JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR
Course Structure and syllabi for
M.Tech-ME-Thermal Sciences and Energy Systems
Offered by Department of Mechanical Engineering
for affiliated Engineering Colleges 2017-18

I YEAR I Semester

S. No	Course code	Subject	L	T	P	C
1.	17D11101	Energy Management in Thermal Systems	4	-	-	4
2.	17D11102	Advanced Thermodynamics	4	-	-	4
3.	17D11103	Renewable Energy Sources	4	-	-	4
4.	17D11104	Fuels & Combustion Technology	4	-	-	4
5.	 17D11105 17D11106 17D11107	Elective-I a) Design of Air-Conditioning Systems b) Energy Conversion Technologies C) Solar Passive Architecture	4	-	-	4
6.	 17D11108 17D11109 17D11110	Elective II a) Instrumentation for Thermal Engineering b) Refrigeration and Cryogenics c) Advanced Power Plant Engineering	4	-	-	4
7.	17D11111	Thermal Science Laboratory	-	-	3	2
		Total	24	-	3	26

I YEAR II Semester

S. No	Course code	Subject	L	T	P	C
1.	17D11201	Advanced Heat and Mass Transfer	4	-	-	4
2.	17D11202	Advanced Energy Technologies	4	-	-	4
3.	17D11203	Energy Auditing and Management	4	-	-	4
4.	17D11204	Computational Fluid Dynamics	4	-	-	4
5.	 17D11205 17D11206 17D11207	Elective-III a) Energy Systems & Modeling Analysis b) Optimization Techniques and its applications c) Energy Storage Systems	4	-	-	4
6.	 17D11208 17D11209 17D11210	Elective – IV a) Design of heat transfer equipment b) Advanced internal combustion Engine c) Cogeneration and waste heat recovery system.	4	-	-	4
7.	17D11211	Manufacturing Simulation Laboratory	-	-	4	2
		Total	24	-	4	26

III SEMESTER

S.No	Subject Code	Subject	L	T	P	C
1.	 17D20301 17D20302 17D20303	Elective V a) Research Methadology b) Human Values and Professional Ethics c) Intellectual Property Rights	4	-	-	4
2.	17D11301	Elective VI (MOOCS)	-	-	-	-
3.	17D11302	Comprehensive Viva – Voice	-	-	-	2
4.	17D11303	Seminar	-	-	-	2
5.	17D11304	Teaching Assignment	-	-	-	2
6.	17D11305	Project work phase – I	-	-	-	4

IV SEMESTER

S.No	Subject Code	Subject	L	T	P	C
1.	17D11401	Project work Phase – II	-	-	-	12

Project Viva Voce Grades:

A: Satisfactory
B: Not Satisfactory

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M. Tech – I year I Sem. (TSES)	**L**	**T**	**P**	**C**
	4	**0**	**0**	**4**

(17D11101) ENERGY MANAGEMENT IN THERMAL SYSTEMS

AIM :

To course is intended to introduce principles of energy auditing and to provide measures for energy
conservation in thermal applications

OBJECTIVES:

To learn the present energy scenario and the need for energy conservation
To learn the instruments suitable for energy auditing.
To study the various measures for energy conservation and financial implications for various thermal utilities

UNIT I INTRODUCTION

Energy Scenario – world and India. Energy Resources Availability in India. Energy consumption pattern. Energy conservation potential in various Industries and commercial establishments. Energy intensive industries – an overview. Energy conservation and energy efficiency – needs and advantages. Energy auditing – types, methodologies, barriers. Role of energy manager – Energy audit questionnaire – energy Conservation Act 2003.

UNIT II INSTRUMENTS FOR ENERGY AUDITING

Instrument characteristics – sensitivity, readability, accuracy, precision, hystersis. Error and calibration. Measurement of flow, velocity, pressure, temperature, speed, Lux, power and humidity. Analysis of stack, water quality, power and fuel quality.

UNIT III THERMAL UTILITIES: OPERATION AND ENERGY CONSERVARTION

(i) Boilers (ii) Thermic Fluid Heaters (iii) Furnaces
(iv) Waste Heat Recovery Systems (v) Thermal Storage

UNIT IV THERMAL ENERGY TRANSMISSION / PROTECTION SYSTEMS

Steam traps – refractories – optimum insulation thickness – insulation – piping design

UNIT V FINANCIAL MANAGEMENT

Investment – need, appraisal and criteria, financial analysis techniques – break even analysis – simple pay back period, return on investment, net present value, internal rate of return, cash flows, DSCR, financing options, ESCO concept.

Course Outcomes:

Having basic understanding of combustion process and knowledge of on-site thermal energy generation systems, insulation and typical thermal utilities and services of organizations.

Becoming aware of the structure and functioning of thermal energy systems of industrial units and organizations.

Student acquired the techniques and skills of thermal energy analysis and identification of opportunities and options for the thermal energy conservation and management.

TEXT BOOKS:

1. Smith, CB Energy Management Principles, Pergamon Press, NewYork, 1981
2. Hamies, Energy Auditing and Conservation; Methods Measurements, Management and Case study, Hemisphere, Washington, 1980

REFERENCES

1. Trivedi, PR, Jolka KR, Energy Management, Commonwealth Publication, New Delhi, 1997
2. Write, Larry C, Industrial Energy Management and Utilization, Hemisphere Publishers, Washington, 1988
3. Diamant, RME, Total Energy, Pergamon, Oxford, 1970
4. Handbook on Energy Efficiency, TERI, New Delhi, 2001
5 .Guide book for National Certification Examination for Energy Managers and Energy Auditors (Could be downloaded from www.energymanagertraining.com)

M. Tech – I year I Sem. (TSES)

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(17D11102) ADVANCED THERMODYNAMICS (ATD)

COURSE OBJECTIVES:

The objective of this course is to prepare graduate level engineering students to effectively solve theoretical and applied thermodynamics problems that are directly applicable to situations faced in research and industry. Significant emphasis is placed on the integration of recent thermodynamics-related research into the traditional resources in order to foster critical analysis of current work as it relates to fundamental principles.

UNIT I AVAILABILITY ANALYSIS AND THERMODYNAMIC PROPERTY RELATIONS

Reversible work - availability - irreversibility and second – law efficiency for a closed system and steady – state control volume. Availability analysis of simple cycles. Thermodynamic potentials. Maxwell relations. Generalized relations for changes in entropy - internal energy and enthalpy - generalized relations for Cp and CV Clausius Clayperon equation, Joule – Thomson coefficient.Bridgeman tables for thermodynamic relations.

UNIT II REAL GAS BEHAVIOUR AND MULTI – COMPONENT SYSTEMS

Different equations of state – fugacity – compressibility - principle of corresponding States - Use of generalized charts for enthalpy and entropy departure - fugacity coefficient,Lee – Kesler generalized three parameter tables. Fundamental property relations for systems of variable composition.Partial molar properties.Real gas mixtures - Ideal solution of real gases and liquid - activity - equilibrium in multi phase systems - Gibbs phase rule for non – reactive components.

UNIT III CHEMICAL THERMODYNAMICS AND EQUILIBRIUM

Thermochemistry - First law analysis of reacting systems - Adiabatic flame temperature – entropy change of reacting systems - Second law analysis of reacting systems - Criterion for reaction equilibrium.Equilibrium constant for gaseous mixtures - evaluation of equilibrium composition.

UNIT IV STATISTICAL THERMODYNAMICS

Microstates and Macrostates - thermodynamic probability - degeneracy of energy levels - Maxwell – Boltzman, Fermi – Diarc and Bose – Einstein statistics - microscopic interpretation of heat and work, evaluation of entropy, partion function, calculation of the Macroscopic properties from partition functions.

UNIT V IRREVERSIBLE THERMODYNAMICS

Conjugate fluxes and forces - entropy production Onsager's reciprocity relations - thermo – electric phenomena, formulations.

COURSE OUTCOMES:

By the end of this course, students will be able to:

1. Describe and calculate thermodynamic properties of single-phase and multi-phase systems
2. Apply the laws of statistical and classical thermodynamics to chemically reactive systems, kinetics, and combustion. 3. Relate course principles to solve problems regarding gas turbines, combustion, refrigeration, and solar energy.

TEXT BOOKS :

1. Kenneth Wark Jt.m, Advanced Thermodynamics for Engineers, McGrew – Hill Inc., 1995.
2. Bejan, A., Advanced Engineering Thermodynamics, John Wiley and Cons, 1988.
3. Holman, J.P., Thermodynamics, Fourth Edition, McGraw – Hill Inc., 1988.

REFERENCES

1. Smith, J.M. and Van Ness., H.C., Introduction to Chemical Engineering Thermodynamics, Fourth Edition, McGraw – Hill Inc., 1987.
2. Sonntag, R.E., and Van Wylen, G, Introduction to Thermodynamics, Classical and Statistical Themodynamics, Third Edition, John Wiley and Sons, 1991.
3. Sears, F.W. and Salinger G.I., Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Third Edition, Narosa Publishing House, New Delhi, 1993.
4. DeHotf, R.T., Thermodynamics in Materials Science, McGraw – Hill Inc., 1993. Rao, Y.V.C., Postulational and Statistical Thermodynamics, Allied Publisher Limited, New Delhi, 1999.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

M. Tech – I year I Sem. (TSES)

L	T	P	C
4	0	0	4

(17D11103) RENEWABLE ENERGY SOURCES (RES)

COURSE OBJECTIVES:

1. TO provide an introduction to energy systems and renewable energy resources, with a scientific examination of the energy field and an emphasis on alternate energy sources and their technology and application.
2. To explore society's present needs and future energy demands, examine conventional energy sources and systems, including fossil fuels and nuclear energy.
3. To focus on alternate, renewable energy sources such as solar, biomass (conversions), wind power, geothermal, and hydro, Energy conservation methods.

Unit-I

SOLAR RADIATION AND COLLECTING DEVICES:

Solar Incident Flux ,Extraterrestrial Radiation, Clear Sky Irradiation, Solar Radiation Measurement, Monthly Average Radiation on Tilted Surfaces.

Cover plates, Collector Plate Surfaces, Collector Performance, Collector Improvement, Effect of Incident Angle, Heat Transfer to Fluids, Heat Transfer Factors, Concentrating Collectors, Reflectors.

Unit-II

SOLAR SYSTEM DESIGN AND ECONOMIC EVALUATION

Hot water heating , heating and hot water systems , pumps and fans, sizing pipe and duct work, fundamentals of economic analysis, systems optimization

Unit-III

WIND ENERGY SYSTEMS:

Orientation systems and Regulating devices, Types of Wind Turbines, Operating Characteristics, Basics of Airfoil Theory, Wind energy for water pumping and generation of electricity, Installation operation and maintenance of small wind energy conversion systems.

Unit-IV

ENERGY FROM WATER:
OTEC–Principle of operation, Open and Closed OTEC cycles,
Wave energy: Wave energy conversion machines and recent advances

Tidal Energy: Single basin and double basin tidal systems
Small-Mini-Micro hydro system: Concepts, Types of turbines, Hydrological analysis

Unit-V
GEOTHERMAL ENERGY:
Introduction, Classification of Geo-thermal areas, Applications of Geo-thermal energy for power generation, Economics of Geo-thermal energy.

MHD POWER GENERATION:
Principles of MHD Power Generation, Ideal MHD–Generator Performance, Practical MHD Generator: Faraday and Hall Configurations, MHD Technology.

COURSE OUTCOMES: At the successful completion of subject the student is expected to have/be able to:
1. List and generally explain the main sources of energy and their primary applications in the US, and the world.
2. Describe the challenges and problems associated with the use of various energy sources, including fossil fuels, with regard to future supply and the environment.
3. Discuss remedies/potential solutions to the supply and environmental issues associated with fossil fuels and other energy resources.
4. List and describe the primary renewable energy resources and technologies.

TEXT BOOK:
1. Peter J.Lunde *Solar Thermal Engineering* , John Wiley & Sons

REFERENCE BOOKS :
1. G.N Tewar*i ,"Solar Thrmal Engineerng , TMH*
2. H.P Garg, *Solar Energy Fundamentals and Applications,* , TMH
3. S.P sukhatme, *Solar Energy Principles of thermal storage*,TMH

M. Tech – I year I Sem. (TSES)

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(17D11104) FUELS AND COMBUSTION TECHNOLOGY

Course Objective: To learn about types of fuels and their characteristics, and combustion systems with emphasis on engineering applications.

UNIT I CHARACTERIZATION

Fuels - Types and Characteristics of Fuels - Determination of Properties of Fuels – Fuels Analysis - Proximate and Ultimate Analysis - Moisture Determination - Calorific Value - Gross & Net Calorific Values - Calorimetry - DuLong's Formula for CV Estimation - Flue gas Analysis - Orsat Apparatus - Fuel & Ash Storage & Handling - Spontaneous Ignition Temperatures.

UNIT II SOLID FUELS & LIQUID FUELS

(a) Solid Fuels

Types - Coal Family - Properties - Calorific Value - ROM, DMMF, DAF and Bone Dry Basis - Ranking - Bulk & Apparent Density - Storage - Washability - Coking & Caking Coals – Renewable Solid Fuels - Biomass - Wood Waste - Agro Fuels - Manufactured Solid Fuels.

(b) Liquid Fuels

Types - Sources - Petroleum Fractions - Classification - Refining - Properties of Liquid Fuels - Calorific Value, Specific Gravity, Flash & Fire Point, Octane Number, Cetane Number etc, - Alcohols - Tar Sand Oil - Liquefaction of Solid Fuels.

UNIT III GASEOUS FUELS

Classification - Composition & Properties - Estimation of Calorific Value - Gas Calorimeter. Rich & Lean Gas - Wobbe Index - Natural Gas - Dry & Wet Natural Gas - Stripped NG - Foul & Sweet NG - LPG - LNG - CNG - Methane - Producer Gas - Gasifiers - Water Gas - Town Gas - Coal Gasification - Gasification Efficiency - Non - Thermal Route - Biogas - Digesters - Reactions - Viability - Economics.

UNIT IV COMBUSTION : STOICHIOMETRY & KINETICS

Stoichiometry - Mass Basis & Volume Basis - Excess Air Calculation - Fuel & Flue Gas Compositions - Calculations - Rapid Methods - Combustion Processes - Stationary Flame - Surface or Flameless Combustion - Submerged Combustion - Pulsating & Slow Combustion Explosive Combustion. Mechanism of Combustion - Ignition & Ignition Energy - Spontaneous Combustion – Flame Propagation - Solid, Liquid & Gaseous Fuels Combustion - Flame Temperature - Theoretical, Adiabatic & Actual - Ignition Limits - Limits of Inflammability.

UNIT V COMBUSTION EQUIPMENTS

Coal Burning Equipments - Types - Pulverized Coal Firing - Fluidized Bed Firing - Fixed Bed &
Recycled Bed - Cyclone Firing - Spreader Stokers - Vibrating Grate Stokers - Sprinkler Stokers,
Traveling Grate Stokers. Oil Burners - Vaporizing Burners, Atomizing Burners - Design of Burners. Gas Burners - Atmospheric Gas Burners - Air Aspiration Gas Burners - Burners Classification according to Flame Structures - Factors Affecting Burners & Combustion.

Course Outcome:

• Ability to characterize the fuels
• Understanding of thermodynamics and kinetics of combustion
• Understand and analyze the combustion mechanisms of various fuels

TEXT BOOKS :

1. Samir Sarkar, Fuels & Combustion, 2nd Edition, Orient Longman, 1990
2. Bhatt, Vora Stoichiometry, 2nd Edition, Tata Mcgraw Hill, 1984
3. Blokh AG,Heat Transfer in Steam Boiler Furnace, Hemisphere Publishing Corpn, 1988.

REFERENCES :

1. Civil Davies, Calculations in Furnace Technology, Pergamon Press, Oxford, 1966
2. Sharma SP, Mohan Chander, Fuels & Combustion, Tata Mcgraw Hill, 1984

M. Tech – I year I Sem. (TSES)	**L**	**T**	**P**	**C**
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(17D11105) DESIGN OF AIR CONDITIONING SYSTEMS (DACS)
(Elective-1)

Course Objective:

1. To estimate different heat loads
2. To design different air conditioning systems.

Unit-I

PSYCHROMETRY:

Psychrometry and psychrometric properties – Psychrometric relations – Psychrometric processes

HEATING AND COOLING LOAD CALCULATIONS:

Introduction – Thermal comfort – Estimation of heat loss and heat gain – Design conditions – Infiltration and ventilation loads.

Unit-II

Procedure for estimating heating loads and cooling loads.

AIR CONDITIONING SYSTEMS:

Thermal distribution systems – Single zone system – Design calculations.

Unit-III

Multi zone system – Water systems – Variable air volume systems – Unitary system.

Unit-IV

FAN AND DUCT SYSTEMS:

Pressure drop in straight and rectangular ducts – Sudden enlarge and contraction – Design of duct systems – Velocity method – Equi-friction method – Fan laws – Air distribution in rooms

Unit-V

COOLING AND DEHUMIDIFYING COILS:

Types of cooling and dehumidifying coils – Calculating the surface area of the coil – Actual coil condition curves – Solving for outlet conditions

AIR CONDITIONING CONTROLS:

Pneumatic control hardware, Direct and reverse acting thermostat – Temperature transmitter with receiver controller – Dampers – Out door air control –Summer, winter changeover – Humidistat and humidifiers

Course Outcomes:

Have a good understanding of the principles of air conditioning design, and consideration that influence the design including human comfort, weather and environmental parameters and building structure;
Be equipped with basic design skills to be able to estimate life-cycle costing and choose the right type of system;
Have a deep understanding of load estimation and analysis, psychometric analysis of a system and climate data and its use.

TEXT BOOKS:

1. C.P.Arora, *Refrigeration & Air-Conditioning , TMH .*
2. Stoecker W.F., and Jones, *J.W., Refrigeration & Air-Conditioning,* McGraw Hill

REFERENCE BOOKS:

1. Manohar Prasad, *Refrigeration, Air-Conditioning* , New Age
2. Domkunduwar and Arora, *Refrigeration & Air-Conditioning*, Dhanpatrai & Sons

M. Tech – I year I Sem. (TSES)

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(17D11106) ENERGY CONVERSION TECHNOLOGIES (ECT)

(Elective-1)

Course Objective: The purpose of this course is to study the different ways of converting energy resources into useful energy services.

Unit-I

ENERGY CLASSIFICATION, SOURCES, UTILIZATION, ECONOMICS AND TERMINOLOGY:

Introduction , Mass-Energy Dependence , Energy , Mass and Power Units , Energy Types and Classifications , Energy Sources , Energy Reserves.

Energy Utilization , Energy Economics , Power Generation Terminology.

Unit-II

PRINCIPAL FUELS FOR ENERGY CONVERSION :

Introduction , Biomass Fuels , Fossil Fuels , Nuclear Fuels , Solar Energy .

Unit-III

PRODUCTION OF THERMAL ENERGY :

Introduction , Conversion of Mechanical Energy , Conversion of Electrical Energy , Conversion of Electromagnetic Energy , Conversion of Chemical Energy ,Conversion of Nuclear Energy .

PRODUCTION OF MECHANICAL ENERGY :

Introduction , Conversion of Thermal Energy , Turbines , Electromechemical Conversion

Unit-IV

PRODUCTION OF ELECTRICAL ENERGY :

Introduction , Conversion of Thermal Energy into Electricity , Conversion of Chemical Energy into Electricity.

Conversion of Electromagnetic energy into Electricity , Conversion of Nuclear Energy into Electricity , Conversion of Mechanical Energy into Electricity .

Unit-V

ENERGY STORAGE :

Introduction , Storage of Mechanical Energy , Storage of Electrical Energy, Storage of Chemical Energy , Storage of Nuclear Energy , Storage of Thermal Energy .

Course outcome: After this course the students should be able to: -

1. Describe the major processes for producing electricity
2. Give the typical sizes of the technologies
3. Explain the influence major parameters that influence the efficiency of the power plants.

TEXT BOOK :

1. Archie W.Culp , Jr, *Principles of Energy Conversion* , Tata McGraw –Hill

REFERENCE BOOKS:

1. H.A.Sorenson , *Energy Conversion Systems* , John Willey & sons.
2. Bansal, K.Leeman, Renewable Energy sources & Conversion Technology, & Meliss.

M. Tech – I year I Sem. (TSES)	**L**	**T**	**P**	**C**
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(17D11107) SOLAR PASSIVE ARCHITECTURE (SPA)
(Elective-1)

Course Objective: This course aims to provide an understanding of the concept of reduction in energy consumption through low energy building design. It will highlight strategies to integrate daylighting and low energy heating/cooling in buildings.

Unit-I
Introduction

Introduction to architecture; Architecture as the art of science of designing buildings; Building science and its significance; Energy management concept in building

Thermal Analysis And Design For Human Comfort

Thermal comfort; Criteria and various parameters; Psychometric chart; Thermal indices, climate and comfort zones; Concept of sol-air temperature and its significance; Calculation of instantaneous heat gain through building envelope; Calculation of solar radiation on buildings; building orientation.

Introduction to design of shading devices; Overhangs; Factors that effects energy use in buildings; Ventilation and its significance; Air-conditioning systems; Energy conservation techniques in air-conditioning systems

Unit-II
Passive Cooling And Heating Concepts

Passive heating concepts: Direct heat gain, indirect heat gain, isolated gain and sunspaces.

Passive cooling concepts: Evaporative cooling, radiative cooling; Application of wind, water and earth for cooling; Shading, paints and cavity walls for cooling; Roof radiation traps; Earth air-tunnel.

Unit-III
Heat Transmission In Buildings

Surface co-efficient: air cavity, internal and external surfaces, overall thermal transmittance, wall and windows; Heat transfer due to ventilation/infiltration, internal heat transfer; Solar temperature; Decrement factor; Phase lag.

Design of daylighting; Estimation of building loads: Steady state method, network method, numerical method, correlations; Computer packages for carrying out thermal design of buildings and predicting performance.

Unit-IV

Bioclimatic Classification

Bioclimatic classification of India; Passive concepts appropriate for the various climatic zones in India; Typical design of selected buildings in various climatic zones; Thumb rules for design of buildings and building codes.

Unit-V

Energy Efficient Landscape Design

Modification of microclimatic through landscape element for energy conservation; Energy conservation through site selection, planning, and design; Siting and orientation

Course outcomes: On completion of this course, the students would:

a) Have acquired an understanding of the concept and theoretical background of low energy building design.

b) Be able to demonstrate their learning about use of simulation tools to achieve energy efficiency.

Text books:

1. M.S.Sodha, N.K. Bansal, P.K. Bansal, A. Kumar and M.A.S. Malik(1986), *Solar Passive Building, Science and Design*, Pergamon Press,.
2. J.R. Williams(1983), *Passive Solar Heating*, Ann Arbar Science,

References:

1. R.W.Jones, J.D. Balcomb, C.E. Kosiewiez, G.S. Lazarus, R.D. McFarland and W.O.Wray(1982), *Passive Solar Design Handbook, Vol. 3,* Report of U.S. Department of Energy(DOE/CS-0127/3),.
2. J Krieder and A Rabi (1994), *Heating and Cooling of Buildings : Design for Efficiency*, McGraw-Hill
3. 3.R D Brwon, T J Gillespie (1990), *Microclimatic Landscape Design*, John Wiley & Sons, NewYork,
4. D.S. Lal(2003), *Climatology*, Sharda Pustak Bhawan, Allahabad,
5. Majumder Milli, *Energy Efficient Buildings*, TERI, New Delhi
6. T A Markus, E N Morris(1980)Building, Climate and Energy, Spott woode Ballantype Ltd.London,
7. Sanjay Prakash (et al.)(1991), *Solar architecture and earth construction in the*
8. *NorthWest Himalaya,* Vikas, New Delhi,

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M. Tech – I year I Sem. (TSES)	**L**	**T**	**P**	**C**
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(17D11108) INSTRUMENTATION FOR THERMAL ENGINEERING
(Elective-II)

AIM:
To enhance the knowledge of the students about various measuring instruments, techniques and importance of error and uncertainty analysis.

OBJECTIVES:
(I) To provide knowledge on various measuring instruments.
(II) To provide knowledge on advance measurement techniques.
(III) To understand the various steps involved in error analysis and uncertainty analysis.

UNIT I MEASURMENT CHARACTERISTICS
Instrument Classification, Characteristics of Instruments – Static and dynamic, experimental error analysis, Systematic and random errors, Statistical analysis, Uncertainty, Experimental planning and selection of measuring instruments, Reliability of instruments.

UNIT II MICROPROCESSORS AND COMPUTERS IN MEASURMENT
Data logging and acquisition – use of sensors for error reduction, elements of micro computer
interfacing, intelligent instruments in use.

UNIT III MEASURMENT OF PHYSICAL QUANTITIES
Measurement of thermo-physical properties, instruments for measuring temperature, pressure and flow, use of sensors for physical variables.

UNIT IV ADVANCE MEASURMENT TECHNIQUES
Shadowgraph, Schlieren, Interferometer, Laser Doppler Anemometer, Hot wire Anemometer, heat flux sensors, Telemetry in measurement.

UNIT V MEASURMENT ANALYSERS
Orsat apparatus, Gas Analysers, Smoke meters, gas chromatography, spectrometry.

Course Outcomes:
- Knowledge of field instrumentations
- Dynamic modeling and system behavior study
- Design of controllers

• Application of control systems in processes

TEXT BOOKS :

1. Holman, J.P., Experimental methods for engineers, McGraw-Hill, 1988.
2. Barnery, Intelligent Instrumentation, Prentice Hall of India, 1988.
3. Prebrashensky, V., Measurements and Instrumentation in Heat Engineering, Vol. 1 and 2, MIR Publishers, 1980.

REFERENCES

1. Raman, C.S., Sharma, G.R., Mani, V.S.V., Instrumentation Devices and Systems, Tata McGraw- Hill, New Delhi, 1983.
2. Holman, J.P., Experimental methods for engineers, McGraw-Hill, 1958.
3. Barney, Intelligent Instrumentation, Prentice Hall of India, 1988
4. Prebrashensky. V., Measurement and Instrumentation in Heat Engineering, Vol.1 and MIR
Publishers, 1980.
5. Raman, C.S. Sharma, G.R., Mani, V.S.V., Instrumentation Devices and Systems,
6. Tata McGraw-Hill, New Delhi, 1983.
7. Doeblin, Measurement System Application and Design, McGraw-Hill, 1978.
8. Morris. A.S, Principles of Measurements and Instrumentation Prentice Hall of India, 1998

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M. Tech – I year I Sem. (TSES) **L T P C**
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(17D11109) REFRIGERATION AND CRYOGENICS (RCG)
(Elective-II)

COURSE OBJECTIVES:

1. History and applications of cryogenic engineering, properties of cryogenic liquids and solids, refrigeration technologies, air liquefaction process, industrial gas separation and purification system, low power cryocoolers, adiabatic and vacuum technologies, cryogenic liquid storage and transportation , as well as cryogenic measurements
2. To understand different refrigeration systems and their applications.
3. Introduce cryogenics and its applications

Unit-I: VAPOUR COMPRESSION REFRIGERATION SYSTEMS:

Analysis of vapour compression refrigeration cycle – effect of suction temperature and condensing temperature on cycle performance – actual refrigeration cycle – effect of sub cooling the liquid – the effect of super heating the suction vapour- the effect of wet suction

Unit-II: COMPOUND VAPOUR COMPRESSION SYSTEM

Removing of flash gas – inter cooling – compound compression ultra water inter cooler- liquid flash cooler – flash inlet cooler.

MULTIPLE EVAPORATOR AND COMPRESSION SYSTEMS

One compressor system – individual compressors – compound compression – cascade systems.

Unit-III: ABSORPTION REFRIGERATION SYSTEMS

Elementary properties of binary mixtures – simple theoretical absorption refrigeration systems – the practical ammonia absorption system- Three fluid absorption systems – the lithium bromide water absorption system.

ABSOPTION SYSTEM WITH MULTIPLE EVOPARATORS

Three fluid absorption systems-the Lithium Bromide water absorption system.

Unit-IV: OTHER REFRIGERATION SYSTEMS:

Steam jet water vapour systems – thermoelectric refrigeration systems – vortex refrigeration system – pulse tube refrigeration.

Unit-V: REFRIGERANTS:
Desirable properties – designation of refrigerants – inorganic, halo carbon refrigerants – inorganic halo carbon reactions- secondary refrigerants – reaction of refrigerants with moisture and oil – properties of mixtures of refrigerants – ozone depletion potential and global warming potential of CFC refrigerants – substitutes for CFC refrigerants.

CRYOGENIC
Cryogenic liquefaction and refrigeration systems- low temperature insulations-typical applications of refrigeration and cryogenics.

COURSE OUTCOMES:-
1. Introduce the working principles of three basic methods to achieve low temperature by using adiabatic expansion, provide a thorough understanding of applications of classical thermodynamics to different cryogenic technologies, gas separation and purification system, and low power cryocoolers
2. Understand the structures of different cryogenic systems and the analytical method for cryogenic thermodynamic cycle, and cryogenic gases and liquids and their mixtures
3. Understand the measurement equipment and basic experimental skills, in particular of cryogenic heat transfer, superconducting magnetic levitation, as well as low power cryocoolers
4. Provide design experiences for practical cryogenic systems requiring significant consideration of thermodynamics cycles
5. Reinforcement theory

TEXT BOOKS:

1. C.P. Arora, *Refrigeration & Air-Conditioning by* , TMH
2. R.F Barron ,*Cryogenic Systems* , Oxford University Press .

REFERENCE BOOKS:

1. Stoecker W.F.*Refrigeration & Air-Conditioning, and Jones,* J.W., McGraw Hill
2. Manohar Prasad, *Refrigeration & Air-Conditioning* , New Age .
3. Domkunduwar, *Refrigeration & Air-Conditioning and Arora* , Dhanpatrai & Sons

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M. Tech – I year I Sem. (TSES)

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(17D11110)ADVANCED POWER PLANT ENGINEERING
(Elective-II)

AIM:
To introduce the advances in operations and applications of different types of power plants

OBJECTIVES:

- To make the students to understand the energy scenario and the environmental issues related to the power plants
- Creating awareness to the students on the various utilities in the power plants and the avenues for optimizing them

UNIT I INTRODUCTION

Overview of Indian power sector – load curves for various applications – types of power plants – merits and demerits – criteria for comparison and selection - Economics of power plants.

UNIT II STEAM POWER PLANTS

Basics of typical power plant utilities - Boilers, Nozzles, Turbines, Condensers, Cooling Towers, Water Treatment and Piping system - Rankine Cycle – thermodynamic analysis. Cycle improvements – Superheat, Reheat, Regeneration

UNIT III DIESEL AND GAS TURBINE POWER PLANTS

I.C Engine Cycles - Otto, Diesel & Dual –Theoretical vis-a-vis actual – Typical diesel power plant – Types – Components - Layout - Performance analysis and improvement - Combustion in CI engines - E.C cycles – Gas turbine & Stirling - Gas turbine cycles – thermodynamic analysis – cycle improvements - Intercoolers, Re heaters, regenerators.

UNIT IV ADVANCED POWER CYCLES

Cogeneration systems – topping & bottoming cycles - Performance indices of cogeneration systems – Heat to power ratio - Thermodynamic performance of steam turbine cogeneration systems – gas turbine cogeneration systems – reciprocating IC engines cogeneration systems- Binary Cycle - Combined cycle – IGCC – AFBC / PFBC cycles – Thermionic steam power plant. MHD – Open cycle and closed cycle- Hybrid MHD & steam power plants

UNIT V HYDROELECTRIC & NUCLEAR POWER PLANTS

Hydroelectric Power plants – classifications - essential elements – pumped storage systems – micro and mini hydel power plants General aspects of Nuclear Engineering – Components of nuclear power plants - Nuclear reactors & types – PWR, BWR, CANDU, Gas Cooled, Liquid Metal Cooled and Breeder reactor - nuclear safety – Environmental issues

OUTCOME

Possible mitigation of anthropogenic emissions by optimizing the power plant cycles/utilities

REFERENCES

1. Nag, P.K., Power Plant Engineering, Tata Mcgraw Hill Publishing Co Ltd, New Delhi, 1998.
2. Arora and Domkundwar, A course in power Plant Engineering, Dhanpat Rai and CO, 2004.
3. Haywood, R.W., Analysis of Engineering Cycles, 4th Edition, Pergamon Press, Oxford, 1991.
4. Wood, A.J., Wollenberg, B.F., Power Generation, operation and control, John Wiley, New York,1984.
5. Gill, A.B., Power Plant Performance, Butterworths, 1984.
6. Lamarsh, J.R., Introduction to Nuclear Engg.2nd edition, Addison-Wesley, 1983.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

M. Tech – I year I Sem. (TSES)

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(17D11111) THERMAL SCIENCE LABORATORY

1. To find the exhaust emissions of an automobile (HC, CO, NO_X) .
2. Analysis of exhaust gases on IC engine.
3. Combustion analysis of CI engine
4. To find Octane number of given blends of fuel.
5. Performance analysis of Heat Pipe
6. Two Phase flow heat transfer estimation.
7. To estimate the COP of a vapour compression refrigeration system (Refrigerator).
8. To find the solar flat plate collector efficiency.
9. To find direct solar incident flux absorbed by using Pyranometer or concentratic parabolic collector.
10. Case study for energy audit.

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M. Tech – I year II Sem. (TSES)	L	T	P	C
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(17D11201) ADVANCED HEAT AND MASS TRANSFER

OBJECTIVES:

- To develop the ability to use the heat transfer concepts for various applications like finned systems, turbulence flows, high speed flows.
- To analyse the thermal analysis and sizing of heat exchangers and to learn the heat transfer coefficient for compact heat exchanges.
- To achieve an understanding of the basic concepts of phase change processes and mass transfer.

UNIT I CONDUCTION AND RADIATION HEAT TRANSFER

One dimensional energy equations and boundary condition - three-dimensional heat conduction equations - extended surface heat transfer - conduction with moving boundaries - radiation in gases and vapour.Gas radiation and radiation heat transfer in enclosures containing absorbing and emitting media – interaction of radiation with conduction and convection.

UNIT II TURBULENT FORCED CONVECTIVE HEAT TRANSFER

Momentum and energy equations - turbulent boundary layer heat transfer - mixing length concept - turbulence model – k Є model - analogy between heat and momentum transfer – Reynolds, Colburn, Prandtl turbulent flow in a tube - high speed flows.

UNIT III PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGER

Condensation with shears edge on bank of tubes - boiling – pool and flow boiling – heat exchanger –Є – NTU approach and design procedure - compact heat exchangers.

UNIT IV NUMERICAL METHODS IN HEAT TRANSFER

Finite difference formulation of steady and transient heat conduction problems – discretization schemes – explicit - Crank Nicolson and fully implicit schemes - control volume formulation steady one-dimensional convection and diffusion problems - calculation of the flow field – SIMPLER Algorithm.

UNIT V MASS TRANSFER AND ENGINE HEAT TRANSFER CORRELATION

Mass transfer - vaporization of droplets - combined heat and mass transfers - heat transfer correlations in various applications like I.C. engines - compressors and turbines.

OUTCOME:

- On successful completion of this course the student will be able to apply the law of thermodynamics to engines.

REFERENCES

1. Yunus A.Cengal, Heat and Mass Transfer – A practical Approach, 3rd edition, Tata McGraw - Hill,
2007.
2. Holman.J.P, Heat Transfer, Tata Mc Graw Hill, 2002.
3. Ozisik. M.N., Heat Transfer – A Basic Approach, McGraw-Hill Co., 1985
4. Incropera F.P. and DeWitt. D.P., Fundamentals of Heat & Mass Transfer, John Wiley & Sons,
2002.
5. Nag.P.K, Heat Transfer, Tata McGraw-Hill, 2002
6. Ghoshdastidar. P.S., Heat Transfer, Oxford University Press, 2004
7. Yadav, R., Heat and Mass Transfer, Central Publishing House, 1995.

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M. Tech – I year II Sem. (TSES)

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(17D11202) ADVANCED ENERGY TECHNOLOGIES (AET)

CourseObjectives:-

To provide a detailed engineering treatment of various emerging energy technologies, Engineering design, thermodynamic performance, environmental impacts and economic considerations.

Unit-I

HIGH PRESSURE BOILERS

Introduction , Advantages of High Pressure Boilers, LaMont Boiler , Benson Boiler, Loeffler Boiler , Supercharged Boilers , Waste Heat Boilers , Corrosion in Boilers and its Prevention , Causes of Boiler Tube Failures and Prevention

Unit-II

FLUIDIZED BED COMBUSTION (FBC)

Introduction , Principle of FBC , Types of FBC , FBC for low grade fuels , Corrosion of FBC system , Control of FBC system , Starting of Fluid-Bed Firing system.

Erosion and Corrosion and its prevention in FBC Boilers , Advantages of Fluidized Bed Systems

Uint-III

COMBINED CYCLE TECHNOLOGY

Introduction , Arrangement of Combined Cycles , Combined Cycle with Gas Production from coal , Combined cycles using PFBC system.

Optimum design of Gas Turbine Unit for Combined cycle plant , Advantages of Combined Cycle , Performance of Combined Cycle , Economics of Combined Cycle

Unit-IV

COGENERATION

Concepts, Types of Co generating Systems , Performance Evaluation of Co generating System

Unit-V

WASTE HEAT RECOVERY SYSTEM

Introduction , Sources of Waste Heat and their Grading , Thermodynamic Cycles for Waste Heat Recovery.

Heat Recovery Forms and Methods , Other Uses of Heat , Heat Pump Systems , Different Wastes for Power Generation .

Course Outcomes: Students understand holistically energy systems, their components and interaction outside the system boundaries. Students understand renewable energy integration into energy systems. Students understand economics of energy systems and basics of energy markets. Students are able to develop and calculate example cases related to renewable energy and its integration into energy systems.

TEXT BOOKS:

1. 1.S.Rao &B.B. Parulekar, *Energy Technology* Khanna Publishers

REFERENC*E BOOKS:*

1. D.A. Reay, *Waste heat recovery systems*,Pergmon Press
2. Arora and Domukundwar, *Power Plant Engineering* ,Dhanapat Rai & Co .,

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M. Tech – I year II Sem. (TSES)

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(17D11203) ENERGY AUDITING AND MANAGEMENT (EAM)

OBJECTIVES: A growing worldwide concern for conservation of energy has reawakened interest in ecologically sustainability, processes and sources of energy. Different types of industries are consisted of various energy intensive processes. Hence, Energy efficiency and energy conservation in industries are as important as finding new energy sources.

Unit-I: ENERGY CONSERVATION

Rules for efficient energy conservation, Technologies for energy conservation, Load management, Energy use patterns, Necessary steps of energy management programme, Concepts of energy management, General principles of energy management, Energy management in manufacturing and process industries – Qualities and functions of energy managers

Unit-II: ENERGY AUDITING

Definition &objectives, level of responsibility, Control of energy , Check lists, Energy conservation schemes, Energy index, Cost index, Pie charts, Sankey diagrams, Load profiles.

Types of energy audits – Questionnaire ,Energy audit of industries, General energy audit , Detailed energy audit ,Energy saving potential

Unit-III: THERMAL INSULATION & REFRACTORS

Heat loss through un insulated surfaces effect of insulation on current carrying wires-economic thickness of insulation – critical radius of insulation –properties of thermal insulators – classification of insulation materials.

classification of refractors – properties of refractors- criteria of good refractory material – applications of insulating & refractory materials.

Unit-IV: ENGINEERING ECONOMICS

Steps in planning- efficiency of organization – capital budgeting – classification of cost– interest- types – time value of money – cash flow diagrams – present worth factor, capital recovery factor, equal annual payments – nominal and effective interest rates- discrete and continuous compounding- equivalent between cash flows.

PROJECT MANAGEMENT

Method of investment appraisal – rate of return method, pay back method, net present value method(NPV) – adoption of the methods in energy conservation campaign – types of projects – types of budgets –propose of project management – managerial objectives – Classification – role and qualities of project manager – budget committee – budgeting – capital budgeting

Unit-V: ENERGY CONSERVATION IN ELECTRIC UTILITY

Energy conservation in utility by improving load factor, Load curve analysis, Energy efficient motors, Energy conservation in illumination systems, Importance of Power factor in energy conservation - Power factor improvement method

OUTCOME:

This course is designed to aware the students concerning various energy intensive process in different industries and to find out the energy conservation opportunities. Various methods of energy management and energy auditing on the site are also incorporated.

TEXT BOOKS:

1. W.R. Murphy & G. Mickay, *Energy Management*, Butterworths
2. P.W.O' Callghan, *Energy Conservation*, Pargamon Press 1981

REFERENCE BOOKS:

1. D.A. Reay, Waste heat recovery systems, Pergmon Press
2. Albert Thumann, Hand book of energy audits-
3. Craig B. Smithm, Energy Management Prinicples,Pergarmon Press
4. S.C.Tripathy, "Electric Energy Utilization and onservation", TMGDelhi,1991

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M. Tech – I year II Sem. (TSES)	**L**	**T**	**P**	**C**
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(17D11204) COMPUTATIONAL FLUID DYNAMICS

AIM:

This course aims to introduce numerical modeling and its role in the field of heat and fluid flow, it will enable the students to understand the various discrimination methods and solving methodologies and to create confidence to solve complex problems in the field of heat transfer and fluid dynamics.

OBJECTIVES:

 To develop finite difference and finite volume discredited forms of the CFD equations.
 To formulate explicit & implicit algorithms for solving the Euler Eqns & Navier Stokes Eqns.

UNIT I GOVERNING DIFFERENTIAL EQUATION AND FINITE DIFFERENCE METHOD

Classification, Initial and Boundary conditions, Initial and Boundary value problems. Finite difference method, Central, Forward, Backward difference, Uniform and non-uniform Grids, Numerical Errors, Grid Independence Test.

UNIT II CONDUCTION HEAT TRANSFER

Steady one-dimensional conduction, Two and Three dimensional steady state problems, Transient one-dimensional problem, Two-dimensional Transient Problems.

UNIT III INCOMPRESSIBLE FLUID FLOW

Governing Equations, Stream Function – Verticity method, Determination of pressure for viscous flow, SIMPLE Procedure of Patankar and spalding, Computation of Boundary layer flow, Finite difference approach.

UNIT IV CONVECTION HEAT TRANSFER AND FEM

Steady One-Dimensional and Two-Dimensional Convection – Diffusion, Unsteady one-dimensional convection – Diffusion, Unsteady two-dimensional convection – Diffusion – Introduction to finite element method – Solution of steady heat conduction by FEM – Incompressible flow – Simulation by FEM.

UNIT V TURBULENCE MODELS

Algebraic Models – One equation model, K - □ Models, Standard and High and Low Reynolds
number models, Prediction of fluid flow and heat transfer using standard codes.

Outcomes: On successful completion of the course, students will be able to:
Understand solution of aerodynamic flows. Appraise & compare current CFD software. Simplify flow problems and solve them exactly Define and setup flow problem properly within CFD context, performing solid modelling using CAD package and producing grids via meshing tool Understand both flow physics and mathematical properties of governing Navier-Stokes equations and define proper boundary conditions for solution Use CFD software to model relevant engineering flow problems. Analyse the CFD results. Compare with available data, and discuss the findings

TOTAL: 45 PERIODS

REFERENCES

1. Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa
Publishing House, New Delhi, 1995.
2. Ghoshdasdidar, P.S., "Computer Simulation of flow and heat transfer" Tata McGraw Hill
Publishing Company Ltd., 1998.
3. Subas, V.Patankar "Numerical heat transfer fluid flow", Hemisphere Publishing Corporation,
1980.
4. Taylor, C and Hughes, J.B. "Finite Element Programming of the Navier Stock Equation",
Pineridge Press Limited, U.K., 1981.
5. Anderson, D.A., Tannehill, J.I., and Pletcher, R.H., "Computational fluid Mechanic and Heat
Transfer " Hemisphere Publishing Corporation, Newyork, USA, 1984.
6. Fletcher, C.A.J. "Computational Techniques for Fluid Dynamics 1" Fundamental and General
Techniques, Springer – Verlag, 1987.
7. Fletcher, C.A.J. "Computational Techniques for Fluid Dynamics 2" Specific Techniques for
Different Flow Categories, Springer – Verlag, 1987.
8. Bose, T.X., "Numerical Fluid Dynamics" Narosa Publishing House, 1997.

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M. Tech – I year II Sem. (TSES)

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(17D11205) ENERGY SYSTEMS MODELING AND ANALYSIS (ESMA)

(Elective-III)

Course Objectives

This course aims to give an introduction to effective modeling methods applicable for assessing the dynamic behaviors of complex systems for energy supply and conversion.

Unit-I

INTRODUCTION:

Overview of various technologies and conventional methods of energy conversion, Designing a Workable System: Workable and optimum systems, Steps in arriving a workable system, Creativity in concept selection, Workable Vs Optimum system

EQUATION FITTING:

Mathematical modeling, Polynomial representation, Functions of two variables, Exponential forms, Best fit Method of least squares

Unit-II

MODELING OF THERMAL EQUIPMENT:

Counter flow heat exchanger, Evaporators and Condensers, Heat exchanger effectiveness, Effectiveness of a counter flow heat exchanger, NTU, Pressure drop and pumping power

SYSTEM SIMULATION:

Classes of simulation, Information flow diagrams, Sequential and simultaneous calculations, Successive substitution, Newton Raphson method

Unit-III

OPTIMIZATION TECHNIQUES:

Mathematical representation of optimization problems, A water chilling system, Optimization procedure, Setting up the mathematical statement of the optimization problem, Dynamic Programming: Characteristic of the Dynamic programming solution, Apparently constrained problem, Application of Dynamic programming to energy system problems, Geometric Programming: One independent variable unconstrained, Multivariable optimization, Constrained optimization with zero degree of difficulty ,Linear Programming: Simplex method, Big-M method, Application of LP to thermal systems

Unit-IV

LAGRANGE MULTIPLIER'S METHOD: The Lagrange multiplier equations, Unconstrained optimization, Constrained optimization, Sensitivity coefficients

Unit-V

SEARCH METHODS: Single variable – Exhaustive, Dichotomous and Fibonacci, Multivariable unconstrained - Lattice, Univariable and Steepest ascent

MATHEMATICAL MODELING:

Thermodynamic properties-Need for mathematical modeling, Criteria for fidelity of representation, Linear regression analysis, Internal energy and enthalpy, Pressure temperature relationship at saturated conditions, Specific heat, P-V-T equations

Outcomes:

1. Assess the capabilities and limitations of various modeling methods.
2. Apply innovative modeling and simulation to solve complex multi-disciplinary energy system problems individually and in teams.
3. Demonstrate knowledge and comprehension of theoretical principles and operational skills underlying modeling programes

Tex Books / References :

1) W.F.Stoecker (1989), *"Design of Thermal Systems"* McGraw Hill, 3rd Ed.
2) B.K.Hodg(1990), *"Analysis and Design of Thermal Systems",* Prentice Hall Inc.,.
3) I.J.Nagrath & M.Gopal, *"Systems Modelling and Analysis",* Tata McGraw Hill.
4) D.J. Wide(1978), *"Globally Optimal Design",* Wiley- Interscience,

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M. Tech – I year II Sem. (TSES)

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(17D11206) OPTIMIZATION TECHNIQUES AND ITS APPLICATIONS
(Elective-III)

Course Objective: The general objectives of the course is

1. To introduce the fundamental concepts of Optimization Techniques;
2. To make the learners aware of the importance of optimizations in real scenarios.
3. To provide the concepts of various classical and modern methods of for constrained and unconstrained problems in both single and multivariable.

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UNIT- I*:*

Introduction: Engineering Applications of optimization- statement of an optimization problem – Classification of optimization problems.

Single Variable Non-Linear Unconstrained Optimization: One dimensional Optimization methods:- Uni-modal function, elimination methods, Fibonacci method, golden section method, interpolation methods – quadratic and cubic interpolation methods.

UNIT-II

Multi variable non-linear unconstrained optimization: Direct search method – Univariant method - pattern search methods – Powell's- Hook -Jeeves, Rosenbrock search methods- gradient methods, gradient of function, steepest decent method, Fletcher Reeves method, variable metric method.

Linear Programming – Graphical method-Simplex method- Dual simplex method- Revised simplex method- Parametric linear programming- Goal Programming

Simulation- types of simulations- Applications of simulations to inventory, queuing and thermal systems.

UNIT- III:

Integer Programming- Introduction – formulation – Gomory cutting plane algorithm – Zero or one algorithm, branch and bound method

UNIT- IV:

Stochastic Programming: Basic concepts of probability theory, random variables-distributions-mean, variance, correlation, co variance, joint probability distribution-stochastic linear, dynamic programming.

Geometric Programming: Posynomials – arithmetic - geometric inequality – unconstrained G.P- constrained G.P

UNIT- V:

Non Traditional Optimization Algorithms: Genetics Algorithm-Working Principles, Similarities and Differences between Genetic Algorithm and Traditional Methods. Simulated Annealing- Working Principle-Simple Problems. Application in production problems.

Course Outcomes: Upon successful completion of this course, students will be able to

1. Formulate optimization problems;
2. Understand and apply the concept of optimality criteria for various type of optimization problems.
3. Solve various constrained and unconstrained problems in single variable as well as multivariable
4. Apply the methods of optimization in real life situation.

TEXT BOOKS:

1. Optimization theory and Applications,S.S.Rao,New Age International.
2. Optimization for Engineering Design, Kalyanmoy Deb, PHI

REFERENCE BOOKS:

1. Operations Research, S.D.Sharma,
2. Operation Research, H.A.Taha ,TMH
3. Optimization in operations research, R.LRardin
4. Optimization Techniques, Belagundu & Chandraputla, Pearson Asia.
5. Optimization Techniques theory and practice, M.C.Joshi, K.M.Moudgalya, Narosa Publications

M. Tech – I year II Sem. (TSES)

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(17D11207) ENERGY STORAGE SYSTEMS (ESS)
(Elective-III)

Course Objectives:-

Coverage of energy storage techniques involving electrochemical, mechanical and emerging options. Integration of the energy storage media, its effects on the bulk power system, and design tradeoffs to understand environmental impacts, cost, reliabilities, and efficiencies for commercialization of bulk energy storage.

Unit-I

INTRODUCTION:

Need of Energy Storage, Different modes of Energy Storage.

ENERGY STORAGE:

Potential Energy: Pumped Hydro Storage, KE and Compressed gas system: Flywheel Storage, Compressed air energy Storage, Electrical and magnetic energy storage: Capacitors, Electromagnets and battery storage systems.

Unit-II

Chemical Energy Storage: Thermo-Chemical, Bio-Chemical, Electro-Chemical, Fossil fuels and synthetic fuels and Hydrogen storage.

Unit-III

SENSIBLE HEAT STORAGE:

SHS mediums, Stratified storage systems, Rock-bed storage systems, Thermal storage in buildings, Earth storage, Energy storage in aquifers, Heat storage in SHS systems, Aquifers storage.

LATENT HEAT THERMAL ENERGY STORAGE:

Phase Change Materials(PCMs), Selection Criteria Of PCMs, Stefan Problem, Solar Thermal LHTES Systems, Energy Conservation Through LHTES Systems, LHTES Systems in Refrigeration and Air Conditioning Systems.

Enthalpy formulation, Numerical heat transfer in melting and freezing process.

Unit-IV

SOME AREAS OF APPLICATION OF ENERGY STORAGE:

Food Preservation, Waste Heat Recovery, Solar Energy Storage, Green House Heating,

Unit-V

Power Plant Applications, Drying and Heating for Process Industries.

Course Outcomes

1. Compare and contrast methods of energy storage management in terms of cost, size, weight, reliability, efficiency and lifetimes.
2. Describe the energy storage need of the smart grid, both present and future
3. Define the advantages and disadvantages of storage integration in various energy distribution systems, e.g. facility/home, substation, generation facility.
4. Summarize the impact of energy storage in an electric power system on power quality, power reliability and overall system efficiency.

Text Books / References:

1. H.P.Garg et al, D Reidel (1885)*"Solar Thermal Energy Storage",* Publishing Co.
2. V Alexiades & A.D.Solomon(1993) *"Mathematical Modeling of Melting and Freezing Proces" ,* Hemisphere Publishing Corporation,
3. WashingtonNarayan R, Viswanath B(1998), *Chemical and Electro Chemical Energy System*, Universities Press
4. A. Ter-Gazarian(1994)*, "Energy Storage for Power Systems", Peter* Peregrinus Ltd.London
5. B.Kilkis and S.Kakac (1989),"*Energy Storage Systems",*(Ed),KAP,London,1989

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

M. Tech – I year II Sem. (TSES)

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(17D11208) DESIGN OF HEAT TRANSFER EQUIPMENT
(Elective-IV)

Course Objective: To learn the basics and advanced concepts of heat transfer and design methodologies involved in various types of heat transfer devices.

Unit-I

DESIGN OF HEAT EXCHANGERS

Heat Exchangers-mean temperature differences for parallel and counter flow-effectiveness method(NTU).

DESGIN OF CONDERSERS

Overall heat transfer co-efficient –temperature distribution and heat flow in a condenser-pressure drop in a condenser-extended fin surfaces-consideration of fouling factors-LMTD correction factor.

Unit-II

DESIGN OF EVOPORATORS

Temperature distribution and heat flow in an evaporator – pressure drop-factor to be consider in the design of heat transfer equipment – types of heat consideration of fouling factor-correction factor.

DESIGN OF COMPRESSORS

Types – equivalent shaft work- volume metric efficiency- factors affection total volume metric efficiency – compound compression with inter cooling – rotary compressors surging.

Unit-III

DESIGN OF COOLING TOWERS AND SPRAY PONDS

Classification-performance of cooling towers-analysis of counter flow cooling towers – enthalpy – temperature diagram of air and water- cooling ponds- types of cooling ponds- cross flow cooling towers – procedure for calculation of outlet conditions

Unit-IV

DESIGN OF DUCTS

Continuity equation – Bernoulli's equation – pressure losses – frictional charts – co efficient of resistance for fillings – duct sizing methods.

DESIGN OF FANS

Standard air –fan horse power – fan efficiency – similarity laws-fan laws – performance co efficient –theoretical expressions for total pressure drop by a fan-centrifugal fan- axial flow fan – system resistance.

Unit-V

PIPING SYSTEM

Requirements of a good piping system- pressure drop in pipe-Moody chart-refrigerant piping – discharge line- liquid line-suction line – piping arrangement

Course Outcome: • Understanding of various types of heat transfer process and devices • Ability to analyze and select the heat transfer device • Ability to solve the problems of heat transfer related to nano-fluids, micro-channels and heat pipes • Ability to use software tools for solving heat transfer problems

Reference Books

1. Heat and Mass Transfer by - Arora and Domkundwar.
2. Refrigeration and Air conditioning – PL Ballaney.
3. Refrigeration and Air conditioning – CP Arora.
4. Refrigeration and Air conditioning- Stoecker.

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M. Tech – I year II Sem. (TSES)

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(17D11209) ADVANCED INTERNAL COMBUSTION ENGINEERING
(Elective-IV)

Course Description & Objectives: The course aims to develop the students with the knowledge about the advanced theory and working of I.C engines and the phenomena of combustion and modelling.

UNIT I SPARK IGNITION ENGINES

Spark ignition Engine mixture requirements – Fuel – Injection systems – Monopoint, Multipoint injection, Direct injection – Stages of combustion – Normal and abnormal combustion – factors affecting knock – Combustion chambers.

UNIT II COMPRESSION IGNITION ENGINES

States of combustion in C.I. Engine – Direct and indirect injection systems – Combustion chambers – Fuel spray behaviour – spray structure, spray penetration and evaporation – air motion – Introduction to Turbo charging.

UNIT III POLLUTANT FORMATION AND CONTROL

Pollutant – Sources – Formation of carbon monoxide, Unburnt hydrocarbon, NOx, Smoke and Particulate matter – Methods of controlling Emissions – Catalytic converters and Particulate Traps – Methods of measurements and Introduction to emission norms and Driving cycles.

UNIT IV ALTERNATIVE FUELS

Alcohol, Hydrogen, Natural Gas and Liquefied Petroleum Gas- Properties, Suitability, Merits and Demerits as fuels, Engine Modifications.

UNIT V RECENT TRENDS

Lean Burn Engines – Stratified charge Engines – homogeneous charge compression ignition engines – Plasma Ignition – Measurement techniques – laser Doppler, Anemometry.

Course Outcomes: Upon the successful completion of the course, learners will be able to
1. Explain the various working cycles of engine 2. Describe the various types of

combustion in IC engines. 3. Illustrate the engine combustion parameters. 4. Describe the different types of modern engines. 5. Explain the modern electronic engine management system (EMS) of I.C engines.

TEXT BOOK

1. K.K. Ramalingam, Internal Combustion Engine Fundamentals, Scitech Publications, 2002.

REFERENCE BOOKS

1. R.B.Mathur and R.P. Sharma, Internal combustion Engines.
2. V. Ganesan, Int. Combustion Engines, II Edition, TMH, 2002.
3. Duffy Smith, auto fuel Systems, The Good Heart Willox Company, Inc., 198

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M. Tech – I year II Sem. (TSES)

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(17D11210) COGENERATION AND WASTE HEAT RECOVERY SYSTEMS (Elective-IV)

AIM:

To detail on the importance of Total Energy Concept, its advantages and cost effectiveness.

OBJECTIVES:

- To analyze the basic energy generation cycles
- To detail about the concept of cogeneration, its types and probable areas of applications
- To study the significance of waste heat recovery systems and carryout its economic analysis

UNIT I INTRODUCTION

Introduction – principles of thermodynamics – cycles – topping – bottoming – combined cycle – organic rankine cycles – performance indices of cogeneration systems – waste heat recovery – sources and types – concept of tri generation.

UNIT II CONGENERATION TECHNOLOGIES

Configuration and thermodynamic performance – steam turbine congeneration systems – gas turbine cogeneration systems – reciprocating IC engines cogeneration systems – combined cycles cogeneration systems – advanced cogeneration systems: fuel cell, Stirling engines etc.,

UNIT III ISSUES AND APPLICATIONS OF COGENERATION TECHNOLOGIES

Cogeneration plants electrical interconnection issues – utility and cogeneration plant interconnection issues – applications of cogeneration in utility sector – industrial sector – building sector – rural sector – impacts of cogeneration plants – fuel, electricity and environment.

UNIT IV WASTE HEAT RECOVERY SYSTEMS

Selection criteria for waste heat recovery technologies – recuperators – Regenerators – economizers – plate heat exchangers – thermic fluid heaters – Waste heat boilers – classification, location, service conditions, design Considerations – fluidized bed heat exchangers – heat pipe exchangers – heat pumps – sorption systems.

UNIT V ECONOMIC ANALYSIS

Investment cost – economic concepts – measures of economic performance – procedure for economic analysis – examples – procedure for optimized system selection and design – load curves – sensitivity analysis – regulatory and financial frame work for cogeneration and waste heat recovery systems.

Students Learning Outcomes The student can identify different areas of Cogeneration & Waste Heat Recovery Systems. . Can find the applications of all the areas in day to day life.

TEXT BOOKS:

1. Charles H. Butler, Cogeneration, McGraw Hill Book Co., 1984.11
2. EDUCOGEN – The European Educational tool for cogeneration, Second Edition, 2001

REFERENCES:

1. Horlock JH, Cogeneration - Heat and Power, Thermodynamics and Economics, Oxford,1987.
2. Institute of Fuel, London, Waste Heat Recovery, Chapman & Hall Publishers,London, 1963.
3. Seagate Subrata, Lee SS EDS, Waste Heat Utilization and Management, Hemisphere, Washington, 1983.
4. De Nevers, Noel., Air Pollution Control Engineering, McGrawHill, New York,1995

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M. Tech – I year II Sem. (TSES)

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(17D11211) MANUFACTURING SIMULATION LAB

1. Simulation of Plane Poiseuille flow through long Parallel and Stationary Plates and Plotting Velocity Contours and Velocity Variation along the horizontal central line . Take the distance between the plates as 4 cm. Properties of fluid are v=0.000217 m2/s p=800 kg/m2
2. Simulation of Couette flow when the upper plates is moving with a velocity of 40 m/s. Take the distance between the plates as 4 cm properties of fluid are v=0.000217 m2/s, p=800 kg/m3 . Make simulations for a pressure gradient of 0-30000 N/m2/m and 20000 N m2/m and report the variation of velocity contours for each case.
3. Simulation of a channel flow (Tube flow) for a tube of diameter. 5 cm and take the fluid as water at 300C at the entry of the tube of length 0.7m. A heat flux of 3000 W/m2 is imposed along a wall. Obtain the contours of velocity and temperature along the length of the tube and also obtain the centre line temperature and velocity of fluid.
4. Simulation of a channel flow (Tube flow) for a tube of diameter 5 cm and take the fluid as water at 300C at the entry of the tube length 0.7m . A Constant wall temperature of 3000C is imposed along the wall. Obtain the contours of Velocity and temperature along the length of the tube and also obtain the centre line temperature and velocity of fluid.
5. Unsteady simulation of compressible flow of air through 2D a convergent – Divergent nozzle, with inlet and outlet of 0.2m size and both are joined by a throat section where the flow area is reduced by 10% and is of sinusoidal shape. Air enters the nozzle at a pressure of 0.9 bar and leaves at 0.73 bar. Obtain the contours of velocity, pressure and Mach number.
6. Simulation of flow over a circular cylinder of size 5 cm for different Reynold's number values of air and plotting the contours of velocity and vorticity
7. Simulation of temperature counters for a square plate of size 0.2m subjected to different types of boundary conditions.
8. Simulation of temperature counters for a pin fin in natural and forced convective conditions.

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M.Tech III semester (TSES)

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(17D20301) RESEARCH METHODOLOGY
(Elective V-OPEN ELECTIVE)

UNIT I

Meaning of Research – Objectives of Research – Types of Research – Research Approaches – Guidelines for Selecting and Defining a Research Problem – research Design – Concepts related to Research Design – Basic Principles of Experimental Design.

UNIT II

Sampling Design – steps in Sampling Design –Characteristics of a Good Sample Design – Random Sampling Design.
Measurement and Scaling Techniques-Errors in Measurement – Tests of Sound Measurement – Scaling and Scale Construction Techniques – Time Series Analysis – Interpolation and Extrapolation.
Data Collection Methods – Primary Data – Secondary data – Questionnaire Survey and Interviews.

UNIT III

Correlation and Regression Analysis – Method of Least Squares – Regression vs Correlation – Correlation vs Determination – Types of Correlations and Their Applications

UNIT IV

Statistical Inference: Tests of Hypothesis – Parametric vs Non-parametric Tests – Hypothesis Testing Procedure – Sampling Theory – Sampling Distribution – Chi-square Test – Analysis of variance and Co-variance – Multi-variate Analysis.

UNIT V

Report Writing and Professional Ethics: Interpretation of Data – Report Writing – Layout of a Research Paper – Techniques of Interpretation- Making Scientific Presentations in Conferences and Seminars – Professional Ethics in Research.

Text Books:

1. Research Methodology:Methods And Techniques – C.R.Kothari, 2nd Edition,New Age International Publishers.
2. Research Methodology: A Step By Step Guide For Beginners- Ranjit Kumar, Sage Publications (Available As Pdf On Internet)
3. Research Methodology And Statistical Tools – P.Narayana Reddy And G.V.R.K.Acharyulu, 1st Edition,Excel Books,New Delhi.

REFERENCES:

1. Scientists Must Write - Robert Barrass (Available As Pdf On Internet)
2. Crafting Your Research Future –Charles X. Ling And Quiang Yang (Available As Pdf On Internet)

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(17D20302) HUMAN VALUES AND PROFESSIONAL ETHICS
(Elective V-OPEN ELECTIVE)

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

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

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

UNIT IV:
ENGINEERS RESPONSIBILITY FOR SAFETY AND RISK: Safety and risk – Assessment of safety and risk – Risk benefit analysis and reducing riskSafety and the Engineer- Designing for the safety- Intellectual Property rights(IPR).

UINIT V:
GLOBAL ISSUES: Globalization – Cross culture issues- Environmental Ethics – Computer Ethics – Computers as the instrument of Unethical behavior – Computers as the object of Unethical acts – Autonomous Computers- Computer codes of Ethics – Weapons Development - Ethics .

Text Books :

1. “Engineering Ethics includes Human Values” by M.Govindarajan, S.Natarajan and V.S.SenthilKumar-PHI Learning Pvt. Ltd-2009.
2. “Engineering Ethics” by Harris, Pritchard and Rabins, CENGAGE Learning, India Edition, 2009.
3. “Ethics in Engineering” by Mike W. Martin and Roland Schinzinger – Tata McGrawHill– 2003.
4. “Professional Ethics and Morals” by Prof.A.R.Aryasri, Dharanikota Suyodhana-Maruthi Publications.
5. “Professional Ethics and Human Values” by A.Alavudeen, R.Kalil Rahman and M.Jayakumaran , Laxmi Publications.

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(17D20303) INTELLECTUAL PROPERTY RIGHTS
(Elective V-OPEN ELECTIVE)

UNIT – I

Introduction To Intellectual Property: Introduction, Types Of Intellectual Property, International Organizations, Agencies And Treaties, Importance Of Intellectual Property Rights.

UNIT – II

Trade Marks : Purpose And Function Of Trade Marks, Acquisition Of Trade Mark Rights, Protectable Matter, Selecting And Evaluating Trade Mark, Trade Mark Registration Processes.

UNIT – III

Law Of Copy Rights : Fundamental Of Copy Right Law, Originality Of Material, Rights Of Reproduction, Rights To Perform The Work Publicly, Copy Right Ownership Issues, Copy Right Registration, Notice Of Copy Right, International Copy Right Law.
Law Of Patents : Foundation Of Patent Law, Patent Searching Process, Ownership Rights And Transfer

UNIT – IV

Trade Secrets : Trade Secrete Law, Determination Of Trade Secrete Status, Liability For Misappropriations Of Trade Secrets, Protection For Submission, Trade Secrete Litigation.
Unfair Competition : Misappropriation Right Of Publicity, False Advertising.

UNIT – V

New Development Of Intellectual Property: New Developments In Trade Mark Law ; Copy Right Law, Patent Law, Intellectual Property Audits.
International Overview On Intellectual Property, International – Trade Mark Law, Copy Right Law, International Patent Law, International Development In Trade Secrets Law.

TEXT BOOKS & REFERENCES:

1. Intellectual Property Right, Deborah. E. Bouchoux, Cengage Learing.
2. Intellectual Property Right – Nleashmy The Knowledge Economy, Prabuddha Ganguli, Tate Mc Graw Hill Publishing Company Ltd.,