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**SEMESTER- II**

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**Total Credit -24**
TFPC101 ADVANCED FLUID MECHANICS

Module I

Concept of continuum and definition of a fluid. Body and surface forces, stress tensor, Scalar and vector fields, Eulerian and Lagrangian description of flow. Motion of fluid element - translation, rotation and vorticity; strain rate tensor, continuity equation, stream function and velocity potential.

Module II

Transport theorems, constitutive equations, derivation of Navier Stokes equations for compressible flow. Exact solutions of Navier Stokes equations: plane Poiseuille flow and Couette flow, Hagen-Poiseuille flow, flow between two concentric rotating cylinders, Stoke's first and second problem, Hiemenz flow, flow near a rotating disk, flow in convergent- divergent channels. Slow viscous flow: Stokes and Oseen's approximation,

Module III


Books:

1. Advanced Fluid Mechanics, Som and Biswas, Tata McGraw Hill
2. Fluid Mechanics, A.K.Mohanty
3. Fundamentals of Fluid Mechanics, Schlitching
4. Introduction to Fluid Mechanics, Shaughnessy, Oxford University Press
TFPC102 ADVANCED HEAT TRANSFER–I
(Conduction & Radiation)

Module I
Conduction; Derivation of generalized conduction equation for anisotropic inhomogeneous solids, conductive tensor, concepts of isotropic and homogeneous conductivity. ; Steady state conduction: Recapitulation of fundamentals analysis and design variable and cross section and circumferential fins. Analysis of heat conduction in 2-D fins, 2-D and 3-D conduction in solids with complex boundary conditions and heat generation. ;

Module II

Module III
Radiation ; Recapitulation of fundamentals of radiative heat transfer, radiative properties of surfaces, methods of estimating configuration factors, heat exchange between diffusively emitting and diffusively reflecting surfaces. Convective heat transfer of particles by cavitation effect due to ultrasonic frequency, Radiant energy transfer through absorbing, emitting and scattering media. Combined conduction and radiation systems: fins, Introduction to solar radiation in earth’s atmosphere.

Books
1. V.S Arpaci – Conduction Heat Transfer
TFPC103  COMPUTATIONAL FLUID DYNAMICS


Essential Reading:

Supplementary Reading:
Module I

Analysis of refrigeration cycle, principles of psychrometry properties and processes, Air washer, Cooling towers, dehumidifiers, wet bulb and dew point temperatures. Multistage cycle and their optimization.

Module II


Module III

Analysis and thermal design of Refrigeration compressor, condenser, evaporator and flow control devices; Design, Lubrication, charging and testing of refrigeration plants, defrosting capacity control, system component balancing, Design and construction details of unitary refrigeration equipment.

Books

1. Refrigeration and Air Conditioning, C.P.Arora, Tata McGraw Hill
2. Refrigeration and Air Conditioning, Stoecker and Zones, McGraw Hill
3. Refrigeration and Air Conditioning, Domkundwar and Arora, Dhanpat Rai and Sons
4. Refrigeration and Air Conditioning, Manohar Prasad, East West Press
5. Refrigeration and Air Conditioning, P.L.Balaney
Module I
Significance and Scope of Energy conservation and Management, Basic principles and total energy concept, First law optimization, availability. Exergy analysis. Second law optimization of thermal systems.

Module II

Module III
Energy sources, Classification and characterization of fuels (fossil and bio-fuel), conversion and utilization, environmental and economic issues, optimum use of energy resources, Thermodynamic cycles, Principles of thermal energy conversion in boilers, internal combustion engines and gas turbines, cogeneration and combined cycle power generation, fuel cells and MHD technology, solar, wind and nuclear power, utilization of industrial heat, Energy management in industry, Environmental and economic evaluation advanced pollution control technology.

Books
3. V. Kadambi, and M. Prasad, Introduction to energy conversion turbo machinery: Energy conversion cycle- Wiley Eastern, New Delhi, 1974,
TFPE103 GAS DYNAMICS

Module I:
Fundamental Aspects of Gas Dynamics: Introduction, Isentropic flow in a stream tube, speed of sound, Mach waves; One dimensional Isentropic Flow: Governing equations, stagnation conditions, critical conditions, maximum discharge velocity, isentropic relations ; Normal Shock Waves: Shock waves, stationary normal shock waves, normal shock wave relations in terms of Mach number;

Module II:
Oblique Shock Waves: Oblique shock wave relations, reflection of oblique shock waves, interaction of oblique shock waves, conical shock waves; Expansion Waves: Prandtl-Meyer flow, reflection and interaction of expansion waves, flow over bodies involving shock and expansion waves ; Variable Area Flow: Equations for variable area flow, operating characteristics of nozzles, convergent-divergent supersonic diffusers ; Adiabatic Flow in a Duct with Friction: Flow in a constant area duct, friction factor variations, the Fanno line ;

Module III:
Flow with Heat addition or removal: One-dimensional flow in a constant area duct neglecting viscosity, variable area flow with heat addition, one-dimensional constant area flow with both heat exchanger and friction ; Generalized Quasi-One-Dimensional Flow: Governing equations and influence coefficients, solution procedure for generalized flow with and without sonic point ; Two-Dimensional Compressible Flow: Governing equations, vorticity considerations, the velocity potential, linearized solutions, linearized subsonic flow, linearized supersonic flow, method of characteristics.

Essential Reading:

Supplementary Reading:
ELECTIVE II

TFPE104 SOLAR ENERGY TECHNOLOGY

Module I

Module II
Simulations, design methods. System design and optimizations. Solar thermal systems applications to power generation, heating and cooling.

Module III
Solar passive devices solar stills, ponds, greenhouse, dryers. Trombe wall, overhangs and winged walls. Wind energy conversion systems. Economics of solar and wind energy systems.

Books
TFPE105 GAS TURBINE & JET PROPULSION

Introduction, application, shaft power gas dynamics – Compressibility effect, steady one dimensional compressible flow of a perfect gas in a duct, isentropic flow in a constant area duct with friction, normal shock waves, oblique shock wave, isentropic two dimensional, supersonic expansion and compression. ; Centrifugal fans Blowers and Compressors: Principle of operations, work done and pressure rise, slip factor, diffusers, compressibility effects, non dimensional qualities for plotting compressor characteristics. Bray ton cycle, regeneration and reheating cycle analysis ; Axial flow fans and compressors: Elementary theory, degree of reaction, three dimensional flow, simple design methods, blade design, calculation of stage performance, overall performance, and compressibility effects. Performance characteristics. ; Combustion system: Form of combustion, important factors affecting combustion chamber design, combustion processes, combustion chamber performance, practical problem. ; Axial flow turbines: elementary theory, vortex theory, choice of blade profile, pitch and chord ; estimation of stage performance, he cooled turbine. ; Prediction of performance of simple gas turbines: component characteristic, off design shaft gas turbine, equilibrium running gas generators, off design o free turbine and jet engine, methods of displacing the equilibrium, running line, incorporation of variable pressure losses, methods of improving part load performance, matching procedure for twin spool engines, behavior of gas turbine .Gas turbine rotors and stresses.

**Books:**

1. J.E Lee, Theory and design of steam and gas turbine.
2. Cohen & Rogers, Gas Turbines
TFPE106 NUMERICAL METHODS FOR THERMAL RADIATION
HEAT TRANSFER

Fundamentals of thermal radiation; Radiative transfer without participating media; Radiative transfer with participating media; Governing equations in radiative transfer analysis with participating media; Methods for solving radiative transfer problems - analytic method, Monte Carlo method, zonal method, flux method, P-N approximation, discrete ordinate method, finite element method, discrete transfer method, finite volumet method, collapsed dimension method. Application of numerical methods for solving conjugate radiation, conduction and/or convection problems in 1-D and 2-D Cartesian and axi-symmetric geometry.

Books:

TFPC201 ADVANCED ENGINEERING THERMODYNAMICS


Essential Readings:

Supplementary Reading:
TFPC202 ADVANCED HEAT TRANSFER-II
(Convective Heat & Mass Transfer)


Essential Readings:

Supplementary Reading:

Books:
TFPE202 EXPERIMENTAL METHODS IN THERMAL ENGINEERING

Theory and Experimentation in Engineering: Problem solving approaches, Types of engineering experiments, computer simulation and physical experimentation; Generalized measuring system, types of inputs, analog and digital signals, standards, calibration and uncertainty, Measurement System: Performance characteristics, static performance characteristics-static calibration-linearity, static sensitivity, repeatability, hysteresis- threshold- resolution, readability and span; Analysis of Experimental Data : Causes and types of experimental error, un-certainty analysis, statistical analysis of data, probability distributions and curve fitting; Dynamic performance characteristics; Input types; Instrument types- zero order instrument, first order instrument, second order instrument; Experiment Plans: Model building; Measurement Methods and Applications : Measurement of force and torque; Measurement of strain and stress; Measurement of pressure; Flow measurement and flow visualization; measurement of temperature; optical methods of measurements; Data Acquisition and Processing : Types and configurations of DAS, signal conditioning, A/D, D/A conversion; Design, Planning, Execution and Analysis of experimental projects.

Books:

TFPE203 HEAT EXCHANGER ANALYSIS & DESIGN


Essential Reading:

Supplementary Reading:
TFPE204 INTERNAL COMBUSTION ENGINES

Module I

Module II

Module III

Books
3. I.C. Engine, Mathur and Sharma, Dhanpat Rai and Sons
TFPE205 AIRCRAFT & ROCKET PROPULSION


Books:
TFPE206 TWO-PHASE FLOW AND HEAT TRANSFER

Definitions; Review of one-dimensional conservation equations in single phase flows; Governing equations for homogeneous, separated and drift-flux models; Flow pattern maps for horizontal and vertical systems; Simplified treatment of stratified, bubbly, slug and annular flows.

Thermodynamics of boiling; Pool boiling- onset of nucleation, heat transfer coefficients, critical heat flux, effect of sub-cooling; Flow boiling- onset of nucleation, heat transfer coefficients, critical heat flux, effect of sub-cooling.

Condensation- Film and dropwise condensation

Books:

Electives –V (Any One)

**TFPE207 CRYOGENIC TECHNOLOGY**

Introduction: Cryogenic heat transfer applications, Material Properties at cryogenic temperatures, specific heats and thermal conductivity of solid, liquid and gases, Cryogenic insulations, gas-filled and evacuated powders and fibrous materials, microsphere and multi-layer insulations.  
Conduction: One-dimensional steady-state and transient conduction, conduction in composite materials, thermal contact resistance, cool-down in coated surfaces and fluid-storage vessels.  
Convection: Free and forced convection over external surfaces and tubes, Heat transfer in nearcritical region and its correlations, Kapitza conductance.  
Radiation: Radiation from LNG fires, free-molecular flow and heat transfer, free-molecular heat transfer in enclosures.  
Heat Exchanger: Cryogenic heat exchanger types, NTU-effectiveness design method, Giauque- Hampson design, Plate-fin and perforated-plate heat exchanger design, effect of variable specific heat, effect of longitudinal heat conduction, effect of heat transfer from ambient, Regenerators, Regenerator design.

**Essential Reading:**


**Supplementary Reading:**

Sources and characteristics of wind, selection of site, wind resource assessment, power in the wind; classification of wind turbines, horizontal and vertical axis wind turbines, wind turbine aerodynamics, applications—wind diesel systems, wind farms, wind pumps and offshore wind turbines; turbine airfoils and rotor wakes, operational characteristics; structural considerations, wind turbine acoustics, electric power systems, economic assessment, environmental and social issues.

Books:
Preliminary concepts; Conservation of mass, momentum and energy; Exact solutions of the viscous flow equations: Couette flows, Poiseuille flow through ducts, unsteady duct flows; Laminar boundary-layers: integral analysis and similarity solutions; Laminar free shear flows: jet, wake, and plume; Stability of laminar flows; Turbulent flow: fundamentals, Reynolds-averaged equations, velocity profile in wall-bounded flows, turbulent flow in pipes and channels, turbulent free-shear flows (jet, wake, and plume); Turbulence modelling: zero, one, and two equation models of turbulence; Numerical methods.

Books: