ANDHRA UNIVERSITY

DEPARTMENT OF MECHANICAL ENGINEERING

M.TECH HEAT TRANSFER IN ENERGY SYSTEMS
(2019-2020)
REGULATION AND SYLLABUS
EFFECTIVE FROM 2019-2020 BATCH
DETAILED SYLLABUS OF M.TECH (HEAT TRANSFER & ENERGY STUDIES) DAY TIME COURSE WITH EFFECT FROM 2019-2020 ACADEMIC YEAR
### FIRST SEMESTER WITH EFFECT FROM 2019-20

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M. Tech Heat transfer in energy systems/Heat power Engineering

Program outcomes:

PO1: An ability to independently carry out research/investigation and development work to solve 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 the specialization 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 the development of ecofriendly thermal systems.

PO6: To inculcate research culture with abilities to publish at national/international level and develop 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, with commitment to their ethical and social responsibilities.
MTHT 101 Mathematical Methods in Engineering

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

**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.


**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.

Reference Books:

FIRST SEMESTER WITH EFFECT FROM 2019-20

MTHT 102 Conduction and Radiation Heat Transfer

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

COURSE OBJECTIVES:

1. The student is made to understand coordinate systems and evaluation of thermal conductivity.
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:


LEARNING OUTCOMES:
1. The student gets used in developing electrical analogy principle to composite slabs, cylinders and spheres.
2. The student gets awareness on Fourier’s law of heat conduction.

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.

LEARNING OUTCOMES:
1. The student understands various types of fins and evaluation of heat transfer.
2. The student will be able to evaluate fin effectiveness and efficiency.

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.

LEARNING OUTCOMES:
1. The student understands the evaluation of temperature under unsteady state.
2. The student gets in use of Heisler charts for solving unsteady state problems.
Radiation: Review of radiation principles - laws of thermal radiation - surface properties

LEARNING OUTCOMES:
1. The student gets knowledge on various radiation laws.
2. The student understands the theory of radiation.

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.

LEARNING OUTCOMES:
1. The student gets awareness on derivation and usage of shape factor.
2. The student gets concept on black and grey surfaces.

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
3. Fundamentals of heat transfer by Incropera and Hewitt
4. Conduction heat transfer by Schneider, Eddison Wesley
5. Radiation heat transfer by Sparrow and Cess, McGraw-Hill
6. Radiation heat transfer by H.C. Hottel and A.F. Sarofin
7. Thermal radiation by Siegel and Howell.
FIRST SEMESTER WITH EFFECT FROM 2019-20
MTHT 103 Advanced Fluid Mechanics

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

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.

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 its models.

SYLLABUS:

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

Learning Outcomes:
The students will be able to
➢ Understand the ideal, non-ideal flows and fluid motion.
➢ Enlighten the fundamental properties of fluids, including viscosity, Newtonian and non-Newtonian rheology, and viscoelasticity
➢ Obtain the exact solutions to N-S equations for different geometries

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

Learning Outcomes:
The students will be able to
➢ Elucidate the boundary layer equations for laminar flow over external and internal surfaces.
➢ Compare turbulent flow with those of laminar flow.

Unit-III: Integral methods, steady laminar and turbulent incompressible flows.
Learning Outcomes: 
The students will be able to
➢ Illuminate the integral methods for laminar incompressible flows
➢ Understand the integral methods for turbulent incompressible flows

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

LEARNING OUTCOMES:

The students will be able to
➢ Recognize the differences between compressible and incompressible viscous flows
➢ Be familiar with governing equations, Fanno and Rayleigh lines normal and oblique shocks.

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 WITH EFFECT FROM 2019-20
MTHT 104 Measurements in Heat Transfer

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

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 different applications
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/visualization techniques 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.

Learning Objective : To learn analytical methods to handle experimental data


Learning Objective : To learn about various transducers used for measurements


Learning Objective : Learn about functionality of different instruments available for pressure measurement

Learning Objective: To learn about traditional and visualization techniques available for flow measurements

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.

Learning Objective: To learn about electrical and non electrical methods available to measure temperature


Learning Objective: To have an exposure about methods available to measure thermo-physical and radiation properties.

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.
3. Measurements in Heat Transfer by Eckert and gold stein
FIRST SEMESTER WITH EFFECT FROM 2019-20  
MTHT 105 Elective Subject – I  
A) ADVANCED OPTIMIZATION TECHNIQUES

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


**Dynamic programming(D.P):** Multistage decision processes. Concepts of sub optimization and Principal of optimality, computational procedure in dynamic programming calculus method and tabular methods. Linear programming as a case of D.P. and continuous D.P.


**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.

**References:**

1. Operations Research- Principles and Practice by Ravindran, Phillips and Solberg, John Wiely
5. Genetic Algorithms - In Search, Optimization and Machine Learning by David E. Goldberg, Addison-Wesley Longman (Singapore) Pvt. Ltd.
FIRST SEMESTER WITH EFFECT FROM 2019-20
MTHT 105 Elective Subject – I
B) ENERGY MANAGEMENT

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

COURSE OBJECTIVES:

1. Students will have an exposure to the present energy scenario regarding availability/demand and the need for energy conservation
2. Students will be given an insight about energy intensive industries and their energy consumption 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 during energy 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 taught during the course

SYLLABUS:

Learning Objective: To learn the importance of energy conservation in the present day scenario

Learning Objective: To learn about different types of instruments used during energy audits

Learning Objective: To learn about different types of energy audits and activities coordinated during energy audits

Learning Objective: To learn about various energy conservation opportunities available in process equipments/industries


Learning Objective: To learn about financial risk analysis on investments


Learning Objective: To learn fundamentals of pack bay period and other financial 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 instruments used 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 of modification/retrofitting in a process/equipment

TEXT BOOKS:
2. Management by H.Koontz and Cyrill O Donnell
3. Financial Management by S.C. Kuchhal
6. Energy Management by Trivedi, PR, Jolka KR, Commonwealth publication, New Delhi

REFERENCE:
3. Energy Economics/A.V.Desai/Wieley Eastern

FIRST SEMESTER WITH EFFECT FROM 2019-20
MTHT 105 Elective Subject – I
C) ADVANCED FINITE ELEMENT ANALYSIS

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

SYLLABUS:


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 solution procedures. Finite element approximation to initial value - Transient problems.

REFERENCE BOOKS:

1. The Finite Element Method by Zienkiewicz, O.C.
3. Concepts and Applications of Finite Element Analysis by Cook, R.D.
4. Applied Finite Element Analysis by Segerland, L.J.
FIRST SEMESTER WITH EFFECT FROM 2019-20
MTHT 106 SOLAR ENERGY

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

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
4. Design and constructional features of solar passive devices used to convert the solar energy into heat.
5. Design and constructional features of walls and buildings.

SYLLABUS:


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 on fossil fuels
2. The students are able to acquire the knowledge on energy resources, particularly on solar energy.
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. Solar energy – Tiwari and Suneja
7. Power plant technology – ElWakil
FIRST SEMESTER WITH EFFECT FROM 2019-20
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.

LEARNING OUTCOMES:
1. The student is capable of visualizing laminar flow.
2. The student is able to understand the principle of fin and unsteady state phenomenon.

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.

LEARNING OUTCOMES:
1. The student attains to learn solar radiation principles.
2. The students understands the calculations in shell and tube heat exchanger and 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.
LIST OF EXPERIMENTS:

EXERCISE-I:
Solution of I order differential equation with Fourth order Runge-Kutta method. Given \( \frac{dy}{dx} = \left( \frac{3x^2}{2y} \right) \) 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 \( \frac{dy}{dx} = (z-x) \) and \( \frac{dz}{dx} = (x+y) \) with \( x_0 = 0 \) & \( y_0 = 1 \), \( z_0 = 1 \).

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

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-Seidel method.

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

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

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

EXERCISE-IX:
SECOND SEMESTER WITH EFFECT FROM 2019-20
MTHT 201 CONVECTION HEAT TRANSFER

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

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.

LEARNING OBJECTIVES:

1. To learn prominent correlations available in literature regarding forced and free convection
2. Apply these correlations to solve problems in convection
3. Learn the analogy between momentum and heat transfer
4. Extend the fundamentals of heat transfer to mass transfer.

COURSE OUTCOMES:

1. Students will understand the significance of integral momentum equation and energy equation which 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 transfer also

REFERENCE BOOKS:

2. Boundary layer theory by Schlichting
3. Heat transfer by Gebhart
4. Natural convection heat and mass transfer by Y. Jaluria , Pergamon press
SECOND SEMESTER WITH EFFECT FROM 2019-20
MTHT 202 THERMAL ENVIRONMENTAL CONTROL

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

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 load calculations
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


LEARNING OBJECTIVES

1. To learn about thermodynamic variables in refrigeration and air conditioning systems
2. To learn about desirable characteristics of refrigerants and eco-friendly refrigerants
3. To learn about functioning of major components in air conditioning systems
4. To learn estimating cooling load calculations for an air conditioning system

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 WITH EFFECT FROM 2019-20
MTHT 203 DESIGN OF THERMAL EQUIPMENT

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

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.

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

LEARNING OUTCOMES:
1. The student understands classification of heat exchangers on their use.
2. The student is capable of doing the performance of double pipe heat exchanger.

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

LEARNING OUTCOMES:
1. The student gets awareness of the design procedure of shell and tube heat exchanger.
2. The student understands the method to improve the heat recovery in shell and tube heat exchanger.

Condensation of single vapors, mixed vapors.

LEARNING OUTCOMES:
1. The student is now aware of condensers and condensation.
2. The student understands the phenomenon and occurrence of condensation process.

Design considerations for different plate type heat exchangers; regenerators.

LEARNING OUTCOMES:
1. The student does design calculations on plate as well as regenerative heat exchangers.
2. The student understands the usage of plate and regenerative heat exchangers.

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

LEARNING OUTCOMES:
1. The student gets idea of various devices to be used as thermal equipment.
2. The student is aware of factors affecting and equations in 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:**
4. Heat exchanger design by Press and N. Ozisik
5. Standards of the Tubular Exchange Manufacturers Association, TMEA, New York
SECOND SEMESTER WITH EFFECT FROM 2019-20
MTHT 204 BOILING AND TWO-PHASE FLOW HEAT TRANSFER

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

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 on two phase flow.
4. The student is taught the concept of boiling and its occurrence.
5. The student is made to understand calculations on condensation.

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

LEARNING OUTCOMES:
1. The student understands types of flow.
2. The student is capable of analyzing various analytical models.

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

LEARNING OUTCOMES:
1. The student is aware of homogeneous equilibrium flow.
2. The student is capable of evaluating homogeneous and turbulent 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.

LEARNING OUTCOMES:
1. The student understands the method to find pressure drop calculations for different flows.
2. The student attains awareness on 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.

LEARNING OUTCOMES:
1. The student is capable of understanding different cases of boiling.
2. The student is able to solve problems on boiling using boiling correlations.
**Condensation:** Nusselt's theory; boundary layer treatment of laminar film condensation; experimental results for vertical and horizontal tubes; condensation inside a horizontal tube.

**LEARNING OUTCOMES:**
1. The student gets awareness on drop wise and film wise condensation.
2. The student learns to solve different condensation problems.

**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
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, McGraw Hill
SECOND SEMESTER WITH EFFECT FROM 2019-20
MTHT 205 Elective Subject – II
A) THERMAL AND NUCLEAR POWER PLANTS

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

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 power plants 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:


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 generation plants.
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:

3. Power Plant Engineering / P.K. Nag /TMH.
SECOND SEMESTER WITH EFFECT FROM 2019-20  
MTHT 205 Elective Subject – II  
A) TURBO MACHINES

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

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 turbines.
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.

LEARNING OUTCOMES:
1. The student is able to calculate work and efficiency.
2. The student develops interest in getting output parameters on Mollier diagram.

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.

LEARNING OUTCOMES:
1. The student understands the concept of impulse a reaction turbines.
2. The student attains to calculate output values theoretically as well as graphically.

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

LEARNING OUTCOMES:
1. The student attains the interest in analyzing characteristic features of pumps.
2. The student gets awareness on working principle of blowers.

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

LEARNING OUTCOMES:
1. The student is able to derive equations for steam nozzles.
2. The student understands the concept of steam turbines.
Hydraulic turbines – Pelton, Francis and Kaplan turbines, draft tube, performance and regulation of hydraulic turbines.

LEARNING OUTCOMES:
1. The student understands the application of hydraulic turbines.
2. The student is able to derive the equations for 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:
2. Gopalakrishnan, G. and Prithviraj, D., Treatise on Turbo machines, Schitech Publications, 2002
SECOND SEMESTER WITH EFFECT FROM 2019-20
MTHT 205 Elective Subject – II
B) HYDEL POWER AND WIND ENERGY

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

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 and
mechanical aspects of wind machine design.
Wind tunnel simulations, conversion and storage methods; industrial applications.
Instrumentation for wind velocity measurements

Reference books:

i. Non-Conventional Energy Systems by K. Mittal, Wheeler
iii. Non-Convectional Energy Sources by G. D. Rai
iv. Renewable Energy Sources and Emerging Technologies by D. P. Kothari, K. C. Singal,
Rhakesh Ranjan, PHI Learning Pvt.Ltd
vi. Wind Energy explained: Theory, Design and applications by James F Manwell, Jon
G. Mc. Gowan and Anthony L Rogers, Wiley black well
vii. Introduction to Hydro Energy Systems by Wagner, Herman –Josef,
Mathur, Jyotirmoy, Springer Verlog, Berlin.
SECOND SEMESTER WITH EFFECT FROM 2019-20
MTHT 206 THERMO FLUIDS LABS-2

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

COURSE OBJECTIVES:
6. The student is made to understand on fluid mechanics principles.
7. The student is made to get awareness on heat transfer equations.
8. The student is prepared to understand the equations in heat transfer.
9. The student is taught the principle of forced convection.
10. 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.

LEARNING OUTCOMES:
1. The student is capable of estimation of heat flow in heat pipes.
2. The student understands the solar radiation principle in solar concentrator.

CYCLE-2
5. Temperature distribution and efficiency of pin fin apparatus under forced convection.

LEARNING OUTCOMES:
1. The student attains the capability in calculating efficiency of pin fin.
2. The student gets awareness of measuring effective thermal conductivity of lagging material.

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 WITH EFFECT FROM 2019-20
MTHT 207 COMPUTATIONS LAB-2

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

LIST OF EXPERIMENTS:

EXERCISE-I:
Combustion calculations for solid and liquid
fuels 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 steam
pipes EXERCISE-VI:
Pressure drop of air and flue gas in tubes and pipes
EXERCISE-VII:
Pressure drop of air and flue gas over finned
tubes EXERCISE-VIII:
Heat transfer coefficient for steam inside tubes.
EXERCISE-IX:
Heat transfer coefficient for air and flue gas inside tubes
SECOND SEMESTER WITH EFFECT FROM 2019-20
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.

SECOND SEMESTER WITH EFFECT FROM 2019-20
MTHT 301 Elective Subject – III
A) GAS DYNAMICS

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

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

LEARNING OUTCOMES:

1. The student is able to write and understand the term compressibility.
2. The student understands the importance of conservation laws.

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

LEARNING OUTCOMES:

1. The student gets awareness on area variation for isentropic flow.
2. The student gets idea on variation of Mach number with duct length.
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

**LEARNING OUTCOMES:**
1. The student is capable of writing equations for flow conditions.
2. The student gets idea on normal shock waves.

Oblique shock waves – Governing equations, Variation in flow properties

**LEARNING OUTCOMES:**
1. The student understands equations related to oblique shock waves.
2. The student is able get idea on flow properties.

**Propulsion Systems.**
1. The student is able to know the propulsion system.
2. The student gets awareness on working of 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:**

2. Fundamentals of Compressible fluid dynamics, P.Balachandran, PHI Learning (P) Ltd.,
5. Molecular gas dynamics: theory, techniques and application, Yoshio Sone Birk Hauser, Boston,
SECOND SEMESTER WITH EFFECT FROM 2019-20

MTHT 301 Elective Subject – III
B) GAS TURBINES AND JETPROPULSION

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

COURSE OBJECTIVES:

Students are expected to learn about:
1. The working principle of gas turbine engines and fundamentals of thermodynamic gas power cycles.
2. Design and constructional features of turbine blades and determination of efficiencies of blade and gas turbines.
3. Design and constructional features of compressors, impellers, blowers and fans.
4. Design and constructional features of combustion chambers and energy (heat) recovery methods.
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 of gas 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
3. Elements of Gas Dynamics – Yahya
5. Turbines, Pumps, Compressors – Yahya
7. Gas Turbines- Cohen, Roger & Sarvanamuttu
COURSE OBJECTIVES

1. Students will learn about pollution contributors and effects of air pollution on humans and environment
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 solid wastes and health hazard due to solid wastes
5. Students will have an exposure to major polluting industries and their impact on humans and environment

SYLLABUS

Air pollution - Classification and properties of Air pollutants - Sampling and analysis of air pollutants – Control of air pollution.  
**Learning Objective**: To learn about different sources of air pollution and analysis of air pollution

Dispersion of air pollutants - Gaussian plume model- Control of gaseous pollutants - Volatile organic compounds - Control of gaseous emission - Air pollution laws and standards.  
**Learning Objective**: To learn about different compounds contributing towards air pollution and standards for air pollution

Water pollution - Sampling and analysis of waste treatment – Advanced waste water treatments by physical, chemical, biological and thermal methods - Effluent quality standards.  
**Learning Objective**: To learn about methods available to evaluate water pollution and their standards

Solid waste management - Classification and their sources - Health hazards - Handling of toxic and radioactive wastes - Incineration and verification.  
**Learning Objective**: To learn about sources and solid waste management

Pollution control in process industries : Cement, Paper, Petroleum and petrochemical, Fertilizers and distilleries, thermal power plants and automobiles.  
**Learning Objective**: To learn about pollution from different sources of industries
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 national and international agencies
3. Students can become familiar about different sampling techniques and methods to reduce water pollution
4. Students will realize of importance of solid waste management and device methods to handle solid wastes
5. Students can take up projects on pollution and work towards a better future

References:

SECOND SEMESTER WITH EFFECT FROM 2019-20
MTHT 302 Elective Subject – IV
A) COMPUTATIONAL FLUID DYNAMICS

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

SYLLABUS:

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


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


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


Reference books:
3. An Introduction to Computational Fluid Dynamics – FVM Method – H.K. Versteeg, W. Malalasekera (PHI)
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
SECOND SEMESTER WITH EFFECT FROM 2019-20

MTHT 302 Elective Subject – IV
A) RENEWABLE ENERGY SOURCE

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

COURSE OBJECTIVES:

Students are expected to learn about:

1. The various forms of energy (Solar, Wind, and Geothermal); Energy conversion technologies and their limitations.
2. Fundamentals solar energy, wind energy and geothermal energy and their conversion into electricity.
3. Design and constructional features of solar collectors, photovoltaic cells, and their applications.
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:


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 on solar, 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 power plants.
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
7. Renewable Energy Technologies by Ramesh and Kumar, NarosaPublications.
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, the Orr-Sommerfeld equation, Curves of neutral stability and the indifference Reynolds number

LEARNING OUTCOMES:
1. The student is able to understand experimental evidence of various flows.
2. The student is able to use equations for flows.

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

LEARNING OUTCOMES:
1. The student gets concept on effect of pressure gradient on plate boundary layer.
2. The student gets idea on boundary layer in three dimensional form.

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.

LEARNING OUTCOMES:
1. The student is able write steps to get energy equation.
2. The student gets idea on mixing length.

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.

LEARNING OUTCOMES:
1. The student becomes aware of different methods of incompressible boundary layer.
2. The student is able to determine skin friction and heat transfer for compressible boundary layer.

Free shear layers in turbulent flow, plane and axi-symmetric free jets, mixing layers, plane and axi- 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).

**LEARNING OUTCOMES:**
1. The student gets idea on various types of jets.
2. The student is able to write turbulence model equations.

**COURSE OUTCOMES:**
1. The student gets awareness in laminar, transition and turbulent, fundamental equations as well 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:**
THIRD SEMESTER WITH EFFECT FROM 2019-20

MTHT 303 INTERNAL ASSESSMENT OF PROJECT

Periods per week: 3

Viva: 100
Credits: 10

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

FOURTH SEMESTER WITH EFFECT FROM 2019-20

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