits of CAPP. Computer integrated planning systems, and Capacity planning system.

**Text Books:**

1. Mikel P.Groover, Automation, Production systems and Computer Integrated Manufacturing Systems – Pearson Education; Fourth edition 2016.
2. Dr.Sadhu Singh, Computer Aided Design and Manufacturing – Khanna Publishers, 1998.

**Reference Books:**

1. David Bedworth, "Computer integrated design and manufacturing" TMH.

2. K.Lalit Narayan, K.Mallikarjuna Rao, MMM Sarcar, Computer Aided Design and Manufacturing, PHI Publishers, 2008.
3. Radhakrishnan and Subramanian, CAD/CAM/CIM, New Age Publishers, 2007.

**Online Learning Resources:**

- https://nptel.ac.in/courses/112/104/112104188/
- https://www.youtube.com/watch?v=20_K7c65Swg
- https://www.youtube.com/watch?v=y24meNZbUoU
- https://youtu.be/PRjExZxWsNc
- https://nptel.ac.in/courses/103/103/103103164/

| Course Code | | GEOMETRIC MODELING LABORATORY | L | T | P | C |
|---|---|---|---|---|---|---|
| Semester | I | | 0 | 0 | 4 | 2 |

**Course Objectives:**

- To train the students with CAD packages.
- To impart the 2D and 3D modeling skills to the students.
- To import and export different IGES files from one software to another

**Course Outcomes (CO):**

- Students will be able to design different parts of mechanical equipments
- Students will be able to apply their skills in various designing and Manufacturing Industries.

**List of Experiments**:

1. Generation of the following curves using "C" language
   a) Cubic Splines
   b) Bezier curves
   c) B-Splines.
2. Generation of the following surfaces using "C" language
   a) Bezier surfaces
   b) B-Spline surfaces
3. Typical tasks of Modeling using PRO/E, IDEAS, CATIA solid modeling packages
   a) Sketcher Module
   b) Part Module
   c) Assembly Module
   d) Drafting Module
   e) Surface Modelling.

| Course Code | | FINITE ELEMENT ANALYSIS LABORATORY | L | T | P | C |
|---|---|---|---|---|---|---|
| Semester | I | | 0 | 0 | 4 | 2 |

**Course Objectives:**

- To use the commercial Finite Element packages to build Finite Element models and solve a selected range of engineering problems.
- To validate a Finite Element model using a range of techniques.
- To communicate effectively in writing to report (both textually and graphically) the method used, the implementation and the numerical results obtained.
- To discuss the accuracy of the Finite Element solutions.

**Course Outcomes (CO):**

- Ability to solve engineering problems using the commercial software's like ANSYS, SIMUFACT, ABAQUS, SIMULIA, MAT LAB.

**List of Experiments**:

Finite Element Analysis using ANSYS 14.5 Package for different structures the discretization can be done with 1-D, 2-D & 3-D elements to perform the following analysis:

1. **Static Analysis**
   - **a.** Stress analysis of 2D truss.
   - **b.** Stress analysis of a plate with a circular hole and L-Bracket – 2D and 3D
   - **c.** Stress analysis of beams (cantilever, simply supported & fixed ends)
   - **d.** Stress analysis of an axi-symmetric component
2. **Thermal and Fluid flow Analysis**
   - **a.** Conductive heat transfer analysis of a 2D and 3D components
   - **b.** Convective heat transfer analysis of a 2D component
   - **c.** Coupled field analysis of a component
   - **d.** Determination of velocity of a fluid and volumetric flow rates for 1-D Fluid flow
   - **e.** Determination of velocity of a fluid and volumetric flow rates for 2-D Fluid flow
3. **Modal Analysis**
   - **a.** mode frequency analysis of a 2D component
   - **b.** mode frequency analysis of beams (cantilever, simply supported, fixed ends)
4. **Transient analysis**
   - a. Transient analysis of a cantilever beam
5. **FEM through MAT LAB**
   - **a.** Introduction to MAT LAB
   - **b.** Analysis of 1-dimesional & 2D dimensional truss.
   - **c.** Analysis of 1-dimesional & 2D dimensional beam.
   - **d.** Analysis of 1-dimesional & 2D dimensional heat conduction.

| Course Code | | RESEARCH METHODOLOGY AND IPR (Mandatory Course) | L | T | P | C |
|---|---|---|---|---|---|---|
| Semester | I | | 2 | 0 | 0 | 2 |

**Course Objectives:**

- To give an overview of the research methodology and explain the technique of defining a research problem
- To explain the functions of the literature review in research.
- To explain carrying out a literature search, its review, developing theoretical and conceptual frameworks and writing a review.
- To explain the art of interpretation and the art of writing research reports.
- To explain various forms of the intellectual property, its relevance and business impact in the changing global business environment.

**Course Outcomes (CO):**

At the end of the course, the student will be able to

- Understand the meaning of research and various methods of research.
- Select the area of research by studying the literature.
- Understand the concepts of Testing of Hypotheses and Interpretation and Report Writing.

| UNIT - I | **RESEARCH FORMULATION AND DESIGN** | Lecture Hrs: 11 |
|---|---|---|

Motivation and objectives – Research methods vs. Methodology. Types of research – Descriptive Vs Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical, concept of applied and basic research process, criteria of good research. Defining and formulating the research problem, selecting the problem, necessity of defining the problem, importance of literature review in defining a problem, literature review-primary and secondary sources, reviews, monograph, patents, research databases, web as a source, searching the web, critical literature review, identifying gap areas from literature and research database, development of working hypothesis.

| UNIT - II | **DATA COLLECTION AND ANALYSIS** | Lecture Hrs: 10 |
|---|---|---|

Accepts of method validation, observation and collection of data, methods of data collection, sampling methods, data processing and analysis strategies and tools, data analysis with statically Package (Sigma STAT,SPSS for student t-test, ANOVA, etc.), hypothesis testing.

| UNIT - III | **INTERPRETATION AND REPORT WRITING** | Lecture Hrs: 8 |
|---|---|---|

Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports, Conclusions.

| UNIT - IV | **RESEARCH ETHICS, IPR AND SCHOLARY PUBLISHING** | Lecture Hrs: 8 |
|---|---|---|

Ethics-ethical issues, ethical committees (human & animal); IPR- intellectual property rights and patent law, commercialization, copy right, royalty, trade related aspects of intellectual property rights (TRIPS); scholarly publishing- IMRAD concept and design of research paper, Citation and acknowledgement, plagiarism, reproducibility and accountability.

| UNIT - V | **PATENTS RIGHTS & NEW DEVELOPMENTS IN IPR** | Lecture Hrs: 8 |
|---|---|---|

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

**Text Books:**

1. C.R. Kothari, Gaurav Garg, Research Methodology: Methods and Techniques New Age International 4th Edition, 2018.
2. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science

& engineering student.
3. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology Publications. 2 volumes.

**Reference Books:**

1. Research Methods: the concise knowledge base Trochim Atomic Dog Publishing 2005.
2. Conducting Research Literature Reviews: From the Internet to Paper Fink A Sage Publications 2009.

**Online Learning Resources:**

- https://nptel.ac.in/courses/121/106/121106007/
- https://www.youtube.com/watch?v=sI3pUyDUQVg
- https://www.youtube.com/watch?v=GSeeyJVD0JU
- https://www.youtube.com/watch?v=EVcPmmfK1Do

| Course Code | | ADVANCED OPTIMIZATION TECHNIQUES | L | T | P | C |
|---|---|---|---|---|---|---|
| Semester | II | | 3 | 0 | 0 | 3 |

**Course Objectives:**

- To understand the theory of optimization methods and algorithms developed for solving various types of optimization problems.
- To develop and promote research interest in applying optimization techniques in problems of Engineering and Technology.
- To apply the mathematical results and numerical techniques of optimization theory to concrete Engineering problems.

**Course Outcomes (CO):**

Student will be able to

- Understand importance of optimization of industrial process management.
- Apply basic concepts of mathematics to formulate an optimization problem.
- Analyse and appreciate variety of performance measures for various optimization problems.

| UNIT - I | **Linear programming & Assignment problem** | Lecture Hrs: 8 |
|---|---|---|

**Linear programming :** Two-phase simplex method, Big-M method, duality, interpretation, applications.

**Assignment problem**: Hungarian's algorithm, Degeneracy, applications, unbalanced problems, traveling salesman problem.

| UNIT - II | **Classical optimization techniques** | Lecture Hrs: 10 |
|---|---|---|

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 - III | **Numerical methods for optimization** | Lecture Hrs: 10 |
|---|---|---|

Nelder Mead's Simplex search method, Gradient of a function, Steepest descent method, Newton's method, types of penalty methods for handling constraints.

| UNIT - IV | **Genetic algorithm (GA)** | Lecture Hrs: 8 |
|---|---|---|

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,

**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 | **Multi-Objective GA:** | Lecture Hrs: 10 |
|---|---|---|

Pareto's analysis, Non-dominated front, multi – objective GA, Non-dominated sorted GA, convergence criterion, applications of multi-objective problems .

**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, optimization of springs and gears, general optimization model of a machining process, optimization of arc welding parameters, and general procedure in optimizing machining operations sequence.

**Text Books:**

1. Jasbir Arora, Introduction to Optimal design – 4-e, Academic Press, 2011.
2. Kalyanmoy Deb, Optimization for Engineering Design: Algorithms and examples–PHI Publishers, 2012.
3. S.S.Rao, Engineering Optimization: Theory and practice –New Age Publishers, 2000.

**Reference Books:**

1. D.E.Goldberg, Addison, Genetic algorithms in Search, Optimization, and Machine

learning, Wesley Publishers, 1989.
2. John R Koza, Genetic Programming II – Automatic Discovery of Reusable Programs, MIT Press, 1994.
3. Multi objective Genetic algorithms - Kalyanmoy Deb, PHI Publishers.
4. S. Rajasekaran & GA Vijayalakshmi Pai "Neural Networks, Fuzzy Logic, and Genetic Algorithms synthesis and application", PHI

**Online Learning Resources:**

- https://www.youtube.com/watch?v=eo2tOPV3AoE
- https://www.youtube.com/watch?v=4t3z8y4CAcs
- https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-0002-introduction-to-computational-thinking-and-data-science-fall-2016/lecture-videos/lecture-1-introduction-and-optimization-problems/
- https://ocw.mit.edu/courses/sloan-school-of-management/15-093j-optimization-methods-fall-2009/lecture-notes/
- https://web.eng.fiu.edu/arleon/courses/Optimization/Lectures/Classical_Optimization.pdf
- https://nptel.ac.in/content/storage2/courses/105108127/pdf/Module_1/M1L4_LN.pdf
- https://www.iare.ac.in/sites/default/files/OT%20Complete%20Notes_1.pdf

| Course Code | | INDUSTRIAL ROBOTICS & EXPERT SYSTEMS | L | T | P | C |
|---|---|---|---|---|---|---|
| Semester | II | | 3 | 0 | 0 | 3 |

**Course Objectives:**

- To teach students the basics of robotics, construction features, sensor applications, robot cell design, robot programming and application of artificial intelligence and expert systems in robotics.

**Course Outcomes (CO):** Student will be able to

- Students are to the basics kinematics of robotics, and are able to understand the robot programming and also artificial intelligence and expert systems in robotics.

| UNIT - I | **INTRODUCTION AND ROBOT KINEMATICS** | Lecture Hrs: 10 |
|---|---|---|

Definition need and scope of Industrial robots – Robot anatomy – Work volume – Precision movement – End effectors – Sensors. Robot Kinematics – Direct and inverse kinematics – Robot trajectories – Control of robot manipulators – Robot dynamics – Methods for orientation and location of objects.

| UNIT - II | **ROBOT DRIVES AND CONTROL** | Lecture Hrs: 10 |
|---|---|---|

Controlling the Robot motion – Position and velocity sensing devices – Design of drive systems – Hydraulic and Pneumatic drives – Linear and rotary actuators and control valves – Electro hydraulic servo valves, electric drives – Motors – Designing of end effectors – Vacuum, magnetic and air operated grippers.

| UNIT - III | Robotic vision | Lecture Hrs: 8 |
|---|---|---|

Robotic vision system – Image Representation - Image Grabbing –Image processing and analysis – Edge Enhancement – Contrast Stretching – Band Rationing - Image segmentation – Pattern recognition – Training of vision system.

| UNIT - IV | **ROBOT CELL DESIGN AND Programming** | Lecture Hrs: 8 |
|---|---|---|

Robot work cell design and control – Safety in Robotics – Robot cell layouts – Multiple Robots and machine interference – Robot cycle time analysis. Methods of Robot Programming – Characteristics of task level languages lead through programming methods – Motion interpolation.

| UNIT - V | **ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS** | Lecture Hrs: 8 |
|---|---|---|

Artificial intelligence – Basics – Goals of artificial intelligence – AI techniques – problem representation in AI – Problem reduction and solution techniques - Application of AI and KBES in Robots.

**Text Books:**

1. K.S. Fu, R.C. Gonzalez and C.S.G. Lee, "Robotics Control, Sensing, Vision and Intelligence", Mc Graw Hill, 1987.
2. Yoram Koren," Robotics for Engineers' Mc Graw-Hill, 1987.

**Reference Books:**

1. Timothy Jordanides et al ,"Expert Systems and Robotics ", Springer –Verlag, New York,
2. Kozyrey, Yu. "Industrial Robots", MIR Publishers Moscow, 1985.
3. Richard. D, Klafter, Thomas, A, Chmielewski, Michael Negin, "Robotics Engineering – An Integrated Approach", Prentice-Hall of India Pvt. Ltd., 1984.
4. Deb, S.R." Robotics Technology and Flexible Automation", Tata Mc Graw-Hill, 1994.
5. Mikell, P. Groover, Mitchell Weis, Roger, N. Nagel, Nicholas G. Odrey," Industrial Robotics Technology, Programming and Applications", Mc Graw-Hill, Int. 1986.
6. May 1991.

**Online Learning Resources:**

- https://freevideolectures.com/course/4560/nptel-mechanism-robot-kinematics
- https://see.stanford.edu/course/cs223a
- https://cosmolearning.org/courses/introduction-to-robotics/video-lectures/

- https://www.youtube.com/watch?v=0yD3uBshJB0
- https://nptel.ac.in/courses/112/105/112105236/
- https://www.youtube.com/watch?v=xrwz9IxpMJg
- https://www.coursehero.com/file/59785981/Lecture-9-Robot-cell-designppt/
- https://www.plantautomation-technology.com/articles/different-types-of-robot-programming-languages

| Course Code | | CNC TECHNOLOGY & PROGRAMMING | L | T | P | C |
|---|---|---|---|---|---|---|
| Semester | II | Professional Elective Course - III | 3 | 0 | 0 | 3 |

**Course Objectives:**

To study

- Safety in the CNC environment
- CNC Machine Tools compared to Manual Machine tools
- Repeatability and Speed is the Key to CNC C. Programming
- Manual Programming
- CAD/CAM Programming CNC Lathe 1. Uses 2. Setups 3. Tooling 4. CNC Lathe Project
- CNC Mill a. Uses b. Setups c. Tooling d. CNC Mill Project Course Topic

**Course Outcomes (CO):** Student will be able to

Upon completion of this course, the student will be able to:

- Understand the basic procedures and concepts of programming, set up and operation of a CNC Machining Center.
- Identify and understand the basic programming codes.
- Create geometry and toolpaths from the specifications on a blueprint for simple parts using Mastercam programming software.
- Identify and define the functions of the CNC machine control.
- Set up the CNC machining center for manufacturing simple parts.
- Manufacture simple parts on the CNC machining center.

| UNIT - I | **Introduction to CNC Machine tools** | Lecture Hrs: 10 |
|---|---|---|

Evolution of Computerized control in manufacturing, Components, Working principle of CNC, DNC and Machining centers.

Constructional features of CNC machine tools: Introduction, Spindle drives, Transmission belting, axes feed drives, Slide ways, Ball bearing screws.

Accessories: Work tables, Spindles, Spindle heads, Beds and Columns, Tooling – Automatic Tool changer (ATC).

| UNIT - II | **Feedback devices** | Lecture Hrs: 10 |
|---|---|---|

Introduction, Digital incremental displacement measuring systems, encoders, Moire fringes, Digital absolute measuring system.

Electro-magnetic analogue position transducers: Principle, advantages, characteristics, Synchros, Synchro-Resolvers, Inductors, Laser interferometer.

| UNIT - III | **Control Systems and interface** | Lecture Hrs: 8 |
|---|---|---|

Open and closed loop systems, Micro processor based CNC systems, block diagram of typical CNC system, description of hard ware and interpolation systems, Standard and optional features of CNC control systems.

| UNIT - IV | **Manual and APT programming** | Lecture Hrs: 8 |
|---|---|---|

APT language structure, APT geometry, Definition of point, time, vector, circle, plane, patterns and matrices. APT motion commands: setup commands, point-to point motion commands, continuous path motion commands, post processor commands, control commands, Macro subroutines, Part programming preparation for typical examples.

| UNIT - V | **Economics and Maintenance of CNC machine tools** | Lecture Hrs: 8 |
|---|---|---|

Introduction, factors influencing selection of CNC machines, Cost of operation of CNC machines, Maintenance features of CNC machines, Preventive maintenance, Documentation, Spare parts, Training in Maintenance.

**Text Books:**

1. Dr.Radha Krishnanan, Computer Numerical Control Machines – New Age International Pvt Ltd; 1-e, 2018.

2. Hans B. Kief and Frederick Waters, T., Computer Numerical Control - A CNC Reference Guide, Macmillan / McGraw-Hill. New York. 1992.

**Reference Books:**

1. C.Elanchezhian and T.Sundar Selwyn, Computer Aided Manufacturing, University Science Press.
2. Y.Koren – Computer Control of Manufacturing systems - Khanna publications
3. Chao-HWA Chang Michel A Melkanoff, NC machine programming and software design - Prentice Hall.
4. B.S. Aditahn and Pabla, CNC Machines, New Age; 3-e, 2018.

**Online Learning Resources:**

- https://nptel.ac.in/courses/112/105/112105211/
- https://academy.titansofcnc.com/files/Fundamentals_of_CNC_Machining.pdf http://home.iitk.ac.in/~nsinha/CNC.pdf
- https://www.thomasnet.com/articles/custom-manufacturing-fabricating/understanding-cnc-machining/
- https://www.hubs.com/knowledge-base/cnc-machining-manufacturing-technology-explained/
- https://www.youtube.com/watch?v=P0BvBbQoiok
- https://www.youtube.com/watch?v=bfTQVixviAo
- https://en.wikipedia.org/wiki/APT_(programming_language)

| Course Code | | INTERACTIVE COMPUTER GRAPHICS | L | T | P | C |
|---|---|---|---|---|---|---|
| Semester | II | Professional Elective Course - III | 3 | 0 | 0 | 3 |

**Course Objectives:**

- The students can understand the Basics of computer Graphics like drawing line, arc etc.,
- Drawing of spline curves ,Creation of surfaces, Algorithms for 3D viewing, Available drawing standards.

**Course Outcomes (CO):** Student will be able to

The students can understand the following

- Basics of computer Graphics like drawing line, arc etc.
- Drawing of spline curves
- Creation of surfaces
- Algorithms for 3D viewing
- Available drawing standards
- Basics of computer Graphics like drawing line, arc etc.

| UNIT - I | **Introduction to computer graphics** | Lecture Hrs: 10 |
|---|---|---|

Color CRT raster scan monitors, plasma display & liquid crystal display monitors, computer input devices, hard copy devices.

**Raster scan graphics:** Line drawing algorithms – DDA & Bresenham algorithms, circle generation, general function rasterization, displaying lines, characters and polygons.

| UNIT - II | **Filling algorithms** | Lecture Hrs: 8 |
|---|---|---|

polygon filling, edge fill algorithm, seed fill algorithm, fundamentals of antialiasing and half toning.

| UNIT - III | **Line CLIPPING** | Lecture Hrs: 8 |
|---|---|---|

Simple visibility algorithm, Cohen-Sutherland subdivision line clipping algorithm, midpoint sub division algorithm.

**Polygon clipping:** polygon clipping, reentrant polygon clipping – Sutherland – Hodgeman algorithm, character clipping, 3D- clipping.

| UNIT - IV | **Transformations** | Lecture Hrs: 8 |
|---|---|---|

Cartesian and homogeneous coordinate systems two dimensional and three dimensional transformations – scaling, rotation, Shearing, Zooming, viewing transformation, reflection, rotation about an axis, concatenation.

| UNIT - V | **Rendering** | Lecture Hrs: 8 |
|---|---|---|

Hidden line removal algorithms, surface removal algorithms, painters, Warnock, Z-buffer algorithm.

**Shading algorithms:** Constant intensity algorithm, Phong's shading algorithm, gourand shading algorithm, Comparison of shading algorithms.

**Text Books:**

1. Donald Hearn & M.P. Bakers, Computer Graphics, Prentice-Hall; 2-e.1994.
2. D. F. Rogers, Procedural elements for computer graphics- Tata McGraw-Hill.

**Reference Books:**

1. William Newman & Robert Sproull, Interactive computer graphics, McGraw Hill Education, 2001.
2. Steven Harrington, Computer graphics-Harrington, McGraw-Hill Inc.,US;2-e,1983.
3. CAD/CAM theory and practice, Ibrahim Zeid, 2nd edition, Tata McGraw-Hill.

**Online Learning Resources:**

- https://lecturenotes.in/subject/59/computer-graphics-cg
- https://www.dgp.toronto.edu/~hertzman/418notes.pdf
- http://www2.cs.uidaho.edu/~jeffery/courses/324/lecture.html
- http://personal.ee.surrey.ac.uk/Personal/J.Collomosse/pubs/cm20219.pdf
- http://www.svecw.edu.in/Docs%5CCSECGLNotes2013.pdf

- https://www.youtube.com/watch?v=fwzYuhduME4
- https://nptel.ac.in/courses/106/103/106103224/
- https://nptel.ac.in/courses/106/102/106102065/

| Course Code | | ADVANCED COMPOSITE MATERIALS | L | T | P | C |
|---|---|---|---|---|---|---|
| Semester | II | Professional Elective Course - III | 3 | 0 | 0 | 3 |

**Course Objectives:**

- Introduce modern composite materials and their applications to students.
- Build proper background for stress and strength analysis in the design of composite materials and structures.

**Course Outcomes (CO):** Student will be able to

After completion of the course student can be able to**:**

- Understanding of types, manufacturing processes, and applications of composite materials.
- Understanding the theory behind Biocomposites.

| UNIT - I | **INTRODUCTION TO COMPOSITES** | Lecture Hrs: 10 |
|---|---|---|

Fundamentals of composites – Definition – classification of composites materials – based on Matrix – based on structure – Advantages and applications of composites - Reinforcement – whiskers – glass fiber – carbon fiber - Aramid fiber – ceramic fiber – Properties and applications. Testing of composites

| UNIT - II | **POLYMER MATRIX COMPOSITES** | Lecture Hrs: 8 |
|---|---|---|

Polymers - Polymer matrix materials – PMC processes - hand layup processes – spray up processes – resin transfer moulding – Pultrusion – Filament winding – Auto clave based methods - Injection moulding – sheet moulding compound – properties and applications of PMCs.

| UNIT - III | **METAL MATRIX COMPOSITES** | Lecture Hrs: 8 |
|---|---|---|

Metals - types of metal matrix composites – Metallic Matrices. Processing of MMC – Liquid state processes – solid state processes – Insitu processes. Properties and applications of MMCs.

| UNIT - IV | **CERAMIC MATRIX COMPOSITES** | Lecture Hrs: 8 |
|---|---|---|

Ceramic matrix materials – properties – processing of CMCs –Sintering - Hot pressing – Infiltration – Lanxide process – Insitu chemical reaction techniques – solgel polymer pyrolsis – SHS - Cold isostatic pressing (CIPing) – Hot isostatic pressing(HIPing). Properties and Applications of CCMs.

| UNIT - V | **ADVANCES IN COMPOSITES** | Lecture Hrs: 8 |
|---|---|---|

**Carbon /carbon composites**: Advantages of carbon matrix – limitations of carbon matrix carbon fibre – chemical vapour deposition of carbon on carbon fibre perform. Properties and applications of Carbon-carbon composites. Composites for aerospace applications.

**Biodegradable composites:** Biodegradability, introduction of biocomposites, classification, processing of biocomposites, applications of biocomposites - Mechanical, Biomedical, automobile Engineering.

**Text Books:**

1. "Composite materials", Chawla K.K., Springer – Verlag, Second Edition, 1998.
2. "Composite Materials: Engineering and Science", Mathews F.L. and Rawlings R.D., Chapman and Hall, London, England, 1st edition, 1994.

**Reference Books:**

1. "Composite Materials"., H K Shivanand, B V Babu Kiran, ASIAN BOOKS, 2011
2. "Fundamentals of Composite Manufacturing", A.B. Strong, SME, 1989.
3. "Composite materials", S.C. Sharma, Narosa Publications, 2000.
4. "Hand Book of Bioplastics & Biocomposites for Engineering applications", Maureen Mitton, John Wiley publications.

**Online Learning Resources:**

- https://www.youtube.com/watch?v=0kB0G6WKhKE
- https://www.youtube.com/watch?v=3JpXWhHdsdM
- https://www.youtube.com/watch?v=NQfirJs4m1M
- https://nptel.ac.in/courses/101/104/101104010/
- https://nptel.ac.in/courses/112/104/112104168/

| Course Code | | ADVANCED MECHANISM DESIGN | L | T | P | C |
|---|---|---|---|---|---|---|
| Semester | II | Program Elective Course - III | 3 | 0 | 0 | 3 |

**Course Objectives:**

- At the end of this course the students would have developed a thorough understanding of the principle methods, areas of usage, possibilities and limitations as well as environmental effects of the advanced mechanism design.

**Course Outcomes (CO):** Student will be able to

- Compute mobility and motion parameters
- Apply Hall and Ault‟s method, Goodman‟s indirect method and Chase solution, explain instant center of acceleration; apply Euler- Savory equation and Bobillier construction
- Design two- , and three- position synthesis; apply Chebychev spacing; describe cognate linkages
- Analyze forces on static and dynamic mechanisms
- Analyze RSSR mechanism; apply D–H notation; contrast forward and inverse kinematics

| UNIT - I | **Introduction** | Lecture Hrs: 10 |
|---|---|---|

Introduction – review of fundamentals of kinematics - analysis and synthesis – terminology, definitions and assumptions – planar, spherical and spatial mechanisms‟ mobility – classification of mechanisms – kinematic Inversion – Grashoff`s law Position and displacement – complex algebra solutions of planar vector equations – coupler curve generation velocity – analytical methods - vector method – complex algebra methods – Freudenstein‟s theorem.

| UNIT - II | Planar complex mechanisms | Lecture Hrs: 8 |
|---|---|---|

Planar complex mechanisms - kinematic analysis - low degree complexity and high degree complexity, Hall and Ault`s auxiliary point method – Goodman‟s indirect method for low degree of complexity Mechanisms Acceleration – analytical methods – Chase solution - Instant centre of acceleration. Euler-Savory equation - Bobillier construction

| UNIT - III | Synthesis of mechanisms | Lecture Hrs: 8 |
|---|---|---|

Synthesis of mechanisms: Type, number and dimensional synthesis – function generation – two position synthesis of slider crank and crank rocker mechanisms with optimum transmission angle – three position synthesis – structural error – Chebychev spacing - Cognate linkages – Robert-Chebychev theorem – Block‟s method of synthesis, Freudenstein‟s equation.

| UNIT - IV | Static force analysis of planar | Lecture Hrs: 8 |
|---|---|---|

Static force analysis of planar mechanism – static force analysis of planar mechanism with friction – method of virtual work Dynamic force analysis of planar mechanisms - Combined static and inertia force analysis.

| UNIT - V | Kinematic analysis | Lecture Hrs: 8 |
|---|---|---|

Kinematic analysis of spatial revolute-Spherical-Spherical-Revolute mechanism – Denavit-Hartenberg parameters – forward and inverse kinematics of robotic manipulators.

**Text Books:**

1. Amitabh Ghosh and Ashok Kumar Mallik, “Theory of Mechanisms and Machines,”,3e,EWP, 1999.
2. Shighley Joseph Edwards and Uicker John Joseph, “Theory of Machines and Mechanism”, 2e, McGraw Hill,1985.

**Reference Books:**

1. Arthur G. Erdman and G.N. Sandor, “Advanced Mechanism Design: Analysis and Synthesis”, Vol. I, PHI, 1984.
2. Arthur G. Erdman and G.N. Sandor, “Advanced Mechanism Design: Analysis and Synthesis”, Vol. II, PHI, 1984.

| Course Code | | MECHATRONICS & MEMS | L | T | P | C |
|---|---|---|---|---|---|---|
| Semester | II | Program Elective Course - IV | 3 | 0 | 0 | 3 |

**Course Objectives:**

The general objectives of the course are to enable the students to

- Familiarize the technologies behind modern mechatronic systems.
- Explain fundamentals for the development of fully automated system.
- Develop a robotic or automated systems focusing on the hardware and software integration.
- Demonstrate the development of mechatronic system and MEMS.

**Course Outcomes (CO):**

Upon successful completion of this unit, the student will be able to:

- Define the discipline of mechatronics.
- Identify examples of mechatronic systems that are encountered in real life.
- Identify the components of a typical mechatronic system.

| UNIT - I | **INTRODUCTION** | Lecture Hrs: 10 |
|---|---|---|

Definition of Mechatronics, Need for Mechatronics in Industry, Objectives of mechatronics, mechatronics design process, Mechatronics key elements, mechatronics applications – Computer numerical control (CNC) machines, Tool monitoring systems, Flexible manufacturing system (FMS), Industrial Robots, Automatic packaging systems, Automatic inspection systems.

| UNIT - II | **SENSORS** | Lecture Hrs: 8 |
|---|---|---|

Static characteristics of sensors, Selection criteria for sensors, Displacement, Position and Proximity Sensors, Force and torque sensors, Pressure sensors, Flow sensors, Temperature sensors, Acceleration sensors, Level sensors, Light sensors, Smart material sensors, Micro and Nano sensors.

| UNIT - III | **Actuators** | Lecture Hrs: 8 |
|---|---|---|

Mechanical, Electrical, Hydraulic and Pneumatic Actuation systems, Characteristics and their limitations, Selection criteria for actuators, Design of Hydraulic and Pneumatic circuits, Piezoelectric actuators, Shape memory alloys,

| UNIT - IV | **Microprocessors, Microcontrollers and Programmable Logic Controllers:** | Lecture Hrs: 8 |
|---|---|---|

Architecture of Microprocessor, Microcontroller and Programmable Logic Controller, PLC Programming using ladder diagrams, logics, latching, sequencing, timers relays and counters, data handling, Analog input/output, selection of controllers.

| UNIT - V | **Micro Electro Mechanical Systems (MEMS):** | Lecture Hrs: 8 |
|---|---|---|

History, Effect of scaling, Fabrication Techniques: Oxidation, Physical Vapor disposition, Chemical Vapor Deposition, Lithography, Etching, Wafer bonding, LIGA, DRIE, Applications.

**Text Books:**

1. Michael B.Histand and David G. Alciatore, " Introduction to Mechatronics and Measurement Systems", McGraw-Hill International Editions, 1999.
2. Bradley, D.A., Dawson, D, Buru, N.C. and Loader, AJ, "Mechatronics ", Chapman and Hall, 1993.
3. Ramesh.S, Gaonkar, "Microprocessor Architecture, Programming and Applications" Wiley Eastern, 1998.

**Reference Books:**

1. Lawrence J.Kamm, " Understanding Electro-Mechanical Engineering, An Introduction to Mechatronics ", Prentice-Hall, 2000.
2. Ghosh, P.K. and Sridhar, P.R., 0000 to 8085, "Introduction to Microprocessors for Engineers and Scientists ", Second Edition, Prentice Hall, 1995.
3. W. Bolton, Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, Pearson Education; 4th edition, 2010.

**Online Learning Resources:**

- https://www.cet.edu.in/noticefiles/259_Lecturer%20Note%20on%20Mechatronics-ilovepdf-compressed.pdf
- https://lecturenotes.in/subject/137/mechatronics-mech
- http://engineering.nyu.edu/mechatronics/Control_Lab/Criag/Craig_RPI/2001/Mechatronics%20Lecture%20Notes.htm
- https://jcboseust.ac.in/mechanical/images/mtech1stsem/mechatronics_product_design.pdf
- https://www.youtube.com/watch?v=tAkkUNEknGk
- https://nptel.ac.in/courses/112/107/112107298/
- https://www.youtube.com/watch?v=ncSnIkBO-X0

| Course Code | | ADDITIVE MANUFACTURING | L | T | P | C |
|---|---|---|---|---|---|---|
| Semester | II | Program Elective Course - IV | 3 | 0 | 0 | 3 |

**Course Objectives:**

- At the end of this course the students would have developed a thorough understanding of the principle methods, areas of usage, possibilities and limitations as well as environmental effects of the Rapid Prototyping Technologies.

**Course Outcomes (CO):** Student will be able to

- It helps the students to get familiarized with the various methods of rapid prototyping technologies and rapid tooling.

| UNIT - I | **Introduction** | Lecture Hrs: 10 |
|---|---|---|

**Introduction**: Prototyping fundamentals: Need for time compression in product development, Need for Additive Manufacturing, Historical development, Fundamentals of Additive Manufacturing, AM Process Chain, Advantages and Limitations of AM, Commonly used Terms, Classification of AM process, Fundamental Automated Processes: Distinction between AM and CNC, other related technologies. Role of AM in Industry 4.0.

| UNIT - II | **Vat Photopolymerization, Material jetting and extrusion** | Lecture Hrs: 8 |
|---|---|---|

Working principle,Specifications, Materials used, Process, Applications, Advantages and Disadvantages, Case studies of the following AM Technologies

**Vat Photopolymerization AM Systems**: Photopolymers, photo polymerization Stereo lithography Apparatus (SLA), Direct Light Processing (DLP) and Continuous Direct Light Processing (CDLP).

**Material Jetting AM Systems:** Material Jetting, Nano particle jetting and Drop-On-Demand (DOD) material jetting **Binder Jetting AM Systems:** Three dimensional Printing (3DP).

**Material Extrusion AM Systems**: Fused Deposition Modeling (FDM)

| UNIT - III | **Deposition methods.** | Lecture Hrs: 8 |
|---|---|---|

Working principle, Specifications, Materials used, Process, Applications, Advantages and Disadvantages, Case studies of the following AM Technologies

**Powder Bed Fusion AM Systems**: Selective laser sintering (SLS), Selective Laser Melting (SLM) and Direct Metal Laser Sintering (DMLS), Electron Beam Melting (EBM).

**Direct Energy Deposition (DED) AM Systems:** Laser Engineered Net Shaping (LENS) and Electron Beam Additive Manufacturing (EBAM).

**Sheet Lamination AM Systems**: Laminated Object Manufacturing (LOM) and Ultrasonic Additive Manufacturing (UAM).

**Rapid Tooling**: Introduction to Rapid Tooling (RT), Conventional Tooling Vs RT, Need for RT, Classification of Rapid Tooling, Direct and Indirect Tooling Methods, Soft and Hard Tooling methods.

| UNIT - IV | **Reengineering, data formats and software's** | Lecture Hrs: 8 |
|---|---|---|

**Reengineering in AM:** Reengineering Engineering (RE) Methodologies and Techniques, Selection of RE systems, RE software, RE hardware, RE in product development

**AM Data Formats**: STL Format, STL File Problems, Consequence of Building Valid and Invalid Tessellated Models, STL file Repairs: Generic Solution, Slicing Algorithms: Rock Algorithm, Crawford's algorithm, Other Translators, Newly Proposed Formats. Mesh Refining by Sub division Techniques, Topology optimization and Additive Manufacturing.

**AM Software's**: Need for AM software, Features of various AM software's like Magics, Mimics, Solid View, View Expert, 3 D View, Velocity 2, Rhino, STL View 3 Data Expert and 3 D doctor, SurgiGuide, 3-matic, Simplant, MeshLab.

| UNIT - V | **AM applications and cost estimation in AM** | Lecture Hrs: 8 |
|---|---|---|

**AM Applications**: Application – Material Relationship, Application in Design, Engineering Analysis and Planning, Aerospace, Automotive, Jewelry, Coin, GIS, Arts, Architecture. Medical and

Bioengineering Applications, Forensic Science and Anthropology, Visualization of Biomolecules.
**Cost Estimation in AM:** Cost Model, Build Time Model, Laser Scanning Vat Photopolymerization Example, Life-Cycle Costing.

**Text Books:**

1. Chee Kai Chua and Kah Fai Leong, "3D Printing and Additive Manufacturing Principles and Applications" Fifth Edition, World Scientific Publications, 2017
2. Ian Gibson, David W Rosen, Brent Stucker, "Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing", Springer, Second Edition, 2010.

**Reference Books:**

1. Frank W.Liou, "Rapid Prototyping & Engineering Applications", CRC Press, Taylor & Francis Group, 2011.
2. RafiqNoorani, **"**Rapid Prototyping: Principles and Applications in Manufacturing", John Wiley &Sons, 2006.

**Online Learning Resources:**

- NPTEL Course on Rapid Manufacturing. https://nptel.ac.in/courses/112/104/112104265/
- https://www.hubs.com/knowledge-base/introduction-fdm-3d-printing/
- https://slideplayer.com/slide/6927137/
- https://www.mdpi.com/2073-4360/12/6/1334
- https://www.centropiaggio.unipi.it/sites/default/files/course/material/2013-11-29%20-%20FDM.pdf
- https://lecturenotes.in/subject/197
- https://www.cet.edu.in/noticefiles/258_Lecture%20Notes%20on%20RP-ilovepdf-compressed.pdf
- https://www.vssut.ac.in/lecture_notes/lecture1517967201.pdf
- https://www.youtube.com/watch?v=NkC8TNts4B4

| Course Code | | DESIGN AND ANALYSIS OF EXPERIMENTS | L | T | P | C |
|---|---|---|---|---|---|---|
| Semester | II | Program Elective Course - IV | 3 | 0 | 0 | 3 |

**Course Objectives:**

- To know the importance of quality in manufacturing industries.
- To understand the steps involved in Design of Experiments and ANOVA.
- To know how to apply ANOVA & DOE to develop a new manufacturing process.
- To know about the different standardization methods for manufacturing.
- To Understand and apply the principles of math, science, and engineering in design and manufacturing related activities.

**Course Outcomes (CO):**

After completion of the course, the students will be able to:

- Understanding of time and motion study, work sampling, and process flow charting
- Critically observe manufacturing operations.
- Produce short technical reports individually and in teams.
- Contribute to the profitable growth of manufacturing businesses.
- Maintain high standards of professional and ethical responsibility.

| UNIT - I | **Introduction** | Lecture Hrs: 8 |
|---|---|---|

**Design of Experiments:** Introduction, Task aids and Responsibilities for DOE process steps, DOE process steps description.

**Analysis of variance (ANOVA):** no-WAY anova, One-way ANOVA, two-way ANOVA, Critique of F-test, ANOVA for four level factors, multiple level factors.

| UNIT - II | **Randomized block designs and factorial designs** | Lecture Hrs: 8 |
|---|---|---|

**Randomized block designs**: Randomized complete block design - Latin square designs - Graeco-Latin square design - Balanced incomplete block designs.

**Factorial Designs:-** Two levels - $2^k$ factorial designs - confounding and Blocking in factorial designs.

| UNIT - III | **Laminated Object Manufacturing** | Lecture Hrs: 8 |
|---|---|---|

**Fractional Factorial Designs:** The One-Half and One-Quarter Fraction of the $2^k$ Design - General $2^{k-p}$ Fractional Factorial Design - Resolution.

**Robust Design:** comparison of classical and Taguchi's approach - orthogonal designs - S/N ratios - application to process and parameter design.

| UNIT - IV | **Regression Analysis** | Lecture Hrs: 8 |
|---|---|---|

Introduction - simple Linear Regression Analysis - Multiple Linear Regression Model - Model Adequacy Checking.

| UNIT - V | **RSM & Software's used for Design the experiments** | Lecture Hrs: 8 |
|---|---|---|

**Response surface methodology**- parameter - optimization - robust parameter design and its application to control of processes with high variability.

**Software's -** JMP, NCSS, Minitab, Design expert.

**Text Books:**

1. Montgomery DC, Design and Analysis of Experiments, 7th Edition, John Wiley & Sons, NY, 2008.

**Reference Books:**

1. Taguchi methods explained: Practical steps to Robust Design/Papan P.Bagchi/Prentice Hall Ind. Pvt. Ltd. New Delhi.
2. Charles R. Hicks, Kenneth V. Turner Jr., Fundamental concepts in the Design of Experiments, Oxford University press, 1999.
3. Bagchi, T.P. Taguchi Methods explained, pHl,2OO2.
4. Philip.J. Rose, Taguchi Techniques for quality Engineering, Prentice Hail, 2000.
5. Parurerselvam.. Design and Analysis of Expeiiments, pHliearnin Mode 9.2015.

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|---|
| **Online Learning Resources:** |
| • https://nptel.ac.in/courses/110/105/110105087/<br>• https://nptel.ac.in/courses/111/104/111104075/<br>• https://onlinecourses.nptel.ac.in/noc21_mg48/preview |

| Course Code | | PROCESS AUTOMATION LABORATORY | L | T | P | C |
|---|---|---|---|---|---|---|
| Semester | II | | 0 | 0 | 4 | 2 |

**Course Objectives:**

- To train the students in writing programs for robot movements
- To train the students in handling FMS cell for different sequences
- To design the hydraulic and pneumatic circuits by using automation studio software
- To design the automated manufacturing systems by using workspace software.

**Course Outcomes (CO):**

Upon successful completion students should be able to:

- Demonstrate the pick and place Aristo Robot.
- Demonstrate the working of workspace software.
- Check the circuit designs whether working properly or not by using Automation studio software.

**List of Experiments**:

1. **WORKSPACE software.**
   a. Simulation of a manufacturing system for increasing production rate.
   b. Simulation of a simple automation system.
2. **AUTOMATION STUDIO software.**
   **I. Hydraulic Circuits**
   a. Introduction to Automation studio & its control
   b. Draw & Simulate the Hydraulic circuit for series & parallel cylinders connection
   c. Draw & Simulate Meter-in, Meter-out and hydraulic press and clamping.
   d. Sequencing circuits in hydraulics.
   e. Synchronizing circuits in hydraulics.
   **II. Pneumatic circuits**
   a. Sequencing circuits in Pneumatics.
   b. Synchronizing circuits in Pneumatics.
   c. Design and Simulation of simple pneumatic circuit by using Cascade Method.
   d. Design and Simulation of simple pneumatic circuit by using step counter method
3. **Aristo XT Six axis Robot**
   a. Introduction to Robot programming
   b. Robot programming exercises (Point-to-Point and continuous path task)
4. **Additive manufacturing machine**
   a. Introduction to Additive manufacturing Machine.
   b. Design and fabrication of simple symmetrical and unsymmetrical components.
5. **Mechatronics**
   a. Simulation on P Controller.
   b. Simulation on PI Controller.
   c. Simulation on PID Controller.
   d. Simulation of Hydraulic Actuation System.
   e. Simulation of Pneumatic Actuation System.
   f. Simulation on Stepper Motor.
   g. Simulation on Logic gates, decoders and flip-flops.

| Course Code | | CAM LABORATORY | L | T | P | C |
|---|---|---|---|---|---|---|
| Semester | II | | 0 | 0 | 4 | 2 |

**Course Objectives:**

- To get practical knowledge on manual part programming of CNC lathe machine by using G codes and M codes.
- To get practical knowledge on manual part programming of CNC milling and drilling machine by using G codes and M codes.
- To get the practical knowledge on APT language.

**Course Outcomes (CO):**

Upon successful completion students should be able to:

- Use an understanding of General and Machine (G& M) code to generate or edit a program which will operate a CNC Lathe.
- Apply mathematical methods to calculate Cartesian coordinates

**List of Experiments**:

1. Manual part programming (using G and M codes) in CNC Lathe Machine
   (a) Part programming for linear interpolation, circular interpolation, chamfering and grooving.
   (b) Part programming by using standard canned cycles for facing, turning, taper turning and thread cutting.
2. Manual part programming (using G and M codes) in CNC Milling Machine
   (a) Part programming for linear interpolation, circular interpolation and contour motions.
   (b) Part programming involving canned cycles for drilling, peck drilling and boring.
3. APT (Automatically Programmed Tools) language in CNC Milling and Lathe machine.
4. Cutting tool path generation using any one simulation package for different machining operation.

| Course Code | | ADVANCED TOOL DESIGN | L | T | P | C |
|---|---|---|---|---|---|---|
| Semester | III | Program Elective Course - V | 3 | 0 | 0 | 3 |

**Course Objectives:**

- The purpose of this course is to make the students to get familiarized with the design of various tools that can be implemented for different mechanical operations.

**Course Outcomes (CO):**

- It helps the students to get familiarized with advanced tool design for various mechanical operations which includes cutting, jigs and fixtures, press tool dies and modern CNC machine tools.

| UNIT - I | **INTRODUCTION TO TOOL DESIGN** | Lecture Hrs: 10 |
|---|---|---|

Introduction –Tool Engineering – Tool Classifications– Tool Design Objectives – Tool Design in manufacturing- Challenges and requirements- Standards in tool design-Tool drawings -Surface finish – Fits and Tolerances - Tooling Materials- Ferrous and Non ferrous Tooling Materials- Carbides, Ceramics and Diamond -Non metallic tool materials-Designing with relation to heat treatment.

| UNIT - II | **DESIGN OF CUTTING TOOLS** | Lecture Hrs: 10 |
|---|---|---|

Mechanics of Metal cutting –Oblique and orthogonal cutting- Chip formation and shear angle - Single-point cutting tools – Milling cutters – Hole making cutting tools- Broaching Tools - Design of Form relieved and profile relieved cutters-Design of gear and thread milling cutters.

| UNIT - III | **DESIGN OF JIGS AND FIXTURES** | Lecture Hrs: 10 |
|---|---|---|

Introduction – Fixed Gages – Gage Tolerances –selection of material for Gauges – Indicating Gages – Automatic gages – Principles of location – Locating methods and devices – Principles of clamping – Drill jigs – General considerations in the design of drill jigs – Drill bushings – Methods of construction – Types of Fixtures – Vice Fixtures – Milling Fixtures – Boring Fixtures – Broaching Fixtures.

| UNIT - IV | **DESIGN OF PRESS TOOL DIES** | Lecture Hrs: 8 |
|---|---|---|

Types of Dies –Method of Die operation–Clearance and cutting force calculations- Blanking and Piercing die design – Pilots – Strippers and pressure pads- Presswork materials – Centre of pressure - Strip layout – Short-run tooling for Piercing – Bending dies – Drawing dies-Design and drafting.

| UNIT - V | **TOOL DESIGN FOR CNC MACHINE TOOLS** | Lecture Hrs: 8 |
|---|---|---|

Introduction –Tooling requirements for Numerical control systems – Fixture design for CNC machine tools- Sub plate and tombstone fixtures-Universal fixtures– Cutting tools– Tool holding methods– Automatic tool changers and tool positioners – Tool presetting– General explanation of the Brown and Sharp machine.

**Text Books:**

1. Cyrll Donaldson, George H.LeCain, V.C. Goold, "Tool Design", Tata McGraw Hill Publishing Company Ltd., 2000.
2. E.G.Hoffman," Jig and Fixture Design", Thomson Asia Pvt Ltd, Singapore, 2004.

**Reference Books:**

1. Prakash Hiralal Joshi, "Tooling data", Wheeler Publishing, 2000
2. Venkataraman K., "Design of Jigs, Fixtures and Presstools", TMH, 2005.
3. Haslehurst M., "Manufacturing Technology", The ELBS, 1978.

**Online Learning Resources:**

- https://www.iare.ac.in/sites/default/files/lecture_notes/TOOL%20DESIGN_Lecture_Notes.pdf
- https://www.cet.edu.in/noticefiles/261_MMP%20Lecture%20Notes-ilovepdf-compressed.pdf
- https://www.vssut.ac.in/lecture-notes.php?url=production-engineering
- https://nptel.ac.in/courses/112/105/112105233/
- https://www.youtube.com/watch?v=7MkX-sW97rI
- https://nptel.ac.in/courses/112/105/112105126/#

| Course Code | | DESIGN FOR MANUFACTURING | L | T | P | C |
|---|---|---|---|---|---|---|
| Semester | III | Program Elective Course - V | 3 | 0 | 0 | 3 |

**Course Objectives:**

- Students to study and know the Design philosophy, maching and joining processes, and factors for design.

**Course Outcomes (CO):** Student will be able to

- Students are able to know to make Design of the different kinds of the products to manufacture.

| UNIT - I | **Introduction** | Lecture Hrs: 8 |
|---|---|---|

Design philosophy-steps in design process-general design rules for manufacturability-basic principles of designing for economical production-creativity in design.
Materials: Selection of materials for design-developments in material technology-criteria for material selection-material selection interrelationship with process selection-process selection charts.

| UNIT - II | **Machining processes** | Lecture Hrs: 10 |
|---|---|---|

Overview of various machining processes-general design rules for machining-dimensional tolerance and surface roughness-Design for machining ease –redesigning of components for machining ease with suitable examples. General design recommendations for Turning, thread cutting, milling and drilling operations. Case studies.

| UNIT - III | **Metal casting and forging** | Lecture Hrs: 8 |
|---|---|---|

Appraisal of various casting processes, selection of casting process,-general design considerations for casting-casting tolerance-use of solidification, simulation in casting design-product design rules for sand casting.
Design factors for forging – closed die forging design – parting lines of dies – drop forging die design – general design recommendations. Case studies
Casting and forging allowances.

| UNIT - IV | **Metal joining** | Lecture Hrs: 8 |
|---|---|---|

Appraisal of various welding processes, factors in design of weldments – general design guidelines-pre and post treatment of welds-effects of thermal stresses in weld joints-design of brazed joints.

| UNIT - V | **Sheet metal working and plastics** | Lecture Hrs: 8 |
|---|---|---|

**Extrusion & Sheet metal work:** Design guide lines extruded sections-design principles for punching, blanking, bending, deep drawing-Keeler Goodman forging line diagram – component design for blanking.

Plastics: Design and manufacture of plastic components

**Text Books:**

1. John cobert, Design for Manufacture: Strategies, Principles and Techniques, Adisson Wesley. 1995.
2. Geoffrey Boothroyd, Peter Dewhurst, Product Design for Manufacture and Assembly, CRC Press; 3/e, 2010.
3. Vannessa Dr Goodship, Design and Manufacture of Plastic Components for Multifunctionality, Publisher William Andrew, 1/e, 2015.

**Reference Books:**

1. George E. Dieter, ASM Handbook Volume 20: Materials Selection and Design, ASM International, 1997.

**Online Learning Resources:**

- https://nptel.ac.in/courses/112/101/112101005/
- https://www.iare.ac.in/sites/default/files/lecture_notes/DFMA_LECTURE_NOTES.pdf
- https://ocw.mit.edu/courses/mechanical-engineering/2-008-design-and-manufacturing-ii-spring-2004/lecture-notes/

- https://dokumen.tips/documents/design-for-manufacturing-and-assembly-1-lecture-notes-on-design-for-manufacturing.html
- https://www.youtube.com/watch?v=ofmbhbVCUqI
- https://onlinecourses.nptel.ac.in/noc21_me66/preview

| Course Code | | AUTOMATION IN MANUFACTURING | L | T | P | C |
|---|---|---|---|---|---|---|
| Semester | III | Program Elective Course - V | 3 | 0 | 0 | 3 |

**Course Objectives:**

Students are study to know the over view of the automation in manufacturing like automatic material handling, assembling and production lines etc.

**Course Outcomes (CO):** Student will be able to

Students are able to know to understand the automation in manufacturing concept .

| UNIT - I | **Over View of Manufacturing and Automation:** | Lecture Hrs: 10 |
|---|---|---|

Production systems, Automation in production systems, Automation principles and strategies, Manufacturing operations, production facilities. Basic elements of an automated system, levels of automation; Hardware components for automation and process control, programmable logic controllers and personal computers.

| UNIT - II | **Material Handling and Identification Technologies:** | Lecture Hrs: 8 |
|---|---|---|

Material handling, equipment, Analysis. Storage systems, performance and location strategies, Automated storage systems, AS/RS, types. Automatic identification methods, Barcode technology, RFID.

| UNIT - III | **Manufacturing Systems and Automated Production Lines:** | Lecture Hrs: 8 |
|---|---|---|

Manufacturing systems: components of a manufacturing system, Single station manufacturing cells; Manual Assembly lines, line balancing Algorithms, Mixed model Assembly lines, Alternative Assembly systems. Automated production lines, Applications, Analysis of transfer lines-With and without buffer

| UNIT - IV | **Automated Assembly Systems:** | Lecture Hrs: 8 |
|---|---|---|

Fundamentals, Analysis of Assembly systems. Cellular manufacturing, part families, cooling, production flow analysis. Group Technology and flexible Manufacturing systems, Quantitative Analysis.

| UNIT - V | **Machine learning** | Lecture Hrs: 10 |
|---|---|---|

Introduction: Basic definitions, types of learning, hypothesis space and inductive bias, evaluation, cross-validation.

**Text Books:**


1. Automation, production systems and computer integrated manufacturing/ Mikell. P Groover/PHI/3rd edition/2012.
2. CAD/CAM/CIM/ P. Radha Krishnan & S. Subrahamanyarn and Raju/New Age International Publishers/2003.


**Reference Books:**


1. System Approach to Computer Integrated Design and Manufacturing/ Singh/John Wiley /1996.
2. Computer Aided Manufacturing/Tien-Chien Chang, Richard A. Wysk and Hsu-Pin Wang/ Pearson/ 2009.
3. Manufacturing and Automation Technology / R Thomas Wright and Michael Berkeihiser / Good Heart/Willcox Publishers.


**Online Learning Resources:**

- https://www.youtube.com/watch?v=caJ_2TSQDhE
- https://www.youtube.com/watch?v=v-3TmN4HhLc

| Course Code | | BUSINESS ANALYTICS (Open Elective) | L | T | P | C |
|---|---|---|---|---|---|---|
| Semester | | | 3 | 0 | 0 | 3 |

**Course Objectives:**

1. Understand the role of business analytics within an organization.
2. Analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization.
3. To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making.
4. To become familiar with processes needed to develop, report, and analyze business data.
5. Use decision-making tools/Operations research techniques.
6. Mange business process using analytical and management tools.
7. Analyze and solve problems from different industries such as manufacturing, service, retail, software, banking and finance, sports, pharmaceutical, aerospace etc.

**Course Outcomes (CO):**

At the end of this course the students are expected to,

1. Students will demonstrate knowledge of data analytics.
2. Students will demonstrate the ability of think critically in making decisions based on data and deep analytics.
3. Students will demonstrate the ability to use technical skills in predicative and prescriptive modeling to support business decision-making.
4. Students will demonstrate the ability to translate data into clear, actionable insights.

| UNIT - I | **Business analytics & Statistical Tools:** | Lecture Hrs: 10 |
|---|---|---|

Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics.
Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.

| UNIT - II | **Trendiness and Regression Analysis:** | Lecture Hrs: 8 |
|---|---|---|

Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.

| UNIT - III | **Organization Structures** | Lecture Hrs: 8 |
|---|---|---|

Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.

| UNIT - IV | **Forecasting Techniques:** | Lecture Hrs: 8 |
|---|---|---|

Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models. Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.

| UNIT - V | **Decision Analysis:** | Lecture Hrs: 10 |
|---|---|---|

Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, SWOT ananlysis, The Value of Information, Utility and Decision Making.

| |
|---|
| **Text Books:** |
| 1. Project Management: The Managerial Process by Erik Larson and, Clifford Gray. |
| **Reference Books:** |
| 1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press.<br>2. Business Analytics by James Evans, persons Education. |

| Course Code | | INDUSTRIAL SAFETY | L | T | P | C |
|---|---|---|---|---|---|---|
| Semester | | (Open Elective) | 3 | 0 | 0 | 3 |

**Course Objectives:**

- Familiarize with the safety in industry
- Know the wear and corrosion and their prevention
- Explain Periodic and preventive maintenance

**Course Outcomes (CO):**

At the end of this course the students are expected to,

- understand the fundamentals of maintenance engineering .
- apply fault tracing technique to find the fault in industries.
- compare periodic and preventive maintenance

| UNIT - I | **Industrial safety** | Lecture Hrs: 10 |
|---|---|---|

Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and fire fighting, equipment and methods.

| UNIT - II | **Fundamentals of maintenance engineering** | Lecture Hrs: 8 |
|---|---|---|

Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

| UNIT - III | **Wear and Corrosion and their prevention:** | Lecture Hrs: 8 |
|---|---|---|

Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

| UNIT - IV | **Fault tracing:** | Lecture Hrs: 8 |
|---|---|---|

Fault tracing: Fault tracing-concept and importance, decision treeconcept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

| UNIT - V | **Periodic and preventive maintenance** | Lecture Hrs: 10 |
|---|---|---|

Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance.

**Text Books:**

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company.

**Reference Books:**

1. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.
2. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London

| Course Code | | OPERATIONS RESEARCH | L | T | P | C |
|---|---|---|---|---|---|---|
| Semester | | (Open Elective) | 3 | 0 | 0 | 3 |

**Course Objectives:**

- To impart the basic concepts of modeling, models and statements of the operations research.
- Formulate and solve linear programming problem/situations.
- Model strategic behaviour in different economic situations.
- To solve transportation problems to minimize cost.
- Apply Queuing theory to solve problems of traffic congestion, counters in banks, railway bookings etc.

**Course Outcomes (CO):**

After completion of this course the student can be able to

- develop mathematical models for practical problems. (L3)
- apply linear programming to transportation problems. (L3)
- solve games using various techniques. (L3)
- solve production scheduling and develop inventory policies. (L6)
- apply optimality conditions for constrained and unconstrained nonlinear problems. (L3)
- apply dynamic programming methods. (L3)

| UNIT - I | **Introduction to OR and LP** | Lecture Hrs: 8 |
|---|---|---|

**Introduction to Operations Research (OR):** OR definition - Classification of Models, modeling – Methods of solving OR Models, limitations and applications of OR models

**Linear Programming(LP):** Problem Formulation, Graphical Method, Simplex Method, Big-M Method, Two–Phase Simplex Method, Special Cases of LP- Degeneracy, Infeasibility and Multiple Optimal Solutions; Concept of dual theorem

| UNIT - II | **Transportation and Assignment Problems:** | Lecture Hrs: 8 |
|---|---|---|

**Transportation and Assignment Problems:** Transportation Problem – Formulation; Different Methods of Obtaining Initial Basic Feasible Solution –North West Corner Rule, Least Cost Method, Vogel's Approximation Method; Optimality Method – Modified Distribution (MODI) Method; Special Cases – Unbalanced Transportation Problem, Degenerate Problem. Assignment Problem – Formulation, Hungarian Method for Solving Assignment Problems, Traveling Salesman problem.

| UNIT - III | **Game theory and job sequencing** | Lecture Hrs: 8 |
|---|---|---|

**Game theory:** Optimal solution of two person zero sum games, the max min and min max principle. Games without saddle points, mixed strategies. Reduction by principles of dominance, arithmetic, algebraic method and graphical method.

**Job Sequencing:** Introduction to Job shop Scheduling and flow shop scheduling, Solution of Job Sequencing Problem, Processing of n Jobs through two machines, Processing of n Jobs through m machines, graphical method

| UNIT - IV | **Queuing theory & Inventory control** | Lecture Hrs: 8 |
|---|---|---|

**Queuing Theory:** Introduction – Terminology, Arrival Pattern, Service Channel, Population, Departure Pattern, Queue Discipline, Birth & Death Process, Single Channel Models with Poisson Arrivals, Exponential Service Times with infinite and finite queue length; Multichannel Models with Poisson Arrivals, Exponential Service Times with infinite queue length.

**Inventory Control:** Introduction, Deterministic models – EOQ model with and without shortages, Production model, Buffer stock and discount inventory models with single price breaks. Selective inventory control..

| UNIT - V | **Replacement and Maintenance Analysis and DP** | Lecture Hrs: 10 |
|---|---|---|

**Replacement and Maintenance Analysis:** Introduction – Types of Maintenance, Make or buy decision. Types of Replacement Problems, Determination of Economic Life of an Asset, and Simple Probabilistic Model for Items which completely fail-Individual Replacement Model, Group

Replacement Model.

**Dynamic Programming (DP):** Introduction –Bellman's Principle of Optimality – Applications of Dynamic Programming – Shortest Path Problem – Capital Budgeting Problem – Solution of Linear Programming Problem by DP..

**Text books:**


1. Sharma S.D., Operations Research: Theory, Methods and Applications, 15th Edition, Kedar Nath Ram Nath, 2010
2. Taha H.A., Operations Research, 9th Edition, Prentice Hall of India, New Delhi, 2010.


**Reference Books:**


1. Hiller F.S., and Liberman G.J., Introduction to Operations Research, 7th Edition, Tata McGraw Hill, 2010.
2. Sharma J.K., Operations Research: Theory and Applications, 4th Edition, Laxmi Publications, 2009.
3. Prem kumar Gupta and Hira, Operations Research, 3rd Edition, S Chand Company Ltd., New Delhi, 2003.
4. Pannerselvam R., Operations Research, 2nd Edition, Pentice Hall of India, New Delhi, 2006.
5. Sundaresan.V, and Ganapathy Subramanian.K.S, Resource Management Techniques: Operations Research, A.R Publications, 2015.


**Online Learning Resources:**

- http://www2.informs.org/Resources/
- http://www.mit.edu/~orc/
- http://www.ieor.columbia.edu/
- http://www.universalteacherpublications.com/univ/ebooks/or/Ch1/origin.htm
- http://www.wolfram.com/solutions/OperationsResearch/
- http://nptel.iitm.ac.in/video.php?subjectId=112106134
- http://www.youtube.com/watch?feature=player_detailpage&v=ug7O1lSZyg0
- http://www2.ensc.sfu.ca/undergrad/courses/ENSC201/Unit09/lecture9.html

| Course Code | | SUPPLY CHAIN MANAGEMENT (Open Elective) | L | T | P | C |
|---|---|---|---|---|---|---|
| Semester | | | 3 | 0 | 0 | 3 |

**Course Objectives:**

- Explain the basics of supply chain management.
- Familiarize inventory management techniques and models to ensure EOQ batch size under risk management.
- Demonstrate various distribution strategies for shipment of products.
- Focus on evaluating of strategic alliance partners and understanding of RDBMS

**Course Outcomes (CO):**

After completion of this course the student can be able to

- apply the concepts of supply chain management for demand forecasting. (L3)
- make use of SCM and inventory management for procurement(L3)
- analyse the shipment activities and related issues (L4)
- build third party alliances. (L5)
- adapt the RDBMS data for communications and analyzing future challenges and understand e-commerce strategies(L6)

| UNIT - I | **Understanding the supply chain** | Lecture Hrs: 8 |
|---|---|---|

What is SCM? Why SCM? The Complexity, Key issues in SCM Logistics network - Introduction, Data Collection, Transportation, Ware house Management, Strategic location of ware houses, Demand forecasting, Role of aggregate planning, MRP, ERP, Managing variability, Key features of Network configuration.

| UNIT - II | **Inventory management:** | Lecture Hrs: 8 |
|---|---|---|

**Inventory management:** Concepts of Materials Management, Economic lot size model, Effect of Demand uncertainly, Fixed order costs, Variable lead frames, Inventory under certainly & uncertainty, Risk Management

| UNIT - III | **Distribution strategies:** | Lecture Hrs: 8 |
|---|---|---|

**Distribution strategies:** Introduction, Centralized vs Decentralized control, Direct shipment, Cross Docking, Push based vs Pull based supply chain.

| UNIT - IV | **Strategic alliances:** | Lecture Hrs: 8 |
|---|---|---|

Third party Logistics (3PL), Retailer – supplier relationship issues, requirements, success & failures, Distributor integration Types & issues.

| UNIT - V | **MIS & SCM:** | Lecture Hrs: 10 |
|---|---|---|

Relational Data Base Management (RDBMS), System Architecture, Communications, and Implementation of ERP, Decision support systems for SCM: Analytical tools, Presentation tools, Smooth production flow Current issues & directing challenges for future, e-Commerce strategies and world class supply chain management.

**Text Books:**

1. Sunil Chopra, Peter Meindl, Supply Chain Management: Strategy, Planning, and Operation, 4/e, Pearson, 2010.
2. David N. Burt, Donald W. Dobler , World Class Supply Management: The Key to Supply Chain Management, 2/e, McGraw-Hill/Irwin, 2003.

**Reference Books:**

1. John Joseph Coyle, Edward J. Bardi, C. John Langley, The Management of Business Logistics: A Supply Chain Perspective, South-Western/Thomson Learning, 2003.
2. Upendra Kachru ,Logistics and Supply Chain Management, Excel Books, 2009.

**Online Learning Resources:**

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| Course Code | | COMPOSITE MATERIALS (Open Elective) | L | T | P | C |
|---|---|---|---|---|---|---|
| Semester | | | 3 | 0 | 0 | 3 |

**Course Objectives:**

- Introduce composite materials and their applications to students.
- Build proper background for stress and strength analysis in the design of composite materials and structures.

**Course Outcomes (CO):** Student will be able to

After completion of the course student can be able to**:**

- Understanding of types, manufacturing processes, and applications of composite materials.
- Understanding the theory behind polymer matrix composites

| UNIT - I | **INTRODUCTION** | Lecture Hrs: 8 |
|---|---|---|

Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

| UNIT - II | **REINFORCEMENTS** | Lecture Hrs: 8 |
|---|---|---|

Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions.

| UNIT - III | **Manufacturing of Metal Matrix Composites:** | Lecture Hrs: 8 |
|---|---|---|

Manufacturing of Metal Matrix Composites: Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing. Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications.

| UNIT - IV | **Manufacturing of Polymer Matrix Composites:** | Lecture Hrs: 8 |
|---|---|---|

Manufacturing of Polymer Matrix Composites: Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications.

| UNIT - V | **Strength:** | Lecture Hrs: 10 |
|---|---|---|

Strength: Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

**Text Books:**

1. R.W.Cahn – VCH, Material Science and Technology – Vol 13 – Composites, West Germany.
2. WD Callister, Jr., Adapted by R. Balasubramaniam, Materials Science and Engineering, An introduction. John Wiley & Sons, NY, Indian edition, 2007.

**Reference Books:**

1. "Composite Materials"., H K Shivanand, B V Babu Kiran, ASIAN BOOKS, 2011
2. "Fundamentals of Composite Manufacturing", A.B. Strong, SME, 1989.
3. "Composite materials", S.C. Sharma, Narosa Publications, 2000.

**Online Learning Resources:**

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| Course Code | | Waste to Energy (Open Elective) | L | T | P | C |
|---|---|---|---|---|---|---|
| Semester | | | 3 | 0 | 0 | 3 |

**Course Objectives:**

- Introduce conversion of waste to energy
- Familiarize the fundamentals of biomass pyrolysis
- Explain about biomass combustion

**Course Outcomes (CO):**

After completion of this course the student can be able to

- use of various conversation techniques for convert the waste into energy.(L4)
- apply optimization methods to engineering problems.(L3)
- implement Biomass energy programme in India.(L3)
- compare bio gasification techniques. (L4)

| UNIT - I | Introduction to Energy from Waste: | Lecture Hrs: 8 |
|---|---|---|

Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

| UNIT - II | Biomass Pyrolysis: | Lecture Hrs: 8 |
|---|---|---|

Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

| UNIT - III | Biomass Gasification | Lecture Hrs: 8 |
|---|---|---|

Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

| UNIT - IV | Biomass Combustion: | Lecture Hrs: 8 |
|---|---|---|

Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

| UNIT - V | Biogas: | Lecture Hrs: 10 |
|---|---|---|

Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India..

**Text Books:**

1. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.

**Reference Books:**

1. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
2. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

**Online Learning Resources:**

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| Course Code | | MECHATRONICS (Open Elective) | L | T | P | C |
|---|---|---|---|---|---|---|
| Semester | | | 3 | 0 | 0 | 3 |

**Course Objectives:**

- Introduce Mechatronics.
- Familiarize the fundamentals of Signal conditioning and precision mechanical systems
- Explain about microcontroller overview.

**Course Outcomes (CO):**

After completion of this course the student can be able to

- use of digital I/O for signal conditioning.
- implement Electronic interface subsystems.
- compare various types of electromechanical drives.

| UNIT - I | **Introduction:** | Lecture Hrs: 8 |
|---|---|---|

**Introduction:** Definition - Trends - Control Methods: Stand alone, PC Based (Real Time Operating Systems, Graphical User Interface, Simulation) - Applications: SPM, Robot, CNC, FMS, CIM.

| UNIT - II | **Signal Conditioning:** | Lecture Hrs: 8 |
|---|---|---|

**Signal Conditioning:** Introduction - Hardware - Digital I/O , Analog input - ADC , resolution , speed channels Filtering Noise using passive components - Resistors, capacitors - Amplifying signals using OP amps -Software - Digital Signal Processing

| UNIT - III | **Precision Mechanical Systems:** | Lecture Hrs: 8 |
|---|---|---|

**Precision Mechanical Systems:** Pneumatic Actuation Systems - Electro-pneumatic Actuation Systems - Hydraulic Actuation Systems - Electro-hydraulic Actuation Systems - Timing Belts - Ball Screw and Nut - Linear Motion Guides - Linear Bearings - Bearings- Motor / Drive Selection. .

| UNIT - IV | **Electronic Interface Subsystems:** | Lecture Hrs: 8 |
|---|---|---|

**Electronic Interface Subsystems:** Motors Isolation schemes- opto coupling, buffer IC's - Protection schemes - circuit breakers, over current sensing, resettable fuses, Power Supply - Bipolar transistors/ mosfets.

**Electromechanical Drives:** Relays and Solenoids - Stepper Motors - DC brushed motors - DC brushless motors - DC servo motors - PWM's - Pulse Width Modulation - Variable Frequency Drives.

| UNIT - V | **Microcontrollers Overview:** | Lecture Hrs: 10 |
|---|---|---|

**Microcontrollers Overview:** 8051 Microcontroller , micro processor structure - Digital Interfacing - Analog Interfacing - Digital to Analog Convertors - Analog to Digital Convertors - Applications, Programming -Assembly.

**Programmable Logic Controllers:** Basic Structure - Programming: Ladder diagram - Timers, Internal Relays and Counters - Shift Registers - Master and Jump Controls - Data Handling - Analog input / output - PLC Selection, interface - R232 etc.,-Applications.

**Text Books:**

1. Mechatronics Electronics Control Systems in Mechanical and Electrical Engineering , WBolton, Pearson Education Press, 3rd edition, 2005.
2. Mechatronics, Ganesh.S.H, Jones and Bartlett publications.

**Reference Books:**

1. Mechatronics Source Book, Newton C Braga, Thomson Publications, Chennai.
2. Mechatronics, N. Shanmugam, Anuradha Agencies Publisers.
3. Mechatronics System Design, Devdasshetty,Richard,Thomson.
4. Mechatronics, M.D.Singh, J.G.Joshi, PHI.

**Online Learning Resources:**

-

| Course Code | | OPTIMIZATION TECHNIQUES THROUGH MATLAB (Open Elective) | L | T | P | C |
|---|---|---|---|---|---|---|
| Semester | | | 3 | 0 | 0 | 3 |

**Course Objectives:**

- Introduce basics of MATLAB
- Familiarize the fundamentals of optimization
- Explain single variable optimization using various methods
- Implement multi variable optimization using various methods
- Train various evolutionary algorithms.

**Course Outcomes (CO):**

After completion of this course the student can be able to

- use optimization terminology and concepts, and understand how to classify an optimization problem.(L4)
- apply optimization methods to engineering problems.(L3)
- implement optimization algorithms.(L3)
- compare different genetic algorithms. (L5)
- solve multivariable optimization problems. (L4)

| UNIT - I | **Introduction to MAT LAB:** | Lecture Hrs: 8 |
|---|---|---|

**Introduction to MAT LAB:** Overview, MATLAB Preliminaries, Basics of MATLAB, Beyond the Basics of MATLAB, Popular Functions and Commands, Plotting using MATLAB, Optimization with MATLAB.

| UNIT - II | **Introduction to Optimization:** | Lecture Hrs: 8 |
|---|---|---|

**Introduction to Optimization:** Statement of an optimization problem, Classifications of optimization Problems: Single variable optimization, Multi variable optimization with no constraints, Multi variable optimization with equality constraints, Multi variable optimization with inequality constraints, Convex and Concave programming.

| UNIT - III | **Single Variable Optimization:** | Lecture Hrs: 8 |
|---|---|---|

**Single Variable Optimization:** Finite difference method, Central difference method, Runge-Kutta method, interval halving method, golden section method with MATLAB code.

| UNIT - IV | **Multi Variable Optimization:** | Lecture Hrs: 8 |
|---|---|---|

**Multi Variable Optimization:** Conjugate gradient method, Newton's method, Powell's method, Flectcher- Reeves method, Hook and Jeeves method, interior penalty function with MATLAB code.

| UNIT - V | **Evolutionary Algorithms:** | Lecture Hrs: 10 |
|---|---|---|

**Evolutionary Algorithms:** Overview, Genetic Algorithms: Basics of Genetic Algorithms, Options in MATLAB, Multi Objective Optimization using Genetic Algorithms, Ant Colony Optimization, Simulated Annealing, Particle Swarm Optimization.

**Text Books:**


1. Rao V.Dukkipati, MATLAB: An Introduction with Applications, Anshan, 2010.
2. Achille Messac, Optimization in practice with MATLAB, Cambridge University Press, 2015.
3. Jasbir S Arora, Introduction to optimum design, 2/e. Elsevier, 2004.


**Reference Books:**


1. Cesar Perez Lopez, MATLAB Optimization Techniques, Academic press, Springer publications, 2014.
2. Steven C.Chapra, Applied Numerical Methods with MATLAB for Engineers and scientists, 4/e, McGraw-Hill Education, 2018.


**Online Learning Resources:**

| Course Code | | AUTOMOTIVE ELECTRONICS (Open Elective) | L | T | P | C |
|---|---|---|---|---|---|---|
| Semester | | | 3 | 0 | 0 | 3 |

**Course Objectives:**

- To understand the use of electronics in the automobile.
- To appreciate the various electronic and the instrumentation systems used in automobile.

**Course Outcomes (CO):**

After completion of this course the student can be able to

- Obtain an overview of automotive components, like sensors, actuators, communication protocols and safety systems employed in today's automotive industry .
- Interface automotive sensors and actuators with microcontrollers.
- Know, the various display devices that are used in automobiles.

| UNIT - I | **Introduction to microcomputer**: | Lecture Hrs: 8 |
|---|---|---|

**Introduction to microcomputer**: Microcomputer: Buses, memory, timing, CPU registers; Microprocessor architecture: Initialization, operation codes, program counter, branch and jump instructions, subroutine. Analog to digital converters and Digital to analog converters, sampling, polling and interrupts, digital filters, lookup table.

| UNIT - II | **Sensors and actuators:** | Lecture Hrs: 8 |
|---|---|---|

**Sensors and actuators:** Speed sensors, Pressure sensors: Manifold Absolute Pressure sensor, knock sensor, Temperature sensors: Coolant and Exhaust gas temperature, Exhaust Oxygen level sensor, Position sensors: Throttle position sensor, accelerator pedal position sensor and crankshaft position sensor, Air mass flow sensor. Solenoids, stepper motors and relays.

| UNIT - III | **Electronic engine management system** | Lecture Hrs: 8 |
|---|---|---|

**Electronic engine management system:** Electronic engine control: Input, output and control strategies, electronic fuel control system, fuel control modes: open loop and closed loop control at various modes, EGR control, Electronic ignition systems – Spark advance correction schemes, fuel injection timing control.

| UNIT - IV | **Electronic vehicle management system:** | Lecture Hrs: 8 |
|---|---|---|

**Electronic vehicle management system:** Cruise control system, Antilock braking system, electronic suspension system, electronic steering control, traction control system, Transmission control, Safety: Airbags, collision avoiding system, low tire pressure warning system..

| UNIT - V | **Automotive instrumentation system** | Lecture Hrs: 10 |
|---|---|---|

**Automotive instrumentation system:** Input and output signal conversion, multiplexing, fuel quantity measurement, coolant temperature and oil pressure measurement, display devices- LED, LCD, VFD and CRT, Onboard diagnostics(OBD), OBD-II, off board diagnostics.

**Text Books:**

1. Understanding Automotive Electronics, William B Ribbens, Newne Butterworth-Heiner 6th edition 2003.
2. Crouse W H, Automobile Elctrical Equipment, McGraw Hill Book Co.Inc, Newyork 2005.

**Reference Books:**

1. Bechhold "Understanding Automotive Electronics", SAE, 1998.
2. Robert Bosch "Automotive Hand Book", SAE (5th Edition), 2000.
3. Tom Denton,"Automobile Electrical and Electronic Systems" 3rd edition- Edward Arnold, London - 2004.
4. Eric Chowanietz - 'Automotive Electronics' - SAE International USA – 1995.

| Course Code | | RAPID PROTOTYPING (Open Elective) | L | T | P | C |
|---|---|---|---|---|---|---|
| Semester | | | 3 | 0 | 0 | 3 |

**Course Objectives:**

- Familiarize techniques for processing of CAD models for rapid prototyping.
- Explain fundamentals of rapid prototyping techniques.
- Demonstrate appropriate tooling for rapid prototyping process.
- Focus Rapid prototyping techniques for reverse engineering.
- Train Various Pre – Processing, Processing and Post Processing errors in RP Processes.

**Course Outcomes (CO):**

After completion of this course the student can be able to

- use techniques for processing of CAD models for rapid prototyping. (L3)
- understand and apply fundamentals of rapid prototyping techniques. ((L3)
- use appropriate tooling for rapid prototyping process. (L3)
- use rapid prototyping techniques for reverse engineering. (L3)
- identify Various Pre – Processing, Processing and Post Processing errors in RP processes. (L3)

| UNIT - I | **Introduction** | Lecture Hrs: 8 |
|---|---|---|

Introduction**:** Introduction to Prototyping, Traditional Prototyping Vs. Rapid Prototyping (RP), Need for time compression in product development, Usage of RP parts, Generic RP process, Distinction between RP and CNC, other related technologies, Classification of RP.

RP Software**:** Need for RP software, MIMICS, Magics, SurgiGuide, 3-matic, 3D-Doctor, Simplant, Velocity2, VoXim, SolidView, 3DView, etc., software, Preparation of CAD models, Problems with STL files, STL file manipulation, RP data formats: SLC, CLI, RPI, LEAF, IGES, HP/GL, CT, STEP

| UNIT - II | Solid and Liquid Based RP Systems**:** | Lecture Hrs: 8 |
|---|---|---|

Solid and Liquid Based RP Systems**:** Stereolithography (SLA): Principle, Process, Materials, Advantages, Limitations and Applications. Solid Ground Curing (SGC): Principle, Process, Materials, Advantages, Limitations, Applications. Fusion Deposition Modeling (FDM): Principle, Process, Materials, Advantages, Limitations, Applications. Laminated Object Manufacturing (LOM): Principle, Process, Materials, Advantages, Limitations, Applications.

| UNIT - III | Powder Based RP Systems**:** | Lecture Hrs: 8 |
|---|---|---|

Powder Based RP Systems**:** Principle and Process of Selective Laser Sintering (SLS), Advantages, Limitations and Applications of SLS, Principle and Process of Laser Engineered Net Shaping (LENS), Advantages, Limitations and Applications of LENS, Principle and Process of Electron Beam Melting (EBM), Advantages, Limitations and Applications of EBM.

Other RP Systems: Three Dimensional Printing (3DP): Principle, Process, Advantages, Limitations and Applications. Ballastic Particle Manufacturing (BPM): Principle, Process, Advantages, Limitations, Applications. Shape Deposition Manufacturing (SDM): Principle, Process, Advantages, Limitations, Applications.

| UNIT - IV | **Rapid Tooling and Reverse Engineering** | Lecture Hrs: 8 |
|---|---|---|

Rapid Tooling: Conventional Tooling Vs. Rapid Tooling, Classification of Rapid Tooling, Direct and Indirect Tooling Methods, Soft and Hard Tooling methods.

Reverse Engineering (RE): Meaning, Use, RE – The Generic Process, Phases of RE Scanning, Contact Scanners and Noncontact Scanners, Point Processing, Application Geometric Model, Development.

| UNIT - V | **Errors in RP process and RP Applications** | Lecture Hrs: 10 |
|---|---|---|

Errors in RP Processes: Pre-processing, processing, post-processing errors, Part building errors in SLA, SLS, etc.

RP Applications: Design, Engineering Analysis and planning applications, Rapid Tooling, Reverse Engineering, Medical Applications of RP.

**Text Books:**

1. Chua C.K., Leong K.F. and Lim C.S., Rapid Prototyping: Principles and Applications, 2/e Edition, World Scientific Publishers, 2003.
2. Ian Gibson, David W. Rosen, Brent Stucker, Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, 1st Edition, Springer, 2010.
3. Rafiq Noorani, Rapid Prototyping: Principles and Applications in Manufacturing, John Wiley & Sons, 2006.

**Reference Books:**

1. Liou W. Liou, Frank W., Liou, Rapid Prototyping and Engineering Applications: A Tool Box for Prototype Development, CRC Press, 2007.
2. Pham D.T. and Dimov S.S., Rapid Manufacturing; The Technologies and Application of RPT and Rapid tooling, Springer, London 2001.
3. Gebhardt A., Rapid prototyping, Hanser Gardener Publications, 2003.
4. Hilton P.D. and Jacobs P.F., Rapid Tooling: Technologies and Industrial Applications, CRC Press, 2005.

**Online Learning Resources:**

| Course Code | | PROGRAMMING OF ROBOT AND ITS CONTROL (Open Elective) | L | T | P | C |
|---|---|---|---|---|---|---|
| Semester | | | 3 | 0 | 0 | 3 |

**Course Objectives:**

- Learn the fundamental concepts of industrial robotic technology.
- Apply the basic mathematics to calculate kinematic and dynamic forces in robot manipulator.
- Understand the robot controlling and programming methods.
- Describe concept of robot vision system . .

**Course Outcomes (CO):**

After completion of this course the student can be able to

- explain fundamentals of Robots. (L2)
- apply kinematics and differential motions and velocities. (L3)
- demonstrate control of manipulators. (L2)
- understand robot vision. (L2)
- develop robot cell design and programming. (L3)

| UNIT - I | **Fundamentals of Robots:** | Lecture Hrs: 8 |
|---|---|---|

**Fundamentals of Robots:** Introduction, definition, classification and history of robotics, robot characteristics and precision of motion, advantages, disadvantages and applications of robots.

| UNIT - II | **Robot Actuators And Feedback Components** | Lecture Hrs: 8 |
|---|---|---|

**Robot Actuators And Feedback Components:** Actuators, Pneumatic, Hydraulic actuators, Electric & Stepper motors, comparison. Position sensors - potentiometers, resolvers, encoders - velocity sensors, Tactile sensors, Proximity sensors.

| UNIT - III | **Robot Programming:** | Lecture Hrs: 8 |
|---|---|---|

**Robot Programming:** Methods of programming - requirements and features of programming languages, software packages, problems with programming languages. VAL, RAIL, AML, C, C++.

| UNIT - IV | **Control of Manipulators:** | Lecture Hrs: 8 |
|---|---|---|

**Control of Manipulators:** Open- and close-loop control, the manipulator control problem, linear control schemes, characteristics of second-order linear systems, linear second-order SISO model of a manipulator joint, joint actuators, partitioned PD control scheme, PID control Scheme, computer Torque control, force control of robotic manipulators, description of force-control tasks, force control strategies, hybrid position/force control, impedance force/torque control.

| UNIT - V | **Robot Vision:** | Lecture Hrs: 10 |
|---|---|---|

**Robot Vision:** Introduction, architecture of robotic vision system, image processing, image acquisition camera, image enhancement, image segmentation, imaging transformation, Camera transformation and calibrations, industrial applications of robot vision.

**Text Books:**

1. Mikell P. Groover and Mitchell Weiss, Roger N. Nagel,Nicholas G.Odrey , Industrial Robotics — Mc Graw Hill, 1986.
2. R K Mittal and I J Nagrath, Robotics and control, Illustrated Edition, Tata McGraw Hill India 2003.

**Reference Books:**

1. Saeed B. Niku, Introduction to Robotics – Analysis, System, Applications, 2nd Edition, John Wiley & Sons, 2010.
2. H. Asada and J.J.E. Slotine, Robot Analysis and Control, 1st Edition Wiley- Interscience, 1986.
3. Robert J. Schillin, Fundamentals of Robotics: Analysis and control, Prentice-Hall Of India

Pvt. Limited, 1996.
4. Mohsen shahinpoor, A robot Engineering text book, Harper & Row Publishers,1987.
5. John.J.Craig Addison, Introduction to Robotics: Mechanics and Control, Wesley, 1999.
6. K.S. FU, R.C. Gonzalez and C.S.G Lee, Robotics: Control, sensing, vision, and intelligence . Mc Graw Hill, 1987.
7. Richard D. Klafter, Thomas Robotic Engineering an integrated approach, PHI publications 1988.

**Online Learning Resources:**

| Course Code | | INDUSTRY 4.0 (Open Elective) | L | T | P | C |
|---|---|---|---|---|---|---|
| Semester | | | 3 | 0 | 0 | 3 |

**Course Objectives:**

- This course is designed to offer learners an introduction to Industry 4.0 and its applications.
- Learners will gain deep insights into how smartness is being harnessed from data.
- Learners will understand what needs to be done in order to overcome the challenges.
- To familiarize in Industry 4.0 in healthcare services.

**Course Outcomes (CO):**

After completion of this course the student can be able to

- explain fundamentals of Robots. (L2)
- apply kinematics and differential motions and velocities. (L3)
- demonstrate control of manipulators. (L2)
- understand robot vision. (L2)
- develop robot cell design and programming. (L3)

| UNIT - I | Introduction to Industry 4.0: | Lecture Hrs: 8 |
|---|---|---|

Introduction to Industry 4.0- The Various Industrial Revolutions, Digitalisation and the Networked Economy, Drivers, Enablers, Compelling Forces and Challenges for Industry 4.0, Comparison of Industry 4.0 Factory and Today's Factory, Trends of Industrial Big Data and Predictive Analytics for Smart Business Transformation

| UNIT - II | Internet of Things (IoT) | Lecture Hrs: 8 |
|---|---|---|

Internet of Things (IoT) & Industrial Internet of Things (IIoT) & Internet of Services, Smart Manufacturing, Smart Devices and Products, Smart Logistics, Smart Cities, Predictive Analytics.

| UNIT - III | Technologies for enabling Industry 4.0 : | Lecture Hrs: 8 |
|---|---|---|

Technologies for enabling Industry 4.0 - Cyber Physical Systems, Robotic Automation and Collaborative Robots, Support System for Industry 4.0, Mobile Computing, Cyber Security.

| UNIT - IV | 3D printing technologies | Lecture Hrs: 8 |
|---|---|---|

3D printing technologies, selection of material and equipment, develop a product using 3D printing in Industry 4.0 environment.

| UNIT - V | IOT Case studies | Lecture Hrs: 10 |
|---|---|---|

IoT case studies, Industry 4.0 in healthcare services, Strategies for competing in an Industry 4.0 world.

**Text Books:**

1. Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", Apress, 2016.
2. Lan Gibson, David W. Rosen and Brent Stucker, "Additive Manufacturing Technologies Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.

**Reference Books:**

1. Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing", Hanser Publisher, 2011.
2. J. Chanchaichujit, A.Tan, Meng, F., Eaimkhong, S. "Healthcare 4.0 Next Generation Processes with the Latest Technologies", Palgrave Pivot, 2019.

**Online Learning Resources:**

| Course Code | | DISASTER MANAGEMENT (Audit Course 1 and 2) | L | T | P | C |
|---|---|---|---|---|---|---|
| Semester | | | 2 | 0 | 0 | 0 |

**Course Objectives:**

- learn to demonstrate a critical understanding of key concepts in disaster risk reduction and
- humanitarian response.
- critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple
- perspectives.
- develop an understanding of standards of humanitarian response and practical relevance in
- specific types of disasters and conflict situations.
- critically understand the strengths and weaknesses of disaster management approaches,
- planning and programming in different countries, particularly their home country or the countries they work in

**Course Outcomes (CO):**

After completion of this course the student can be able to

- explain various reasons for disasters in India (L2)
- demonstrate Disaster Prone Areas In India (L2)
- understand risk assessment and disaster mitigation. (L2)

| UNIT - I | **Introduction** | Lecture Hrs: 8 |
|---|---|---|

Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.

| UNIT - II | **Repercussions Of Disasters And Hazards**: | Lecture Hrs: 8 |
|---|---|---|

**Repercussions Of Disasters And Hazards**: Economic Damage, Loss Of Human And Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

| UNIT - III | **Disaster Prone Areas In India** | Lecture Hrs: 8 |
|---|---|---|

**Disaster Prone Areas In India:**Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics

| UNIT - IV | **Disaster Preparedness And Management** | Lecture Hrs: 8 |
|---|---|---|

**Disaster Preparedness And Management:** Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.

| UNIT - V | **Risk Assessment & Disaster Mitigation** | Lecture Hrs: 10 |
|---|---|---|

**Risk Assessment:** Disaster Risk: Concept And Elements, Disaster Risk Reduction, Global And National Disaster Risk Situation. Techniques Of Risk Assessment, Global Co-Operation In Risk Assessment And Warning, People's Participation In Risk Assessment. Strategies for Survival.

**Disaster Mitigation:** Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.

**Text Books:**

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.
2. Sahni, PardeepEt.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice

| |
|---|
| Hall Of India, New Delhi. |
| **Reference Books:** |
| 1. Goel S. L. , Disaster Administration And Management Text And Case Studies" ,Deep &Deep Publication Pvt. Ltd., New Delhi. |
| **Online Learning Resources:** |
| |

| Course Code | | SANSKRIT FOR TECHNICAL KNOWLEDGE (Audit Course 1 and 2) | L | T | P | C |
|---|---|---|---|---|---|---|
| Semester | | | 2 | 0 | 0 | 0 |

**Course Objectives:**

- To get a working knowledge in illustrious Sanskrit, the scientific language in the world
- Learning of Sanskrit to improve brain functioning
- Learning of Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power
- The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature

**Course Outcomes (CO):**

After completion of this course the student can be able to

- Understanding basic Sanskrit language
- Ancient Sanskrit literature about science & technology can be understood
- Being a logical language will help to develop logic in students

| UNIT - I | | Lecture Hrs: 8 |
|---|---|---|

- Alphabets in Sanskrit,
- Past/Present/Future Tense,
- Simple Sentences

| UNIT - II | | Lecture Hrs: 8 |
|---|---|---|

- Order
- Introduction of roots
- Technical information about Sanskrit Literature

| UNIT - III | | Lecture Hrs: 8 |
|---|---|---|

- Technical concepts of Engineering-Electrical, Mechanical,
- Architecture, Mathematics

**Text Books:**

1. "Abhyaspustakam" – Dr.Vishwas, Samskrita-Bharti Publication, New Delhi.
2. "Teach Yourself Sanskrit" Prathama Deeksha-VempatiKutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication.

**Reference Books:**

1. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi.

**Online Learning Resources:**

| Course Code | | VALUE EDUCATION | L | T | P | C |
|---|---|---|---|---|---|---|
| Semester | | (Audit Course 1 and 2) | 2 | 0 | 0 | 0 |

**Course Objectives:**

Students will be able to

- Understand value of education and self- development.
- Imbibe good values in students.
- Let the should know about the importance of character.

**Course Outcomes (CO):**

After completion of this course the student can be able to

- Knowledge of self-development
- Learn the importance of Human values
- Developing the overall personality

| UNIT - I | | Lecture Hrs: 8 |
|---|---|---|

- Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism.
- Moral and non- moral valuation. Standards and principles.
- Value judgments

| UNIT - II | | Lecture Hrs: 8 |
|---|---|---|

- Importance of cultivation of values.
- Sense of duty. Devotion, Self-reliance. Confidence, Concentration.
- Truthfulness, Cleanliness.
- Honesty, Humanity. Power of faith, National Unity.
- Patriotism. Love for nature ,Discipline

| UNIT - III | | Lecture Hrs: 8 |
|---|---|---|

- Personality and Behavior Development - Soul and Scientific attitude.
- Positive Thinking. Integrity and discipline.
- Punctuality, Love and Kindness.
- Avoid fault Thinking.
- Free from anger, Dignity of labour.
- Universal brotherhood and religious tolerance.
- True friendship.
- Happiness Vs suffering, love for truth.
- Aware of self-destructive habits.
- Association and Cooperation.
- Doing best for saving nature

**Text Books:**

1. "Abhyaspustakam" – Dr.Vishwas, Samskrita-Bharti Publication, New Delhi.
3. "Teach Yourself Sanskrit" Prathama Deeksha-VempatiKutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication.

**Reference Books:**

2. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi.

**Online Learning Resources:**

| Course Code | | CONSTITUTION OF INDIA | L | T | P | C |
|---|---|---|---|---|---|---|
| Semester | | (Audit Course 1 and 2) | 2 | 0 | 0 | 0 |

**Course Objectives:**

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

**Course Outcomes (CO):**

After completion of this course the student can be able to

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

| UNIT - I | **Introduction** | Lecture Hrs: 8 |
|---|---|---|

**History of Making of the Indian Constitution:**

- History, Drafting Committee, ( Composition & Working)

**Philosophy of the Indian Constitution:**

- Preamble, Salient Features.

| UNIT - II | **Contours of Constitutional Rights & Duties:** | Lecture Hrs: 8 |
|---|---|---|

**Contours of Constitutional Rights & Duties:**

- Fundamental Rights
- Right to Equality
- Right to Freedom
- Right against Exploitation
- Right to Freedom of Religion
- Cultural and Educational Rights
- Right to Constitutional Remedies
- Directive Principles of State Policy
- Fundamental Duties.

| UNIT - III | **Organs of Governance:** | Lecture Hrs: 8 |
|---|---|---|

**Organs of Governance:**

- Parliament
- Composition
- Qualifications and Disqualifications
- Powers and Functions
- Executive
- President
- Governor
- Council of Ministers

| | | |
|---|---|---|
| • Judiciary, Appointment and Transfer of Judges, Qualifications<br>• Powers and Functions | | |
| UNIT - IV | **Local Administration:** | Lecture Hrs: 8 |
| **Local Administration:**<br>• District's Administration head: Role and Importance,<br>• Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation.<br>• Pachayati raj: Introduction, PRI: ZilaPachayat.<br>• Elected officials and their roles, CEO ZilaPachayat: Position and role.<br>• Block level: Organizational Hierarchy (Different departments),<br>• Village level: Role of Elected and Appointed officials,<br>• Importance of grass root democracy | | |
| UNIT - V | **Election Commission:** | Lecture Hrs: 10 |
| **Election Commission:**<br>• Election Commission: Role and Functioning.<br>• Chief Election Commissioner and Election Commissioners.<br>• State Election Commission: Role and Functioning.<br>• Institute and Bodies for the welfare of SC/ST/OBC and women. | | |
| **Text Books:**<br>1. The Constitution of India, 1950 (Bare Act), Government Publication.<br>2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015. | | |
| **Reference Books:** | | |
| 1. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.<br>2. 4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015. | | |
| **Online Learning Resources:** | | |
| | | |

| Course Code | | PEDAGOGY STUDIES | L | T | P | C |
|---|---|---|---|---|---|---|
| Semester | | (Audit Course 1 and 2) | 2 | 0 | 0 | 0 |

**Course Objectives:**

- Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

**Course Outcomes (CO):**

After completion of this course the student can be able to

- What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?
- What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
- How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

| UNIT - I | **Introduction and Methodology:** | Lecture Hrs: 8 |
|---|---|---|

- Aims and rationale, Policy background, Conceptual framework and terminology
- Theories of learning, Curriculum, Teacher education.
- Conceptual framework, Research questions
- Overview of methodology and Searching.

| UNIT - II | Thematic overview: | Lecture Hrs: 8 |
|---|---|---|

- Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries.
- Curriculum, Teacher education.

| UNIT - III | | Lecture Hrs: 8 |
|---|---|---|

- Evidence on the effectiveness of pedagogical practices
- Methodology for the in depth stage: quality assessment of included studies.
- How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?
- Theory of change.
- Strength and nature of the body of evidence for effective pedagogical practices.
- Pedagogic theory and pedagogical approaches.
- Teachers' attitudes and beliefs and Pedagogic strategies.

| UNIT - IV | Professional development: | Lecture Hrs: 8 |
|---|---|---|

- Professional development: alignment with classroom practices and follow-up support
- Peer support
- Support from the head teacher and the community.
- Curriculum and assessment
- Barriers to learning: limited resources and large class sizes

| UNIT - V | **Research gaps and future directions** | Lecture Hrs: 10 |
|---|---|---|

- Research design
- Contexts
- Pedagogy
- Teacher education
- Curriculum and assessment
- Dissemination and research impact.

**Text Books:**

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.

**Reference Books:**

1. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
2. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.
3. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
4. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.

**Online Learning Resources:**

www.pratham.org/images/resource%20working%20paper%202.pdf.

| Course Code | | STRESS MANAGEMENT BY YOGA | L | T | P | C |
|---|---|---|---|---|---|---|
| Semester | I | (Audit Course 1 and 2) | 2 | 0 | 0 | 0 |

**Course Objectives:**

- To achieve overall health of body and mind.
- To overcome stress.

**Course Outcomes (CO):** Student will be able to

Students will be able to:

- Develop healthy mind in a healthy body thus improving social health also.
- Improve efficiency.

| UNIT - I | **Basic Concepts** | Lecture Hrs: 8 |
|---|---|---|

Definitions of Eight parts of yog. ( Ashtanga )

| UNIT - II | **Yam and Niyam** | Lecture Hrs: 8 |
|---|---|---|

**Yam and Niyam**:

Do`s and Don't's in life.

i) Ahinsa, satya, astheya, bramhacharya and aparigraha
ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan

| UNIT - III | **Asan and Pranayam** | Lecture Hrs: 8 |
|---|---|---|

**Asan and Pranayam:**

i) Various yog poses and their benefits for mind & body
ii) Regularization of breathing techniques and its effects-Types of pranayam

**Textbooks:**

1. Janardan Swami Yogabhyasi Mandal 'Yogic Asanas for Group Tarining-Part-I', Nagpur.
2. Swami Vivekananda "Rajayoga or conquering the Internal Nature", Advaita Ashrama (Publication Department), Kolkata.

**Reference Books:**

1. Yoga Student Handbook, Class XI, Trainee manual, Centra Board of Secondary Education, India.
2. Acharya Yatendra, Yoga & Stress Management, Fingerprint! Publishing, 2019.

**Online Learning Resources:**

- https://www.youtube.com/watch?v=bMEqN8yGMu4
- https://www.youtube.com/watch?v=Jf5qUhz-FVk
- https://www.artofliving.org/us-en/how-to-incorporate-the-8-limbs-of-yoga-into-your-practice
- https://www.youtube.com/watch?v=kxVNwXGlXRk

| Course Code | | PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS (Audit Course 1 and 2) | L | T | P | C |
|---|---|---|---|---|---|---|
| Semester | | | 2 | 0 | 0 | 0 |

**Course Objectives:**

- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To awaken wisdom in students

**Course Outcomes (CO):**

After completion of this course the student can be able to

- Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life.
- The person who has studied Geeta will lead the nation and mankind to peace and prosperity.
- Study of Neetishatakam will help in developing versatile personality of students.

| UNIT - I | Neetisatakam | Lecture Hrs: 8 |
|---|---|---|

Neetisatakam-Holistic development of personality

- Verses- 19,20,21,22 (wisdom)
- Verses- 29,31,32 (pride & heroism)
- Verses- 26,28,63,65 (virtue)
- Verses- 52,53,59 (dont's)
- Verses- 71,73,75,78 (do's)

| UNIT - II | | Lecture Hrs: 8 |
|---|---|---|

- Approach to day to day work and duties.
- Shrimad BhagwadGeeta: Chapter 2-Verses 41, 47,48,
- Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35,
- Chapter 18-Verses 45, 46, 48.

| UNIT - III | | Lecture Hrs: 8 |
|---|---|---|

- Statements of basic knowledge.
- Shrimad BhagwadGeeta: Chapter2-Verses 56, 62, 68
- Chapter 12 -Verses 13, 14, 15, 16,17, 18
- Personality of Role model. Shrimad BhagwadGeeta:
- Chapter2-Verses 17, Chapter 3-Verses 36,37,42,
- Chapter 4-Verses 18, 38,39
- Chapter18 – Verses 37,38,63

**Text Books:**

1. "Srimad Bhagavad Gita" by Swami SwarupanandaAdvaita Ashram (Publication Department), Kolkata

**Reference Books:**

1. Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi.