SHRI RAMDEOBABA COLLEGE OF ENGINEERING AND MANAGEMENT, NAGPUR - 440013

An Autonomous College affiliated to
Rashtrasant Tukadoji Maharaj Nagpur University,
Nagpur, Maharashtra (INDIA)

PROGRAMME SCHEME & SYLLABI
2018 - 20

M.TECH. (HEAT POWER ENGINEERING)

Published by
Dr. R.S. Pande
Principal
Shri Ramdeobaba College of Engineering & Management
Ramdeo Tekdi, Gittikhadan, Katol Road, Nagpur - 440 013
Ph. : 0712-2580011 Fax : 0712 - 2583237
ISO 9001 : 2015 CERTIFIED ORGANISATION

About the Department

1. The department was established in 2009.
2. It has well-equipped laboratories like CAD/CAE Lab, Metallurgy Lab, Machine Shop, Workshop, Fluid Mechanics Lab/ Fluid Machinery Lab, Basic Mechanical Engineering lab, Drawing Halls, Theory of Machines Lab, Metrology and Quality Control Lab, Refrigeration and Air Conditioning Lab, Heat Transfer Lab, Solar Energy Lab, Research Lab, Mechanical Measurements Lab, Additive Manufacturing Lab, Simulation and Modeling Lab with WITNESS, CREO and ANSYS for demonstration and hands on experience for the students.
3. M.Tech, Heat Power Engineering started from the session 2013-14.
4. It has adopted latest teaching learning processes like e-learning, NPTEL/SWAYAM, power point presentations, seminars, industrial visits, industry based projects, etc. The department has modern classrooms that use LCD & Overhead Projectors, White Boards, etc for a comfortable and effective learning experience.

Department Vision

"The Mechanical Engineering Department strives to be a leader in imparting quality education and research leading to competent engineers, who are innovative, entrepreneurial, ethical and successful in advanced fields of engineering and research."

Department Mission

1. To prepare the students for successful engineering career by including the leadership qualities to encourage entrepreneurship and the professional and ethical responsibilities for the betterment of the society with a respect for diversity of opinion and culture.
2. To provide a conducive environment for learning and exploring full potential by sensitizing and motivating them.
3. To march ahead with dedication, zeal and with a system highly sensitive to needs of all the stakeholders.

Programme Educational Objectives

1. To prepare post graduates who will create new ways to meet society's needs with their knowledge of Heat Power Engineering.
2. To promote student's awareness of life-long learning and to introduce them to professional ethics and codes of professional practice.
3. To provide students with advanced knowledge in the area of Heat Power Engineering, by using analytical, computational techniques and prepare them for further research.

Programme Outcomes

1. An ability to identify, formulate and solve engineering problems by applying knowledge of Heat Power Engineering.
2. An ability to develop practice of technical communication and function in team.
3. An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, health and safety, manufacturability, and sustain ability.
4. To develop self learning ability.

SEMESTER - I

Sr No	Course Code	Course Name	L	P	Total	Credits	Maximum Marks			Category
							Internal Assessment	End Semester Examination	Total	
1	MET551	Advanced Thermodynamics	4	-	4	4	40	60	100	P.C.
2	MET552	Conduction and Radiation Heat Transfer	4	-	4	4	40	60	100	P.C.
3	MET553	Fluid Dynamics	4	-	4	4	40	60	100	P.C.
4	MEP554	Lab Practice -1	-	4	4	2	25	25	50	P.C.
5	MET555	Program Elective-I	4	-	4	4	40	60	100	P.E.
6	MET556	Research Methodology	3		3	3	40	60	100	F.C.
		Total	**19**	**4**	**23**	**21**	**225**	**325**	**550**	

Course Code	Program Elective-I
MET555-1	Micro Fluidics
MET555-2	Fuels and Combustion
MET555-3	Finite Element Method

SEMESTER - II

Sr No	Course Code	Course Name	L	P	Total	Credits	Maximum Marks			Category
							Internal Assessment	End Semester Examination	Total	
1	MET557	Convective Heat and Mass transfer	4	-	4	4	40	60	100	P.C.
2	MET558	Advanced Refrigeration and Air Conditioning	4	-	4	4	40	60	100	P.C.
3	MET559	Computational Fluid Dynamics	4	-	4	4	40	60	100	P.C.
4	MEP560	Lab Practice -II	-	4	4	2	25	25	50	P.C.
5	MET561	Program Elective -II	4	-	4	4	40	60	100	P.E.
6	MET562	Advanced computational Techniques	3	-	3	3	40	60	100	F.C.
7	MET599	Open Elective	3	-	3	3	40	60	100	O.E.
		Total	**22**	**4**	**26**	**24**	**265**	**385**	**650**	

Course Code	Program Elective-II
MET561-1	Solar Energy Utilization
MET561-2	Industrial Fluid Power
MET561-3	Power Plant Engineering
Course Code	**Open Elective**
MET599-1	Mechatronics
MET599-2	Automobile Engineering

SEMESTER - III

Sr No	Course Code	Course Name	L	P	Total	Credits	Maximum Marks			Category
							Internal Assessment	End Semester Examination	Total	
1	MET651/ INT651	Group Elective - I	4	-	4	4	40	60	100	GE.
2	MET652/ INT652	Group Elective-II	4	-	4	4	40	60	100	GE
3	MEP653	Project Phase-I	-	3	3	6	100	100	200	
		Total	**8**	**3**	**11**	**14**	**180**	**220**	**400**	

Course Code	Group Elective-I
MET651-1	Energy Conservation and Management
MET651-2	Thermal Storage Systems
MET651-3	Advanced Turbo Machines
INT651-1	Total Quality Management
INT651-2	Value Engineering
INT651-3	System Design Engineering
Course Code	**Group Elective-II**
MET652-1	Environmental Pollution & Control
MET652-2	Design of heat Exchangers
MET652-3	Cryogenics
MET652-4	Advanced IC Engines & Alternate Fuels
INT652-1	Computer & Database Management System
INT652-2	Manufacturing Economics and Analysis

SEMESTER - IV

Sr No	Course Code	Course Name	L	P	Total	Credits	Maximum Marks			Category
							Internal Assessment	End Semester Examination	Total	
1	MEP654	Project Phase (II)	-	6	6	12	200	200	400	-
		Total	**-**	**6**	**6**	**12**	**200**	**200**	**400**	

Total 21 + 24 + 14 + 12 = 71 Credits

Syllabus of Semester I, M. Tech. (Heat Power Engineering)

Course Code: MET551 **Course : Advanced Thermodynamics**

L: 4 Hrs, T: 0 Hrs, P: 0 Hrs. Per week **Total Credits : 04**

Course Outcomes :

1. Apply the laws of thermodynamics to closed and open systems including thermodynamic cycles.
2. Discuss a range of approaches to estimate fluid phase equilibria in one and two component system.
3. Estimate the physical properties of mixtures, especially non-ideal mixtures.
4. Predict the equilibria of chemical reactions.
5. Understand the governing equations for compressible fluid flows and normal shocks.
6. Analyze the gas power cycles and cogeneration systems.

Syllabus

Review of basic thermodynamic principles, entropy, availability and irreversibility, first & second law analysis of steady and unsteady systems

General thermodynamic relations, fundamentals of partial derivatives, relations for specific heat, internal energy enthalpy and entropy, Joule Thompson co-efficient, Clapeyron equation

Multi component system, review of equation of state for ideal and real gases, thermodynamic surfaces, gaseous mixtures, fugacity, ideal solutions, dilute solutions, activity, non ideal liquid solution

Multi component phase equilibrium, criteria of equilibrium, stability, and heterogeneous equilibrium, binary vapour liquid systems, the nucleus of condensation and the behavior of steam with formation of large and small drops, Gibbs phase rule, higher order phase transition

Thermodynamic aspects of fluid flow – Basic dynamic equation for steady, one dimensional fluid flow, convenient properties of fluids, Application of basis relations, flow in pipes – adiabatic, irreversible flow in constant area passage, flow with combustion or heat transfer, Normal Shocks

Thermodynamic Optimization: Exergy analysis of Vapour and Gas Power Cycles, Guideline for improving Thermodynamic Effectiveness; Exergy analysis of Simple Power Plant (Steam Plant)

Text Books :

1. Engineering Thermodynamics, P.K.Nag, Tata Mc-Graw Hill Publication.
2. Engineering Thermodynamics with applications, M. David Burhardt,Harper and Row Publishers.
3. Engineering Thermodynamics, William L. Haberman and James E.A.John, Allyn and Bacon Publisher.
4. Fundamentals of Classical Thermodynamics, Gordan J Van Wylen,Richard E.Sonntag, Claus Borgnakke , Wiley Publihers.

Reference Books:

1. Thermodynamics: An Engineering Approach, Yunus A. Cengel & Michael A. Boles, Sixth Edition
2. Advanced Engineering Thermodynamics, Adrian Bejan, Wiley-Interscience Publication, Second Edition.
3. Fundamentals of Engineering Thermodynamics, Michael Moran & Howard Shapiro, Wiley & Sons, Sixth Edition.

Syllabus of Semester I, M. Tech. (Heat Power Engineering)

Course Code : MET552 **Course : Conduction and Radiation Heat Transfer**

L: 4 Hrs, P: 0 Hrs. Per week **Total Credits : 04**

Course Outcomes :

1. Understand the utility of differential equations and boundary conditions in conduction heat transfer analysis.
2. Develop and solve appropriate differential equations for steady state & unsteady state heat transfer analysis.
3. Use analytical, graphical (temperature charts) and numerical solution techniques in solving heat conduction problems.
4. Understand the physical concepts of electromagnetic waves and differentiate electromagnetic spectrum based on wavelength bands.
5. Understand different terminologies of radiation heat transfer, radiation properties and applications of radiation laws with their significance in depth.
6. Carry out thermal radiation exchange analysis between black and gray surfaces.

Syllabus

Conduction Heat Transfer : Heat conduction equation in Cartesian, cylindrical and spherical co-ordinates, boundary conditions, steady and unsteady state heat conduction in one, two and three dimensions.

Analytical, Graphical and Numerical methods of analysis, Conduction shape factor, extended surface heat transfer, transient condition, multi-dimensional systems, numerical methods in unsteady state heat transfer, Integral heat conduction equation, Biot approximate method, Error in temperature measurement.

Radiation Heat Transfer – Fundamentals laws of thermal radiations, surface properties, Heat exchange between non black bodies, Electrical network analogy for thermal radiation system.

Radiative heat exchange among diffuse, gray and non gray surfaces separated by non participating media, Formulation of Numerical solutions, Radiation shields.

Gas radiation, Radiation from gases, vapours and flames, solar radiation, Radiation heat transfer coefficient.

Text Books :

1. Fundamentals of Heat and Mass Transfer, F. P. Incropera, D. P. DeWitt, 7th edition, John Wiley & Sons, 2011
2. Heat Transfer :A practical approach, Y. A. Cengel, 2nd edition, McGraw Hill , 2003
3. Heat Transfer, J.P. Holman, 9th edition, McGraw Hills Publication, 2002
4. Fundamentals of Heat & Mass Transfer, M. Thirumaleshwar, 2nd edition, Dorling Kindersley India ltd. (Pearson), 2009

Reference Books :

1. Heat Conduction, , , 4th edition, Taylor & Francis Group, 2008
2. Thermal Radiation Heat Transfer, Robert Siegel, John Howell, 4th edition, Taylor & Francis, 2002.

Syllabus of Semester I, M. Tech. (Heat Power Engineering)

Course Code : MET553 **Course : Fluid Dynamics**

L: 4 Hrs, P: 0 Hrs. Per week **Total Credits : 04**

Course Outcomes :

Student will be able to :

1. Classify, Identify and apply the Eulerian & Lagranian Approach.
2. Analyze kinematic motion of fluid flow.
3. Apply Reynolds Transport theorem to conservation equations.
4. Understand the exact and approximate solutions of Navier-stokes equations.
5. Understand Principle of similarity and turbulence.
6. Analyze boundary layer formation & separation theory.

Syllabus

Fluid Flow Concepts, Continuum Theory, Eulerian & Lagrangian Approach.

Fluid Kinematics : Transportation, Rotation & Deformation.

Differential Analysis of Fluid Flow: Reynolds Transport Theorem, Continuity equation, Linear Momentum Equation, Differential Momentum Equations, Euler's equation of motion, Navier-Stoke's equations, Energy Equation & Equation of state.Applications of differential equations to fluid flow systems.

Exact solutions of Continuity & Navier-Stoke's equations. Approximate Solutions of Navier Stoke's Equations.

Reynold's principle of similarity, Semi empirical theories of turbulence, RANS equation.

Boundary Layer Theory: Laminar & Turbulent Flow. Boundary Layer equations for flow over flat plate & flow through cylinder, separation of boundary layer, Momentum-Integral equation of the Boundary Layer.

Text Books :

1. Introduction to Fluid Mechanics and fluid Machines, S K SOM & G. Biswas, TATA McGraw Hill.
2. Fluid Mechanics, Yuan, S. W., Prentic Hall Publication.
3. Fluid Mechanics, Cengel, Y. A. & Cimbala J. M., McGraw-Hill Publication.

Reference Books :

1. Fluid Mechanics, White, F. M., McGraw Hill Publication.
2. Elementary Fluid Mechanics, Vennard J. K. & Street R. L., John Wiley Publication.

Syllabus of Semester I, M. Tech. (Heat Power Engineering)

Course Code: MEP554 **Course: Lab Practice I**

L: 0 Hrs,P: 4 Hrs. Per week **Total Credits: 02**

Course Outcomes :

1. Ability to apply the theoretical knowledge to solve problems in Heat Power Engineering.
2. Hands on experience through actual experimentation or simulation.
3. Ability to formulate and analyze practical problems.
4. Ability to prepare mathematical/geometrical model and solve it using appropriate software.
5. Ability to analyze data obtained through experimentation/simulation and drawing suitable technical conclusions.
6. Ability to prepare technical report for the given case study.

Syllabus

Laboratory Practice shall constitute at least two experiments, design, simulation, programming, assignments from each of the course with reports.

Syllabus of Semester I M. Tech. (Heat Power Engineering)

Course Code : MET555-1(Elective-III) **Course : Microfluidics**

L: 4 Hrs, P: 0 Hrs. Per week **Total Credits : 04**

Course Outcomes :

1. Understand the fundamentals of microfluidics technology
2. Solve simple problems of gas and liquid flows in microchannels.
3. Design a microfluidic system to solve real world problem.
4. Describe the basic components of a microfluidic system.

Introduction

Benefits, challenges, physics of miniaturization, applications of microfluidics, scaling laws

Syllabus

Micro-scale fluid mechanics :

Intermolecular forces, state of matter, continuum assumption, governing equations, constitute relations

Gas and liquid flows, boundary conditions, slip theory, transition to turbulence, Low Re flow, entrance effect

Exact solutions, Couette flow, Poiseuille flow, Strokes drag on a sphere, time dependent flows, Thermal transfer in micro-channels

Hydraulic resistance & circuit analysis, straight channel of different cross-sections, Channels in series and parallel

Capillary flows :

Surface tension and interfacial energy, Young-Laplace equation, Contact angle, Capillary length and capillary rise, Interfacial boundary conditions, Marangoni effect.

Electrokinetics :

Electrohydrodynamics fundamentals.

Electro-osmosis, Debye layer, Thin EDL limit, Ideal electro-osmotic flow, Ideal EOF with back pressure, Cascade electro-osmotic micropump, EOF of power-law fluids.

Electrophoresis of particles, Electrophoretic mobility,Electrophoretic velocity dependence on particle size.

Dielectrophoresis, Induced polarization and DEP , Point dipole in a dielectric fluid, DEP force on a dielectric sphere.

Microfabrication Technology :

Micromachining of Silicon and Polymeric Chips

Fabrication Techniques - Chemical etching and bonding

Electron beam lithography, Softlithography: Casting, Injection molding

Components of Microfluidic Devices :

Miniaturized Systems, Actuators, Pumps, Valves, Micro-mixers, Sensors

References Books :

1. Nguyen, N. T., Werely, S. T., Fundamentals and applications of Microfluidics, Artech house Inc., 2002.
2. Bruus, H., Theoretical Microfluidics, Oxford University Press Inc., 2008.
   Madou, M. J., Fundamentals of Microfabrication, CRC press, 2002.
3. Tabeling, P., Introduction to microfluidics, Oxford University Press Inc., 2005.
4. Kirby, B.J., Micro- and Nanoscale Fluid Mechanics: Transport in Microfluidic Devices, Cambridge University Press, 2010.
5. Colin, S., Microfluidics, John Wiley & Sons, 2009.

Syllabus of Semester I M. Tech. (Heat Power Engineering)

Course Code : MET555-2(Elective-II) **Course : Fuels and Combustion**

L: 4 Hrs, P: 0 Hrs. Per week **Total Credits : 04**

Course Outcomes :

1. Understand the fuels & its thermo - physical properties.
2. Understand and compute the properties of reacting mixtures.
3. Comprehend and calculate the structure and properties of a premixed and diffusion flame.
4. Understand the chemical equilibrium and chemical kinetics.
5. Understand & apply conservation equations to the multi-component systems.
6. Recognize and analyze the carbon particle and liquid droplet burning processes.

Syllabus

Types of fuels and their properties, Coal characterization, Combustion chemistry, Stoichiometry, Heat of reaction, Calorific value, adiabatic flame temperature, Chemical equilibrium.

Chemical kinetics, important chemical mechanisms, Simplified conservation equations for Reacting flows, laminar premixed flames, simplified analysis.

Factors influencing flame velocity and thickness, flame stabilization, Diffusion flames, Introduction to turbulent flames.

Fluidized Bed Combustion, different types of FBCs, models for droplet and carbon particle combustion.

Text Books:

1. An introduction to combustion: Concepts and Applications, Stephen R. Turns, McGraw-Hill
2. Fuels and Combustion, S. P. Sharma, Chander Mohan, McGraw-Hill Education
3. Analytic Combustion: With Thermodynamics, Chemical Kinetics, & Mass Transfer, A.W. Date, Cambridge University Press.

Reference Books :

1. Combustion physics , Chung K. Law, Cambridge university press.
2. Fundamentals of combustion , D.P. Mishra, PHI Pvt. Ltd.
3. Introduction to Physics & Chemistry of Combustion: Explosion, Flame, Detonation, Michael A. Liberman, Springer

Syllabus of Semester I, M. Tech. (Heat Power Engineering)

Course Code: MET555-3 (Elective-III) **Course : Finite Element Method**

L: 4 Hrs, P: 0 Hrs. Per week **Total Credits : 04**

Course Outcomes :

Students will be able to :

1. Solve given differential equation by Numerical Method.
2. Apply various approaches to find the field variables.
3. Analyze the 1-D bar and 2-D truss element by FEA method.
4. Develop Elements matmix equation by Rayleigh method
5. Analyze 1-D and 2-D steady state heat conduction and fluid flow problems.
6. Understand Numerical Integration.

Syllabus

Numerical Methods (T.S, R-K,FDM) General Steps of the Finite Element Method, Applications of the Finite Element Method, Advantages of the Finite Element Method, W-R Methods variational approach, Galerkine method, Rayleigh Ritz method,

Axial bar element, Stiffness matrix, load vector, shape function (Linear and quadratic), temperature effect. A analysis of plane truss, Introduction to Numerical Integration.

Heat conduction and convection- Introduction, Derivation of the Basic Differential Equation, Heat Transfer with Convection, One-Dimensional Finite Element Formulation, Two-Dimensional Finite Element Formulation,

Fluid flow: Introduction, Derivation of the Basic Differential Equations, One-Dimensional Finite Element Formulation, Two-Dimensional Finite Element Formulation, Numerical Integration.

Software approach to FEM- Use of ANSYS (Analysis software) to solve the problems based on above syllabus.

Text Books :

1. Finite Elements Methods, J. N. Reddy, TMH
2. Text book of finite element analysis, P.Seshu EEE PHI
3. Finite element procedures , K.J. Bathe, EEE PHI

Reference Books :

1. Finite Elements Methods in Engineering , S. S. Rao, Pergamon press

Syllabus of Semester I M. Tech. (Heat Power Engineering)

Course Code: MET556 **Course : Research Methodology**

L: 3 Hrs., P: 0 Hrs. per week **Total Credits : 03**

Course Outcomes :

1. Understand the concept and scope of Research and its Methodology.
2. Understand and classify the literature available.
3. The student should be able to analyze and formulate the Research problem.
4. Demonstrate the method of data collection.
5. Apply various tools to analyze the data
6. Formulate the appropriate mathematical model.

Syllabus

Introduction: Meaning & Objectives of Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Importance of Knowing How Research is Done, Research Process, Criteria of Good Research.

Literature Review and Formulating a Research Problem : Significance of Literature Review, Procedure for reviewing the literature, what is a Research Problem, Sources of a Research Problem, Selecting the Problem, Necessity of Defining the Problem, Techniques involved in defining a Problem.

Method of Data Collection, Data Analysis and Sampling Fundamentals : Types of Variables, Collection of Primary Data, Various Methods of Data Collection, Data Analysis, Need for Sampling, Sampling Distributions, Sample Size Determination.

Hypothesis Testing and Analysis of Variance : What is Hypothesis, Procedure for Hypothesis Testing, Hypothesis testing of means and samples, limitations of tests of Hypotheses, What is ANOVA, ANOVA Technique, Two- Way ANOVA.

Mathematical Model : Logic Based modeling : Experimental data based modeling; Field data based modeling; Modeling based on design of new system/Process/ Product; Modeling based on facts generated by earlier investigators.

Reliability of Established Model : Review of theory of reliability; Demonstration of application of theory of reliability of model.

Optimization of Model/Process/ Product: Optimization theory; Application of optimization theory to modeling; Solution to the situation of conflicting optimization conditions.

Role of computer in Research : Introduction to spreadsheet application, features and functions, Using formulas and functions, Data storing, Feature for Statistical data analysis, Generating Charts / ghrap and other features, Use of MS Excel, Power Point, Use of statical Analyis software. Report writing and publication : Planning of report Writing, Thesis writing, Formats of report writing, Types of reports Different steps in writing report, Formats of publications in Research journals.

Text Books :

1. Research Methodology: Methods and Techniques, Kothari C.K. (2004), 2/e, New Age International, New Delhi.
2. Research Methodology: A Step by Step Guide for Beginners, 2nd ed.: Ranjit Kumar: Pearson
3. Design and Analysis of Experiments, Montgomery, Douglas C. (2007), (Wiley India) 5th ed.

Reference Books:

1. Design and Analysis of Experiments: Angela Dean and Daniel Voss, Springer-Verlag New York.
2. Theories of Engineering Experimentation, 1st ed.: H. Schenck Jr., Mc-Graw Hill.
3. Simulation Modeling and Analysis, 2nd ed.: Law, A. M, W. D. Kelton, 1991, McGraw Hill
4. Applied Statistics & Probability for Engineers: Montgomery, Douglas C. & Runger, George C. (2007), 3/e, (Wiley India)

SEMESTER - II

Syllabus of Semester II, M. Tech. Heat Power Engineering

Course Code: MET557 **Course : Convective Heat and Mass Transfer**

L: 4 Hrs, P: 0 Hrs, per week **Total Credits :0 4**

Course Outcomes :

1. Understand the hydrodynamic, thermal boundary layer concept and the relevant equations.
2. Understand the heat transfer in seminar & turbulent fluid flow.
3. Ability to apply the various empirical correlations used in forced convection.
4. Understanding free convection & convection in phase change applications.
5. Ability to design the basic heat exchanger configuration.
6. Understand the mass transfer theories.

Syllabus

Heat transfer by convection: Hydrodynamic and Thermal boundary Layer, Turbulence. Energy equation of boundary layer, Momentum equation, Von-Karmann integral momentum equation.

Relationship between fluid friction and heat transfer. Turbulent Boundary-Layer Heat transfer, Heat transfer in Laminar and Turbulent fluid flow, heat transfer in high speed flow.

Empirical and practical relations for forced convection heat transfer. Relations for pipes and tube flow, flow across cylinder and sphere. Flow across tube banks, Liquid metal heat transfer.

Free Convection, Convection with change of phase, Condensation and boiling heat transfer.

Heat Exchangers: Design and performance analysis.

Mass transfer: Fick's law, diffusion in gases, diffusion in liquids and solids, Convection mass transfer, mass transfer co-efficient, Ablation and heat pipe, Transpiration cooling, Low density heat transfer.

Text Books :

1. Convective Heat and Mass Transfer, W.M. Kays, M.E Crawford, TMH
2. Convective Heat Transfer, Bejan A, John Wiley 1984.
3. Heat Transfer, Yunus A Cengel, Mc Graw Hill
4. Fundamentals of Heat & Mass Transfer, M.Thirumaleshwar, Pearson

Reference Books :

1. Heat Transfer, J.P. Holman, McGraw Hills Publication.
2. Introduction to Heat Transfer , Incropera & Dewitt J., Wiley, John Wiley & Sons
3. Elements of Heat Transfer , M.N.Ozisik, Mc Graw Hill
4. Heat Transfer , S.P.Sukhatme, Universities Press

Syllabus of Semester II, M. Tech. Heat Power Engineering

Course Code: MET558 **Course: Advanced Refrigeration and Air Conditioning**

L: 4 Hrs, P: 0 Hrs, per week **Total Credits: 04**

Course Outcomes :

1. Understand the environmental and social impact of old and alternative refrigerants.
2. Ability to design and select the various components of refrigeration systems.
3. Ability to carry out thermodynamic analysis of convemtional and non-conventional refrigeration systems.
4. Ability to carry out heat load calculations and design air conditioning systems.
5. Ability to design air distribution system.
6. Understand & analyse low temperature refrigeration system.

Syllabus

Refrigerants: Nomenclature, Properties, Ozone layer depletion and Global warming, Montreal and Kyoto Protocol, Alternatives to CFC's and HFC's, Natural refrigerants.

Actual vapor compression system, Multi pressure vapour compression system, Advanced vapour absorption refrigeration systems.

Analysis of Non-conventional Refrigeration Systems – Steam jet refrigeration systems, Thermoelectric refrigeration system, Vortex tube refrigeration system, Pulse tube refrigeration system, Mixture refrigeration system, Adsorption refrigeration system, Desiccant cooling, hybrid systems.

Advanced Psychrometry - Heat load calculations and equipment selection, Duct design and air distribution systems, measuring instruments in air conditioning, Thermal insulation.

Low temperature refrigeration: cascade system, Joule-Thompson coefficient, systems for liquefaction of air, Applications of cryogenics.

Text Books :

1. A textbook of Refrigeration and Air Conditioning, R. K. Rajput, S. K. Kataria & Sons.
2. Refrigeration and Air Conditioning, C.P. Arora, Tata McGraw-Hill Education
3. Refrigeration and Air Conditioning , , New Age International
4. Fundamentals of Cryogenic Engineering, Mamata Mukhopadhyay, PHI Learning Pvt. Ltd.

Reference Books :

1. Refrigeration & Air-conditioning , Stocker & Jones – McGraw-Hill Publication
2. Principle of Refrigeration & Air-conditioning, Roy J.Dossat-Pearson Edu.
3. A Course in Refrigeration & Air conditioning, Domkundwar & Arora,Dhanpat Rai & Co.
4. Air Conditioning Engineering by Jones W.P., Edward Amold Publishers Ltd.
5. ASHRAE Guide and Data Book

Syllabus of Semester II, M. Tech. Heat Power Engineering

Course Code: MET559 **Course : Computational Fluid Dynamics**

L: 4 Hrs, P: 0 Hrs, per week **Total Credits : 4**

Course Outcomes :

Students will be able to

1. Understand the governing equations of fluid flow and heat transfer.
2. Classify, identify applications of partial differential equations.
3. Illustrate CFD methodlogy and gird generation.
4. Analyze the flow by FDM /FVM.
5. Apply one or tow equation model to Turbulence.
6. Understand pressure - velocity coupling, stability, conference, accuracy, errors in CFD modeling.

Syllabus

Governing equations of fluid flow & heat transfer, Conservative forms of the governing equations, Non-Conservative forms of the governing equations.

Mathematical behavior of Partial Differential Equations: Elliptical, Parabolic & Hyperbolic Equations.

CFD solution methodology: Preprocessing, Solver & Post processing.

Grid Generation Techniques.

Introduction to Finite Difference Discretisation, Finite Volume Method: FVM for 1-D, 2-D & 3-D diffusion problems, FVM for unsteady flows.

Initial & Boundary Conditions: Implementation of various boundary conditions.

Turbulence Modeling: One equation models, Two equation models & their respective applications.

Introduction to solution algorithms for pressure-velocity coupling in steady flows.

CFD solution analysis essentials: Consistency, Stability, Convergence & Accuracy.

Errors and Uncertainty in CFD modeling.

Case studies using CFD codes.

Text Books :

1. An Introduction to Computational Fluid Dynamics, Date A.W., Cambridge University Press Publication.
2. Basics of Computational Fluid Dynamics, Niyogi P., Chakrabartty S.K. & Laha M.K., Pearson Prentice Hall Publication.

Reference Books :

1. Computational Fluid Dynamics –The Basics with Applications, Anderson J.D., Mc Graw Hill Publication.
2. An Introduction to Computational Fluid Dynamics, H. Versteeg & W. Malalasekra, Pearson Prentice Hall Publication.

Syllabus of Semester II M.Tech. (Heat Power Engineering)

Course Code: MEP560 | **Course : Lab Practice II**

L: 0 Hrs, T: 0 Hrs, P: 4 Hrs. per week | **Total Credits : 02**

Course Outcomes :

1. Ability to apply the theoretical knowledge to solve problems in Heat Power Engineering.
2. Hands on experience through actual experimentation or simulation.
3. Ability to formulate and analyze practical problems.
4. Ability to prepare mathematical/geometrical model and solve it using appropriate software.
5. Ability to analyze data obtained through experimentation/simulation and drawing suitable technical conclusions.
6. Ability to prepare technical report for the given case study.

Syllabus

Laboratory Practice shall constitute at least two experiments, design, simulation, programming, assignments from each of the course with reports.

Syllabus of Semester II, M. Tech. Heat Power Engineering

Course Code: MET561-1 (Elective-I) | **Course : Solar Energy Utilization**

L: 4 Hrs, P: 0 Hrs, per week | **Total Credits : 4**

Course Outcomes :

1. Develop familiarity with terminology and types of solar energy utilization.
2. Organize the meteorological data to interpret insolations for given location and time of year.
3. Understand solar photo voltaic systems in detail.
4. Understand various solar thermal systems in detail
5. Design solar photovoltaic & solar thermal systems for given requirements.
6. Undertake research carrier in solar Energy Utilization.

Syllabus

Global energy scenario, status of solar energy utilization in world, various ways of solar energy utilization

Solar Resources : Introduction to electromagnetic spectrum, solar spectrum, estimation of extraterrestrial radiations, solar constant, air mass, attenuation of solar radiations through atmosphere, solar geometry, measurement of solar radiations, empirical equations for predicting availability of terrestrial radiations, solar charts.

Solar Thermal : principles of solar thermal energy collection, different types of solar thermal collectors, components of thermal collection, performances indicating parameters, novel designs of collectors, design and performance analysis of collectors. Solar thermal power plants, solar energy storage: sensible, latent and thermo chemical storage. Solar thermal applications: water and space heating; solar ponds; dryers, distillation, solar cooker, passive solar design.

Basics of solar photovoltaic's : Photovoltaic effect, different types of photovoltaic cells, cell materials, module specifications, manufacturing of PV cells and modules, PV cell characteristics, performance indicating parameters, performance affecting factors, cost of PV technologies.

Components of Photovoltaic Systems : balance of PV systems, module hot spots, bypass diodes, PV arrays and PV systems, mounting structures, series and parallel connections of PV modules, mismatch in PV connections, charge controllers, MPPT, cables, storage batteries, inverters.

Design of PV Systems : standalone PV systems, grid connected PV systems, rooftop solar power plants, economics and future prospects.

Text Books :

1. Solar Energy: Principles of Thermal Collection and Storage, S.P. Sukhatme, 2nd edition, Tata Mc Graw Hill New Delhi, 1984.
2. Solar Energy Fundamentals and applications, H.P,Garg, J Prakash, 1st edition, Tata Mc Graw Hill, New Delhi, 1997.
3. Energy Technology: Nonconventional, Renewable and Conventional, S. Rao, B. B. Parulekar, 3rd edition, Khanna Publisher, New Delhi 1999.
4. Solar Photovoltaics: Fundamental Applications and Technologies, C. S. Solanki, 2nd edition, Prentice Hall of India New Delhi 2011.

Reference Books:

1. Solar Engineering of Thermal Processes, Duffie. J. A. & W. A. Beckman, 3rd edition, John Wiley & Sons, 2006.
2. Renewable Energy Resources, John Twidell, Tony Weir, Taylor & Francis; 2nd edition, 2005.

Syllabus of Semester II, M. Tech. Heat Power Engineering

Course Code: MET561-2 (Elective-II) **Course: Industrial Fluid Power**

L: 4 Hrs, P: 0 Hrs, per week **Total Credits: 04**

Course Outcomes :

1. Identify and apply the principles and functions for safe operation of hydraulic and pneumatic systems and their components.
2. Understand the working of various types of control valves.
3. Inspect and safely perform maintenance and troubleshooting on hydraulic and pneumatic systems and their components, in accordance with the manufacturer's service manuals, and acceptable industry practices and applicable regulations.
4. Ability to design hydraulic circuit for given application.
5. Identify and apply basic theory and computation skills regarding hydraulic and pneumatic power as they relate to various applications.
6. Develop the Pneumatic circuits for industrial applications and automation.

Syllabus

Fluid power systems : Components, advantages, applications in the field of M/c tools, material handling, hydraulic presses, mobile & stationary machines, clamping &indexing devices etc. Transmission of power at static & dynamic states. Types of Hydraulic fluids like petroleum based, synthetic & water based. Properties of fluids, Selection of fluids, additives, effect of temperature & pressure on hydraulic fluids. Seals, sealing materials, selection of seals, Filters strainers, sources of contamination of fluid & its control.

Accumulators & intensifiers: Types & functions of accumulators, Intensifiers, applications, selection & design procedure.

Control of fluid power: Necessity of pressure control directional control, Flow control valves, Principle of pressure control valves, direct operated, pilot operated, Relief valves pressure reducing valve, sequence valve & methods of actuation of valves.

Flow control valves: Principle of operation, pressure compensated, temp.

Compensated flow control valves, meter in & meter out flow control circuits, bleed off Circuits.

Direction control valves: Check valves, types of D.C.Valves: Two way two Position, four way three position, four way two position valves, open center, close center Tandem center valves, method of actuation of valves, manually operated solenoid Operated, pilot operated etc.

Actuators: Linear & Rotary actuators, Hydraulic motors, Types, vane, gear Piston, radial piston, Calculations of piston velocity thrust under static & dynamic applications. Design Consideration for cylinders.

Hoses & Pipes: Types, Materials, pressure drop in hoses / pipes.

Hydraulic piping connections.

Design of hydraulic circuits: Circuit illustrating use of pressure reducing valves, sequencing valve, counter balance, Valves, unloading valves with the use of electrical controls, accumulators etc. Maintenance, trouble shooting & safety precautions of Hydraulic Circuits.

Methods of control of acceleration

Pneumatics: Introduction to pneumatic power sources, e.g. reciprocating & rotary Compressors, roots-blower etc. Comparison of pneumatics with Hydraulic power Transmission, Air preparation units, filter, regulators & lubricators. Actuators, linear Single & double acting rotary actuators, air motors, pressure regulating valves.

Directional control valves two way, three way & four way valves, solenoid operated, Push button; & lever control valves. Flow control valves. Check valves methods of Actuation, mechanical, pneumatic & electrical etc. Pneumatic circuits for industrial applications & automation. e.g. Feeding clamping, Indexing, picking & placing etc.

Text Books :

1. Introduction to Fluid Power, N. V. Sahashtrabudhe, Nirali Prakashan, Pune
2. Industrial Hydraulics, J. J. Pipenger, McGraw Hill Co.
3. Pneumatics Systems, S. R. Mujumdar, Tata McGraw Hill.

Reference Books :

1. Industrial Fluid Power, Pinches, Prentice Hall
2. Manuals on Industrial Hydraulics, Vickers
3. Hydraulics & Pneumatics, H.L. Stewart, Industrial Press
4. Fluid Power Design Handbook, Yeaple.

Syllabus of Semester II, M. Tech. Heat Power Engineering

Course Code: MET561-3 (Elective-III) **Course: Power Plant Engineering**

L: 4 Hrs, P: 0 Hrs, per week **Total Credits: 4**

Course Outcomes :

1. Understand the economic environmental and regulatory issues related to power generation.
2. Compute cast of power generation & tariff for various power plants.
3. Analyze and understand the design of the major systems of conventional fossil-fuel steam - cycle power plants.
4. Through knowledge of the basic design principles fo nuclear power plant and it's waste disposal.
5. Analyze the gas turbine for it's operation and performance.
6. Investigate the combined cycle power plants and understand water pollution & solid waste management in power plants.

Syllabus

Energy reserves and Energy utilization in the world, Electrical power Generation & consumption in India. Types of power plants, merits and demerits, Criteria for selection of power plant. Power Plant Economics

Steam Power Plant: Layout, Super Heaters, Reheaters, Condensers, Economizers and Feed Water heaters, Operation and performance, Rankine cycle with Superheat, Reheat and Regeneration. Super critical boilers, Fluidized Bed combustion boiler - Advantages, Waste heat Recovery boilers, Co-generation Power Plant, Emissions and their controls.

Nuclear Power Plant: Overview of Nuclear Power Plant, Nuclear physics Radio activity-fission process Reaction Rates, diffusion theory and Critical heat flux -Nuclear Power Reactors, different types, advantages and limitations, Materials used for Reactors. Hazards in nuclear power plant, remedial measures, safety precautions, methods of waste disposal, different form of waste from power plant.

Gas Turbine : Layout of Gas Turbine, Basic Gas turbine cycle, cycle improvements, Intercoolers, Reheaters and regenerators, Thermodynamic analysis of Gas turbine, Operations and performance of Gas Turbine.

Combined Cycle Power Plant: Binary vapour cycles, Coupled cycles ,Combined Power cycle Plants, Advantages and Limitations, Gas turbine, Steam turbine Power Plant and MHD, Steam Power Plant.

Water pollution and Solid waste management in power plants, Effluent quality standards.

Text Books :

1. Power Plant Engineering, P. K. Nag, Mc Graw Hill
2. Power Plant Engineering Technology, M.M. Wakil, Mc Graw Hill

Reference Books :

1. Steam Plant Operation, E. B. Woodruff Lammers, T.F.Lammers, McGrawHill
2. Standard Hand Book of Power Plant Engineering ,Thomas C. Elliott, Kao Chen, Robert C.Swamekamp, Mc Graw Hill.
3. Power Plant Engineering , V.M.Domkundwar, Dhanpat Rai & sons.

Syllabus of Semester II, M. Tech. (Heat Power Engineering)

Course Code: MET599-1 (Open Elective-I) **Course: Mechatronics**

L: 3 Hrs, P: 0 Hrs. Per week **Total Credits: 03**

Course Outcome :

The expected learning outcome is that the students will be able to:

1. Understand and appreciate synergistic combination of all related branches of engineering.
2. Explore recent trends in improving electrical systems with Mechatronic concepts.
3. Explain construction and working of CNC machines as Mechatronic systems.
4. Understand &appreciate application of Mechatronic concept to various process industries in reference to energy & heat power.
5. Demonstrate desire to remain abreast with the fast changing technology in all walks of life.
6. Use the Mechatronics design procedure for creating smart products.

Syllabus

Unit-I: Introduction

Review of definitions, Evolution, Multidisciplinary nature, Design of Mechatronics System, Modeling and Simulation, Digital Electronics, Sensors and Signal Processing, Smart sensors, Control System Engineering, Micro Controller and PLC, Microprocessors and Applications, Power Electronics, Machine Vision System

Unit-II: Electrical Machines and Drives

Electrical Circuits and Transformers, Electrical Motors, Speed Control and Starting, Electrical Drives, Solid State Drives

Unit-III: Machining Technology

Kinematics of Machinery, Dynamics of Machines, Manufacturing Technology- additive and subtractive, CNC Machining Technology, Computer Aided Manufacturing, Applied Hydraulics and Pneumatics, Metrology and Measurements

Unit-IV: Heat Power Systems

Thermodynamics Principles and Applications, Measurement of Power, Flow and Temperature, HVAC systems, Internal combustion engines

Unit- V: Emerging Fields

Automotive Mechatronics, Medical Mechatronics, Office automation.

Unit- VI: Future scope in Mechatronics

Product Design and Development- Concept Generation and Selection, Product Architecture, Industrial Design, Design for Manufacturing and Product Development

Reference Books :

1. Mechatronics System Design, Shetty, D. and Kolk, R. A., Cengage Learning India Pvt. Ltd., Delhi
2. Mechatronics: A Multidisciplinary Approach, Bolton, W., 4th Ed., Pearson Education
3. Mechatronics: Principles, Concepts and Applications, Mahalik N.P., Tata McGraw Hill
4. Mechatronics - Integrated Mechanical Electronics System, K.P. Ramachandran, Wiley India Pvt. Ltd. New Delhi
5. Mechatronics & Microprocessors, K.P. Ramachandran, Wiley India Pvt. Ltd., New Delhi
6. Introduction to Mechatronics and Measurement Systems, David Alciatore & Michael B. Hilstand, Tata McGraw Hill, India , 2001.
7. Mechatronics, HMT, Tata McGraw Hill, India.

Syllabus of Semester II, M. Tech. (Heat Power Engineering)

Course Code: MET599-2 (Open Elective-II) **Course : Automobile Engineering**

L: 3 Hrs, P: 0 Hrs. Per week **Total Credits : 03**

Course Outcomes : Students would be able to

1. Recognize the fundamentals and applications of various subsystems of automobile
2. Illustrate the importance and working of transmission and driveline components
3. Explore components and working of steering, braking and suspension system and their recent advancements.
4. Demonstrate the importance of various electrical, electronic devices, sensors & recent trends in automobiles.
5. Express the need and functioning of passenger safety equipment in automobiles and emission control devices.
6. Explain the recent advances in automobile Technology Recognize.

Syllabus

Introduction: Classification, Chassis, Power train basics, Carburetor and Fuel Injection system, Variable Valve timing, alternate power trains.

Transmission system: Necessity, requirements of a clutch system. Types of Clutches, Gear box - Necessity of transmission, principle, types of transmission, Automatic Transmission. Drive line components, Steering basics, Electric and Hydraulic power steering.

Suspension, Tyres & Brakes: Tyre specification, factors affecting tyre performance, Special tyres, STPMS, Function of spring and shock absorber, Independent suspension System, Active suspensions. Brake Components, types, method of actuation, Antilock Braking system.

Electronics & Electrical Systems: Operation and maintenance of Batteries, Alternator, and Starter motor, Ignition systems, electronic ignition, windshield wiper, instrumentation & sensors. Automotive lighting.

Vehicle Pollution Control & Safety: cause and types of Emissions from Vehicle, Euro and Bharat Stage norms, Methods to reduce vehicular pollution, after treatment devices, Catalytic Converter. Active and passive safety, Restrain Systems, Air Bags, structural components for Safety. Safety Glasses, Crumple Zone, antiroll bars.

Recent Advances in automobile technology: Electric Vehicle, Hybrid Cars, types of hybrids, Micro Hybrid. Traction control, intelligent highway system, Collision avoidance system, Automatic Cruise Control, Navigational aids, Parking Assistance system.

Text Books :

1. Automobile Engineering Vol. 1 & Vol. 2 by Kirpal Singh, Standard Publishers.
2. Automobile Engineering by G.B.S. Narang, Khanna publisher
3. Motor Vehicle Technology – J. A. Dolan, Heinemann Educational Books

Reference Books :

1. Automotive Mechanics – W.H. Crouse, D.L Anglin, Tata McGraw Hill Education.
2. Motor Vehicle – K. Newton and W. Seeds, T.K. Gawet, Butterworth, Limited, London, England,
3. Automotive Machanics – Joseph Heitner, Van Nostrand Reinhold

Syllabus of Semester II M. Tech. (Heat Power Engineering)

Course Code: MET562 **Course : Advanced Computational Techniques**

L: 3 Hrs., P: 0 Hrs. per week **Total Credits : 03**

Course Outcomes :

At the end of the course the student should be able to

1. Understand the concept of computational techniques.
2. Understand soft computing techniques and their role in problem solving.
3. Apply fuzzy logic and reasoning to handle uncertainty and solve engineering problems.
4. Understand the fundamental theory and concepts of ANN, several paradigms and its application.
5. Understand basics of evolutionary computing paradigm such as GA.
6. Explore soft computing techniques such as GA, SA, PSO for optimization.

Introduction to computational techniques, Role of Computes in research, use of statistical software. Introduction to soft computing, Data analysis using Microsoft Excel.

Fuzzy Logic : Introduction, basic concepts of fuzzy logic, FIS, fuzzy membership functions, Explore MATLAB FUZZY Toolbox.

Fuzzy Optimization, Soft Constraints, Approximate reasoning, Multi criterion, Developing expert systems using Fuzzy logic.

Ann : Introduction to neural networks, single and multiplayer neural networks, recurrent network, radial basis function network, Explore MATLAB ANN Toolbox.

Genetic algorithm mechanism, Appraisal of GA performance, Procedures and operations in GA search, Computer Implementation and applications,

Simulated Annealing, Metropolis Algorithm, Ant Colony Optimization, Particle Swarm Algorithm.

Reference Books :

1. Genetic Algorithms in Optimization and Machine Learning : D.E. Goldberg, Addision Wesley Reading, MA, USA 1989.
2. Understanding Neural Networks & Fuzzy Logic : Basic Concepts and Application : Stamatios V. Kartalopoulos, Prentic Hall of India New Delhi.
3. Multi objective Optimisation using Evolutionary Algorithm : K. Deb Chichester 2002.
4. Neural Networks, Fuzzy Logic and Genetic Algorithm; A synthesis and Applications : S. Rajashekharan, G.A. Vijayalkshmi Pai, Prentice Hall of India, New Delhi 2003.
5. An Introduction to Data Development Analysis, A Tool For Performance Management : SAGE Publications New Delhi 2003.

SEMESTER - III

Syllabus of Semester III, M. Tech. (Heat Power Engineering)

Course Code : MET651-1 (Group Elective-I) **Course : Energy Conservation and Management**

L:04 Hrs, P: 0 Hrs. Per week **Total Credits : 04**

Course Outcomes :

1. Ability to understand the basic concept of energy conservation and its role in energy management.
2. Learn the purpose and detailed methodology of energy audit.
3. Ability to analyze the energy conservation opportunities in the energy intensive industries.
4. Ability to analyze the quantum of electrical energy that can be saved by the use of energy efficient lighting systems.
5. Learn the concept of cogeneration, trigeneration and waste heat recovery in detail.
6. Ability to understand the total energy system.

Syllabus

Introduction : Energy scenario, Energy Conservation, Energy Consumption patterns-resource availability, Role of energy management in industry. Energy economics, Project Management, Energy action planning, Energy monitoring.

Energy Audit - Types and methodology, Material and Energy Balance.

Thermal Energy auditing: Energy audit - purpose, methodology with respect to process industry- power plants, boilers etc. Characteristics method employed in certain energy intensive industries, various energy conservation measures in steam systems, Losses in Boiler, Methodology of Upgrading Boiler Performance, FBC Boilers, Energy Conservation in Pumps, Fans and compressors, air conditioning and refrigeration systems, steam traps- types, functions, necessity, waste heat recovery systems.

Cogeneration and Waste Heat Recovery System: Principles of Thermodynamics, Topping Cycle –Bottoming Cycle, combined cycle, Organic, Rankine Cycles, Performance indices of cogeneration systems ,waste heat recovery sources and types, Concept of tri-generation

Electrical energy auditing : Potential areas for electrical energy conservation in various industries, energy management opportunities in electrical heating, lighting systems, cable selection - energy efficient motors - factors involved in determination of motor efficiency. Adjustive AC drives, applications and its use, variable speed drives/belt drives. Role of instrumentation in energy conservation.

Total Energy systems: concept of total energy, advantages and limitations, Total Energy system and application, various possible schemes employing steam turbines movers used in total energy systems.

Text Books :

1. Principles of Energy Conservation, Archie, W Culp, McGraw Hill, 1991.
2. Energy Management, P. O. Callaghan, Mc Graw Hill Book Company, 1993.
3. Handbook of Energy Engineering, Thuman A , Mehta D Paul, The Fairmount Press.

Reference Books :

1. Energy Management Principles, C.B. Smith, Pergamon Press
2. Energy Management, Trivedi. P.R., Jolka K.R., Common wealth Publication.
3. Industrial Energy Management and Utilization, Witte, Larry C., Hemisphere Publisher
4. Handbook on Energy Audits and Management, Amit Kumar Tyagi, TERI
5. Energy Efficient Buildings, Majumder Milli, TERI
6. Energy Management, Paul O'Callaghan, McGraw Hill
7. Bureau of Energy Efficiency Study material for Energy Managers and Auditors Examination: Paper I to IV.

Syllabus of Semester III M. Tech. (Heat Power Engineering)

Course Code: MET651-2 (Group Elective-I) **Course: Thermal Storage Systems**

L: 4 Hrs,P: 0 Hrs. per week **Total Credits: 04**

Course Outcomes

1. Understand the necessity of thermal storage systems.
2. Study the classification and working various thermal storage systems.
3. Understand the concept of thermal stratification and heat transfer enhancement.
4. Apply basics of Fluid Mechanics and heat transfer to Model various TSS.
5. Study various heat exchangers for TSS.
6. Explore the different application of TSS.

Syllabus

Introduction : Necessity of Thermal storage, Energy storage devices, types of storage system, Specific areas of application, Heat Transfer Enhancement methods

Sensible Heat Storage system : Basic Concepts and modeling of heat storage units, modeling of simple water and rock bed storage system, Use of TRNSYS, pressurized water storage system for power plant applications , packed beds.

Regenerators : Parallel flow and counter flow regenerators, Finite conductivity model, Non-linear model, Transient performance, step changes in inlet gas temperature, step changes in gas flow rate, Parameterization of transient response, Heat storage exchangers.

Latent Heat Storage system, Storage materials modeling of phase change problems & solution methodologies, Enthalpy modeling, Heat transfer enhancement configuration, Parameterization of rectangular, cylindrical geometric problems.

Applications : Specific areas of application of energy storage, Food preservation, Waste heat recovery, solar energy storage, Green House heating, Power Plant applications, drying and heating for process industries.

Text Books:

1. Thermal Energy Storage: Systems and Applications, İbrahim Dinçer, Marc A. Rosen Second Edition, John Wiley & Sons, Ltd
2. Sustainable Thermal Storage Systems: Planning Design & Operations, Lucas B Hyman, Goss Engineering, Mc Graw Hill Publisher,2011.

Reference Books:

1. Thermal storage & Regeneration, F. W. Schmidt & A. J. Willmott, Hemisphere Publishing Corporation
2. Heat Transfer in cold climates, V. J. I. Unardini, D Van Nostrand Reinhold, New York

Syllabus of Semester III M. Tech. (Heat Power Engineering)

Course Code: MET651-3 (Group Elective-I) **Course : Advanced Turbo Machines**

L: 4 Hrs, P: 0 Hrs. per week **Total Credits : 04**

Course Outcomes : Students will be able to

1. Recognize typical designs of turbo machines
2. Determine the velocity triangles in turbo machinery stages operating at design and off- design conditions
3. Analyses performance of various turbo machines

Syllabus

Principles of Turbo machinery : Introduction, Overview & Machinery Classification, Review of Conservation Laws, Scaling Laws, Work and Efficiencies in Compressor Stages, Selection of centrifugal, axial, mixed flow, Axial flow machines based on specific Speed.

Flow Through Cascades : Two-dimensional Flow, Cascade of Blades,
Cascade Tunnel, Axial Turbine Cascades, Axial Compressor Cascades.

Analysis of Axial Turbine Stage : Single Impulse Stage, Multi-stage
Velocity and Pressure Compounded Impulse, Reaction Stages, Losses and Efficiencies, Performance Charts

Analysis of Centrifugal Blower : Theoretical Characteristic Curves, Euler Characteristics and Euler Velocity Triangles, Losses and Efficiencies, Flow through impeller Casing, Multi-vane Impellers of Impulse Type, Cross flow Fans.

Testing and Control of Fans : Fan Testing, Noise Control, Materials and Components Blower, Regulation, Speed Control, Throttling Control at Discharge and Inlet.

Design and Application of Blowers : Special Design and Applications of Blower, Induced and Forced Draft Fans for Cooling Towers, Ventilation Systems, Booster Systems.

Reference Books :

1. Stepanoff A.J.,Turbo blowers, John Wiley & Sons, 1970.
2. Brunoeck, Fans, Pergamon Press, 1973.
3. Austin H. Chruch, Centrifugal pumps and blowers, John Wiley and Sons, 1980.
4. S.L. Dixon, Fluid Mechanics, Thermodynamics of Turbo machinery, Elsevier
5. S.L. Dixon,Worked examples in Turbo machinery, Pergamon Press, 1984.
6. S M Yahya, Turbines, Compressors and Fans, Tata McGraw Hill Publishing Company Ltd.

Syllabus of Semester III M. Tech. (Heat Power Engineering)

Course Code : INT651-1 (Group Elective-I) **Course : Total Quality Management**

L: 4 Hrs, P: 0 Hrs. per week **Total Credits : 04**

Course Outcomes :

1. To develop understanding of Quality concepts.
2. To apply QC tools and modern quality management tools.
3. To implement TQM concepts in manufacturing & service sector.

Syllabus

Evolution of product and service quality TQM Framework Contrinutions of Deming, Juran and Crosby, Customer focus, Costs of quality.

Leadership, Strategic quality planning, Employee involvement, Quality circles, PDCA cycle, 5S, Kaizen.

The seven traditional tools of quality and new QC tools, Control Charts, Process Capability, Concepts of Six Sigma, Quality Function Development (QFD), Taguchi quality loss function.

ISO 9000 Quality System, Documentation, Quality Auditing, ISO 14000, TQm Implementation in manufacturing and services sectors.

Text Books :

1. Dale H. Besterfield, et at., " Total Quality Management", Third Edition, Pearson Education Asia, Indian Reprint, 2006.

References :

1. James R. Evans and William M. Lindsay, " The Management and Control of Quality", 8th Edition, First Indian Edition, Cengage Learning, 2012.
2. Suganthi L and Anand Samuel, " total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006.
3. Janakiraman. B and Gopal. R.K., "Total Quality Management- Text and Cases", Prebtice Hall (India) Pvt. Ltd., 2006
4. R.P. Mohanty and R.R. lakhe, "TQM in the Servive Sector"- Jaico Publishing House 2002.

Syllabus of Semester III M. Tech. (Heat Power Engineering)

Course Code : INT651-2 (Group Elective- I) **Course : Value Engineering**

L: 4 Hrs, P: 0 Hrs. per week **Total Credits : 04**

Course Outcomes :

Students will be able to

1. Apply cost reduction techniques.
2. To evaluate various alternatives.
3. To prioritize functions of products.
4. To identify under value products.
5. To improve value of product.

Syllabus

Value engineering and its application in product design, Identification of major function and removal of poor value functions in a product, Types of value Effects of functions and cost on value, Life cycle of product and value engineering, Steps in value engineering, Methodology in value engineering, Fast diagram, Matrix method and other approaches in value engineering, Evaluation of value alternatives, Case studies in value engineering.

Text Books :

1. Value engineering in Manufacturing: American Society of Tool & Manufacturing Engineers, New Jersey, Prentice Hall incorporated, 1967.
2. Cost Engineering Analysis: Park, W. R. New York, John Wiley & Sons, 1973
3. An Introduction to Value Engineering: L. D. Miles

Syllabus of Semester III M. Tech. (Heat Power Engineering)

Course Code: INT651-3 (Group Elective-I) **Course : System Design Engineering**

L: 4 Hrs, P: 0 Hrs. per week **Total Credits : 04**

Course Outcomes :

1. Students will develop understanding of system Concepts, Component, properties.
2. Will be familiarized with process of design of system.
3. Will be able to understand the concept of system reliability, maintainability,

Syllabus

Types of information :

Operational, tactical, strategic and statutory, need of information systems, management structure,

requirements of information at different levels of management, functional allocation of management, requirements of information for various functions, qualities of information.

Requirements determination :

requirements specifications, feasibility analysis, final specifications, hardware and software study, system design, system implementation, system evaluation, system modification.

Role of systems analyst :

attributes of a systems analyst, tools used in system analysis. Strategies: methods, documenting study, system requirements.

Specification from narratives of requirements to classification of requirements as strategic, tactical, operational and statutory. Deciding project goals: examining alternative solutions, cost benefit analysis, quantifications of costs and benefits, payback period, system proposal preparation for management, parts and documentation of a proposal, tools for prototype creation.

Data flow diagrams:

Case study for use of DFD, good conventions, leveling of DFDs, leveling rules, logical and physical DFDs, software tools to create DFDs.

Procedure specifications in structured English :

Examples and cases, decision tables for complex logical specifications, specification oriented design vs procedure oriented design.

Entity relationship model:

E-R diagrams, relationships cardinality and participation, normalizing relations, various normal forms and their need, some examples of relational data base design.

Text Books:

1. Systems Engineering and Analysis (5th Edition): (Prentice Hall International Series in Industrial & Systems Engineering) by Benjamin S. Blanchard and Wolter J. Fabrycky (2010)
2. Systems Engineering Principles and Practice : (Wiley Series in Systems Engineering and Management) by Alexander Kossiakoff, William N. Sweet, Sam Seymour and Steven M. Biemer(2011)
3. System Engineering Management: (Wiley Series in Systems Engineering and Management) by Benjamins. Blanchard (Jul28,2008)

Syllabus of Semester III M. Tech. (Heat Power Engineering)

Course Code : MET652-1 (Group Elective-II) **Course : Environmental Pollution and Control**

L: 4 Hrs,P: 0 Hrs. per week **Total Credits : 04**

Course Outcomes :

Students will be able to

1. Understand the various sources and hazards of pollution
2. Apply various techniques to control the environmental pollution.
3. Understand the emission standards for automobiles and industries.

Syllabus

Pollution and Environmental Ethics and Risk Analysis

Air pollution, Dispersion of Pollutants, Measurement of Air Quality, Control and Laws

Water pollution, Measurement of Water quality, water treatment, Nonpoint source Water Pollution

Soil pollution, Marine pollution, Noise pollution,

Thermal pollution, Nuclear hazards Environmental impact and economic aspects,

Emission standards and regulations for Automobiles and Industries.

Reference Books :

1) Environmental Pollution and Control, J. Jeffrey Peirce, P Aarne Vesilind, Ruth Weiner, Butterworth-Heinemann,
2) Environmental Pollution Control Engineering, C.S. Rao, New Age International

Syllabus of Semester III M. Tech. (Heat Power Engineering)

Course Code : MET652-2 (Group Elective-II) **Course : Design of Heat Exchangers**

L: 4 Hrs, P: 0 Hrs. per week **Total Credits : 04**

Course Outcomes :

CO 1. : Understanding the constructional details of Heat Enchanters.

CO 2. : Apply principles of fluid mechanics and heat transfer to design the heat exchanger.

CO 3. : Understanding the basic design aspects of Heat Exchangers.

CO 4. : Understanding of the various methods for design at heat exchanger.

CO 5. : Understanding of design considerations & Performance Enhancement for heat exchangers.

CO 6. : Ability to use TEMA standard for design, selection of Heat exchangers etc.

Syllabus

Constructional details & Heat Transfer Aspects: Classification of heat Exchangers, Industrial applications, Basic thermal design: LMTD, correction factor (F), ε - NTU method, Effectiveness.

Heat exchanger design methodology: Thermal, Hydraulic & Mechanical design. Heat exchanger design sheets.

Design of shell & tube exchangers: Preliminary analysis, Rating program, Kerns method, Bell Daleware method. Pressure drop analysis of different heat exchangers.

Design considerations for Condensers, Evaporators, Cooling Tower etc.

Compact heat exchangers. Heat transfer enhancement techniques.

Selection of heat exchangers & their components, testing & maintenance. Advance topics on subject.

Text Books :

1. Fundamentals of Heat Exchanger Design, , ,John Wiley & Sons Ltd.
2. Heat Exchanger Design, P. O. Fraas, John Wiley & Sons, 1988

Reference Books :

1. Heat Exchangers: Theory & Practices, T. Taboreck, G. F. Hewitt & N. Afgan, TMH,1980
2. Industrial Heat Exchanger: A Basic Guide, Walkar, TMH Book co,1980
3. Heat Exchangers: Basics Design Applications, Edited by Jovan Mitrovic, InTech Publisher

Syllabus of Semester III, M. Tech. Heat Power Engineering

Course Code: MET652-3 (Group Elective-II) **Course : Cryogenics**

L: 4 Hrs, P: 0 Hrs, per week **Total Credits : 4**

Course Outcomes :

1. Understanding of the cryogenic system requirements.
2. Ability to understand various gas liquefaction, gas separation & purification systems.
3. Ability to evaluate the performance of different cryogenic systems.
4. Ability to understand different working fluids and engineering materials in cryogenic systems.

Syllabus

Introduction : Limitations of Carnot cycle, vapor compression cycle and air refrigeration cycle.

Production of low temperature by reversible and irreversible adiabatic expansion of a gas, Joule Thomson effect; Joule Thomson co-efficient, Inversion curve.

Gas Liquefaction Systems : Linde -Hampson, Linde dual pressure, Claude, Heylandt and Kapitza systems; Systems for liquefaction of Neon, Hydrogen and Helium; Collins and Simon systems for helium liquefaction.

Gas Separation and Purification Systems: Ideal system, Gas separation by simple condensation or evaporation, principles of rectification.

Air separation systems : Linde single column and double column, Linde– Frankl, Heylandt, Argon separation system; Neon separation system; Linde – Bronn system for hydrogen separation, Hydrogen – deuterium separation system; Helium separation from natural gas; Physical adsorption for gas purification.

Gas Refrigeration Systems : Joule Thomson refrigeration system, Pre cooled Joule Thomson refrigeration system, Expansion engine refrigeration system, Cold gas refrigeration system, Stirling cryocooler.

Material and fluid properties : Thermal and Mechanical properties of engineering materials at cryogenic temperatures, Properties of cryogens, Cryogenic insulations.

Cryogenic Applications : Applications in space, on-ground, medical, electronic cooling, manufacturing processes, preservation and bio-technology.

Text Books :

1. Cryogenic systems, R. Barron, McGraw–Hill Company
2. Fundamentals of Cryogenics Engineering, Mamata Mukhopadhyay, PHI Learning Pvt. Ltd.
3. Cryogenic Fundamentals, G. G. Hasseldon, Academic Press
4. Advanced Cryogenics, Bailey, Plenum Press

Reference Books :

1. Industrial Refrigeration Handbook, W. F. Stoecker, McGraw-Hill Publication.
2. ASHRAE HANDBOOKS (i) Fundamentals (ii) Refrigeration

Syllabus of Semester III M. Tech. (Heat Power Engineering)

Course Code: MET652-4 (Group Elective-II) **Course : Advanced I.C Engines & Alternate Fuels**

L: 4 Hrs, P: 0 Hrs. per week **Total Credits : 04**

Course Outcomes : Students will be able to

1. Analyse engine cycles and the factors responsible for making the cycle different from the ideal cycle.
2. Apply principles of thermodynamics, and understand various engine emissions their causes and control method.
3. Express the need of various alternate fuels and summarize the modifications needed for these fuels.
4. Understand the Parameters affecting Full Injection in S-I & C-I engines.
5. Reeling the importance of Eutectic feel Injection methods in archiving PERFORMANCE & emission Targets.
6. Demonstrate and understanding of the relationship between various engine performance parameters.

Syllabus

Engine Basics & Materials: Basic working of I.C engine, Combustion in I.C engines, various engine components, cylinder head, spark plug, piston etc. material and characteristics.

Alternate Fuels: characteristics of fuel or S.I and C.I engines, Need of alternate fuels, Types of fuels Alcohols, Vegetable oils and bio-diesel, Bio-gas, Natural Gas, Liquefied Petroleum Gas, Hydrogen, Properties, Suitability, Engine Modifications.

Electronic Injection System: Gasoline injection, EFI system, MPFI system, electronic control system, injection timing, Electronic diesel injection system and control.

Engine Emissions & Control: Air pollution due to IC engines, norms, engine emissions, HC, CO, NOx, particulate, other emissions, emission control methods, exhaust gas reticulation, modern methods, Catalytic Converter.

Measurement & Testing: Introduction, engine performance parameters, measurement and testing, engine operating characteristics, performance maps. Heat balance Sheet.

Text Books :

1. The Internal Combustion Engine in Theory and Practice, Volume I & II , Charles Fayette Taylor, MIT Press
2. Internal Combustion Engines, V. Ganesan, 2nd edition, Tata McGraw Hill
3. Internal Combustion Engines Fundamentals, J. B. Heywood, McGraw Hill

Reference Books :

1. Internal Combustion Engines, M. L. Mathur & S. C. Mehta, Dhanpat Rai
2. Engineering fundamentals of Internal Combustion Engines 2nd Edition-William Pulkrbek, PHI.

Syllabus of Semester III, M. Tech. Heat Power Engineering

Course Code: INT652-1 (Group Elective-II) **Course: Computer and Database Management**

L: 4 Hrs, P: 0 Hrs, per week **Total Credits : 4**

Course Outcomes :

1. Understand the concepts of Database, RDBMS and software applications in industrial engineering.
2. Apply the concepts of Database, DBMS and software applications in industrial engineering.
3. Design databases using RDBMS Tools.
4. To realize the importance of information for decision making in the organizing.
5. Develop Databases and computer programs for the solution of engineering Problems

Syllabus

Information concepts, System concepts, Examples of Information systems, Concept of General System Theory and their applications to Information Systems. Definition of data, information and knowledge . Introduction to Transaction processing systems, management information system, Decision Support Systems etc. Electronic Commerce and its impact on Business Strategy. ERP

Introduction to databases and relational database management systems. Design and development of databases, What is a DBMS, File verses Database, uses of DBMS, Different Data models, Levels of Abstraction, introduction to Data Independence and Concurrency Control. Structure of a DBMS.

The Entity-Relationship Model : Entity, Entity Set, Relationship, Constraints, attributes, data flow diagrams and ER diagrams, Normalizing relations; Data input methods; Structured Systems Analysis and Design.

Introduction to SQL, DDL Commands, DML Commands, DCL Commands, Function Of SQL Plus , Select Statement with all options, Creating, Dropping and Altering Tables, Types of Keys, Relational Algebra, Projection, Selection, Union, Intersection, Set-Difference, Joins, Division,

Management of database users and security. Introduction to front-end and its connectivity with the database. Safety of data, evaluation of database system to avoid fraud.

Reference Books :

1. An Introduction to Database Systems: C. J. Date, Addison-Wesley, 2000
2. Management Information System: Gordon B. Davis and M.H. Olson, Tata McGrawHill.
3. Database system concept: Henry Korth and S. Sudarshan, Tata McGraw Hill.
4. Database Management
   Systems, 3rd Edition by Raghu Ramakrishnan, Johannes Gehrke Tata McGrawHill.
5. Complete reference Oracle 10g: Oracle Press.

Syllabus of Semester III, M. Tech. Heat Power Engineering

Course Code: INT652-2 (Group Elective-II) **Course: Manufacturing Economics and Analysis**

L: 4 Hrs,P: 0 Hrs, per week **Total Credits: 4**

Course Outcomes for Manufacturing Economic Analysis:

The course intends to enable students to understand and apply

1. The concept of time value of money and cash flow diagrams.
2. Economic analyses techniques in the decision making process to justify or reject alternatives / projects on an economic basis, depreciation methods replacement analysis, and after - tax analysis.
3. Principles of financial accounting, interpretation and analysis of financial statements.
4. BEP / CVP analysis, marginal and absorption costing.

Syllabus

The principal and use of economic analysis in the engineering practices, Time Value of Money :

Nominal and effective interest rates and continuous compounding Role of engineering economy in the decision making process, Discounted cash flow analysis, evaluation of investment alternatives, evaluation of alternatives with equal and unequal lives, the effects of income tax on

economic studies, Replacement analysis.

Capital budgeting :

Rate of return computation & Cost of Capital; Payback period; Present worth, Annual Worth and capitalized cost evaluation; Benefit/Cost ratio evaluation.

Financial accounting & Costing :

Accounting Principles, Financial Statements, Interpretation and use of accounting information. Cost Accounting, Cost control, Analysis of cost, fixed, variable and semi variable cost, Break-even analysis, CVP Analysis, Marginal and absorption costing, Depreciation: Concepts and Computational Models. Theory of Firm as an owner and as a Producer-Economics of scale-Market Models-Production Function

Text Books :

1. Engineering Economy : Theusen H. G. and others Prentice Hall of India
2. Engineering Economy : William G. Sullivan, Prentice Hall
3. Engineering Economy : Leland Blank and Anthony Tarquin, McGraw Hill
4. Cost Accounting : Jawaharlal, Tata McGraw Hill
5. Advanced Accounts Volume II : M. C. Shukla, TS. Grewal, S. C. Gupta, S. Chand and company

Reference Books :

1. Engineering Economy : De; Garmo PE., MacMillan Publication
2. Cost Accounting, Principles& Practice : Jain Narang, PHI

Syllabus of Semester III M. Tech. (Heat Power Engineering)

Course Code: MEP653 **Course : Project Phase I**

L: 0 Hrs, P: 3 Hrs. Per week **Total Credits : 06**

Course Outcomes :

1. Ability to identify the research topic.
2. Ability to carry out literature review.
3. Understand the concept and scope of project work.
4. Ability to identify the appropriate Methodology to carry out the project work.

Syllabus

Seminars on project work.

Syllabus of Semester IV M. Tech. (Heat Power Engineering)

Course Code: MEP654 **Course : Project Phase II**

L: 0 Hrs,P: 6 Hrs. per week **Total Credits : 12**

Course Outcomes :

1. Ability to analyze and formulate the project topic in depth.
2. Understand the concept and scope of project work and its methodology.
3. Understand the experimental simulation aspects of project work in depth.
4. Ability to interpret the results through various analytical tools and report writing.

Syllabus

The M.Tech. Project is aimed at training the students to identify and analyze the research topic independently. The project may be a purely analytical piece of work, a completely experimental one or a combination of both. In few cases, the project can also involve a sophisticated design work. The project report is expected to show clarity of thought and expression, critical appreciation of the existing literature and analytical, experimental or design skill.