राष्ट्रीय प्रौद्योगिकी संस्थान रायपुर
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DEPARTMENTOFMECHANICAL ENGINEERING

COURSE OUTLINE

NameoftheSubject	Advanced Numerical Technique	SubjectCode	ME41111ME
Semester	M.Tech Ist Sem	BoardofStudies	MechanicalEngg.
MaximumMarks	ESE-100	MinimumMarks	40
Type of course	Compulsory	Contact Hours	44
L+T+P	3+1+0	Credits	4
Prerequisite	Engg Mathematics at UG level, computer programming.		

COURSE OUTCOME:

At the end of this Course the students are expected to be able to:

1. Apply the methods for solving algebraic, transcendental and linear equations.
2. Apply the methods for solving single variable optimization problems.
3. Apply the methods for curve fitting using regression and interpolation techniques.
4. Apply the methods to solve differentiation and integration numerical.
5. Apply the methods for solving ordinary and partial differential equations.
6. Design and develop computer programs for the various numerical methods to solve engineering problems.

SYLLABUS

UNIT - I: ROOTS OF FUNCTIONS AND LINEAR EQUATIONS
Transcendental & Algebraic Equations: Bracketing & open Methods- Bisection, False Position, Newton Rapshon Method, Secant Method. Gauss Elimination, Gauss Jordon applications, Gauss Seidal, LU decomposition, Matrix Inversion.

UNIT - II: SINGLE VARIABLE OPTIMISATION
Single variable optimization: Optimality Criterion, Bracketing methods - Exhaustive Search Method, Bounding Phase Method, Region Elimination Method - Interval Halving Method, Fibonacci Search Method, Golden Section Search Method, Point Estimation Method - Successive quadratic estimation method, Gradient based methods - Newton - Raphson Method, Bisection Method, Secant Method, Cubic Search Method, Root Finding Method using Optimization Technique.

UNIT – III: CURVE FITTING

Regression analysis – Least square method, Linear regression, Polynomial regression, Fouries regression, Non linear regression, Interpolation – Newton's forward and backward interpolation, Newton's divided difference interpolation, Lagrange's interpolation, Gauss's central difference interpolation

UNIT – IV: NUMERICAL INTEGRATION AND DIFFERENTIATION

Newton Cotes Integration formulas- Trapezoidal, Simpson, Romberg, Gaussian Quadrature, Numerical Differentiation-Finite Difference Method.

Types of Differential equations, Picard's Series Method, Taylor Series Method, Euler's Method, Modified Euler's Method, Runge Kutta Method, Predictor Corrector Method, Milnes Method, and Application to Initial & Boundary value Problems.

UNIT – V: PARTIAL DIFFERENTIAL EQUATIONS

Introduction to PDE Elliptic, Parabolic & Hyperbolic Equation. Finite Difference Schemes, Forward, Backward, Central Difference, Application to Laplace & Poisson's Equation, Iterative & Relaxation Techniques, Laplacian Operator in Cartesian, polar and other coordinate systems.Solution of Parabolic Equations, Implicit & Explicit Schemes, Crank Nicholson, ADI scheme. Solution of Hyperbolic Equations.

Note: Computer Programs for the above methods are to be practiced using any high level language.

Text Book:

1. Numerical Mathematical analysis, James B. Scarborough, Oxford and IBH Publishing Ltd

2. Optimization for Engineering Design - Algorithms and Examples, Kalyanmayi Deb, PHI Pvt. Ltd

Reference Book:

1. Numerical Methods by Engineers by Steven C Chapra and Raymond P Canale, TMH Publications.

2. Numerical Methods for Engineers and Scientists, J D Hoffman, Marcel Dekker.

3. Numerical Methods, B. S. Garewal, Khanna Publishers Ltd.

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DEPARTMENT OF MECHANICAL ENGINEERING

COURSE OUTLINE

Name of the Subject	Advance Thermodynamics	Subject Code	ME41112ME
Semester	M.Tech Ist Sem	Board of Studies	Mechanical Engg.
Maximum Marks	ESE-100	Minimum Marks	40
Type of course	Compulsory	Contact Hours	44
L+T+P	3+1+0	Credits	4
Prerequisite	Applied Thermodynamics		

COURSE OUTCOME:

At the end of the course students will be able to:

1. Apply the concepts of basic thermodynamic, entropy and exergy for analyses of thermal energy systems.
2. Understand properties of pure substance and thermodynamic properties of real gases.
3. Apply energy balances to reacting systems for both closed and open system.
4. Define the chemical equilibrium constant and apply the general criteria for chemical equilibrium analysis to reacting ideal-gas mixtures.

SYLLABUS

UNIT - I: RECAPITULATION OF FUNDAMENTALS.

Basic definition and concepts; The basic laws of Thermodynamics, Entropy flow and enropy production, 3rd law of Thermodynamics, Availability in steady flow open system and in a closed system, energy analysis of typical; Irreversibility and effectiveness.

UNIT – II: PROPERTIES OF PURE SUBSTANCES.

P-V-T susfaces, phase diagram, phase changes, various properties diagram, 1st order phase transition and 2nd order phase transition, Clapeyron’s equation, Ehrenfest’s equations, Maxwell’s equations, equation for internal energy, enthalpy, entropy, specific heat and joule Thompson coefficient.

UNIT – III: EQUATION OF STATE FOR REAL GASES.

Compressibility factor and generalised compressibility chart, Law of corresponding state, law of pseudo critical pressure and temperature, reduced coordinate, Wander-Walls equation of state and other equation of state.

UNIT – IV: CHEMICAL REACTION.

Fuels and Combustion, First-Law Analysis of Reacting Systems: Steady-Flow Systems and Closed Systems, Entropy Change of Reacting Systems, Second-Law Analysis of Reacting systems.

UNIT – V: CHEMICAL THERMODYNAMICS.

Gibb's theorem, Gibbs function of mixture of inert ideal gases, Chemical equilibrium, Thermodynamic equation for phase, Degree of reaction, equation of reaction, law of mass action, heat of reaction and Vant Hoff Isober, Phase Equilibrium for a Single-Component System and Multi-Component System

Text books:

1. Thermodynamics – G.J. Van Wylen.
2. Thermodynamics – Cengel and Boles.
3. Thermodynamics – P.K. Nag.

Reference books:

1. Heat and thermodymics – M. Zemansky.
2. Concepts of thermodynamics – O.R. Obert.

DEPARTMENTOFMECHANICAL ENGINEERING

COURSE OUTLINE

NameoftheSubject	Heat Transfer –I (Conductive & Radiative)	SubjectCode	ME41113ME
Semester	M.Tech Ist Sem	BoardofStudies	MechanicalEngg.
MaximumMarks	ESE-100	MinimumMarks	40
Type of course	Compulsory	Contact Hours	44
L+T+P	3+1+0	Credits	4
Prerequisite	Basic Heat and mass Transfer		

COURSE OUTCOME:

After completing the course students will be able to:

1. Perceive and solve conduction problem for complex governing equation along with complex boundary condition.
2. Apply mixed mode heat transfer principle in solving engineering problems that are related to heat transfer like fins, furnaces etc.
3. Evaluate steady and unsteady heat conduction in one and multi dimensions.
4. Apply finite difference method to heat transfer problem with particular emphasis on heat conduction.
5. Evaluate the radiant heat transfer between solid bodies, black or gray. Developing the analogy for radiation by converting in to electric circuit.

SYLLABUS

UNIT - I: INTRODUCTION TO HEAT TRANSFER.

Typical heat transfer situation, modes of heat transfer, introduction to loss, some heat transfer parameters, Fourier's law and thermal conductivity, differential equations of heat conduction, boundary conditions and initial conditions.

UNIT – II: STEADY STATE SITUATION IN HEAT CONDUCTION.

Plane wall, cylinder, sphere, concept of thermal resistance, concept of U, critical radius, variable thermal conductivity, heat generation, pin fin, other fin configuration, steady state 1-D and 2-D problems.

UNIT – III: TRANSIENT CONDUCTION.

Lumped capacitance model, 1-D transient problems, analytical solution, 1-D heisler charts, product solutions, 1-D transient problems-explicit and implicit.

UNIT – IV: FUNDAMENTALS OF RADIATION.

Basic ideas spectrum, basic definitions, laws of radiation, black body radiation, Planks's law, Stefan boltzman law, Wien's displacement law, Lambert cosine law.

UNIT – V: RADIATION EXCHANGE.

Radiation exchange between black surfaces, shape factor, radiation exchange between gray surfaces-Radiosity-Irradiation method, parallel plate, enclosures(non participating gass), gas radiation.

Text books:

1. heat transfer: HOLMAN – TMH.
2. heat transfer: P.K. Nag – TMH.
3. Heat and mass transfer: Cengel – McGraw Hill.

Reference books:

1. Fundamentals of eng. Heat and mass transfer - R.C. SACHDEVA – New Age International
2. heat transfer – Ghoshdastidar – oxford university Press – IInd edition.
3. Heat and mass transfer – R.K. Rajput
4. Fundamental of heat transfer and mass transfer – incropera and dewitt – john wiley. Publication.

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DEPARTMENTOFMECHANICAL ENGINEERING

COURSE OUTLINE

NameoftheSubject	Refrigeration System Components	SubjectCode	ME41114ME
Semester	M.Tech I^st Sem	BoardofStudies	MechanicalEngg.
MaximumMarks	ESE-100	MinimumMarks	40
Type of course	Compulsory	Contact Hours	44
L+T+P	3+1+0	Credits	4
Prerequisite	Heat and mass Transfer , Fluid Mechanics, Refrigeration and air conditioning		

COURSE OUTCOME:

At the end of this course the students will be able to:

1. Evaluate volumetric efficiency and power input of reciprocating compressors and also differentiate qualitatively the effects of evaporator and condenser temperatures, with understanding various methods of regulating its, their classification and lubrication.
2. Analyse the performance of a centrifugal compressor and evaluate required impeller diameter, speed and minimum refrigeration capacity with the understanding of surging.
3. Estimate condenser design parameters, optimum condenser pressure and effect of presence of non-condensable gases on its performance with understanding the comparison of air-cooled with water-cooled condensers
4. Estimate thermal design parameters of evaporators, and classify them with analysing its salient features of different types of evaporators
5. Estimate the required length of capillary tubes, analyse the practical problems encountered in the operation of various types of expansion devices.

SYLLABUS

UNIT - I: REFRIGERANT RECIPROCATING COMPRESSORS.

Classification of compressors based on working principle and arrangement of compressor motor or external drive, working principle of compressors, Performance aspects of ideal compressors with and without clearance, Effect of evaporator temperature at a fixed condenser temperature, condenser temperature at a fixed evaporator temperature, pressure ratio and type of refrigerant on compressor discharge temperature.

UNIT - II: REFRIGERANT ROTARY COMPRESSORS.

Working principle and characteristics of a fixed vane, rolling piston type compressor, multiple vane, rotary compressor, twin-screw type compressor, single-screw type compressor, specific advantages of a scroll compressor, working principle of a centrifugal compressor, its analysis, selection of impeller diameter and speed using velocity diagrams, effect of blade width, phenomenon of surging, commercial refrigeration systems using centrifugal compressors,

UNIT – III: CONDENSERS.

General aspects of condensers, classifications based on the external fluid used, based on constructional details, Comparisons, Present analysis and design aspects, estimation of heat transfer coefficients on both side for different configurations, Effect of presence of air and other non-condensable gases in condensers, concept of optimum condensing pressure for lowest running cost of a refrigeration system,

UNIT – IV: EVAPORATOR

Classification of evaporators natural or forced convection type, flooded or dry type, refrigerant flow inside the tubes or outside the tubes, salient features of: natural convection coils, flooded evaporators, shell-and-tube type evaporators, shell-and-coil evaporator, double pipe evaporators, Baudelot evaporators, direct expansion fin-and-tube type evaporators, plate surface evaporators, plate type evaporators, thermal design aspects of refrigerant evaporators, enhancement of boiling heat transfer, concept of Wilson's plot.

UNIT – V: EXPANSION DEVICES.

Basic functions of expansion devices, classification, operating principle, concept of balance point, effect of load variation, selection of capillary tubes, the advantages and disadvantages of capillary tubes, working principle of an automatic expansion valve, its performance under varying loads and its applications, working principle of a thermostatic expansion valve, its performance, variations available, external equalizer and limit charging, advantages and disadvantages of TEVs, low-side and high-side float valves, an electronic expansion valve, practical problems.

Text books:

1. Refrigeration And Air Conditioning by C.P.Arora, Tata McGraw-Hill.
2. Refrigeration and Air Conditioning by R.K.Rajput Katson Publication

Reference books:

1. Refrigeration And Air Conditioning by Stooker W.F
2. Refrigeration And Air Conditioning by Ahmadul Ameen, PHI Publication
3. Hand Book of Air Conditioning and Refrigeration by Shan K. Wang, Tata McGraw-Hill.
4. Refrigeration and Air Conditioning by Arora & Domkundwar , Dhanpat Rai and Sons

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DEPARTMENTOFMECHANICAL ENGINEERING

COURSE OUTLINE

NameoftheSubject	Advanced Finite Element Method	SubjectCode	ME41135ME
Semester	M.Tech I[st] Sem	BoardofStudies	MechanicalEngg.
MaximumMarks	ESE-100	MinimumMarks	40
Type of course	Elective	Contact Hours	44
L+T+P	3+1+0	Credits	4
Prerequisite	Advanced Mathematics, Mechanics of Solids and Fluids, Heat transfer, Numerical method		

COURSE OUTCOME:

At the end of this course the students will be able to :

1. Synthesise information and ideas for use in the evaluation process.
2. Develop governing equations of mechanical systems using domain knowledge and mathematical principles and apply principles of variation and integral forms of solution to formulate finite element problem.
3. Analyse and build FEA model for complex engineering problems.
4. Perceive the fundamental theory of the finite elements.
5. Develop skills to model the behavior of structures under mechanical and thermo-mechanical loads.

SYLLABUS

UNIT - I:

Finite Element Formulation: Introduction, Weighted Residual Method, weak form of WR statement, Principle of stationary total potential (PSTP),Rayleigh – Ritz Method.

UNIT – II:

One Dimensional Finite Element Analysis: General form of total potential for 1-D and finite element equations, Linear bar element, Quadratic bar element, Cubic bar element, Higher order elements, Beam Element, Frame elements, Applications of one dimensional elements, Natural co- ordinates and Co-ordinate transformation, Numerical integration.

UNIT – III:

Two Dimensional Finite Element Analysis: Introduction, Simple three nodded triangular element, four noded rectangular element, six noded triangular element, serendipity and higher order 2-D elements, Isoparametric element.

UNIT – IV:

Axisymmetric elements, Structural mechanics applications of 2-D and axisymmetric elements, Incorporation of Boundary conditions, Solution of static Equilibrium Equations. Heat transfer applications in 2-D.

UNIT – V:

Dynamic Analysis

Introduction, Equations of motion based on weak form and using Lagrange approach, Consistent and lumped mass matrix, Solution of Eigen value problems, transient vibration analysis

Recommended Text Book:

1. Textbook of Finite Element Analysis, P Sheshu, PHI, 2004.
2. Finite Element Methods for Engineers, U S Dixit, Cengage Learning, 2011.

Recommended Reference Book:

1. Concepts and Application of Finite Elements Analysis, Cook, Malkus and Plesha, Wiley.
2. Finite Element Method, J N Reddy, McGraw Hill International Edition.

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DEPARTMENTOFMECHANICAL ENGINEERING

COURSE OUTLINE

Name of the Subject	Computational fluid Dynamics	SubjectCode	ME41211ME
Semester	M.Tech II Sem	Board of Studies	Mechanical Engg.
Maximum Marks	ESE-100	Minimum Marks	40
Type of course	Compulsory	Contact Hours	44
L+T+P	3+1+0	Credits	4
Prerequisite	Fluid mechanics and heat transfer fundamentals, Turbulence modelling, Applied computational methods		

COURSE OUTCOME:

At the end of this course the students will be able to :

1. Get an insight into the state – of-the arts of the Finite Volume method used in the modern computational Fluid Dynamics to solve the flow and heat transfer problems.
2. Understand the basic fundamentals and applications to the simple but realistic flow situations
3. Explain single phase flow and multiphase flow.
4. Get hands on experience of using the various techniques of CFD using FLUENT.

SYLLABUS
UNIT – I:

Conservation equations ,Classification of equations, Idealisation and approximation in flow/transport phenomenon, Theory of Visualisation, Method of Discretization, Boundry conditions, Components and properties of numerical solution methods ,Turbulence modelling, Briefing.

UNIT – II: SOLUTION OF GENERALISED TRANSPORT EQUATION.

Method for steady diffusion and convection- diffusion problems, Various differencing schemes, Implementation of different boundary conditions, Algebraic equation systems, examples.

UNIT – III: METHOD FOR UNSTEADY PROBLEMS.
Implicit, Explicit and semi explicit formulation , examples.
UNIT – IV: METHOD OF FLOW FIELD CALCULATION.
Necessity, Solution of inviscid flow, Simple viscous flow, Boundary layer flow and Navier stroke equation, Variable grid arrangements, Pressure calculation, Vorticity based methods, Simple, Simple and Simplec algorithm, Fractional time steps method and artificial compressibility method, examples.

UNIT – V: ALGEBRAIC EQUATION SYSTEM SOLUTION METHODS.
Direct methods, Indirect methods, Coupled equations and its solutions, Convergence criteria and types of solvers, Problem with mesh independence, Post processing of results, Iteration errors analysis and estimation, Recommended practices in CFD.

Introduction to advanced topics (if time permits)

Text book:

1. S.V. Patanka- Numerical heat transfer and fluid flow, hemisphere publishimng company,1980.
2. Malalashekhara and Versteeg: An introduction of computational fluid dynamics (finite volume method)
3. Ferzior and Peric: Computational methods for fluid dynamics, Springer(1996)
4. Farrashkhalvat and Miles: Basic structured grid generation.

Reference books:

1. Huebner and Thornton: Finite element methods for engineers, John-Wiley, 2nd edition, 1992
2. J.N. Reddy and D.K. Gartling: The finite element method in heat transfer and fluid dynamics, CRC Press,1994.
3. A.I. Haker: Finite elements computational fluid mechanics, hemisphere publishing company, 1983
4. P.S. Ghoshdrstidar, Computer simulation of flow and heat transfer, TMH publishing company Ltd, New Delhi,1998.

DEPARTMENTOFMECHANICAL ENGINEERING

COURSE OUTLINE

NameoftheSubject	Heat Transfer – II (Convective Heat Transfer)	SubjectCode	ME41212ME
Semester	M.Tech IInd Sem	BoardofStudies	MechanicalEngg.
MaximumMarks	ESE-100	MinimumMarks	40
Type of course	Compulsory	Contact Hours	44
L+T+P	3+1+0	Credits	4
Prerequisite	Basic Heat and Mass Transfer		

COURSE OUTCOME:

After studying this course, student will be able to:

1. Visualise the boundary layer development and derive the different equation that govern convection on the basis of mass, momentum and energy balance and solve these equations for flow over flat plate.
2. Analyze external and internal forced convection by applying related empirical correlation.
3. Evaluate Nusselt No. for natural convection cases and assess the relative importance of combined natural and forced convection.
4. Design heat exchangers using LMTD and effectiveness – NTU method for cross – flow, multi pass and compact heat exchangers.

SYLLABUS

UNIT - I: PRINCIPLES OF CONVECTION.
Convection boundary layers, velocity boundary layers, thermal boundary layers, significance of boundary layers, laminar and turbulent flow, significance of dimensionless parameters, Reynold-Colburn analogy, drag & heat transfer.

UNIT – II: EXTERNAL FORCED CONVECTION.
Parallel flow over flat plate, flow errors Cylinders and spheres, flow across tube banks (aligned and staggered), correlations for all the mentioned cases.

UNIT – III: INTERNAL FLOW.

Hydrodynamic considerations, flow conditions, velocity profiles in fully developed regions, laminar flow inside tubes, turbulent flow in tubes, bulk temperature flow through tube annulus, correlations related to mentioned cases, convection correlations for Non circular tubes, heat transfer enhancement.

UNIT – IV: NATURAL CONVECTION.

Equations of motions, Grashof's number, natural convection over surfaces, Plates, Cylinders, Spheres (all cases), natural convection inside enclosures, combined free and forced convection, correlations related to mentioned cases.

UNIT – V: HEAT EXCHANGERS.

Design of Parallel flow, Counter flow, Cross flow, Multipass-cross flow, Heat exchangers, LMTD, method design, effectiveness-NTU method, compact heat exchangers, heat exchanger optimization.

Text Books:

1. Heat transfer - J.P. Holman
2. Fundamentals of heat transfer - Dewitt Incopera
3. Heat Transfer - R.C Sachdeva

Reference books:

1. Heat Transfer – Kays & Crawford
2. Process heat Transfer – D.Q. Kern

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DEPARTMENTOFMECHANICAL ENGINEERING

COURSE OUTLINE

NameoftheSubject	Advance Fluid mechanics	SubjectCode	ME41213ME
Semester	M.Tech II Sem	BoardofStudies	MechanicalEngg.
MaximumMarks	ESE-100	MinimumMarks	40
Type of course	Compulsory	Contact Hours	44
L+T+P	3+1+0	Credits	4
Prerequisite	Fluid Mechanics		

COURSE OUTCOME:

At the end of this course the students will be able to:

1. Perceive of the basic principles of fluid mechanics.
2. Apply fluid mechanics principles to the analysis of real systems;
3. Expand skills in analyzing fluid flows through the proper use of modeling and the application of basic fluid-flow principles.
4. Develop and implement problem solving and analytical skills.
5. Impact some specific knowledge regarding fluid-flow phenomena observed in mechanical engineering systems

SYLLABUS

UNIT – I: FLUID KINEMATICS.

Concept of Continuum and definition of fluid, Body and surface forces, Scalar and Vector field, Eulerian and Lagrangian description of flow, Motion of fluid element: Translation, rotation, linear strain rate, shear strain rate, Vorticity and Rotationality, Comparison of solid body rotation and Line vortex, Vortex flow.

UNIT – II: INTEGRAL RELATION FOR CONTROL VOLUME.

Basic physical law of Fluid Mechanics, System versus Control volume, Renold Transport theorem, Conservation of mass, Linear momentum equation, Momentum flux, Correction factor, Angular momentum theorem, Energy equation, Kinetic energy correction factor, Frictionless flow and Bernoulli equation.

UNIT – III: DIFFERENTIAL ANALYSIS OF FLUID FLOW.

Continuity equation, Stream function in cylinder coordinate, Cauchy's equation of Linear momentum, Navier Stokes eqation, Differential analysis of fluid flow problems, calculation of the Pressure field for a known Velocity field, Exact solution of Continuity and Navier Stroke equations.

UNIT – IV: APPROXIMATE SOLUTIONS OF THE NAVIER-STOKES EQUATION.

Introduction, Creeping flow, Drag on sphere in creeping flow, approximations for inviscid regions flow, Irrotational flow approximation, two dimensional irrotational region of flow, Boundary layer approximation, Boundary layer equations, Boundary layer with pressure gradients.

UNIT – V: POTENTIAL FLOW

Introduction and review, Line Source and Sink at the origin, Line Irrotational Vortex, Superposition, Source plus an equal sink, sink plus a vortex at the origin, Rankine half body, Circulation flow past a vortex, vortex sheet, Doublet flow past a circular cylinder.

Text books:

1. Fluid mechanics: F.M. White McGraw Hill
2. Fluid mechanics: Som and Biswas, T.M.H.

Reference books:

1. Fluid mechanics: P.K. Kundu & Ira M. Cohen
2. Fluid mechanics: G.K. Batchelor

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DEPARTMENTOFMECHANICAL ENGINEERING

COURSE OUTLINE

NameoftheSubject	Design of thermal system	SubjectCode	ME41214ME
Semester	M.Tech II Sem	BoardofStudies	MechanicalEngg.
MaximumMarks	ESE-100	MinimumMarks	40
Type of course	Elective	Contact Hours	44
L+T+P	3+1+0	Credits	4
Prerequisite	Heat Transfer, fluid dynamics		

COURSE OUTCOME:

After completing the course students will be able to:

1. Synthesize the knowledge and skills acquired in their previous curriculum, in the context of realistic design project.
2. Reduce their problem in mathematical modelling and solve the problem using numerical simulation by choosing the design variables which affects the problem.
3. Address a broad range of requirements such as economic analysis for adapting a new technology.
4. Understand and solve the optimization problem for single variable and multivariable using the classical optimization technique.

SYLLABUS

UNIT – I:
Introduction to engineering design, Thermal systems, Basic Considerations in design, Conceptual design, Steps in the design process, Computer-aided design of thermal systems, Material selection, Properties and characteristics for thermal systems.

UNIT – II:
Modelling of thermal systems, Types of models, Interaction between models, Mathematical modelling, physical modelling and dimensional analysis, Curve fitting.

UNIT – III:

Numerical modelling and simulation, Solution procedure, Numerical model for a system, System simulation, Methods for numerical simulation.

Acceptable design of a thermal system, Design of system from different application

UNIT – IV:

Economic consideration, Introduction, Calculation of interest, Worth of money as a function of time, Series of payments, Raising capital, Economic factor in design, Cost comparision, rate of return, Application to thermal systems.

UNIT – V:

Optimization in design, Basic concepts, Mathematical formulation, Optimization methods, Calculus methods, Search methods, Optimization of thermal systems, Optimization of unconstrained problems, Conversion of constrained to unconstrained, Optimization of constrained problems

Text books:

1. Design and Optimization of Thermal systems – Yogesh Jaluria – CRC Press
2. Optimization of Engineering Design – Kalyanmoy Deb – PHI

Reference books:

1. Design of thermal systems – W.F. Stoecker -TMH Publication

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COURSE OUTLINE

NameoftheSubject	Solar Energy Utilization	SubjectCode	ME41245ME
Semester	M.Tech II Sem	BoardofStudies	MechanicalEngg.
MaximumMarks	ESE-100	MinimumMarks	40
Type of course	Elective	Contact Hours	44
L+T+P	3+1+0	Credits	4
Prerequisite	Heat and mass Transfer , Fluid Mechanics		

COURSE OUTCOME:

At the end of this course the students will be able to:

1. Design and analyze of working effect of related parameters of solar flat plate collectors.
2. Understand and analyze interrelated parameters and various heat transfer involved within a of solar Distillation units.
3. Develop mathematical model and evaluate heat transfer involved in solar Drying/Cookers.
4. Understand working, Modelling, application, types and parametric studies of solar air heaters
5. Analyze the economic analysis of solar thermal equipment that includes payback period, deprecation etc.

SYLLABUS

UNIT – I: FLAT PLATE COLLECTORS.
Introduction, Classification, Evolution, Material involved, Losses, its Optimization, various heat transfer coefficients, Testing and performance, Fins and its efficiency, Thermal analysis, Configuration of FPC, Inclination, Effect of heat capacity and dust, Evolution of evacuated tubes solar collector.

UNIT – II: SOLAR DISTILLATION.

Introduction, Working principal, Thermal efficiency, Instantaneous. efficiency, Overall thermal efficiency, Heat transfer, External heat transfer, Top loss coefficient, Bottom and Side loss coefficient, Internal heat transfer, Radiative loss coefficient, Convective loss coefficient, Evapourative loss coefficient, Determination of distillate output, Passive solar stills, Effect of various parameters, Other designs, Modified internal heat transfer.

UNIT –III: SOLAR CROP DRYING AND COOKER.

Introduction, Working principal, Classification, Energy Balancing, Modelling, Moisture content, Drying characteristics curves, Energy requirement, Designing

Solar cooker: Working, Comparison, various phases of cooking, various shapes, Performance evaluation.

UNIT – IV: SOLAR AIR HEATERS.

Description and classification, Conventional heaters, Double exposure heaters, Air heaters with flow above and both sides of the absorbers, Two pass solar air heater, Heater with finned absorber, Yee-Corrugated absorber, Reverse absorber heater, with porous absorber, Testing of solar air collector, Parametric studies, Application of air heaters, Comparision and performance of liquid and air collector.

UNIT – V: ECONOMIC ANALYSIS OF SOLAR EQUIPMENTS.

Introduction, Cost analysis, Cash flow diagram, Cost comparison with equal and unequal duration, Payback time with and without interest, Benefit cost analysis, Affect of depreciation, Cost comparison after taxes.

Text books:

1. Solar energy: G.N. Tiwari, Narosa publication
2. Solar distillation practice for water desalination systems: G.N. Tiwari and A.K. Tiwari, Anamya publishers.

Reference books:

1. Solar energy by Duffi and Beckman
2. Solar energy by Sukhatme

राष्ट्रीय प्रौद्योगिकी संस्थान रायपुर
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DEPARTMENTOFMECHANICAL ENGINEERING

COURSE OUTLINE

NameoftheSubject	Air Conditioning System Design	SubjectCode	
Semester	M.Tech 2nd Sem	BoardofStudies	MechanicalEngg.
MaximumMarks	ESE-100	MinimumMarks	40
Type of course	Compulsory	Contact Hours	44
L+T+P	3+1+0	Credits	4
Prerequisite	Heat and mass Transfer , Fluid Mechanics, Refrigeration and air conditioning		

COURSE OUTCOME:

At the end of this course the students will be able to:

6. Estimate heating /cooling loads because of solar radiation that includes heat gain/loss through walls, windows, doors, ventilation and infiltration that affects air Conditioning system.
7. Analyze thermal distribution technique through a air conditioning system and its various types and advantages
8. Understand ducts and air handling unit involving transmission of conditioned air.
9. Understand the different types of air distribution arrangement and studying the ventilation for conditioning the spaces.

SYLLABUS

UNIT - I: COOLING AND HEATING LOAD CALCULATION – I: ESTIMATION OF SOLAR RADIATION.

Introduction, solar radiation, constant and irradiation geometry and various related basic and derived angle ,angle of incident for horizontal, vertical and tilted surfaces, calculation of direct, diffuse and reflected radiation using ASHRAE solar radiation model including effect of clouds.

UNIT – II: COOLING AND HEATING LOAD CALCULATION – II: SOLAR RADIATION FENESTRATION, VENTILATION AND INFILTERATION.

Fenestration, need, effect on air conditioning systems, estimation, concepts, SHGF, shading coefficient, external shading, calculation of shaded area, windows with overhang, infiltration and ventilation, causes, estimation of heat transfer rate.

UNIT – III: COOLING AND HEATION LOAD CALCULATION – III: HEAT TRANSFER THROUGH BUILDING, FABRIC HEAT GAIN/LOSS.

Heat transfer through buildings, 1-D, steady state and unsteady state heat transfer through homogeneous, non homogeneous walls, air spaces, composite walls, opaque walls, roofs. The analytical and in brief numerical methods used to solve the 1-D transient heat transfer problem, semi-emperical methods, physical significance of decrement and time lag factor, typical tables of CLTD for walls and roofs.

UNIT – IV: SELECTION OF AIR CONDITIONING SYSTEMS.

Introduction to thermal distribution systems, there functions, selection criteria and there classification of air conditioning systems, working principal, advantages, disadvantages and its application for various air/water flow systems.

UNIT – V: TRANSMISSION OF AIR IN AIR CONDITIONING DUCTS.

Describe an air handling unit(AHU) its functions, need for studying transmission , air flow through ducts, Bernoulli and modified Bernoulli equation, static, dynamic, datum and total head, fan total pressure(FTP) and power input to fan, estimation of pressure loss through ducts, estimation of dynamic pressure drop in various types of heatings.

Text books:

1. Refrigeration and air conditioning by Stooker W.F.
2. Refrigeration and air conditioning by C.P. Arora, Tata McGraw Hill.

Reference books:

1. Refrigeration and air conditioning by Ahmad ul Ameen, PHI publication.

Handbook of air conditioning and Refrigeration by Shan K. Wang,Tata McGraw Hill.

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DEPARTMENTOFMECHANICAL ENGINEERING

COURSE OUTLINE

NameoftheSubject	Optimization Technique	SubjectCode	
Semester	M.Tech 1st Sem	BoardofStudies	MechanicalEngg.
MaximumMarks	ESE-100	MinimumMarks	40
Type of course	Elective	Contact Hours	44
L+T+P	3+1+0	Credits	4
Prerequisite	Mathematics		

COURSE OUTCOME:

Upon completing the subject, the student will be able to:

1. Acquire knowledge and develop basic understanding of the concepts of optimization and mathematical modeling.
2. Acquire knowledge for basic modeling techniques to formulate a real life problem into a mathematical model.
3. Employ some optimization methods and techniques and apply them to some practical problems.
4. Use different direct and gradient based optimisation method to solve single and multivariable un-constrained or constrained nonlinear function for minimization or maximization
5. Use non-traditional optimization methods such as Genetic Algorithms, Simulated Annealing, Global Optimization
6. Learn software related to optimization and also develop the computer programs for different optimization algorithms
7. Get aware to Goal Programming, Advanced Optimization Techniques and Dynamic Programming

SYLLABUS

UNIT – I:

Introduction, Single Variable Optimization, Bracketing Methods (Exhaustive Search Method, Bounding Phase Method), Region Elimination Methods (Interval halving Method, Fibonacci Search Method, Golden Section Method), Point Estimation Methods, Gradient Based Methods (Newton-Raphson Method, Bisection Method, Secant Method, Cubic Search Method)

UNIT – II:

Multivariable Optimization Techniques,Unidirectional Search Methods, Direct Search Methods (Evolutionary Optimization Method, Simplex Search Method, Hooke-Jeeves Pattern Search Method, Powell's Conjugate Direction Method), Gradient Based Methods (Cauchy's Steepest Descent Method, Newton's Method, Marquardt's Method, Conjugate Gradient Method, Variable –Metric Method)

UNIT – III:

Constrained Optimization AlgorithmsTransformation Methods (Penalty Function Method, Method of Multipliers), Direct Search (Variable Elimination Method, Complex Search Method, Random Search Method), Linearized Search (Frank-Wolfe Method, Cutting Plane Method), Feasible Direction Methods, Reduced Gradient Methods, Gradient Projection Methods

UNIT – IV:

Linear Programming, Simplex Method, Transportation Problem, Dual Phase Methods, Dual Simplex method

UNIT – V:

Non Traditional optimization, Genetic Algorithms, Simulated Annealing, Global Optimization Specialized Algorithms, Software related to Optimization, Goal Programming, Advanced Optimization Techniques, Introduction to Dynamic Programming

Textbooks:

1. S. S. Rao, Optimization: *Theory and Applications*
2. Kalyanmoy Deb, Optimization for Engineering Design
3. Mohan C Joshi & K. M. Moudgalya