DEPARTMENT OF MECHANICAL ENGINEERING
A.U. COLLEGE OF ENGINEERING (A), VISAKHAPATNAM

SCHEME AND SYLLABI OF M.TECH. (HEAT POWER ENGINEERING)
(FOR THE ACADEMIC YEAR 2025-26 ONWARDS)

M.TECH. (HEAT POWER ENGINEERING) - I SEMESTER

Course code	Course Title	Hours per week		Internal Marks	External Marks	Total Marks	Credits
		L	P				
MTHT 101	Mathematical Methods in Engineering	4	0	30	70	100	4
MTHT 102	Conduction & Radiation Heat Transfer	4	0	30	70	100	4
MTHT 103	Advanced Fluid Mechanics	4	0	30	70	100	4
MTHT 104	Measurements in Heat Transfer	4	0	30	70	100	4
MTHT 105	Elective Subject – 1	4	0	30	70	100	4
MTHT 106	Solar Energy	4	0	30	70	100	4
MTHT 107	Thermo Fluids Lab – 1	0	3	50	50	100	1.5
MTHT 108	Computations Lab - 1	0	3	50	50	100	1.5
						Total Credits:	**27**

M.TECH. (HEAT POWER ENGINEERING) - II SEMESTER

Course code	Course Title	Hours per week		Internal Marks	External Marks	Total Marks	Credits
		L	P				
MTHT 201	Convection Heat Transfer	4	0	30	70	100	4
MTHT 202	Thermal Environmental Control	4	0	30	70	100	4
MTHT 203	Design of Thermal Equipment	4	0	30	70	100	4
MTHT 204	Boiling & Two-Phase Flow Heat Transfer	4	0	30	70	100	4
MTHT 205	Elective Subject – 2	4	0	30	70	100	4
MTHT 206	Thermo Fluids Lab – 2	0	3	50	50	100	1.5
MTHT 207	Computations Lab - 2	0	3	50	50	100	1.5
MTHT 208	Seminar	0	3	50	50	100	1
						Total Credits :	**24**

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M.TECH. (HEAT POWER ENGINEERING) - III SEMESTER

Course code	Course Title	Hours per week L	Hours per week P	Internal Marks	External Marks	Total Marks	Credits
MTHT 301	Elective Subject - 3	4	0	30	70	100	4
MTHT 302	Elective Subject - 4	4	0	30	70	100	4
MTHT 303	Internal Assessment of Project	-				100	4
						Total Credits :	**12**

M.TECH. (HEAT POWER ENGINEERING) - IV SEMESTER

Course code	Course Title	Scheme of Examination	Total Marks	Credits
MTHT 401	External Assessment of Project	Viva - Voce	100	16

DEPARTMENT OF MECHANICAL ENGINEERING
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SCHEME AND SYLLABI OF M.TECH. (HEAT POWER ENGINEERING)
(FOR THE ACADEMIC YEAR 2025-26 ONWARDS)

M.TECH. (HEAT POWER ENGINEERING)

ELECTIVE SUBJECTS

Elective – 1
A) Advanced Optimization Techniques
B) Energy Management
C) Advanced Finite Element Analysis

Elective – 2
A) Thermal and Nuclear Power Plants
B)Turbo Machines
C) Hydel Power and Wind Energy

Elective-3
A) Gas Dynamics
B) Gas Turbines and Jet Propulsion
C) Environmental Pollution and Control

Elective-4
A) Computational Fluid Dynamics
B) Renewable Energy Source
C) Introduction to Turbulence

M. TECH HEAT POWER ENGINEERING

Program outcomes:

PO1 : An ability to independently carry out research /investigation and development work tosolve practical problems

PO2 : An ability to write and present a substantial technical report/document.

PO3 : Students should be able to demonstrate a degree of mastery over the area as per thespecialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

PO4 : To produce employable post graduate for industry and research establishments, in the field of heat transfer, fluid dynamics, heat exchanger design, refrigeration, cryogenics,air-conditioning, gas dynamics, gas turbines, and non-conventional sources of energy.

PO5 : Students should be able to utilize non-conventional energy resources for thedevelopment of ecofriendly thermal systems.

PO6: To inculcate research culture with abilities to publish at national/international level anddevelop prototype technologies, in the domain of thermal and fluid sciences.

PO7 : To equip masters students with the skills of effective interpersonal communication and attitude of lifelong learning, needed to engage as leader in nurturing diverse teams, withcommitment to their ethical and social responsibilities.

FIRST SEMESTER

MTHT 101 MATHEMATICAL METHODS IN ENGINEERING

Periods per week : 4
Sessionals : 30
Credits : 4

Examination : 70 ;
Examination (Theory): 3hrs.

Course Objectives

1. Understand the consistency of linear systems of equations (both homogeneous and non-homogeneous) and solve them using methods like Gauss Elimination, Gauss-Jordan, Jacobi, Gauss-Seidel, LU Factorization, and other numerical techniques.
2. Apply numerical methods for solving ordinary differential equations, including Picard's Method, Taylor's Series, Euler's Method, Modified Euler's Method, Runge-Kutta Methods (2nd and 4th orders), and Milne's Predictor-Corrector Method.
3. Study the method of separation of variables to solve partial differential equations (PDEs) in engineering applications, including wave equations, one-dimensional heat flow, two-dimensional steady-state heat flow, and Laplace's equation in Cartesian and polar coordinates.
4. Classify second-order partial differential equations and solve elliptic, parabolic, and hyperbolic equations using numerical methods such as Jacobi and Gauss-Seidel methods, Schmidt explicit formula, Crank-Nicolson formula, and Bendre-Schmidt recurrence relation.

SYLLABUS:

System of Simultaneous Equations:- Consistency of Linear System of equations (Non-homogeneous and Homogeneous), Solving Linear system of equations: Gauss Elimination Method, Gauss-Jordan Method , Numerical methods, Jacobs Gauss-Seidal method, LU factorization method, Characteristic equation, Eigen Values and Eigen Vectors of a Matrix, their properties. finding the largest Eigen Value of a matrix, Rayleigh's power method.

Numerical Solution of Ordinary Differential Equations:- Picard's Method, Taylor's Series, Euler's Method, Modified Euler's Method, Runge- Kutta Method (2^{nd} and 4^{th} orders), Milne's Predictior- Corrector Method.

Applications of Partial Differential equations:- Method separation of variables, PDE's of Engineering , vibrations of a stretched string wave equation, one dimensional heat flow, two dimensional heat flow in the steady state, solution of Laplace equation in Cartesian and polar co- ordinates.

Numerical Solutions of Partial Differential Equations:- Classification of second order PDE's, elliptic equations, solution of Laplace's equation and Poisson's equation using Jacob and Gauss-Seidal methods, Parabolic equations, solution of heat equation, Schmidt explicit formula, Crank-Nicolson formula, Bendre- Schmidt recurrence relation, Hyperbolic equations, solution of Wave equation.

Course Outcomes

1. Solve both homogeneous and non-homogeneous systems of linear equations using various methods like Gauss Elimination, Gauss-Jordan, Jacobi, Gauss-Seidel, and LU Factorization.

2. Use numerical methods such as Picard's, Taylor's Series, Euler's, Modified Euler's, Runge-Kutta Methods (2nd and 4th orders), and Milne's Predictor-Corrector Method to solve ordinary differential equations.
3. Apply separation of variables to solve partial differential equations in engineering, including problems related to vibrations, heat flow, and Laplace's equation in both Cartesian and polar coordinates.
4. Solve elliptic, parabolic, and hyperbolic partial differential equations using numerical methods, and apply techniques like Schmidt explicit formula, Crank-Nicolson formula, and Bendre-Schmidt recurrence relation.

Reference Books:

1. Higher Engineering Mathematics – B. S. Grewal, Khanna Publishers.
2. Introductory methods of Numerical Analysis – S. S. Sastry, Prentice Hall Publications.
3. Numerical methods in Engineering and Science by B.S. Grewal, Khanna Publishers.
4. Advanced Differential equations – M. D. Raisinghania, S. Chand & Co., Publications.

FIRST SEMESTER

MTHT 102 CONDUCTION AND RADIATION HEAT TRANSFER

Periods per week : 4
Sessionals : 30
Credits : 4

Examination : 70 ;
Examination (Theory): 3hrs.

COURSE OBJECTIVES:

1. The student is made to understand coordinate systems and evaluation of thermalconductivity.
2. The student is prepared to understand the concept of fins and its performance.
3. The student is made to understand unsteady flow and use of Heisler charts.
4. The student is prepared to learn and understand different laws of radiation.
5. The student is educated on application of radiation principles using shape factors.

SYLLABUS:

Conduction: heat equation in Cartesian, cylindrical and spherical coordinates –Steady one dimensional heat conduction with and without heat generation in different geometries, thermal resistance network, composite systems, effect of variable thermal conductivity, heat transfer in common configurations, conduction shape factor. Steady two dimensional heat conduction: solution by method of separation of variables.

Extended surfaces heat transfer: different fin geometries, differential equation for fin of uniform and variable cross sections, solution of fin equation for different boundary conditions, fin performance.

Transient conduction: lumped system analysis, transient conduction in various geometries, one term approximate solutions, use of Heisler’s charts, semi infinite solids, transient conduction in multi dimensional systems: product solution for transient conduction in various geometries, Conduction with phase change - integral method, solidification and melting - numerical methods.

Radiation: Review of radiation principles - laws of thermal radiation - surface properties

Radiative heat exchange among diffuse, gray and non-gray surfaces separated by non-participating media - gas radiation and radiation transfer in enclosures containing absorbing and emitting media - interaction of radiation with conduction and convection.

COURSE OUTCOMES:

1. The student gets knowledge on various coordinate systems and evaluation of thermal conductivity of composite systems.
2. The student develops capability on use of fins to various applications.
3. The student is capable of using Heisler charts and the concepts of unsteady flow.
4. The student develops an idea of various radiation laws.
5. The student gets knowledge on black and grey body and electrical analogy principle.

References:

1. Analysis of heat and mass transfer by Eckert and Drake, McGraw-Hill
2. Fundamentals of heat transfer by Grober, Erk and Grigull, McGraw-Hill
3. Fundamentals of heat transfer by Incropera and Hewitt
5. Conduction heat transfer by Schneider, Eddison Wesley
6. Radiation heat transfer by Sparrow and Cess, McGraw-Hill
7. Radiation heat transfer by H.C. Hottel and A.F. Sarofin
8. Thermal radiation by Siegel and Howell.

FIRST SEMESTER
MTHT 103 ADVANCED FLUID MECHANICS

Periods per week : 4
Sessionals : 30
Credits : 4

Examination : 70 ;
Examination (Theory): 3hrs.

COURSE OBJECTIVE:

- To impart knowledge of boundary layer flows, governing equations of fluid flow for different flow regimes, different geometries under the effect of various boundary conditions.
- To get familiar with laminar, turbulent incompressible and compressible viscous flows and its models.

SYLLABUS:

Unit-I: Ideal and non-ideal flows, General equations of fluid motion, Navier-Stokes equationsand their exact solutions.

Unit-II: Boundary layer theory, solutions to flow over external surfaces, flow through internalsurfaces

Unit-III: Integral methods, steady laminar and turbulent incompressible flows.

Unit-IV: Introduction to compressible viscous flows, governing equations, Fanno and Rayleighlines, normal and oblique shocks

COURSE OUTCOMES:

Students will be able to

- Formulate and solve fluid flows under the laminar and turbulent regime
- Apply perturbation and asymptotic methods and analyze boundary layer flows.
- Demonstrate a fundamental understanding of computational fluid mechanics.
- Understand the concept of stability of fluid motion.
- Appreciate the basics of turbulent flows and industrial applications of fluid flows.
- Acquainted with laminar, turbulent incompressible and compressible viscous flows and itsmodels.

REFERENCE BOOKS:

1. Boundary layer theory, Schlichting by McGraw Hill
2. Foundations of fluid mechanics by Yuan, Prentice Hall
3. Turbulence, Bradshaw by Springer-Verlag

FIRST SEMESTER
MTHT 104 MEASUREMENTS IN HEAT TRANSFER

Periods per week : 4
Sessionals : 30
Credits : 4

Examination : 70 ;
Examination (Theory): 3hrs.

COURSE OBJECTIVES

1. Students must learn different analytical methods of handling experimental data
2. Students should understand the basic concepts of measuring instruments used for differentapplications
3. Students must have inquisitive knowledge of measuring instruments
4. With acquainted knowledge a student must logically select an appropriate measuring instrument as per situation
5. To have a comprehensive idea about traditional techniques and non-traditional/visualizationtechniques available in measuring instruments

SYLLABUS:

Analysis of experimental data: Causes and types of experimental errors, Error analysis on a commonsense basis, Uncertainty analysis, Statistical analysis of experimental data probability distributions, The Gaussian or normal error distribution, Probability graph paper, The Chi-square test of goodness of fit, Method of least squares, Standard deviation of the mean, Graphical analysis and curve fitting, General considerations in data analysis.

Basic electrical measurements and sensing devices - Transducers, The variable -Resistance transducers, The differential transformer (LVDT), Capacitive transducers, Piezoelectric transducers, Photoelectric effects, Photoconductive transducers, Photovoltalic cells, Ionizationtransducers, Magnetometer search coil: Hall-effect transducers.

Pressure measurement: Dynamic response considerations, Mechanical pressure -Measurement devices, Dead-weight tester, Bourdon-tube pressure gauge, Diaphragm and bellows gauges, The Bridgman gauge, Low-pressure measurement. The Mcleod gauge, Pirani thermal-conductivity gauge, The Knudsen gauge, The ionization gauge, The alphatron.

Flow measurement: Positive displacement methods flow - Obstruction methods, Practical consideration for obstruction meters, The sonic nozzle. Flow measurement by drag effects, Hotwire and hot-film anemometers, Magnetic flow meters, Flow- visualization methods, The shadowgraph, The schlieren, The interferometer, The Laser Doppler Anemometer (LDA), Smoke methods, Pressure probes, Impact pressure in supersonic flow.

The measurement of temperature: Temperature scales. The ideal-gas thermometer, Temperature measurement by mechanical effect. Temperature measurement by electrical effects, Temperature measurement by radiation, Effect of heat transfer or temperature measurement, Transient response of thermal systems, Thermocouple compensation, Temperature measurements in high-speed flow.

Thermal and transport Property measurement: Thermal conductivity measurements, Thermal conductivity of liquids and gases, Measurement of viscosity, Gas diffusion, Calorimetry, Convection heat-transfer measurements. Humidity measurements, Heat-flux meters.

Thermal radiation measurements: Detection of thermal radiation, Measurement of emissivity, Reflectivity and transmissivity measurements, Solar radiation measurements.

COURSE OUTCOMES:

1. Students will learn to use available analytical methods to present experimental data
2. Student will have an idea about functionality of different components in measuring instruments
3. Students can select an appropriate measuring instrument according to the range of measurement required
4. Students can handle the instruments with minimum additional instructions given to them
5. Students will get an exposure to traditional techniques and non-traditional/visualization techniques available in measuring instruments.

Reference books:

1. Experimental Methods for Engineers by Holman, J.P.
2. Mechanical Measurements by Thomas G. Beckwith, N. Newis Buck.
3. Measurements in Heat Transfer by Eckert and gold stein

FIRST SEMESTER
MTHT 105 ELECTIVE SUBJECT – 1

A) ADVANCED OPTIMIZATION TECHNIQUES

Periods per week : 4
Sessionals : 30
Credits : 4

Examination : 70 ;
Examination (Theory): 3hrs.

Course Objectives

1. Solve unconstrained and constrained geometric programming problems using differential calculus and arithmetic methods, and understand primal-dual relationships and sufficiency conditions.
2. Explore dynamic programming concepts such as multistage decision processes, suboptimization, and the principle of optimality, along with computational procedures and tabular methods for solving dynamic programming problems.
3. Apply methods like Gomory's cutting plane, Bala's algorithm, branch-and-bound, and other techniques to solve integer programming problems.
4. Understand the fundamental concepts of probability theory and apply them to solve stochastic linear programming problems.
5. Study and apply non-traditional optimization techniques such as multi-objective optimization, genetic algorithms, simulated annealing, and neural network-based optimization.

SYLLABUS:

Geometric programming (G.P): Solution of an unconstrained geometric programming, differential calculus method and arithmetic method. Primal dual relationship and sufficiency conditions. Solution of a constrained geometric programming problem (G.P.P), Complementary Geometric Programming (C.G.P)

Dynamic programming(D.P): Multistage decision processes. Concepts of sub optimizationand Principal of optimality, computational procedure in dynamic programming calculusmethod and tabular methods. Linear programming as a case of D.P. and continuous D.P. **Integer programming(I.P):** Graphical representation. Gomory's cutting plane method. Bala'salgorithm for zero-one programming problem. Branch-and-bound method, Sequential lineardiscrete Programming, Generalized penalty function method.

Stochastic Programming (S.P): Basic Concepts of Probability Theory, Stochastic Linear programming.

Non-traditional optimization techniques: Multi-objective optimization - Lexicographic method, Goal programming method, Genetic algorithms, Simulated annealing, Neural Networks based Optimization.

Course Outcomes

1. Formulate and solve geometric programming problems using both differential calculus and arithmetic methods, and apply primal-dual relationships and sufficiency conditions.
2. Use dynamic programming techniques to solve multistage decision problems, apply the principle of optimality, and use computational methods to solve dynamic and continuous programming problems.
3. Solve integer programming problems using graphical methods, Gomory's cutting

plane method, Bala's algorithm, branch-and-bound, and other advanced techniques.
4. Apply probability theory and stochastic programming techniques to solve optimization problems involving uncertainty in a variety of decision-making contexts.
5. Utilize multi-objective optimization, genetic algorithms, simulated annealing, and neural network-based techniques to solve complex real-world optimization problems.

References:

1. Operations Research- Principles and Practice by Ravindran, Phillips and Solberg, John Wiely
2. Introduction to Operations Research by Hiller and Lieberman, Mc Graw Hill
3. Engineering Optimization - Theory and Practice by Rao, S.S., New Age International (P) Ltd. Publishers.
4. Engineering Optimization By Kalyanmanai Deb, Prentice Hall of India, New Delhi.
5. Genetic Algorithms - In Search, Optimization and Machine Learning by David E.Goldberg, Addison-Wesley Longman (Singapore) Pvt. Ltd.

FIRST SEMESTER
MTHT 105 ELECTIVE SUBJECT – 1
B) ENERGY MANAGEMENT

Periods per week : 4
Sessionals : 30
Credits : 4

Examination : 70 ;
Examination (Theory): 3hrs.

COURSE OBJECTIVES:

1. Students will have an exposure to the present energy scenario regarding availability/demandand the need for energy conservation
2. Students will be given an insight about energy intensive industries and their energyconsumption trends
3. Students will be taught, working of various instruments used during energy audits
4. Students will be taught about different types of audits and the activities coordinated duringenergy audits
5. Students will learn about various energy conservation opportunities available in process equipments/industries
6. A systematic approach towards financial assistance/evaluation of projects will also be taughtduring the course

SYLLABUS:

Introduction: Energy Scenario – World and India, Energy Resource Availability in India, Energy Consumption, Energy intensive industries – an overview, Need for Energy Conservation, Role of Energy manager, Principles of Energy Management. Energy conservation Act 2003.

Instruments for Energy auditing: Instrument characteristics – sensitivity, readability, accuracy,precession, hystersis, Error and Calibration, Measurement of Flow, Velocity, Pressure,Temperature, Speed, Lux, Humidity, Analysis of stack, Water quality, Fuel quality and Power

Energy Audit: Definition and Concepts, Types of Energy Audits – Basic Energy Concepts – Energy audit questionnaire, Data Gathering – Analytical Techniques. Energy Consultant: Need of Energy Consultant – Consultant Selection Criteria

Energy Conservation: Technologies for Energy Conservation – energy flow networks – criticalassessment of energy usage – Boilers, Thermic fluid heater, Furnaces, Waste heat recoverysystems, Thermal storage systems, Steam traps, Refractories, Insulation - Optimum thickness Synthesis of alternative options and technical analysis of options, Process integration.

Economic Analysis: Scope, Characterization of an Investment Project – Types of Depreciation – Time Value of money – budget considerations, Risk Analysis.

Methods of Evaluation of Projects: Payback – Annualized Costs – Investor's Rate of return – Present worth – Internal Rate of Return – Pros and Cons of the common methods of analysis – replacement analysis.

COURSE OUTCOMES:

1. Students can realize the importance of energy conservation in the present day scenario
2. Concepts learnt might help students to understand the working and limitations of instrumentsused during energy audits
3. Students can take up energy manager or energy auditor as their career in future
4. Students will understand and evaluate the energy conservation opportunities in a process/equipment
5. Their knowledge about financial approach can help them to logically evaluate the feasibility ofmodification/retrofitting in a process/equipment

TEXT BOOKS:

1. Energy Management Hand book by W.C. Turner (Ed)
2. Management by H.Koontz and Cyrill O Donnell
3. Financial Management by S.C. Kuchhal
4. Energy Management by W.R.Murthy and G.Mc Kay
5. Hamies, Energy Auditing and Conservation. Methods and Measurements, Management andCase study, Hemisphere, Washington, 1980
6. Energy Management by Trivedi, PR, Jolka KR, Commonwealth publication, New Delhi
7. Guide book for National Certificate Examination for Energy Managers and Energy Auditors(Could be downloaded from www.energymanagertraining.com)

REFERENCE:

1. Energy Management/W.R.Murphy, G.Mckay/Butterworths.
2. Energy Management Principles/C.B.Smith/ Pergamon Press.
3. Energy Economics/A.V.Desai/Wieley Eastern

Industrial Energy Management and Utilization/L.C. Witte, P.S. Schmidt, D.R. Brown/Hemisphere Publication/Washington

FIRST SEMESTER
MTHT 105 ELECTIVE SUBJECT – 1

C) ADVANCED FINITE ELEMENT ANALYSIS

Periods per week : 4
Sessionals : 30
Credits : 4

Examination : 70 ;
Examination (Theory): 3hrs.

Course Objectives

1. To introduce the finite element method (FEM) for solving elastic continuum problems, including the displacement approach, weighted residuals, and variational approaches.
2. To understand and apply FEM for plane stress, plane strain, axisymmetric stress analysis, and 3-D stress analysis.
3. To learn about element shape functions, C-continuity, isoparametric elements, and numerical integration for 2-D and 3-D stress analysis applications.
4. To study the bending of thin plates, non-conforming elements, substitute shape functions, and reduced integration techniques in FEM.
5. To explore energy principles of elasticity, Lagrangian constraints, complete field and interface variables, and hybrid methods for solving elasticity problems.
6. To investigate the use of shells in FEM, including axisymmetric shells, semi-analytical processes, and their application in 3-D analysis.
7. To study steady-state field problems, including heat conduction, electric and magnetic potentials, and field flow using FEM.
8. To understand and apply finite element approximations to initial value and transient problems in the time domain, including semi-discretization and dynamic problems.

SYLLABUS:

Introduction, Finite elements of an elastic continuum - displacement approach, generalizationof the finite element concept - weighted residuals and variational approaches. Plane stress and plane strain, Axisymmetric stress analysis, 3-D stress analysis.
Element shape functions - Some general families of C continuity, curved, isoparametric elements and numerical integration. Some applications of isoparametric elements in two-and- three dimensional stress analysis.
Bending of thin plates - A C continuity problem. Non-conforming elements, substitute shape functions, reduced integration and similar useful tricks. Lagrangian constraints in energy principles of elasticity, complete field and interface variables (Hybrid method).
Shells as an assembly of elements, axisymmetric shells, semi-analytical finite element processes
- Use of orthogonal functions, shells as a special case of 3-D analysis.
Steady-state field problems - Heat conduction, electric and magnetic
potentials, field flow.
The time domain, semi-descritization of field and dynamic problems and analytical solutionprocedures. Finite element approximation to initial value - Transient problems.

Course Outcomes

1. Apply the finite element method to solve elastic continuum problems using the displacement approach, weighted residuals, and variational methods.

2. Solve plane stress, plane strain, axisymmetric, and 3-D stress analysis problems using finite element modeling.
3. Develop and utilize element shape functions, C-continuity, isoparametric elements, and numerical integration for stress analysis in two- and three-dimensional problems.
4. Solve bending problems of thin plates, implement non-conforming elements, and apply substitute shape functions and reduced integration in FEM models.
5. Understand and apply Lagrangian constraints and energy principles of elasticity in solving problems, and utilize hybrid methods for complete field and interface variable solutions.
6. Use shells as an assembly of elements in FEM, apply semi-analytical finite element processes, and solve 3-D analysis problems.
7. Solve steady-state field problems (heat conduction, electric and magnetic potentials, and field flow) using FEM techniques.
8. Model and solve time-dependent and transient problems in the time domain, using finite element approximations, semi-discretization, and dynamic solution procedures.

REFERENCE BOOKS:

1. The Finite Element Method by Zienkiewicz, O.C.
2. The Finite Element Methods in Engineering by Rao, S.S.
3. Concepts and Applications of Finite Element Analysis by Cook, R.D.
4. Applied Finite Element Analysis by Segerland, L.J.

FIRST SEMESTER
MTHT 106 SOLAR ENERGY

Periods per week : 4
Sessionals : 30
Credits : 4

Examination : 70 ;
Examination (Theory): 3hrs.

COURSE OBJECTIVES:
Students are expected to learn about:
1. The current energy resources available all over the globe and their limitations
2. Fundamentals solar energy and its transmission from the Sun to the Earth
3. Design and constructional features of solar collectors and their performance parameters andestimation.
4. Design and constructional features of solar passive devices used to convert the solar energyinto heat.
5. Design and constructional features of walls and buildings.

SYLLABUS:
Current alternate energy sources - thermodynamic view point and conversion methods. Solar Radiation, direct and diffuse radiation, measurement and estimation. Constructional features of photovoltaic cell.

Components of solar energy systems, collector performance. Radiation and meteorological data processing, long term conversion factors. Water and air heating collectors. Concentrating collectors design procedure. Storage systems.

System configurations and system performance prediction, simulations, solar thermal systems applications to power generation, heating and cooling. Solar passive devices : solar stills, ponds, greenhouse, dryers. Trombe wall, overhangs and winged walls, Solar Economics.

COURSE OUTCOMES:
1. Students are able to know the limitations of conventional energy resources particularly onfossil fuels
2. The students are able to acquire the knowledge on energy resources, particularly on solarenergy.
3. Students are able to design and construct the solar collectors.
4. Students can acquire the knowledge and skills on design of solar passive devices.
5. Students can demonstrate the design features of buildings.

REFERENCE BOOKS:

1. Principles of solar engineering – Kreith and Kerider
2. Solar energy thermal processes – Duffie and Beckman
3. Solar energy –Sukhatme
4. Solar energy –Garg
5. Solar energy –Magal
6. Solarr energy – Tiwari andSuneja
7. Power plant technology – ElWakil

FIRST SEMESTER
MTHT 107 THERMO FLUIDS LAB- I

Periods per week : 3
Sessionals : 50

Examination: 50
Credits : 1.5

COURSE OBJECTIVES:

1. The student is made to understand on fluid mechanics principles.
2. The student is made to get awareness on heat transfer equations.
3. The student is prepared to understand the equations in heat transfer.
4. The student is taught the use of fins.
5. The student is taught to draw line diagrams and understand function of equipment.

List of Experiments:

CYCLE- I

1. Stream line flows of various geometries on laminar flow table.
2. Temperature distribution and efficiency of an extended surface.
3. Unsteady state heat transfer of a cylindrical specimen.

CYCLE- 2

4. Solar radiation on thermal energy storage training system.
5. Overall heat transfer coefficient of a shell and tube heat exchanger.6 Steady state unidirectional heat transfer on a metal bar.

COURSE OUTCOMES:

1. The student gets an idea to read properties of fluids.
2. The students gets awareness to see and record from data book and graphs.
3. The student is able to assess the usage of solar energy.
4. The student gets idea on estimation of values in shell and tube heat exchanger.
5. The student is capable of estimation of temperature from unsteady state.

FIRST SEMESTER
MTHT 108 COMPUTATIONS LAB- I

Periods per week : 3 Examination: 50
Sessionals : 50 Credits : 1.5

Course Objectives

1. To understand and apply numerical methods for solving first-order differential equations using the Fourth-order Runge-Kutta method.
2. To solve systems of first-order differential equations using the Fourth-order Runge-Kutta method.
3. To solve second-order differential equations by transforming them into a system of first-order equations and applying the Fourth-order Runge-Kutta method.
4. To implement and solve two-dimensional steady-state heat conduction problems in a slab using various iterative methods like Jacobi, Gauss-Seidel, and successive over-relaxation.
5. To apply numerical methods such as the Crank-Nicolson method and Thomas algorithm to solve unsteady-state heat conduction problems in both a slab and a circular disc.
6. To solve transient heat transfer problems in a circular fin using the Crank-Nicolson method and Thomas algorithm.

LIST OF EXPERIMENTS:

EXERCISE-I:
Solution of I order differential equation with Fourth order Runge - Kuttamethod. Given $(dy/dx)=(3x^2/2y)$ with $x_0 =0$ and $y_0 =y(0)=1$.

EXERCISE-II:
Solution of a system of two first order differential equations using Fourth order Runge-Kutta method.
Given $(dy/dx) = (z-x)$ and $(dz/dx) = (x+y)$ with $x_0 = 0$ & $y_0 = 1$, $z_o = 1$.

EXERCISE-III:
Solution of II order differential equations with Fourth order Runge-Kutta method.
Given:$(d^2y/dx^2) = (y+x)$ and $(dy/dx) = z$, $x_i = 0$,$x_f = 1$, $h = (x_f-x_i)/10$.

EXERCISE-IV:
Solution for two dimensional steady state heat conduction in a slab using the Jocobi method .

EXERCISE-V:
Solution for two dimensional steady state heat conduction in a slab using the Gauss-siedel method .

EXERCISE-VI:
Solution for two dimensional steady state heat conduction in a slab using the successiveover relaxation method.

EXERCISE-VII:
Solution for unsteady state heat conduction in a slab using crank-Nicolson method andThomas algorithm. (Solution of parabolic equation).

EXERCISE-VIII:
Solution for unsteady state heat transfer in a circular disc using crank-Nicolson methodand Thomas algorithm.

EXERCISE-IX:
Solution for unsteady state heat transfer in a circular fin using Crank-Nicholson and Thomson algorithm.

Course Outcomes

1. Solve first-order differential equations using the Fourth-order Runge-Kutta method and interpret the results.
2. Solve and analyze systems of first-order differential equations using the Fourth-order Runge-Kutta method.
3. Solve second-order differential equations by converting them into first-order systems and applying the Fourth-order Runge-Kutta method.
4. Use the Jacobi method to solve two-dimensional steady-state heat conduction problems in a slab and analyze the results.
5. Solve two-dimensional steady-state heat conduction problems in a slab using the Gauss-Seidel method and interpret the numerical results.
6. Implement the successive over-relaxation method for solving steady-state heat conduction problems and evaluate the accuracy of the solution.
7. Solve unsteady-state heat conduction problems in a slab using the Crank-Nicolson method and the Thomas algorithm for parabolic equations.
8. Apply the Crank-Nicolson method and Thomas algorithm to solve unsteady-state heat transfer problems in a circular disc and analyze the results.
9. Solve transient heat transfer problems in a circular fin using Crank-Nicholson and Thomas algorithms and understand the implications of the solution.

SECOND SEMESTER
MTHT 201 CONVECTION HEAT TRANSFER

Periods per week : 4
Sessionals : 30
Credits : 4

Examination : 70 ;
Examination (Theory): 3hrs.

COURSE OBJECTIVES:

1. Students will learn momentum & energy equation and extend it to boundary layer theory
2. Students be taught how correlations were developed which are available in literature
3. Students be taught analogy between momentum and heat transfer
4. Students will learn different correlations available in convection for different geometries
5. Students be taught combined effect of free and forced convection

SYLLABUS

Derivation of equations of conservation of mass, momentum and energy, boundary layer approximations, similarity solutions for laminar boundary layer over flat plate, integral methods, forced convection in turbulent flows, eddy diffusivity, momentum and energy equation in turbulent shear layer, analogy between momentum and heat transfer, liquid metal heat transfer, natural convection from a vertical plate and cylinders, free convection in enclosed spaces, combined free and forced convection, heat transfer in MHD systems, transpiration cooling.

COURSE OUTCOMES:

1. Students will understand the significance of integral momentum equation and energy equationwhich can be further used to develop correlations in convection
2. Students can formulate correlations as per modified boundary conditions
3. Students can solve problems confined to forced and free convection for all geometries
4. With fundamental concepts of convection student will understand the concept of mass transferalso

REFERENCE BOOKS:

1. Analysis of heat and mass transfer by E.R.G. Eckert and Robert M. Drake, McGraw Hill
2. Boundary layer theory by Schlichting
3. Heat transfer by Gebhart
4. Natural convection heat and mass transfer by Y. Jaluria , Pergamon press
5. Convective heat and mass transfer by Kays, W.M., and Crawford, M.E., McGraw Hill

SECOND SEMESTER
MTHT 202 THERMAL ENVIRONMENTAL CONTROL

Periods per week : 4
Sessionals : 30
Credits : 4

Examination : 70 ;
Examination (Theory): 3hrs.

COURSE OBJECTIVES

1. Students will learn various thermodynamic considerations confined to HVAC
2. Students will be taught the influence of various thermodynamic variables in a vapour compression refrigeration cycles
3. Students will be taught, working and influencing parameters in a vapour absorption refrigeration cycle
4. Students will learn estimating psychometrics properties of moist air useful for cooling loadcalculations
5. Students will have an exposure to working of major components in air conditioning systems
6. Students will be taught to estimate cooling load calculations for air conditioning systems

SYLLABUS

Introduction: Thermodynamic consideration, Heat transfer considerations: Refrigeration. Vapour compression cycles, Refrigerants, Absorption refrigeration; Psychromatrices: Thermodynamic properties of moist air; Psychrometric charts, Cooling towers and evaporators - Condensers - Cooling and Dehumidifying coils, Air conditioning calculations.

COURSE OUTCOMES:

1. Students will understand the influence of thermodynamic variables in HVAC systems
2. Students can solve problems in vapour compression/absorption refrigeration cycles
3. Students can become familiar about working of major components in air conditioning units
4. Students can become familiar about different refrigerants commercially available and eco-friendly refrigerants
5. Students can take up cooling load calculations for an air conditioning unit

References:

1. Thermal Environmental Engineering by Threkled, J.L.
2. Refrigeration and Air conditioning by Stoker, W.F.

SECOND SEMESTER
MTHT 203 DESIGN OF THERMAL EQUIPMENT

Periods per week : 4
Sessionals : 30
Credits : 4

Examination : 70 ;
Examination (Theory): 3hrs.

COURSE OBJECTIVES:

1. The student is made to learn different types of heat exchangers.
2. The student is prepared to know the design procedures of thermal equipment.
3. The student is made to understand the accessories of the heat transfer equipment.
4. The student is made aware of the calculations of the thermal devices.
5. The student is prepared to understand the concept of furnace calculations.

SYLLABUS:

Classification of heat exchangers; basic design methods for heat exchangers, double pipe heatexchangers, parallel and counter flow

Design of shell and tube heat exchangers; TEMA codes; flow arrangements for increased heatrecovery

Condensation of single vapors, mixed vapors.

Design considerations for different plate type heat exchangers; regenerators.

Steam generators, condensers, radiators for space power plant, cooling towers, power plantheat exchangers, furnace calculations.

COURSE OUTCOMES:

1. The student gets knowledge the design procedures of thermal equipment.
2. The student acquires skills in getting thermal performance of heat transfer equipment.
3. The student is used to get the readings from TEMA code tables.
4. The student gets idea between boilers and condensers.
5. The student is capable of designing different heat exchangers suitable to the necessity.

Reference books:

1. Process heat transfer by Donald Kern, Tata McGraw Hill Publishing Company Ltd.
2. Heat Exchanger Selection, Rating and Thermal Design by Sadic Kakac and HongtonLiu, CRC Press
3. Process Heat Transfer by Sarit Kumar Das, Narosa Publishing House Pvt.Ltd.
4. Heat exchanger design by Press and N. Ozisik
5. Standards of the Tubular Exchange Manufacturers Association, TMEA, New York
6. Heat Exchangers by Kakac, S., A.E. Bergles and F. Mayinger (Eds.) Hemisphere, 1981
7. Compact Heat exchangers by Kays, W.M., and A.L. London, McGraw Hill

SECOND SEMESTER
MTHT 204 BOILING AND TWO-PHASE FLOW HEAT TRANSFER

Periods per week : 4
Sessionals : 30
Credits : 4

Examination : 70 ;
Examination (Theory): 3hrs.

COURSE OBJECTIVES:
1. The student is made to understand the two phase flow phenomenon.
2. The student is prepared to know the different theories and concepts of two phase flow.
3. The student is created to have awareness on heat transfer and pressure drop calculations ontwo phase flow.
4. The student is taught the concept of boiling and its occurrence.
5. The student is made to understand calculations on condensation.

SYLLABUS:
Definitions: Types of flow; volumetric concentration; void fraction; volumetric flux; relativevelocity; drift velocity; flow regimes; flow maps; analytical models.

Homogeneous flow: One-dimensional steady homogeneous equilibrium flow; homogeneousfriction factor; turbulent flow friction factor

Separated flow: Slip; Detailed discussion on bubbly, slug and annular flow; Lockhart-Martinelli method foe pressure drop calculation; pressure drop for flow with boiling; flow with phase change. **Drift flow model:** General theory; gravity flows with no wall shear; correlation to simple theory; Armond or Bankoff flow parameters.

Boiling: Regimes of boiling; nucleation; growth of bubbles; bubble motion at a heating surface; heat transfer rates in pool boiling; Rohsenow correlation for nucleate boiling. Zuber's theory for critical heat flux. Bromley theory for film boiling; forced convection boiling; Chen's correlation for flow boiling; maximum heat flux or burn out.

Condensation: Nusselt's theory; boundary layer treatment of laminar film condensation; experimental results for vertical and horizontal tubes; condensation inside a horizontal tube.

COURSE OUTCOMES:
1. The student is capable of getting equations in two phase flow.
2. The student is now aware of different models in two phase flow.
3. The student understands homogeneous and heterogeneous flow constraints.
4. The students gets concept of solving problems in boiling.
5. The student gets knowledge on laminar and turbulent boundary layers in condensation.

Reference books:

1. One-dimensional two-phase flow by Wallis, McGraw-Hill
2. Two-phase flow and heat transfer by Butterworth and Hewitt, Oxford
3. Convective boiling and condensation by J.G. Collier, McGraw-Hill
4. Boiling heat transfer and two phase flow by L.S. Tong, John Wiley
5. Transport processes in boiling and two-phase flow systems by Hsu and Graham, McGrawHill

SECOND SEMESTER
MTHT 205 ELECTIVE SUBJECT – 2
THERMAL AND NUCLEAR POWER PLANTS

Periods per week : 4
Sessionals : 30
Credits : 4

Examination : 70 ;
Examination (Theory): 3hrs.

COURSE OBJECTIVES:

Students are expected to learn about:

1. The current energy resources available all over the globe.
2. Energy conversion technologies and recent trends in power generation plants
3. Constructional features and working principle of all types of boilers (low pressure, high pressure, and super critical boilers)
4. Constructional features and working principle of coal based (steam based) thermal powerplants and their accessories.
5. Design and constructional features of conventional and Fluidized bed combustion systems.
6. Design and constructional features of gas turbine power plants and gas power cycles .
7. Design, constructional, and safety features nuclear power plants.
8. Performance factors and economic features of all verities of power plants

SYLLABUS:

Introduction – Sources of Energy, types of Power Plants, Direct Energy Conversion System, Energy Sources in India, Recent developments in Power Generation. Combustion of Coal, Volumetric Analysis, Gravimetric Analysis, Flue gas Analysis.

Steam Power Plants: Introduction – General Layout of Steam Power Plant, Modern Coal-fired Steam Power Plants, Power Plant cycles, Fuel handling, Combustion Equipment, Ash handling, Dust Collectors. Steam Generators: Types, Accessories, Feed water heaters, Performance of Boilers, Water Treatment, Cooling Towers, Steam Turbines, Compounding of Turbines, Steam Condensers, Jet& Surface Condensers.

Gas Turbine Power Plant: Cogeneration, Combined cycle Power Plants, Analysis, Waste-Heat Recovery, IGCC Power Plants, Fluidized Bed Combustion – Advantages & Disadvantages.

Nuclear Power Plants: Nuclear Physics, Nuclear Reactors, Classification–Types of Reactors, Site Selection, Methods of enriching Uranium, Applications of Nuclear Power Plants. Nuclear Power Plants Safety: By-Products of Nuclear Power Generation, Economics of Nuclear Power Plants, Nuclear Power Plants in India, Future of Nuclear Power.

Economics of Power Generation**:** Factors affecting the economics, Load Factor, Utilization factor, Performance and Operating Characteristics of Power Plants. Economic Load Sharing, Depreciation, Energy Rates, Criteria for Optimum Loading, Specific Economic energy problems. Power Plant Instrumentation**:** Classification, Pressure measuring instruments, Temperature measurement and Flow measurement. Analysis of Combustion gases, Pollution– Types, Methods to Control.

COURSE OUTCOMES:

1. Students are able to know the advantages and limitations of current energy resources.
2. Students are able to understand the design features of combustion systems.
3. The students are able to acquire the knowledge on all kinds of power generation plants.
4. Students are able to understand the design and construction of all kinds of power generationplants.
5. Students can acquire the knowledge about power plant instruments.
6. Students can demonstrate the design features and performance factors of power plants.

REFERENCE BOOKS:

1. Power Plant Technology / ElWakil.
2. Power Plant Engineering / P.C.Sharma / KotariaPublications.
3. Power Plant Engineering / P.K. Nag /TMH.

SECOND SEMESTER
MTHT 205 ELECTIVE SUBJECT – 2
A) TURBO MACHINES

Periods per week : 4
Sessionals : 30
Credits : 4

Examination : 70 ;
Examination (Theory): 3hrs.

COURSE OBJECTIVES:

1. The student is made to learn principles of turbo machines.
2. The student is made to understand the velocity triangles of turbo machines.
3. The student is taught the working of pumps turbines and blowers.
4. The student is created awareness on compounding of steam turbins.
5. The student is made to learn various hydraulic turbines.

SYLLABUS:

Definition and classification of turbo machines; principles of operation; specific work and its representation on T-s and h-s diagrams; losses and efficiencies; energy transfer in turbo machines; Euler equation of turbo machinery.

Flow mechanism through the impeller – velocity triangles, ideal and actual flows, slip and its estimation; degree of reaction - impulse and reaction stages; significance of impeller vane angle.

Similarity; specific speed and shape number; cavitations in pumps and turbines; performance characteristics of pumps and blowers; surge and stall; thin aerofoil theory; cascade mechanics

Steam turbines - flow through nozzles, compounding, effect of wetness in steam turbines; gasturbines

Hydraulic turbines – Pelton, Francis and Kaplan turbines, draft tube, performance and regulation of hydraulic turbines.

COURSE OUTCOMES:

1. The student understands the equations in turbo machines.
2. The student attains capability of drawing velocity triangles.
3. The student gets awareness in dealing with performance of turbo machines.
4. The student gets an understanding on gas turbines.
5. The student gets an idea of application of hydraulic turbines.

Reference books:

1. Yahya, S. M., Turbines, Compressors and Fans, Tata McGraw-Hill, 1983.
2. Gopalakrishnan, G. and Prithviraj, D., Treatise on Turbo machines,Schitech Publications, 2002
3. Shepherd, D. G., Principles of Turbomachinery, Macmillan Publishing Company, 1957
4. Csanady, G. T., Theory of Turbomachines, McGraw-Hill, 1964.
5. Dixon, S. L., Fluid Mechanics, Thermodynamics of Turbomachinery,Third Edition, Pergamon Press, 1978. Nechleba, M., Hydraulic Turbine, Arita, 1957.

SECOND SEMESTER

MTHT 205 ELECTIVE SUBJECT – 2

B) HYDEL POWER AND WIND ENERGY

Periods per week : 4
Sessionals : 30
Credits : 4

Examination : 70 ;
Examination (Theory): 3hrs.

Course Objectives

1. To understand the principles and methods for estimating stream flow data and water power, and to learn how to use hydrographs for water power analysis.
2. To study the characteristics and part-load performance of hydraulic turbines, including the design of wheels, draft tubes, and penstocks.
3. To learn about cavitation in hydraulic turbines and its effects on plant performance and operation.
4. To gain knowledge of plant layouts for hydel power plants and understand the costing involved in water power generation.
5. To estimate wind energy potential using wind maps, and understand aerodynamic and mechanical aspects of wind machine design.
6. To explore wind tunnel simulations for wind energy applications and understand methods for conversion and storage of wind energy.
7. To study instrumentation techniques used for wind velocity measurements and their role in wind energy generation.

SYLLABUS:

Hydel Power: Stream flow data and water power estimates, use of hydrographs Hydraulic turbine, characteristics and part load performance, design of wheels, draft tubes and penstocks, cavitation; plant layouts; costing of water power.

Wind Power and Engineering: Estimates of wind energy potential, wind maps; aerodynamic andmechanical aspects of wind machine design.

Wind tunnel simulations, conversion and storage methods; industrial applications.

Instrumentation for wind velocity measurements

Course Outcomes

1. Estimate stream flow data and water power potential using hydrographs and apply these methods to evaluate hydel power generation.
2. Analyze the characteristics and performance of hydraulic turbines and design various components, such as wheels, draft tubes, and penstocks, for efficient turbine operation.
3. Understand the concept of cavitation in turbines, its causes, and how to mitigate its effects on turbine and plant performance.
4. Design and analyze hydel power plant layouts, including considerations of plant efficiency, and calculate the costs associated with water power generation.
5. Estimate wind energy potential using wind maps, and apply aerodynamic and mechanical principles in the design of wind machines.
6. Implement wind tunnel simulations to study wind energy conversion and apply methods for efficient energy storage and distribution.

Utilize instrumentation techniques for accurate wind velocity measurements and integrate these measurements into wind energy systems for improved efficiency.

Reference books:

i. Non-Conventional Energy Systems by K.Mittal, Wheeler
ii. Non-Conventional Energy by Ashok V Desai, Wiley Eastern Publications
iii. Non-Convectional Energy Sources by G.D.Rai
iv. Renewable Energy Sources and Emerging Technologies by D.P.Kothari,K.C.Singal, Rakesh Ranjan, PHI Learning Pvt.Ltd
v. Wind Energy Engineering by Pramod Jain, Mc Graw Hill
vi. Wind Energy explained: Theory, Design and applications by James F Manwell, JonG.Mc.Gowan and Anthony L Rogers, Wiley black well
vii. Introduction to Hydro Energy Systems by Wagner, Herman – Josef,Mathur,Jyotirmoy, Springer Verlog, Berlin.
viii. Hydro Electrical Energy, Tamra orr, Cherry lake Publishing.

SECOND SEMESTER
MTHT 206 THERMO FLUIDS LABS-2

Periods per week : 3 | Examination: 50
Sessionals : 50 | Credits : 1.5

COURSE OBJECTIVES:

1. The student is made to understand on fluid mechanics principles.
2. The student is made to get awareness on heat transfer equations.
3. The student is prepared to understand the equations in heat transfer.
4. The student is taught the principle of forced convection.
5. The student is taught to draw line diagrams and understand function of equipment.

List of Experiments:

CYCLE-1

1. Fluid friction of smooth pipes.
2. Evaluation of heat transfer on heat pipe demonstrator.
3. Solar radiation on solar concentrator training system.

CYCLE-2

4. Evaluation of output parameters of shell and tube heat exchanger.
5. Temperature distribution and efficiency of pin fin apparatus under forced convection.
6. Effective thermal conductivity of a lagged pipe.

COURSE OUTCOMES:

1. The student gets an idea to read the properties of fluids.
2. The students gets awareness to see and record from data book and graphs.
3. The student is able to assess the usage of solar energy.
4. The student gets idea on estimation of values for friction factor
5. The student is capable of estimation of thermal conductivity of insulating materials.

SECOND SEMESTER
MTHT 207 COMPUTATIONS LAB-2

Periods per week : 3 Examination: 50
Sessionals : 50 Credits : 1.5

Course Objectives

1. To perform combustion calculations for solid and liquid fuels to analyze their efficiency and performance in energy systems.
2. To conduct combustion calculations for gaseous fuels and understand their behavior in different combustion processes.
3. To estimate fin tip temperatures and understand the heat transfer processes in various thermal systems.
4. To evaluate the efficiency of boilers and heaters based on real field data and assess their performance in practical applications.
5. To analyze the pressure drop of saturated and superheated steam in pipes and understand its impact on system efficiency.
6. To investigate the pressure drop of air and flue gas in tubes and pipes, and its influence on heat transfer and system performance.
7. To measure and analyze the pressure drop of air and flue gas over finned tubes and understand the effects on thermal efficiency.
8. To calculate the heat transfer coefficient for steam inside tubes and assess the efficiency of heat exchange in boiler systems.
9. To determine the heat transfer coefficient for air and flue gas inside tubes and evaluate the performance of heat exchangers.

LIST OF EXPERIMENTS:

EXERCISE-I:
Combustion calculations for solid and liquidfuels
EXERCISE-II:
Combustion calculations for gaseous fuels
EXERCISE-III:
Estimation of fin tip temperatures EXERCISE-IV:
Efficiency of boilers and heaters based on field data
EXERCISE-V:
Pressure drop of saturated and super heated steampipes
EXERCISE-VI:
Pressure drop of air and flue gas in tubes and pipes
EXERCISE-VII:
Pressure drop of air and flue gas over finnedtubes
EXERCISE-VIII:
Heat transfer coefficient for steam inside tubes.
EXERCISE-IX:
Heat transfer coefficient for air and flue gas inside tubes

Course Outcomes

1. Perform combustion calculations for solid and liquid fuels and interpret the results to improve energy efficiency in combustion processes.
2. Conduct combustion calculations for gaseous fuels and analyze the outcomes to optimize fuel usage and emissions control.
3. Estimate fin tip temperatures and analyze the heat transfer behavior in thermal systems, contributing to better design and efficiency.
4. Assess the efficiency of boilers and heaters using field data and interpret the results for optimizing energy production in real-world systems.
5. Analyze pressure drop in saturated and superheated steam pipes and understand its effects on system performance and efficiency.
6. Measure and analyze pressure drops of air and flue gas in tubes and pipes, and apply this knowledge to improve heat transfer efficiency.
7. Investigate the pressure drop over finned tubes and understand its impact on heat transfer, contributing to the design of more efficient thermal systems.
8. Calculate the heat transfer coefficient for steam inside tubes and apply the results to optimize the performance of steam boilers and heat exchangers.
9. Determine the heat transfer coefficient for air and flue gas inside tubes and apply the findings to improve the design and performance of air and gas-based heat exchangers.

SECOND SEMESTER
MTHT 208 SEMINAR

Periods per week : 3 Examination: 50
Sessionals : 50 Credits : 1

A student has to give seminar on the topics related to his specialization.

THIRD SEMESTER

MTHT 301 ELECTIVE SUBJECT – 3
A) GAS DYNAMICS

Periods per week : 4
Sessionals : 30
Credits : 4

Examination : 70 ;
Examination (Theory): 3hrs.

COURSE OBJECTIVES:

1. The student is to give awareness on compressible flow.
2. The student is made to understand concepts of isentropic and isothermal flows.
3. The student is taught relations for a shock wave
4. The student is made to learn governing equations for a shock wave.
5. The student is made to study various propulsion systems.

SYLLABUS:

Conservation laws for compressible flow, Concepts of compressible flow, Effect of Mach number on compressibility

Isentropic flow with variable area, Effect of area variation, Impulse function, Fanno flow - Variation of flow properties, Variation of Mach number with duct length, Isothermal flow with friction

Rayleigh flow - Variation of flow properties, Maximum heat transfer, Normal shock waves- Variation of flow properties, Prandtl Meyer relation, Rankine-Hugoniot relations, strength of shock wave

Oblique shock waves – Governing equations, Variation in flow properties

Propulsion Systems.

COURSE OUTCOMES:

1. The student gets knowledge on conservation laws for compressible flow.
2. The student is capable of using Mach number in isothermal and isentropic flows.
3. The student get awareness on the strength of shock wave.
4. The student understands the flow properties on oblique shock waves.
5. The student understands the importance of propulsion systems.

Reference books:

1. Fundamentals of Compressible flow with Aircraft and Rocket Propulsion,S.M.Yahya, New age International (P) Ltd., Publishers
2. Fundamentals of Compressible fluid dynamics, P.Balachandran, PHI Learning (P) Ltd.,
3. Gas Dynamics: Theory and Applications, George Turrel, John Wiley & Sons, 1997
4. Fundamentals of Gas dynamics, Robert D Zucker and Oscar Biblaz, John Wiley &Sons, 2002
5. Molecular gas dynamics: theory, techniques and application, Yoshio Sone BirkHauser, Boston,
6. Applied Gas Dynamics, Ethirajan Rathakrishnan, John Wiley & Sons, 2010.

THIRD SEMESTER

MTHT 301 ELECTIVE SUBJECT – 3
B) GAS TURBINES AND JETPROPULSION

Periods per week : 4
Sessionals : 30
Credits : 4

Examination : 70 ;
Examination (Theory): 3hrs.

COURSE OBJECTIVES:

Students are expected to learn about:

1. The working principle of gas turbine engines and fundamentals of thermodynamic gas powercycles.
2. Design and constructional features of turbine blades and determination of efficiencies of bladeand gas turbines.
3. Design and constructional features of compressors, impellers, blowers and fans.
4. Design and constructional features of combustion chambers and energy (heat) recoverymethods.
5. Constructional features, Working principle and Design features of all (types) of jet engines.

SYLLABUS:

Thermodynamic cycle analysis of gas turbines; open and closed cycles, axial flow turbines, blade diagrams and design of blading, performance characteristics, First-second and third laws of Thermodynamics.

Centrifugal and axial flow compressors, blowers and fans, theory and design of impellers and blading, matching of turbines and compressors.

Fuels and combustion: effect of combustion chamber design and exhaust on performance,basic principles and methods of heat recovery.

Thermodynamic cycle analysis and efficiencies of propulsive devices, thrust equation, classification and comparison of ram jets, turbojets, pulse jets and rockets.
Performance of turbo-prop, turbo-jet and turbo-fan engines, augmentation of thrust.

COURSE OUTCOMES:

1. Students are able to understand about the thermodynamic analysis of gas turbine cycles.
2. The students are able to acquire the knowledge on turbine-blade design and performance ofgas turbine engines.
3. Students are able to understand the constructional and design features of compressors.
4. Students can acquire the knowledge on Jet engines: working principles and limitations.
5. Students can demonstrate the working and design features of all gas turbines and jet engines.

Reference books:

1. Fundamentals of Turbo machines – Shephard
2. PractiseonTurbomachines–G.Gopalakrishnan&D.Prithviraj,SciTechPublishers,Chennai.
3. Elements of Gas Dynamics – Yahya
4. Gas Turbines – Theory and practice –Zucrow
5. Turbines, Pumps, Compressors – Yahya
6. Axial Flow Compressors – Horlock.
7. Gas Turbines- Cohen, Roger & Sarvanamuttu

THIRD SEMESTER

MTHT 301 ELECTIVE SUBJECT – 3
ENVIRONMENTAL POLLUTION AND CONTROL

Periods per week : 4
Sessionals : 30
Credits : 4

Examination : 70 ;
Examination (Theory): 3hrs.

COURSE OBJECTIVES

1. Students will learn about pollution contributors and effects of air pollution on humans andenvironment
2. Students will be taught how to control air pollution and air pollution laws with standards
3. Students will be taught sampling and advanced waste water treatment methods
4. Students will learn handing of sold wastes and health hazard due to solid wastes
5. Students will have an exposure to major polluting industries and their impact on humans andenvironment

SYLLABUS

Air pollution - Classification and properties of Air pollutants - Sampling and analysis of airpollutants –Control of air pollution.

Dispersion of air pollutants - Gaussian plume model- Control of gaseous pollutants - Volatileorganic compounds - Control of gaseous emission - Air pollution laws and standards.

Water pollution - Sampling and analysis of waste treatment – Advanced waste water treatmentsby physical, chemical, biological and thermal methods - Effluent quality standards.

Solid waste management - Classification and their sources - Health hazards - Handling of toxicand radioactive wastes - Incineration and verification.

Pollution control in process industries : Cement, Paper, Petroleum and petrochemical, Fertilizers and distilleries, thermal power plants and automobiles.

COURSE OUTCOMES:

1. Students can realize the impact of air pollution on humans and environment
2. Student will become familiar about recent pollution laws and standards defined by nationaland international agencies
3. Students can become familiar about different sampling techniques and methods to reducewater pollution
4. Students will realize of importance of solid waste management and device methods to handlesolid wastes
5. Students can take up projects on pollution and work towards a better future

References:

1. Manster, G.M., Introduction to Engineering and Science, 2nd ed., Pearson Publishers, 2004.
2. Rao, E.S., Environmental Pollution Control Engineering, Wiley Eastern Ltd., 1991.
3. Mahajan, S.P., Pollution Control in Process Industries, Tata McGraw-Hill, 1985.
4. Crawford, M., Air Pollution Control Theory, TMH, 1976.

THIRD SEMESTER
MTHT 302 ELECTIVE SUBJECT – 4
A) COMPUTATIONAL FLUID DYNAMICS

Periods per week : 4 | Examination : 70 ;
Sessionals : 30 | Examination (Theory): 3hrs.
Credits : 4

Course Objectives

1. To classify partial differential equations (PDEs) and understand their different types and characteristics.
2. To learn discretization methods such as finite difference and finite volume formulations for numerical solutions of PDEs.
3. To explore the finite difference, finite element, and finite volume methods in solving various types of PDEs.
4. To solve parabolic PDEs using finite difference and finite volume methods, applying both explicit and implicit schemes, and understanding consistency, stability, and convergence criteria.
5. To understand the numerical solution of systems of linear algebraic equations using Gaussian elimination and iterative methods such as Jacobi and Gauss-Seidel, and to study the conditions for convergence of iterative schemes.
6. To apply the finite volume method for discretizing diffusion problems, including steady-state and transient one-dimensional diffusion problems, and use iterative methods for solving discretized equations.
7. To solve the Navier-Stokes equations for incompressible flows, utilizing methods such as stream-function vorticity and artificial compressibility.
8. To understand the basics of grid generation and apply numerical techniques to solve hyperbolic equations, including the Burgers equation.

SYLLABUS:

Classification of partial differential equations - Discretization methods - finite difference and finite volume formulations –classification of PDES.

An overview of finite difference, finite element and finite volume methods. Numerical solution of parabolic partial differential equations using finite-difference and finite volume methods: explicit and implicit schemes, consistency, stability and convergence.

Numerical solution of systems of linear algebraic equations: general concepts of eliminationand iterative methods, Gaussian elimination, Jacobi and Gauss-Seidel iterations, necessary and sufficient conditions for convergence of iterative schemes.

The finite volume method of discretization for diffusion problems: one dimensional steady diffusion problems, specification of interface diffusivity, source-term linearization. Discretization of transient one-dimensional diffusion problems. Solution of discretized equations using point and line iterations, strongly implicit methods and pre-conditioned conjugate gradient methods.

Numerical solution of the Navier-Stokes system for incompressible flows: stream-function vorticity and artificial compressibility methods.

Basics of grid generation- Numerical solution of hyperbolic equations - Burgers equation generation.

Course Outcomes

1. Classify various partial differential equations (PDEs) and identify the appropriate methods for solving each type.
2. Use discretization methods like finite difference and finite volume formulations to solve PDEs numerically.
3. Implement finite difference, finite element, and finite volume methods to solve a wide range of PDE problems and interpret the results.
4. Solve parabolic PDEs using both explicit and implicit finite difference and finite volume methods, while analyzing consistency, stability, and convergence of the schemes.
5. Apply Gaussian elimination and iterative methods (Jacobi, Gauss-Seidel) to solve systems of linear algebraic equations, and understand the convergence conditions for iterative schemes.
6. Use the finite volume method to discretize and solve one-dimensional steady-state and transient diffusion problems, applying appropriate iterative techniques for solving the equations.
7. Solve the Navier-Stokes system for incompressible flows using stream-function vorticity and artificial compressibility methods, and analyze fluid dynamics in engineering applications.
8. Generate grids and solve hyperbolic equations, including Burgers' equation, using numerical techniques for real-world applications in fluid dynamics and heat transfer.

Reference books:

1. Tannehill, J.c., Anderson, D.A., and Pletcher, R.H., Computational Fluid Mechanics and Heat Tran5fer, 2nd ed., Taylor & Francis, 1997.
2. Numerical heat transfer and fluid flow – S.V. Patankar (Hemisphere Pub. House)
3. An Introduction to Computational Fluid Dynamics – FVM Method – H.K. Versteeg, W.Malalasekhara (PHI)
4. Peyret, R. and Taylor, T. D., Computational Methods for Fluid Flow, Springer-Verlag,1983.
5. Computational Fluid Dynamics – Hoffman and Chiang, Engg Education System
6. Computational Fluid Dynamics – Anderson (TMH)
7. Computational Methods for Fluid Dynamics – Ferziger, Peric (Springer)
8. Computational Fluid Dynamics, T.J. Chung, Cambridge University
9. Computaional Fluid Dynamics – A Practical Approach – Tu, Yeoh, Liu (Elsevier) Text Book of Fluid Dynamics, Frank Chorlton, CBS Publishers.

THIRD SEMESTER
MTHT 302 ELECTIVE SUBJECT – 4
A) RENEWABLE ENERGY SOURCE

Periods per week : 4 Examination : 70 ;
Sessionals : 30 Examination (Theory): 3hrs.
Credits : 4

COURSE OBJECTIVES:
Students are expected to learn about:
1. The various forms of energy (Solar, Wind, and Geothermal); Energy conversion technologiesand their limitations.
2. Fundamentals solar energy, wind energy and geothermal energy and their conversion intoelectricity.
3. Design and constructional features of solar collectors, photovoltaic cells, and their applications.
4. Design and constructional features of wind turbines/windmills.
5. Working principle of geothermal energy conversion systems.
6. Working principle and constructional features of tidal/wave energy conversion systems.
7. Working principles of various direct energy conversion systems and their working principles.

SYLLABUS:
SOLAR ENERGY COLLECTION AND ITS APPLICATIONS: Flat plate and concentrating collectors, Classification of concentrating collectors, Orientation and thermal analysis, Advanced collectors. Solar energy storage and applications: Different methods, Sensible, Latent heat and stratified storage, Solar ponds. Solar Applications- Solar heating and cooling technique, Solar distillation and drying, Photovoltaic energy conversion.

WIND ENERGY AND BIO-MASS: Sources and potentials, Horizontal and vertical axis windmills, Performance characteristics, Betz criteria, Bio- mass: Principles of Bio-Conversion, Anaerobic/aerobic Digestion, Types of Bio-gas digesters, Gas yield, Combustion characteristics of bio-gas, Utilization for cooking, IC Engine operation and economic aspects.

GEOTHERMAL ENERGY AND OCEAN ENERGY: Resources, Types of wells, Methods of harnessing the energy, Potential in India, Ocean Energy: OTEC, Principles of utilization, Setting of OTEC plants, Thermodynamic cycles. Tidal and wave energy: Potential and conversion techniques, Mini-hydel power plants, and their economics.

DIRECT ENERGY CONVERSION : Need for Direct Energy Conversion, Carnot cycle, Limitations, Principles of DEC, Thermo-electric generators, Seebeck, Peltier and Joule Thomson effects, Figure of merit, Materials, Applications, MHD generators, Principles, Dissociation and Ionization, Hall effect, Magnetic flux, MHD accelerator, MHD, Engine, Power generation systems, Electron gas dynamic conversion, Economic aspects. Fuel cells, Principles, Faraday's law's, Thermodynamic aspects, Selection of fuels and operating conditions.

COURSE OUTCOMES:

1. Students are able to know the renewable energy resources.
2. The students are able to acquire the knowledge on renewable energy resources, particularly onsolar, wind, geothermal and wave energy.
3. Students are able to design and construct the solar passive devices.
4. Students can demonstrate the working principle and design features of wind turbines/ mills.
5. Students can acquire the knowledge on geothermal energy conversion systems.
6. Students can demonstrate the working principle and design features of mini-hydel powerplants.
7. Students can demonstrate the performance parameters of various energy conversion devices.

TEXT BOOKS:

1. Renewable Energy Resources by Tiwari and Ghosal, NarosaPublications..
2. Non-Conventional Energy Sources by G.D.Rai

REFERENCES:

1. Renewable Energy Sources by Twidell&Weir
2. Solar Energy bySukhatme
3. Solar Power Engineering by B.S Magal, Frank Kreith and J.FKreith.
4. Principles of Solar Energy by Frank Krieth and John FKreider.
5. Non-Conventional Energy by Ashok V Desai, Wiley EasternPublications.
6. Non-Conventional Energy Systems by K Mittal ,Wheeler.
7. Renewable Energy Technologies by Ramesh and Kumar, NarosaPublications.

THIRD SEMESTER
MTHT 302 ELECTIVE SUBJECT – 4
B) INTRODUCTION TO TURBULENCE

Periods per week : 4
Sessionals : 30
Credits : 4

Examination : 70 ;
Examination (Theory): 3hrs.

COURSE OBJECTIVES:

1. The student is made to aware of stability theory.
2. The student is made to understand the concept of boundary layer.
3. The student is prepared to know equations of mean motion and internal flow.
4. The student is taught incompressible and compressible boundary layers.
5. The student is made to know turbulence modeling.

SYLLABUS:

Laminar Turbulent Transition, Experimental Evidence, Fundamentals of Stability theory, theOrr- Sommerfeld equation, Curves of neutral stability and the indifference Reynolds number

Plate boundary layer, experimental confirmation, effects of pressure gradient, suction, compressibility and wall roughness, instability of the boundary layer for three dimensional perturbations.

Fundamental equations for mean motion, the k-equation, energy equation, boundary layer equations for plane flows; Internal flows, universal law of the wall, friction law, mixing length, fully developed internal flows, generalized law of the wall, pipe flow, slender channel theory.

Incompressible boundary layers, defect formulation, equilibrium boundary layers, boundary layer on a flat plate at zero incidence, boundary layers with separation, integral methods, field methods, thermal boundary layers; Compressible boundary layers, skin friction and Nusselt number, natural convection.

Free shear layers in turbulent flow, plane and axi-symmetric free jets, mixing layers, plane andaxi- symmetric wakes, buoyant jets, plane wall jet; Turbulence modeling, zero equation, one equation and two equation models, derivation of the model equations, RNG model, DNS and large eddy simulation (LES).

COURSE OUTCOMES:

1. The student gets awareness in laminar, transition and turbulent, fundamental equations aswell as stability theory.
2. The student understands plate boundary layer.
3. The student was capable of getting boundary layer equations.
4. The student is able to analyze the boundary layers by integral method.
5. The student gets confidence in derivation of turbulent models.

Reference books:

1. Schlitching, H., Gersten, K., Boundary Layer Theory, Springer –Verlag, 2004.

2. Hinze, J. O., Turbulence, Second Edition, McGraw-Hill, 1975.
3. Biswas, G., Easwaran, V., (Eds.), Turbulent flows, Narosa Publishers, 2002.

THIRD SEMESTER
MTHT 303 INTERNAL ASSESSMENT OF PROJECT

Periods per week : 3 Viva : 100
Credits : 4

A student has to submit his proposal for his Project work, which includes the area of interest coupled with literature survey.

FOURTH SEMESTER

MTHT 401 EXTERNAL ASSESSMENT OF PROJECT

Total Marks: 100 Credits: 16

A student has to submit and defend his work in the presence of Expert Committee which includes external Examiner