SHRI RAMDEOBABA COLLEGE OF ENGINEERING AND MANAGEMENT, NAGPUR

An Autonomous College of Rashtrasant Tukadoji Maharaj
Nagpur University, Nagpur, Maharashtra, India

TEACHING SCHEME & SYLLABUS
2014-15

MECHANICAL ENGINEERING DEPARTMENT
M.TECH. HEAT POWER ENGINEERING

Published by
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ISO 9001 : 2008 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, Mechanical Measurements 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, power point presentations, seminars, industrial visits, industry based projects, etc. The department has modern classrooms that use LCD and 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 leadershipqualities 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 theirknowledge of Heat Power Engineering.
2. To promote student's awareness of life-long learning and to introduce them toprofessional ethics and codes of professional practice.
3. To provide students with advanced knowledgein the area of heat power engineering,by using analytical,computationaltechniques and prepare them for further research.

Program Outcomes

1. An ability to identify, formulate and solve engineering problems 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 sustainability.
4. To develop self learning ability.

Master of Technology in Mechanical Engineering with Specialization in Heat Power Engineering

SEMESTER - I

Sr. No.	Code	Course	L	T	P	Credits	Maximum Marks			Exam Duration
							Internal Assessment	End Sem Exam	Total	
1	MET501	Advanced Thermodynamics	4	0	4	8	40	60	100	3 Hrs.
2	MET502	Conduction and Radiation Heat Transfer	4	0	4	8	40	60	100	3 Hrs.
3	MET503	Fluid Dynamics	4	0	4	8	40	60	100	3 Hrs.
4	MET504	Fuels& Combustion	4	0	4	8	40	60	100	3 Hrs.
5	MET505	Elective -I	4	0	4	8	40	60	100	3 Hrs.
6	MEP506	Lab Practice-1	0	4	4	4	25	25	50	--
		Total	20	4	24	44				

Course Code	Elective-I
MET505-1	Advanced Energy Technology
MET505-2	Energy Conservation and Management
MET505-3	Finite Element Methods

SEMESTER - II

Sr. No.	Code	Course	L	T	P	Credits	Maximum Marks			Exam Duration
							Internal Assessment	End Sem Exam	Total	
1	MET507	Computational Fluid Dynamics	4	0	4	8	40	60	100	3 Hrs.
2	MET508	Convective Heat and Mass transfer	4	0	4	8	40	60	100	3 Hrs.
3	MET509	Advanced Refrigeration and Air Conditioning	4	0	4	8	40	60	100	3 Hrs.
4	MET510	Power Plant Engineering	4	0	4	8	40	60	100	3 Hrs.
5	MET511	Elective -II	4	0	4	8	40	60	100	3 Hrs.
6	MEP512	Lab Practice -II	-	4	4	4	25	25	50	--
		Total	20	4	24	44				

Course Code	Elective-I
MET511-1	Solar Energy Utilization
MET511-2	Industrial Fluid Power
MET511-3	Optimization Techniques

SEMESTER - III

Sr. No.	Code	Course	L	T	P	Credits	Maximum Marks			Exam Duration
							Internal Assessment	End Sem Exam	Total	
1	MET601	Research Methodology	3	0	0	6	40	60	100	3 Hrs.
2	MET602	Advanced Internal Combustion Engines	4	0	0	8	40	60	100	3 Hrs.
3	MET603	Elective -III	4	0	0	8	40	60	100	3 Hrs.
4	MEP604	Project Phase (I) Seminar	0	6	0	24	200	-	200	--
		Total	11	6	0	46				

Course Code	Elective-III
MET603-1	Thermal Storage Systems
MET603-2	Design of Heat Exchangers
MET603-3	Cryogenics
MET603-4	Biomechanical Engineering

SEMESTER - IV

Sr. No.	Code	Course	L	T	P	Credits	Maximum Marks			Exam Duration
							Internal Assessment	End Sem Exam	Total	
1	MEP605	Project Phase (II) Viva-Voce and dissertation	-	12	-	48	200	200	400	-
		Total		12		48				

SEMESTER - I

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

Course Code: MET501 | Course: Advanced Thermodynamics

L: 4 Hrs, T: 0 Hrs, P: 0 Hrs. Per week | Total Credits: 08

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 and second law analysis of steady and unsteady systems

General thermodynamic relations, fundamental s of partial derivatives, relations for specific heat, internal energy enthalpy and entropy, Joule Thompson co-efficeient, 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 Vapor 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,RichardE.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 : MET502 Course : Conduction and Radiation Heat Transfer

L: 4 Hrs, T: Hrs, P: 0 Hrs. Per week Total Credits : 08

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 and 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, YamanYener, SadıkKakaç, 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: MET503 — Course: Fluid Dynamics

L: 4 Hrs, T: 0 Hrs, P: 0 Hrs. Per week — Total Credits: 08

Course Outcomes

1. Ability to analyze various types of fluid flows.
2. Ability to model various flow conditions.
3. Ability to understand and solve complex fluid flow problems.
4. Ability to understand physical significance of the different fluid flow situation and corresponding equations.

Syllabus

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

Taylors series expansion, Vector Products & Differentiation Rules, Directional Derivative & Gradient, Divergence, Curl. Integral Theorems (Gauss & Divergence theorem).

Fluid Kinematics: Transportation, Rotation & Deformation.

Differential Analysis of Fluid Flow: Euler's equation of motion, Continuity equation.

Linear Momentum Equation, Newton's Second law for fluid particle, Navier-Stoke's equation. Exact solutions of Continuity &Navier-Stoke's equations.Approximate Solutions of NavierStoke's Equations.

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

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

Elements of 2-D Aerofoil theory, Symmetrical Aerofoil theory.

Text Books :

1. Fluid Mechanics, Yuan, S.W., Prentice Hall Publication.
2. Fluid Mechanics & Fluid Power Engineering, Kumar D. S., S. K. Kataria Publication.
3. Fluid Mechanics, Çengel,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: MET504 | Course: Fuels and Combustion

L: 4 Hrs, T: 0Hrs, P: 0 Hrs. Per week | Total Credits: 08

Course Outcomes

1. Study of thermo-physical properties of various fuels and combustion characteristics, use of the basic combustion equation for combustion reactions, with or without excess air to calculate air requirements and amount of combustion products.
2. Balance chemical reactions, understand &estimate the calorific values, enthalpy, Gibbs function, entropy, adiabatic flame temperature and equilibrium composition of major combustion products.
3. Comprehend and calculate the structure and properties of a premixed and diffusion flame.
4. Understand the role of elementary and global reactions on reaction rates, reaction mechanisms,liquid droplet, solid fuel and fluidized bed combustion and Arrhenius equation.
5. Understand and apply the multi component conservation equations with reactions to a combustion system.

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.

Pollution control in process industries.

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, and 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 and Chemistry of Combustion: Explosion, Flame, Detonation, Michael A. Liberman, Springer

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

Course Code: MET505-1 (Elective-I) Course: Advanced Energy Technology

L: 4 Hrs, T: Hrs, P: 0 Hrs. Per week Total Credits: 08

Course Outcomes

1. Ability to describe world energy scenario and conventional and non conventional energy sources
2. Ability to analyze primary renewable energy sources, their feasibility and challenges.
3. Ability to understand solar energy as a principal source of non conventional energy.
4. Describe main features of renewable energy sources like solar, wind, ocean etc.
5. Ability to understand the concepts of thermoelectric power generation, chemical- electrical energy conversions, hydrogen energy technology, thermionic generations etc.

Syllabus

Global energy scenario, consumption rates, conventional and non conventional sources of energy, merits and challenges.

Solar Energy: solar radiation geometry, estimation and measurement of solar radiations, ways of solar energy utilization, solar thermal energy collection techniques, theories of various collectors, various solar thermal applications, solar power generation. Solar Photovoltaic: Principle of photovoltaic conversion types of solar cells, photovoltaic system components and different applications

Wind energy: - Global scenario of wind energy utilizations, Power in wind, forces on blades, wind energy: Basic principle of wind energy conversion site selection consideration wind data and energy estimation, basic components of WECS classification of WEC systems, Savonius and Darrieu'srotor's, performance of wind machines, applications of wind energy.

Thermo Electric Power: Thermo Electric effect, thermoelectric materials, thermoelectric generators, and its performance analysis, system design.

Magneto Hydrodynamic Power: Operating principles of MHD generator, analysis of MHD Generator, MHD power plant and generator operation, MHD power Cycles.

Thermionic Generation: basic principles, analysis of thermionic generators.

Chemical energy sources: working of fuel cells, classification of fuel cells, work output and emf. Hydrogen energy: production methods, storage, transportation, applications.

Ocean Energy: Ocean currents and wave, ocean wave power, Conversion of wave energy, pneumatic and oscillating wave converters. Tidal Power: Power developed, single basin and two basin power plants. Ocean thermal energy conversion systems: Ocean temperature profile, OTEC power plant development.

Geothermal Energy: Geothermal energy resources, power generation methods.

Text Books:

1. Non Conventional Energy Sources,G.D. Rai, Khanna Publishers, New Delhi.
2. Energy Technology : Nonconventional, Renewable and Conventional,S.Rao, B.B.Parulekar, Khanna Publisher, New Delhi.
3. Renewable Energy Sources Basic Principles and Applications, G. N. Tiwari , M. K. Ghoshal, Narosa Publishing House, New Delhi.
4. Solar Energy: Principles of Thermal Collection and Storage,S.P. Sukhatme, Tata McGraw-Hill

Reference Books:

1. Renewable Energy Resources,John Twidell,Tony Weir, Taylor & Francis; 2nd edition, 2005
2. Renewable Energy, Bent Sørensen,3rd edition, Elsevier Science, 2004
3. Solar Engineering of Thermal Processes,Duffie, J. A, W. A. Beckman, 3rd ed. John Wiley & Sons, Inc., 2006
4. Renewable energy: Power for a sustainable future,Boyle, G, Oxford University press, Oxford, UK., 2004

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

Course Code: MET505-2 (Elective-I) | Course: Energy Conservation and Management

L: 4 Hrs, T: Hrs, P: 0 Hrs. Per week | Total Credits: 08

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.

Syllabus

Introduction : Energy scenario, Energy Conservation,Energy Consumption patterns-resource availability, Role of energy management in industry.Energyeconomics, 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 –BottomingCycle, combinedcycle, Organic, RankineCycles, 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 ofinstrumentation 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,McGraw 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,MajumderMilli, 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 I, M. Tech. (Heat Power Engineering)

Course Code: MET505-3 (Elective-I) Course: Finite Element Methods

L: 4 Hrs, T: Hrs, P: 0 Hrs. Per week Total Credits: 08

Course Outcomes

1. Understand the basic concept of FEM and its applicability.
2. Ability to apply various approaches to find the field variables.
3. Ability to analyze the 1-D bar and 2-D truss element by FEA method.
4. Ability to analyze plane stress, plane strain and axi-symmetric problems by using CST elements.
5. Ability to analyze beam subjected to various boundary conditions, loading and the analysis of structure subjected to free vibration using finite element methods.
6. Ability to analyze 1-D and 2-D steady state heat conduction and fluid flow problems.

Syllabus

Brief History, Introduction to Matrix Notation, Role of the Computer , General Steps of the Finite Element Method, Applications of the Finite Element Method, Advantages of the Finite Element Method, Comparison of FEM with others method like variational approach, Galerkine method, Rayleigh Ritz method, Basic equation of elasticity, strain displacement relation.

Axial bar element, Stiffness matrix, load vector, shape function (Linear and quadratic), temperature effect. Analysis of plate with CST element, analysis of plane truss.

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.

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

Text Books:

1 Theory of Elasticity, S.P. Timoshenko ,McGraw-Hill

2 Introduction to Finite Elements in Engineering, T.R. Chandrupatla&AD. Belegundu,PHI

3 Finite Element Methods: Basic Concepts and Applications, C. R. Alavala , PHI

Reference Books:

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

2) A First Course in the Finite Elemets Method, D. L. Logan, Thomsen Education

3) Finite Elements Analysis in Heat Transfer : Basic, Comini, Gianni, Nonino

4) Finite Elements Methods, J. N. Reddy, TMH

5) Finite Element Method, Daryl L. Logan (Cengage Learning)

6) Finite Element Analysis,SaeedMoaveni (Pearson)

7) Finite Element Analysis, S. S. Bhavikatti (New Age International)

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

Course Code: MEP506 | Course: Lab Practice I

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

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.

SEMESTER - II

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

Course Code: MET507 | Course: Computational Fluid Dynamics

L: 4 Hrs, T: 0 Hrs, P: 0 Hrs, per week | Total Credits: 8

Course Outcomes

1. Understanding of the governing equations of the fluid flow & their applications.
2. Ability to develop mathematical model for the different fluid flow problems.
3. Ability to apply existing mathematical models as per the requirement of the fluid flow problem.
4. Ability to write algorithms for the fluid flow problems.
5. Understanding of Grid generation techniques & its significance.
6. Ability to use available codes to solve fluid flow problems.

Syllabus

Governing equations of fluid flow & heat transfer, continuity, momentum, and energy equation, equation of state. Conservative forms of the governing equations. Navier-Stokes' Equations for a Newtonian fluid.

Classification of physical behaviors: Elliptical, Parabolic & Hyperbolic Equations.

Finite Volume Method (FVM) for Steady & Unsteady flows.

Turbulence & its Modeling.

Implicit & Explicit Solution Algorithms.

Solution algorithms for pressure-velocity coupling in steady flows.

Initial & Boundary Conditions.

Grid Generation Techniques.

Uncertainty Analysis.

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: MET508 Course: Convective Heat and Mass Transfer

L: 4 Hrs, T: 0 Hrs, P: 0 Hrs, per week Total Credits: 8

Course Outcomes

1. Understand the hydrodynamic, thermal boundary layer concept and the relationship between fluid friction and heat transfer.
2. Understand the concept and mechanism of forced and natural convection.
3. Understand the mass transfer theories.
4. Ability to apply the various empirical correlations used in different fluid flow situations.
5. Ability to analyze and solve complex heat transfer phenomenon.
6. Ability to design the heat exchangers for various industrial applications.

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: MET509 Course: Advanced Refrigeration and Air Conditioning

L: 4 Hrs, T: 0 Hrs, P: 0 Hrs, per week Total Credits: 8

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 multi pressure, cryogenic and other non-conventional refrigeration systems.
4. Ability to carry out heat load calculations and design air conditioning systems.
5. Ability to design air handling system.

Syllabus

Refrigerants : Nomenclature, Properties, Mixture refrigerants, 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 , Manohar Prasad, 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: MET510 — Course: Power Plant Engineering

L: 4 Hrs, T: 0 Hrs, P: 0 Hrs, per week — Total Credits: 8

Course Outcomes

1. Analyze and understand the design of the major systems of conventional fossil-fuel steam-cycle power plants.
2. Thorough knowledge of the basic design principles of nuclear, gas turbine, combined cycle, and alternate power plants.
3. Understand the economic, environmental, and regulatory issues related to power generation.
4. Compute the cost of power generation and tariffs for various 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: MET511-1 (Elective-II) Course: Solar Energy Utilization

L: 4 Hrs, T: 0 Hrs, P: 0 Hrs, per week Total Credits: 8

Course Outcomes

1. Develop familiarity with terminology and types of solar energy utilization.
2. Organize metrological data, formulate and interpret insolations for given location and time of year.
3. Identify the appropriate type of solar thermal and photovoltaic system based on application, site and load.
4. Perform quantitative design and analysis of typical solar heating and photovoltaic systems.
5. Undertake research career 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: MET511-2 (Elective-II) Course: Industrial Fluid Power

L: 4 Hrs, T: 0 Hrs, P: 0 Hrs, per week Total Credits: 08

Course Outcomes

1. Identify and apply the principles and functions for safe operation of hydraulic and pneumatic systems and their components.
2. 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.
3. Identify and apply basic theory and computation skills regarding hydraulic and pneumatic power as they relate to various applications.

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 circuits, S.R. Mujumdar.

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: MET511-3 (Elective-II) Course: Optimization Techniques

L: 4 Hrs, T: 0 Hrs, P: 0 Hrs, per week Total Credits: 8

Course Outcomes

1. To make students determine optimal solution in non linear environment by using classical methods.
2. To make students understand significance of use of digital methods for optimizing non linear programming problems and motivate them to implement the optimization algorithms.
3. To introduce optimization in uncertain environment.
4. To introduce students with network tools for finding shortest route and maximal flow problems.
5. To introduce students with bio-inspired optimization processes.

Syllabus

Sensitivity analysis, Parametric programming, Goal programming.

Univariable, Multivariable, non-linear unconstrained optimization, Geometric Programming

Integer programming, zero - one programming, Markov chain.

Maximal flow problems, minimum spanning tree problem.

Introduction to evolutionary optimization technique: Genetic Algorithms, Ants colony algorithm.

Text Books:

1. Optimization techniques in Engineering Design, S.S. Rao, Willey Eastern
2. Quantitative Technique in Management, N.D. Vohra, - TMH Publication.
3. Operation Research, Pannerselvam, PHI

Reference Books:

1. Operation Research Principles & Practice, Ravindran, Phillips,Solbers,Wiley Publication Operation Research,Wagnor.

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

Course Code: MEP512 | Course: Lab Practice II

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

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.

SEMESTER - III

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

Course Code: MET601 | Course: Research Methodology

L: 3 Hrs, T: 0 Hrs, P: 0 Hrs. per week | Total Credits: 06

Course Outcomes

1.Understand the concept and scope of Research and its Methodology.

2. Ability to analyze and formulate the Research problem.

3.Understand the experimental aspects of research and coming up with probable solutions.

4.Ability to interpret the results through various analytical tools and report writing.

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: Place 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

Methods 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.

Simulation Technique: ANN Simulation; Fuzzy logic Based simulation.

Report Writing and Technical Documentation.

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) 5thed.

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)

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

Course Code: MET602 Course: Advanced Internal Combustion Engines

L: 4 Hrs, T: 0Hrs, P: 0 Hrs. per week Total Credits: 08

Course Outcomes

1. Analyze engine cycles and the factors responsible for making the cycle different from the ideal cycle
2. Apply principles of thermodynamics, fluid mechanics, and heat transfer to influence the engine's performance
3. Understand the delay period and fuel injection system
4. Demonstrate an understanding of the relationships between the design of the IC engine and environmental and social issues

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Syllabus

Measurement & Testing:Introduction,engine performance parameters, measurementand testing, engine operating characteristics, performance maps

Engine Materials:Various engine components,cylinder head, spark plug, gaskets,cylinder block, piston,piston rings, gudgeon pin, connecting rod, crankshaft,bearings, crankcase,fuel injector

Engine Design:Preliminary analysis, cylinder number, size and arrangement,experimental development.

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, particulates ,other emissions, emission control methods,exhaust gas recirculation ,modern methods, Crankcase blow by.

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, 2ndedition, 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,DhanpatRai
2. Engineering fundamentals of Internal Combustion Engines 2nd Edition-William
   Pulkrbek, PHI.

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

Course Code: MET603-1(Elective-III) Course: Thermal Storage Systems

L: 4 Hrs, T: 0 Hrs, P: 0 Hrs. per week Total Credits: 08

Course Outcomes

1. Analyze the quantum of energy that can be retrieved and stored in a thermal system.
2. Apply principles of fluid mechanics and heat transfer to model the heat storage units.
3. Understand the heat transfer enhancement configurations.
4. Demonstrate an understanding of the various applications of thermal storage systems.

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 and 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 energystorage, 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 and Operations,Lucas B Hyman, Goss Engineering McGraw 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 NostrandReinhold,NewYork

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

Course Code : MET603-2 (Elective-III) Course : Design of Heat Exchangers

L: 4 Hrs, T: 0 Hrs, P: 0 Hrs. per week Total Credits : 08

Course Outcomes

1. Analyze the quantum of energy that can be retrieved with the help of thermal system.
2. Apply principles of fluid mechanics and heat transfer to model the heat exchangers.
3. Understand the heat transfer enhancement configurations.
4. Demonstrate anunderstanding of the various applications of heat exchange systems.

Syllabus

Constructional details and Heat Transfer: Types, Shell and Tube heat Exchangers, Regenerators,Recuperator, Industrial applications,temperature distributionand its implications, LMTD, Effectiveness.

Flow distribution and stress analysis: Effect of Turbulence, Friction factor, Pressure loss, Channel diversion,heater sheets and pressure vessels,thermal stresses, shear stresses,Types of failure.

Design Aspects: Heat transfer and Pressure loss, Flow configuration,Effects of Baffles, effects of deviation from ideality, Design of typical liquid, gas, gas -Liquid heat exchanger.

Condensers and Evaporators design: Design of surface and evaporative condensers, Design of shell and tube, plate type evaporator, Cooling Tower:

Packing's, sprays design, selection of pumps, fans and pipe, testing and maintenance, experimental methods, Advance topic on subject.

Text Books:

1. Fundamentals of Heat Exchanger Design,R. K. Shah , D.P. Sekulic,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 : MET603-3 (Elective-III) Course: Cryogenics

L: 4 Hrs, T: 0 Hrs, P: 0 Hrs, per week Total Credits: 8

Course Outcomes

1. Ability to understand various gas liquefaction, gas separation & purification systems.
2. Ability to evaluate the performance of different cryogenic systems.
3. Ability to understanddifferent working fluids and engineering materials in cryogenic systems.
4. Abilty to analyze low temperature systems for various applications.

Syllabus

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

Production of low temperature by reversible and irreversible adiabatic expansion of agas , 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, Stirlingcryocooler.

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, MamataMukhopadhyay, 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.

ASHRAE HANDBOOKS (i) Fundamentals (ii) Refrigeration

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

Course Code: MET603-4 (Elective-III) | Course: Bio-Mechanical Engineering

L: 4 Hrs, T: 0 Hrs, P: 0 Hrs, per week | Total Credits: 8

Course Outcomes

1. Ability to understand fluid flow physics of human body.
2. Ability to apply governing equations of fluid flow and analyze the various circulation systems of the human body.
3. Ability to prepare model of the body parts by applying segmentation techniques.
4. Ability to apply mechanical engineering tools to study and analyze the biomedical devices.
5. Ability to apply mechanical codes to understand flow physics of the human body.

Syllabus

Introduction tohuman body and its flow physics.

Applications of governing equations of fluid flow & Heat transfer to human body.

Introduction to various diseases, Significance of various body & fluid parameters.

Imaging techniques.

Respiratory System: Theory & Analysis.

Cardiovascular System: Theory & Analysis.

Introduction to Biomechanics: Structural Analysis.

Bio-medical devices: FDA approval Procedure

Case studies on :

- Respiratory System
- Cardiovascular System
- Joints

Text Books:

1. Grays Anatomy, Henry Gray, Churchill Livingstone, Elsevier.
2. Principles& Practice of Medicine, Davidson's, Churchill Livingstone, Elsevier.

Reference Books:

1. Computational Fluid Dynamics –The Basics with Applications, Anderson J.D., McGrawHill Publication.
2. FDA procedures Handbook

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

Course Code: MEP604 Course: Project Phase I

L: 0 Hrs, T: 0 Hrs, P: 6 Hrs. Per week Total Credits: 24

Course Outcomes

1. Ability to analyze independently any problem posed to them to be carried as project work.
2. Ability to formulate the project topic in detail.
3. Understand the concept and scope of project work and its methodology.

Syllabus

Seminars on project spade work.

SEMESTER - IV

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

Course Code: MEP605 | Course: Project Phase II

L: 0 Hrs, T: 0 Hrs, P: 12 Hrs. per week | Total Credits: 48

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 aspects of project work and coming up with probable solutions.
4. Ability to interpret the results through various analytical tools and report writing.

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Syllabus

The M.Tech. Project is aimed at training the students to analyze independently any problem posed to them. 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.