PROGRAM
M. Tech.

Thermal & Fluids Engineering

Faculty of Engineering

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Programme Outcomes

An ability to independently carry out research /investigation and development work to solve practical problems

P O 1 : An ability to write and present a substantial technical report/document

P O 2 : 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

Programme Specific Outcomes

PO1: Equip students to solve practical problems in the field of thermal & fluids engineering.

PO2: Develop ability to carry out independent research in the area of Thermal & Fluids Engineering.

PO3: Equip students to write quality technical reports and manuscripts worth publishing in reputed journals.

Evaluation Scheme and Grading System

(a)EVUALATION SCHEME

Internal			**External**	**Total**
Components	*Weightage*		Examination conducted for 100 Marks Weightage: 50 %	Internal + External =100
First Periodical	15 %	50 %		
Second Periodical	15 %			
*Continuous Evaluation	20 %			

Continuous Evaluation

Subject Seminar/Assignments = 10 marks
Class Test/Class Notes = 10 marks

(b) GRADING SYSTEM

Grades are awarded to the students following a grade distribution scheme typically given as follows.

Sl.No.	**Grade**	**Lower Bound**	**Upper Bound**	**No. of students**	**% of students**
1.	O	90	100		
2.	A^+	80	89		
3.	A	70	79		
4.	B^+	60	69		
5.	B	50	59		
6.	C	45	49		
7.	P	40	44		
8.	F	0	39		

*What is shown above is a typical grading system and the grade distribution scheme can change depending on the Class Committee decision.

Syllabus, Course Objectives and Course Outcomes

Semester1

17MA650 ADVANCED ENGINEERING MATHEMATICS 3- 0 -0-3

Course Outcomes

CO1: Demonstrate competence with the basic ideas of linear algebra including concepts of linear system independence, theory of matrices, bases and dimension, eigenvalues, eigenvectors.

CO2: Implement the concept of linear algebra in transformations.

CO3: Demonstrate the basic skills in solving differential equations, using functions of complex variables, and the calculus of variations in solving physics problems.

CO4: Solve problems in several dimensions, coordinate transformations, vector functions and tensors.

Syllabus

Vector and Tensor Analysis (Cartesian and Curvilinear): Orthogonal coordinate systems, ransformation of coordinate systems; Paths and line integrals, Fundamental theorems of calculus for line integrals, vector fields and gradients; Double and triple integrals, Iterated integrals, Change of variables formula, Applications to area and volume, Green's theorem, Two-dimensional vector fields and gradients; Surface Integrals; Parametric representation of a surface, Fundamental vector product and normal to a surface, Stokes' theorem, Curl and divergence of a vector field, Gauss' divergence theorem; Algebra of Cartesian Tensors, Index notation, Isotropic tensors, Invariants of a tensor.

Fourier series, Fourier transforms, Laplace transforms, applications.

Review of ODEs; Laplace & Fourier methods, series solutions, and orthogonal polynomials. Sturm-Liouville problem;

Review of 1st and 2nd order PDEs. Classification of PDEs, Similarity transformations for converting PDEs to ODEs. Solution of PDEs, Special functions, Bessel functions: 1st and 2nd kind, applications

Linear systems of algebraic equations, Systems of non-linear equations, Systems of Differential Equations.

17TF601 - ADVANCED FLUID DYNAMICS 3-0-0-3

Course Outcomes:

CO1: Fundamental knowledge in the subject of fluid mechanics
CO2: Development of capacity to analyse fluid flows of different types associated with different engineering situations
CO3: Develop skill to suggest better solutions to fluid flow problems to cater to industrial needs
CO4: Academic capability to conduct research activities in the area of fluid mechanics

Syllabus

Review of Basic Concepts: Concept of continuum, types of fluid.
Differential Fluid Flow Analysis: differential forms of mass, momentum, and energy conservation equations; Potential flow, Navier-Stokes equations and exact solutions, energy equation. Ideal Fluid Flow Analysis: Two dimensional flow in rectangular and polar coordinates; Continuity equation and the stream function; Irrotationality and the velocity potential function; Vorticity and circulation.
Plane potential flow and the complex potential function; Sources, sinks, doublets and vortices; Flow over bodies and d'Alembert's paradox; Aerofoil theory and its application. Boundary Layer Theory:
Laminar Boundary Layer Equation: Two dimensional equations, displacement and momentum thickness, general properties of the boundary layer equations, skin friction.
Turbulent Boundary Layer: Two-dimensional equation, Prandtl's mixing layer Karman's hypothesis universal velocity distribution, RANS models, flow over a flat plate, skin friction drag. Introduction to hydrodynamic theory of lubrication. Introduction to turbo-machinery: pumps, compressors, fans and turbines.
Compressible Fluid Flow: One dimensional isentropic flow, Fanno and Rayleigh flows, chocking phenomenon, normal and oblique shocks.

17TF602 – ADVANCED HEAT TRANSFER (3-0-0-3)

Course Outcomes:

CO1: Deal with the practical situations which involve one or more than one modes of heat transfer
CO2: Deal with transient and multi-dimensional conduction problems
CO3: Analyse the situation including fluid flow and heat transfer
CO4: Deal with the effect of radiation and heat transfer associated with it in practical situations

Syllabus

Fourier's law, thermal conductivity of matter, heat diffusion equation for isotropic and anisotropic media, boundary and initial conditions. One-dimensional steady-state conduction

through plane wall, cylinder and sphere. Conduction with thermal energy generation, heat transfer from extended surfaces, radial fins and fin optimization;

Multidimensional- steady-state heat conduction; Transient conduction – lumped capacitance method and its validity, plane wall and radial systems, semi-infinite solid, anisotropic conduction, numerical solution of conduction problems: FDM and FEM methods.

Radiation heat transfer, blackbody radiation, Plank distribution, Wien's displacement law, Stefan –Boltzmann law, surface emission, surface emission, surface absorption, reflection, and transmission, Kirchoff's law, gray surface; Radiation intensity and its relation to emission, irradiation and radiosity, View factors and Radiation exchange between surfaces.

Review of viscous flow. Hydrodynamic and thermal boundary layers, Laminar flow heat transfer to developed and developing flow, laminar forced convection in pipe and ducts with different boundary conditions, external flows. Laminar Natural Convection, natural convection in Enclosures, heat transfer correlations.

Turbulence modelling, Heat transfer in turbulent boundary layers, Eddy diffusivity of heat and momentum, turbulent flow through circular tubes and parallel plates with heat transfer, analogies between heat and momentum transfer, Turbulent free convection from vertical surface, turbulent heat transfer correlation. Boiling and condensation heat transfer – correlation and applications.

17TF603 ADVANCED ENGINEERING THERMODYNAMICS 3-0-0-3

Course Outcomes:

CO1: Understanding and applications of first and zeroth law of thermodynamics.

CO2: Second Law and Entropy analysis

CO3: Exergy analysis

CO4: Thermodynamic cycles

CO5: Thermodynamic Properties of Homogeneous Mixtures

CO6: Kinetic theory of gases

Syllabus

Review of I and II Laws of Thermodynamics: Maxwell equations, Joule-Thompson experiment, irreversibility and availability, Transient flow analysis, entropy balance, entropy generation.

Exergy Analysis: Concepts, exergy balance, exergy transfer, exergetic efficiency, exergy analysis of power and refrigeration cycles.

Real Gases and Mixtures: Thermodynamic cycles and cycle efficiency.

Thermodynamic Properties of Homogeneous Mixtures: Partial molal properties, chemical potential, fugacity and fugacity coefficient, fugacity relations for real gas mixtures, ideal solutions, phase equilibrium.

Kinetic theory of gases, basic assumption, molecular flux, equation of state for an ideal gas, collisions with a moving wall, principle of equipartition of energy, classical theory of specific heat capacity, Equations of state, thermodynamic property relations, residual property functions, properties of saturation states.

17TF604 – COMPUTATIONAL METHODS IN THERMAL AND FLUIDS ENGINEERING (3-0-3-4)

Course Outcomes:

CO1: Understanding of the underlying concepts and fundamental hypothesis of computational methods in engineering.

CO2: Practical skills in using the main computational techniques; numerical methods for finding the roots of equations, solution of systems of equations.

CO3 Numerical differentiation and integration

CO4: Application of numerical techniques in the efficient modelling and solution of engineering problems, with special emphasis in thermal and fluid engineering problems.

CO5: Application of finite difference method to thermal engineering problems.

CO6: Critical analysis and interpretation of the simulation results, including error estimation and validation of results.

Syllabus

Taylor series expansion, root finding, interpolation, extrapolation; Numerical solution of systems of nonlinear algebraic equations; Newton-Raphson method.

Solution of linear algebraic systems, determinant, inverse, norms and condition number. Elementary Matrix Computation, Eigenvalue Problems and singular Value Decomposition. Systems of Linear Equations, Solution using various iterative methods, matrix inversion methods. Conjugate gradient, BiCGStab, GMRES.

Numerical Differentiation, Numerical integration: Newton-Cotes methods, error estimates, Gaussian quadrature.

Numerical integration of ODEs: Boundary Value Problems, Differential Algebraic Equations, Euler, Adams, Runge-Kutta methods, and predictor-corrector procedures; stability of solutions; solution of stiff equations. Finite difference (FD) method. Forward, Backward and Central schemes. Solution of ODE by FD method. Introduction to stability, numerical errors and accuracy.

Application of finite difference method to thermal engineering problems. Solution of hydrodynamic and thermal boundary layer equations by FD method. Stream function-vorticity formulation, Solution of 2-D flows in complex geometries. Application to transient heat transfer by FD method. FD method used for 2D and 3D problems.

17TF605 EXPERIMENTAL METHODS IN THERMAL & FLUIDS ENGG. 0 0 3 1

Course Outcomes

CO1: To enable the students to revise the practical fundamentals of heat transfer, fluid mechanics & hydraulic machinery.

CO2: To improve the practical engineering knowledge of PG students specializing in Thermal & Fluids Engineering in the specific areas of heat transfer, fluid mechanics and turbomachinery.

CO3 To enable students to apply their theoretical subject fundamentals practically and, realize and make thorough what they have learned.

CO4: To increase the subject exposure to the students and thereby improve their employability in core industries to the best extent possible.

Syllabus

1. Pipe friction apparatus & b) Reynolds apparatus
2. Thermal conductivity of solids & b) Heat transfer through pin fin
3. Notch apparatus & b) Pelton wheel test rig
4. Forced convection heat transfer & b) Natural convection heat transfer
5. Verification of Bernoulli equation & b) Centrifugal pump test rig
6. Parallel & counter flow heat exchanger & b) Shell and tube heat exchanger
7. Meta-centre apparatus & b) Venturi and orifice meter test rig
8. Stephan-Boltzmann apparatus & b) Emissivity apparatus
9. Francis turbine test rig & b) Hele-shaw flow apparatus
10. R&AC test rig.

17TF606 SEMINAR 0- 0- 3- 1

Course Outcomes:

CO1: Students will learn how to conduct a systematic literature survey on a given advanced topic in the area of fluids and thermal engineering

CO2: Students will learn how to best present a technical topic using the best tools in practice

CO3: Students will learn to prepare a technical report in a prescribed format along with the oral presentation.

CO4: Seminar will equip students to learn a topic by themselves which is not covered in the class room

Syllabus

The student will be given some advanced topics in the field of fluid flow and heat transfer. He/she shall extensively refer literature (min. 3 hrs in a week) and prepare a properly formatted seminar report. He/she need to present the work at the end of the semester. The valuation will be based on viva-voce during the presentation and content and organization of the report.

Semester 2

17TF607 TURBO MACHINES 3-0-0-3

Course Outcomes

CO1: Select suitable turbomachines for a particular application

CO2: Analyse and assess the performance of a given turbomachinery and suggest improvements/modifications

CO3: Trouble shooting of turbomachinery to detect faults.

CO4: Perform design calculations for pump category and turbine category machines.

Syllabus

Classification- Specific work- Representation of specific work in T-S and H-S diagrams- Internal and external losses – Euler's equation of Turbo machinery-Ideal and actual velocity triangles-Slip and it's estimation-Impulse and reaction type machines-Degree of reaction-Effect of outlet blade angle on blade shape-Model laws, Specific speed and Shape number-Special features of hydro, steam and gas turbines-Performance characteristics of turbo-machines- Thin aerofoil theory-Cascade mechanics. Pumps, compressors, blowers and fans – Design and off-design Characteristics (Cavitation, Surge and Stall)

17TF608 DESIGN OF HEAT EXCHANGER EQUIPMENTS (3-1-0-4)

Course Outcomes

CO1: Background, Application, Classification and Common terminologies of Heat exchangers

CO2: Design of Tubular Heat Exchangers

CO3: Design of Condensers

CO4: Design of Regenerative and Compact Heat exchangers

CO5: Design concepts of Heat Pipes.

Syllabus

Unit 1

Introduction: classification, Design of heat exchangers: engineering design- steps for designing, design a workable system, optimum systems, economics, probabilistic approach to design, sizing and rating problems; LMTD and ε-NTU approach of design. Introduction to Design codes (ASME, TEMA, HTRI etc)

Design of shell and tube heat exchanger – basic design procedure and theory, overall heat transfer coefficient, fouling factors, shell and tube exchangers: construction details, general design considerations: Fluid allocation, Shell and tube fluid velocities, Pressure drop, tube-side and shell side heat-transfer coefficient and pressure drop, (single phase), Kern's method, design problems. Design of Double pipe heat exchanger: introduction, design producer of double pipe heat exchanger, fins, fin effectiveness and fin efficiency, pressure drop analysis of plate fin heat exchanger, problems. Introduction to Three fluid/ multi fluid heat exchanger behaviour.

Unit 2

Design of Condenser; Heat-transfer fundamentals, Condensation outside horizontal tubes, inside and outside vertical tubes, inside horizontal tubes, Condensation of steam, Mean temperature difference, De-superheating and sub-cooling, Pressure drop in condensers, design problems. Design of Compact heat exchanger: introduction, design producer of compact heat exchanger, fins, fin effectiveness and fin efficiency, pressure drop analysis of plate fin heat exchanger, problems. Plate heat exchanger: Gasketed plate heat exchangers, Welded plate, advantages and disadvantages over the other heat exchangers, design procedure, heat transfer coefficient and pressure drop calculation on both the sides of exchanger, problems on plate exchanger.

Unit 3

Heat pipe: introduction, working principle, working fluids, wick structure and material, classification of heat pipe, pressure variation along the heat pipe, limitations of a heat pipe, problems on heat pipe.

Thermal design of heat exchanger such as Regenerative heat exchanger, Super heater, Air pre-heaters, analysis and design of cooling towers.

17TF609 COMPUTATIONAL FLUID DYNAMICS & HEAT TRANSFER 3-0-3-4

Course Outcomes

CO1: Understanding the governing equations for mass, momentum and energy.

CO2: Classification of system of partial differential equations.

CO3 Grid generation methods

CO4: Finite volume methods for diffusion and convection-diffusion problems.

CO5: Higher order and TVD schemes

CO6: Pressure-velocity coupling and Solution of Navier-Stokes equation

CO7: Finite volume methods: SIMPLE family, PISO, Presto, Turbulence.

CO8: Unsteady Finite volume methods for Navier-Stokes equation

Syllabus

Review of Conservation equations for mass, momentum and energy; coordinate systems;
Eulerian and Lagrangian approach, Conservative and non-conservative forms of the equations, rotating co-ordinates.
Classification of system of PDEs: parabolic elliptic and hyperbolic; Boundary and initial conditions; Overview of numerical methods;
Review of Finite Difference Method, Introduction to integral method, method of weighted residuals, finite elements finite volume method & least square method.
Numerical Grid Generation: Basic ideas, transformation and mapping, unstructured grid generation, moving grids, unmatched meshes.
Finite Volume Method: Basic methodology, finite volume discretization, approximation of surface and volume integrals, interpolation methods - central, upwind and hybrid formulations and comparison for convection-diffusion problem; Basic computational methods for compressible flows.
Advanced Finite Volume methods: FV discretization in two and three dimensions, SIMPLE algorithm and flow field calculations, variants of SIMPLE, Turbulence and turbulence modelling, illustrative flow computations, Introduction to turbulence modelling, CFD methods for compressible flows.
Commercial software FLUENT and CFX – grid generation, flow prediction and post-processing.
Validation methods for CFD analysis.

17TF610 ADVANCED THERMAL & FLUIDS ENGG. LAB 0-0-3-1

Course Outcomes

CO1: To provide the practical exposure to the students with regard to the determination of amount of heat exchange in various modes of heat transfer including condensation& boiling
CO2: Apply scientific and engineering principles to analyze and design thermo-fluid aspects of engineering systems.
CO3: To enable the students to apply their theoretical knowledge and observe through visualization techniques and Hele shaw experiment.
CO4: To perform real time wind tunnel experiments to understand the aerodynamic characteristics of flow over bluff bodies.

Syllabus

Dynamic similarity and scaling; Types of measurement devices & techniques; Errors in Measurement and its Analysis: Causes and types of experimental errors, systematic and random errors; Uncertainty analysis, computation of overall uncertainty, calibration.
Experiments in Wind Tunnel: Surface pressure distribution on circular cylinder, symmetric and cambered aero-foils-estimation lift and drag, smoke flow visualization. Laminar-turbulent transition for various geometries.
Experiments in Water Channel: Visualization of flow over streamline and bluff bodies-vortex shedding from bluff bodies (like circular cylinder)-study of vortex streets.
2-D laminar flow over bluff bodies (Hele-Shaw flow)-construction of flow net (velocity potential lines and streamlines).Numerical visualization of flow over bluff bodies using

Ansys/Algor Software-comparison of numerical flow patterns with experimental ones.
Performance characteristics of Centrifugal compressor and axial flow fan.
Free Convection Heat Transfer-Forced Convection Heat Transfer-Measuring instruments for R&A/C applications-measurement of very low temperature-Measurement of density and viscosity of oils-measurement of gas flow rate through pipelines.
Steady state and transient convective heat transfer
Radiation Heat Transfer - Boiling Heat Transfer-Performance evaluation of vapour compression refrigeration-performance evaluation of thermoelectric refrigerator and heat pump-Measurement and analysis of combustion parameters in I.C. Engines-Evaluation of the calorific value of gaseous and liquid fuels.

17TF611 PROJECT SEMINAR & INDUSTRY FAMILIARISATION 0-0-6-2

Course Outcomes

CO1: Students will learn how to identify a research topic in the area of fluids and thermal engineering by conducting a systematic literature survey through which a potential research problem is identified. They will carry out their final year project in the research problem thus identified.

CO2: Equip students to learn various methodologies (experimental/numerical or both) adopted to solve a research problem in the chosen topic of research.

CO3: Exposure to industrial practices and equipment (design and operation) relevant to the field of Fluids & Thermal Engineering.

Syllabus

Students will be assigned an M.Tech project by the end of the first semester. He/she shall extensively study (min. 6hrs in a week) the research already carried out in the in the field of their thesis work. The student shall bring out the current status of the problem, clearly indicating the shortcomings and gaps in understanding. He/she shall prepare a properly formatted seminar report giving all of the above details. He/she need to present the work carried out at the end of the semester. Credits will be awarded based on the viva-voce during the presentation and the content and organization of the report.

The students shall visit industrial units connected with their curriculum and present reports about the plant design, equipment, instrumentation etc.

17TF798 – DISSERTATION-STAGE 1 8 CREDITS

Course Outcomes

CO1: Contribute to the academic and research in the field of thermal and fluids engineering.

CO2: Develop an ability to apply knowledge of mathematics, science, and engineering to solve engineering problems

CO3: Develop an ability to communicate effectively with the engineering community and the society at large, using skills like technical writing and effective presentation.

Syllabus

Students will be assigned an M.Tech project by the end of the first semester. He/she would have completed the literature review in the second semester. In the current semester he/she shall extensively work on the topic (min. 8hrs in a day) using theoretical/computational/experimental methods and complete the preliminary studies on the project. He/she shall prepare a properly formatted project report giving all the details. He/she need to present the work carried out in front of a review committee constituted by the department HOD. Credits will be awarded based on the viva-voce during the presentation and the content and organization of the report.

17TF799 – DISSERTATION-STAGE 2 14 CREDITS

Course Outcomes

CO1: Contribute to the academic and research in the field of thermal and fluids engineering.

CO2: Develop an ability to apply knowledge of mathematics, science, and engineering to solve engineering problems

CO3: Develop an ability to communicate effectively with the engineering community and the society at large, using skills like technical writing and effective presentation.

Syllabus

Students will be assigned an M.Tech project by the end of the first semester. He/she would have completed the literature review in the second semester. In the current semester he/she shall extensively work on the topic (min. 8hrs in a day) using theoretical/computational/experimental methods and complete the preliminary studies on the project. He/she shall prepare a properly formatted project report giving all the details. He/she need to present the work carried out in front of a review committee constituted by the department HOD. Credits will be awarded based on the viva-voce during the presentation and the content and organization of the report.

Electives

17TF701 BOUNDARY LAYER THEORY 3-0-0-3

Course Outcomes:

CO1: Students will gain a deep understanding of the Boundary layer Theory.

CO2: Equip students to design of majority of fluids and thermal systems where this subject is applicable such as design of aircraft wings, turbomachinery blades etc.

CO3: Enable students to solve practical (industrial) problems

CO4: Develop capability in students to carry out independent research in fluid systems with boundary layer flows occur.

Syllabus

Introduction: Ideal and real fluids, the concept of boundary layer, Navier- Stokes equations, the limiting cases of large and small Reynolds number, energy equation.
Laminar Boundary Layer Equation: Two dimensional equations, displacement and momentum thickness, general properties of the boundary layer equations, skin friction.
Similarity Solutions: Wedge flow and its particular cases, flow past a cylinder, two dimensional inlet flows in straight channel. Approximate Methods: Karman-Polhausen methods, numerical methods.
Symmetrical Boundary Layers: Circular jet, body of revolution, Manglers transfixion.
Boundary Layer Control: Different methods of boundary layer control, flow over a flat plate with uniform suction.
Turbulent Boundary Layer: Two-dimensional equation, Prandtl's mixing layer Karman's hypothesis universal velocity distribution, flow over a flat plate, skin friction drag.
Thermal Boundary Layers: Two-dimensional equations forced flow over flat plate at zero in advances, natural flow over a vertical plate.

17TF702 INTRODUCTION TO TURBULENCE 3-0-0-3

Course Outcomes

CO1: To understand the concept of origin of turbulence, examples and character of turbulence, Reynolds stress, energy relations, closure problem, phenomenology, eddy viscosity etc.

CO2: To understand the statistics of turbulence such as spectra, space-time correlations, macro &micro scales.

CO3: To study statistical theory of turbulence, locally isotropic turbulence, Kolmogorov's hypothesis, correlation method, spectral method, turbulence diffusion.

CO4: To understand Numerical Turbulence modelling, one-, two- and multiple equations for turbulence modelling, Reynolds and Favre averaging, RSM, Large eddy and DNS methods.

CO5: To understand the experimental techniques in turbulence such as Hot Wire Anemometer, Laser Doppler Anemometer, Flow visualisation techniques, laminar-turbulent transition.

Syllabus

Origin, examples and character of turbulence, Reynolds stress, energy relations, closure problem, phenomenology, eddy viscosity. Statistics. spectra, space-time correlations, macro &micro scales, statistical theory of turbulence, locally isotropic turbulence, Kolmogorov's hypothesis, correlation method, spectral method, turbulence diffusion.

Numerical Turbulence modelling, one-, two- and multiple equations for turbulence modelling, Reynolds and Favre averaging, RSM, Large eddy and DNS methods.

Experimental techniques: Hot Wire Anemometer, Laser Doppler Anemometer, Flow visualisation techniques, laminar-turbulent transition.

17TF703 ADVANCED GAS DYNAMICS 3-0-0-3

Course Outcomes:

CO1: Understand the basic characteristics of compressible flows, including wave propagation, speed of sound and the Mach number.

CO2: Analyze one-dimensional isentropic compressible flows as well as effects of friction and heat transfer.

CO3: Analyze normal shock, oblique shock and Prandtl Meyer flows.

CO4: Learn the development of thermodynamic and flow relationships and apply these to practical problems; become familiar with application-type problems in gas dynamics

Syllabus

Basic equations of gas dynamics: Introduction, Isentropic flow in a stream tube, speed of sound, Mach waves and Mach cone, Effect of Mach number on compressibility.

One dimensional Isentropic Flow: Governing equations, stagnation conditions, critical conditions, maximum discharge velocity, isentropic relations.

Shock Waves: Normal Shock waves, stationary normal shock waves, normal shock wave relations in terms of Mach number, Hugoniot Equations; 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; Linearized two dimensional subsonic flows; Prandtl-Glaurt / Goethert transformation, Linearized supersonic flow; Ackeret's theory.

Variable Area Flow: Equations for variable area flow, operating characteristics of nozzles, convergent-divergent supersonic diffusers, flow separation, contour optimization, bell nozzle, new nozzle concepts.

Adiabatic Flow in a Duct with Friction: Flow in a constant area duct, friction factor variations, the Fano line.

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.

Unsteady wave motions: Moving normal shock waves, Reflected shock waves, Physical features of wave propagation, Elements of acoustic theory, Incident and reflected waves, Shock tube relations, Piston analogy, Incident and reflected expansion waves, Finite compression waves, Shock tube relations.

3D flow: Cones at angle of attack, Blunt-nosed bodies at angle of attack.

Introduction to experimental facilities: Subsonic wind tunnels, Supersonic wind tunnels, Shock tunnels, Free-piston shock tunnel, Detonation-driven shock tunnels, and Expansion tubes.

17TF704 FLUID STRUCTURE INTERACTION 3-0-0-3

Course Outcomes:

CO1: Students will develop a deep understanding in Fluid-Structure Interaction.

CO2: Equip students to design of majority of fluids and thermal systems where this subject is applicable such as design of heat exchangers, cooling towers, tall chimneys etc.

CO3: Enable students to solve practical (industrial) problems where FSI is applicable.

CO4: Develop capability in students to carry out independent research in FSI.

Syllabus

Introduction: Vibration, Mode Shapes; Flow around bluff bodies- Vortex shedding and induced vibrations- Fluid Elastic excitations and instabilities- Galloping, ovalling and turbulence induced vibrations- Interference effects- Jet switching- Vibrations of fluid conveying conduits and flexible tubes- Wave induced vibrations-Wake structures associated with flow-induced vibrations.

Some practical problems: Tube bundle vibrations in heat exchangers and nuclear reactors- Vibrations of stacks and other tall structures, transmission line vibrations- Methods of suppressing flow-induced vibrations. Bio-fluid mechanics.

17TF705 DESIGN OF IC ENGINES AND SYSTEMS 3-0-0-3

Course Outcomes:

CO1: Understanding of the constructional features of different types of internal combustion engines: Number, size and arrangement of cylinders

CO2: To study the effect of various design parameters on combustion and emission from IC engines; Heat transfer and energy flow in IC engines.

CO3 Understanding of fluid motion in IC engines: Swirl, Squish and Tumble.

CO4: To develop good design model of cooling and exhaust systems in IC engines using CFD.

CO5: Application of CFD in IC engine systems.

Course Syllabus

Constructional features of different types of internal combustion engines: Number, size and arrangement of cylinders; Fluid motion in IC engines: Swirl, Squish and Tumble; Effect of various design parameters on combustion and emission from IC engines; Heat transfer and energy flow in IC engines; Design of cooling systems in IC engines; Design procedure for important components like cylinder, piston, piston rings, intake and exhaust manifolds and poppet valves; Design procedure for inlet and exhaust ports of two-stroke engines; Design of silencer and air filter.

17TF706 CHEMICAL REACTOR ANALYSIS 3-0-0-3

Course Outcomes

CO1: Concept of reactor design for single and multiple reactions

CO2: Understanding Residence time distribution (RTD) and its usage for reactor design

CO3 Design of batch and steady flow reactor

CO4: Design of continuously stirred tank reactor (CSTR) and tubular reactors

CO5: Design of multiphase catalytic reactors

CO6: Bubble columns and gas-solid-liquid reactors – design and applications

Syllabus

Review of design of ideal isothermal homogeneous reactors for single and multiple reactions.

Residence time distribution (RTD) of ideal reactors, interpretation of RTD data, flow models for non-ideal reactors – axial dispersion, N tanks in series, and multi-parameter models, diagnosing the ills of reactors, influence of RTD and micro-mixing on conversion.

Adiabatic and non-adiabatic operations in batch and flow reactors, optimal temperature progression, hot spot in tubular reactor, auto thermal operation and steady state multiplicity in continuously stirred tank reactor (CSTR) and tubular reactors, introduction to bifurcation theory.

Introduction to multiphase catalytic reactors, effectiveness factor, selectivity, catalyst deactivation, use of pseudo-homogeneous models for design of heterogeneous catalytic reactors (fixed and fluidized beds). Gas-liquid-solid reactors, hydrodynamics and design of bubble column, slurry and trickle-bed reactors.

17TF707 TWO-PHASE FLOW AND HEAT TRANSFER 3-0-0-3

Course Outcomes

CO1: Concept of types of two-phase flows and flow patterns

CO2: Understanding and application of homogeneous equilibrium model

CO3 Understanding Separated Flow model and Lockhart-Martinelli parameter

CO4: Drift Flow Model and Armond or Bankoff flow parameters

CO5: Models and correlation for boiling heat transfer

CO6: Models and correlation for condensation heat transfer

Syllabus

Introduction: Review of one-dimensional conservation equations in single phase flows,

Types of flow, volumetric concentration, void fraction, volumetric flux, relative velocity, drift velocity, flow regimes, flow pattern maps, analytical models.

Homogeneous Flow: One dimensional steady homogeneous equilibrium flow, homogeneous friction factor, turbulent flow friction factor.

Separated Flow: Slip, Lockhart-Martinelli method for pressure drop calculation, pressure drop for flow with boiling, flow with phase change.

Drift Flow Model: General theory, gravity flows with no wall shear, correction to simple theory, Armond or Bankoff flow parameters.

Compressible multi-fluid formulations.

Boiling: Thermodynamics of boiling, Regimes of boiling, nucleation, gas nucleation in bulk liquid, growth of bubbles, motion at a heating surface, heat transfer rates in pool boiling, forced convection boiling, heat transfer correlations, maximum heat flux or burnout, boiling of metals.

Condensation: Nusselt theory, Film and drop-wise condensation, boundary layer treatment of laminar film condensation, condensation in vertical and horizontal tubes, condensation inside a horizontal tube.

17TF708 GAS TURBINE THEORY AND DESIGN 3-0-0-3

Course Outcomes

CO1: Select suitable gas turbine for a particular application

CO2: Analyse and assess the performance of a given gas turbine and the pertinent thermodynamic cycle, and suggest improvements/modifications

CO3: Trouble shooting of gas turbines to detect faults.

CO4: Perform design calculations for gas turbines.

Syllabus

General Considerations of Turbomachinery: Classification; Euler's Equation for Turbomachinery; Velocity triangle; Cascade analysis & nomenclature. Shaft Power & Aircraft Propulsion Cycles. Centrifugal Compressors: Work done and pressure rise; Slip; Compressibility effects; Compressor characteristics. Axial Flow Compressors: Stage pressure rise; Blockage in compressor annulus; Degree of reaction; 3-D flow; Stage performance; h-s diagram & efficiency; off-design performance; Performance characteristics; Design process. Combustion System. Axial Flow Turbines: Stage performance; Degree of reaction; h-s diagram & efficiency; Vortex theory;
Overall turbine performance; Performance characteristics; Blade cooling; Design process. Prediction of performance of simple gas turbines; Off Design performance; Gas turbine blade materials; matching procedure.

17TF709 MICRO AND NANO SCALE THERMAL & FLUIDS ENGINEERING 3-0-0-3

Course Outcomes

CO1: Students will develop a deep understanding in micro and nano scale thermal and fluid transport.

CO2: Equip students to design and develop micro and nano scale devices like microchannels, MEMS/NEMS, micro heat exchangers etc.

CO3: Introduce students to nanofluids and their applications.

CO4: Develop capability in students to carry out independent research in this field.

Syllabus

Microscale Energy Transport in Solids: Microstructure of solids, crystal vibrations and phonons, photon interactions, particle transport theories, non-equilibrium energy transfer.
Molecular Clusters: Clusters and clustering, thermo-physical properties of clusters, control of clusters and condensation.
Molecular Forces and Phase Change in Thin Liquid Films: Thermodynamics of thin films, interfacial meniscus properties, interfacial mass flux.
Heat Transfer and Pressure Drops in Microchannels: Single phase and two phase flow, flow boiling, dryout, bubble behavior, flow pattern
Micro Heat Pipes: Fundamental operating principles, steady state and transient modeling and construction techniques.
Microscale Heat Transfer in Biological Systems at Low Temperature: Life above and below the freezing temperature of water, freezing of cells and tissues, mechanism of freeze survival.
Microscale Thermal Sensors and Actuators: MEMS technology, flow sensors, infrared radiation detectors, thermal conductivity sensor, thermal expansion actuators and micro-steam engine.
Nanofluids: Preparation of nano-fluids, sputtering, characterization of nano-fluids, thermal properties of nano-fluids, single phase convective and boiling heat transfer processes.

17TF710 CRYOGENICS 3-0-0-3

Course Outcomes

CO1: To provide knowledge on the properties of materials at low temperature.

CO2: To familiarize with various gas liquefaction systems

CO3: To provide knowledge on the cryogenic storage and transfer systems.

CO4: To provide design aspects of cryogenic storage and transfer lines

CO5 Analyse performance of cryogenics gas liquefaction system.

Syllabus

Methods of producing cold: thermodynamic basis, first and second law analysis. Review of Solid and fluid properties at low and cryogenic temperatures- Liquefaction systems: Open and Closed cycles; Effect of component efficiencies as performance of different liquefaction cycles- Cryogenic refrigerators; Recuperative and Regenerative cycles - Effect of irreversibilities on system performance; Micro-miniature and miniature cryo-coolers for space and defence applications. Thermal stratification in cryo tanks, cryo tank insulation.

17TF711 RENEWABLE ENERGY 3-0-0-3

Course Outcomes

CO1: To acquire in-depth knowledge on performance of solar thermal energy systems

CO2: To design and evaluate the performance of wind energy conversion systems.

CO3: Identify a suitable bio-energy conversion method for industrial applications.

CO4: Identify the challenges in ocean and geothermal energy sources.

CO5 To familiarise with latest renewable energy extraction techniques

Syllabus

Renewable energy sources in India-potential sites, availability. Solar Energy: measurement and collection, flat plate collectors, concentrating collectors, solar ponds, photovoltaic conversion, Thermal energy storage. Ocean Energy: Principles of OTEC (Ocean Thermal Energy Conversion)-wave energy, tidal energy, energy conversion systems. Wind Energy: Principle, potential and status; Wind characteristics; National Wind Atlas; Theory of wind turbine blades; types of wind turbines and their characteristics. Bio-fuels: Sources and potential, properties and characterization; Biogas generation through aerobic and anaerobic digestion; Thermo-chemical methods of bio-fuel utilization: Combustion and gasification; Status of bio-fuel technology. Geo-thermal Energy-nature, types and utilization. Recent trends in renewable energy- Flow Induced Vibration as a source of energy. Applications: Applications of renewable energy sources-typical examples. Energy audit.

17TF712 AERODYNAMICS 3-0-0-3

Course Outcomes

CO1: To understand the concept and write the equations governing the fluid flow.

CO2: The concept of Stream function, velocity potential solutions to laplace's equation and to know the conditions under which potential-flow theory hold.

CO3: Use superposition to build simple potential flows and to understand the concept of conformal mapping and its applications.

CO4: To study the aerofoil nomenclature, characteristics and the Prandtl's lifting line theory and to do practical problems based on this theory.

CO5: To understand the bluff body aerodynamics, separation, unsteady aerodynamics, turbulence etc.

Syllabus

Basics equations of Fluid Mechanics, Inviscid flows, Steam function, Velocity potential, Two-dimensional incompressible flows: laplace's equation, its solutions, Flows over aerofoils: Conformal transformation, thin airfoil theory. Introduction to finite wings: Prandtl's lifting line theory. Effect of boundary layer separation on flow over airfoils. Introduction to bluff body aerodynamics: flow over circular cylinders, effect of geometry, dynamic effects, unsteady aerodynamics.

17TF713 INSTRUMENTATION AND PROCESS CONTROL 3-0-0-3

Course Outcomes

CO1: Measure the various physical quantities using appropriate instrument

CO2: Develop mathematical models for control systems

CO3: Analyze the models using standard test signals in time and frequency domain

CO4: Examine the stability and relative stability of control system in time and frequency domain

CO5: Design and implementation of feedback control systems for industrial application

Syllabus

Instrumentation Introduction: Measurement and its classification by physical characteristics, direct and inferential measurement, on- and off- line measurement. Static Characteristics of Instruments: Error, accuracy, repeatability, drift, threshold, backlash, hysteresis, zero-stability, static, coulomb and viscous friction, live zero, suppressed zero, working bind.

Sensor and Transducers: Classification, principles and applications, interpretation of performance specification of transducers.

Building Blocks of an Instrument: Transducer, amplifier, signal conditioner, signal isolation, signal transmitter, display, data acquisition modules, I/O devices, interfaces. Process Instrumentation: Working principles of transducers/instruments employed for the measurement of flow, level, pressure, temperature, density, viscosity, etc. and their merits and demerits.

Data Acquisition and Signal Processing: Systems for data acquisition and processing, modules and computerized data system, digitization rate, time and frequency domain representation of signals, and Nyquist criterion; A brief description of elements of mechatronics, modular approach to mechatronics and engineering design. Introduction to LabView and Matlab for data capture and analysis.

Process Control Introduction: The concept of process dynamics and control, review of Laplace transform methods, Laplace transform of disturbances and building functions, dynamic model building of simple systems.

Linear Open Loop System: Physical examples of first order systems and their response for step, impulse and sinusoidal inputs, linearization of nonlinear models, response of first order system in series, examples of second order systems and their response. Linear Closed Loop System: The control system and its elements, closed loop transfer functions, transient response of simple control systems, concept of stability and use of Routh-Hurwitz test for stability.

Controllers: Modes of control action, control system and its closed-loop transfer function.

Root Locus Method: Root locus treatment, response from root locus and its application to control system design. Frequency Response: Introduction to frequency response, Bode diagrams of simple systems, Bode stability criterion, control system design by frequency response, use of gain and phase margins.

17TF714 POWER PLANT AND THERMAL SYSTEMS ENGINEERING 3-0-0-3

Course Outcomes

CO1: Describe sources of energy, types of power plants and power plant economics.

CO2: Analyse Rankine cycles and estimate efficiencies in a steam power plant.

CO3: Discuss the components of a thermal power plant.

CO4: Describe basic working principles of gas turbine and diesel engine power plants. Define the performance characteristics and components of such power plants

CO5: List the principal components and types of nuclear reactors.

CO6: Describe elements of hydropower station, evaluate hydraulic efficiency and performance.

CO7: Introduction to Renewable energy sources: solar, wind, geothermal, fuel cell etc.

Syllabus

Energy scenario, Overview power plants, Types of power stations, Economy and thermal schemes of power stations.

Review of various ideal cycles–Rankine and Brayton–and fuel-air cycles. Thermodynamics optimization of design parameters. Real cycle effects–internal and external irreversibilitites, pressure drops, heat loss, condenser air leakage, fouling of heat transfer surfaces, combustion losses–and their impact on the thermodynamic cycle. Optimization of real and double reheat cycles. Analysis of off-design performance. Analysis of steam cycles, Feed water heaters, Deaerator and drain cooler, Optimization of cycle parameters, reheat and regeneration, Analysis of multi-fluid coupled cycles, Cogeneration of power and process heat. Thermal power plant equipment, Combustion mechanisms, Furnaces, Combustion control, boilers (coal based, RDF based), economizers, feed water treatment. feed water heater, Boiler maintenance. Down-comers and risers. Drum and its internals. Convective and radiant super heaters. Superheat temperature control, condensers, combustion chamber and gas loops, elements of gas turbines theory, cooling towers, and Dust and ash removal systems. Combined cycle power plants, Internal combustion engine plants for peak load standby and start up, Elements of hydropower generation and wind turbine, Elements of nuclear power plants, nuclear reactors and fuels, Recent advances in power plants, Renewable energy: solar, geothermal, wind, biomass, ocean, fuel cells, Environmental aspects of power generation, sustainability and future scenarios.

17TF715 PROPULSION 3-0-0-3

Course Outcomes

CO1: Introduction to thermodynamic cycles and analysis of efficiencies of various propulsive devices.

CO2: Introduction to aerospace propulsion and understanding of various propulsive devices used for airospace applications. Analysis of exit velocity, thrust and the specific impulse of engines.

CO3: Understanding of different nozzle flow conditions in a rocket engine.

CO4: Functioning of solid propellant rockets and design and analysis of grain compositions and corresponding thrust time profiles.

Syllabus

Principles of propulsion: Thermodynamic cycle analysis and efficiencies of propulsive devices. Introduction to Aerospace propulsion, various propulsive devices used for aerospace applications. Launch vehicle dynamics, Classifications of rockets: Electric, Nuclear and Chemical rockets, cryogenic and semi-cryogenic engines, Applications of rockets.

Nozzle design: Flow through nozzle, Real nozzle, Equilibrium and frozen flow, Adaptive and non-adaptive nozzles. Thrust vector controls, Rocket performance parameters. Solid propellant rockets, Grain compositions. Design of grain. Liquid propellant rockets, Injector design, cooling systems,

Feed Systems: Pressure feed and turbo-pump feed system. Heat transfer problems in rocket engines.

Introduction to various aircraft propulsive devices: Piston-prop, Turbo-prop, Turbojet, Turbofan, Turbo shaft, Ramjet, Vectored- thrust, Lift engines. Gas Turbine Cycles and cycle based performance analysis; 1-D and 2-D analysis of flow through gas turbine components - Intake, Compressors, Turbines, Combustion Chamber, Afterburner, and Nozzle. Compressor and Turbine blade shapes; cascade theory; radial equilibrium theory; matching of compressor and Turbine. Turbine cooling. Single spool and Multi- spool engines. Power plant performance with varying speed and altitude. Thermo-acoustic instability.

17TF716 BIO-FLUID MECHANICS 3-0-0-3

Course Outcomes

CO1: Understanding of the fundamentals of Newtonian and non-Newtonian fluid flows.

CO2 Understanding of steady and pulsatile flows in rigid and elastic tubes and their application to arterial system.

CO3: To study the flow and material exchange in capillary network, flow through bends and constrictions and branches using CFD.

CO4: Analysis of flow through distensible tubes and its application to venous system.

CO5: To study the physiological characteristics of cardiovascular system.

Syllabus

Physiological characteristics of cardiovascular system- Newtonian and non-Newtonian fluids- Flow properties of blood and its various constituents- Steady and pulsatile flows in rigid and elastic tubes and their application to arterial system- Flow and material exchange in capillary network-Flow through bends, constrictions and branches- Flow through distensible tubes and its application to venous system.

17TF717 IC ENGINE COMBUSTION AND EMISSIONS 3-0-0-3

Course Outcomes

CO1: Understanding of the basic concepts of combustion, thermo-chemistry and thermodynamics of combustion, laminar and turbulent premixed flames.

CO2: To study the concept of direct injection and CI engine combustion; Combustion systems and management.

CO3 Understanding of formation of air pollutants and pollution, genesis and formation of engine emissions.

CO4: Understand different emission standards and measurement techniques; Control of emissions in SI and CI engines.

CO5: To study the impact of engine design parameters on emissions, exhaust after treatment.

Syllabus

Introduction to Combustion; Thermo-chemistry and thermodynamics of combustion; Laminar and turbulent premixed flames, Premixed engine combustion; Spray formation and atomization, Direct injection and CI engine combustion; Combustion systems and management. Introduction to air pollutants and pollution; Genesis and formation of engine emissions, NO kinetics, Soot formation and oxidation, NOx-Soot tradeoff. Different emission standards and measurement techniques; Control of emissions in SI and CI engines, Impact of engine design parameters on emissions, exhaust after treatment, lean de-NOx catalysts, DISC and HCCI engines; Alternative propulsion systems e.g., HEV, FCV etc.; Engine fuel impacts on emissions, alternative fuels e.g., CNG, alcohols, biodiesel, hydrogen, GTL.

17TF718 NUMERICAL RADIATION HEAT TRANSFER 3-0-0-3

Course Outcomes

CO1: Radiative transfer without participating media

CO2: Radiative transfer with participating media

CO3: Approximate and Exact solutions of one-dimensional gray media

CO4: Monte Carlo method, zonal method, flux method

CO5: discrete ordinate method, finite element method, discrete transfer method

CO6: Application of numerical methods for solving conjugate radiation problems

Syllabus

Fundamentals of thermal radiation; Radiative transfer without participating media;

Radiative transfer with participating media; Governing equations in radiative transfer analysis with participating media; Radiative properties of molecular gases and particulate media; Exact solutions of one-dimensional gray media; Approximate solution methods for one-dimensional 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 volume 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.

17TF719 HEAT TRANSFER IN POROUS MEDIA 3-0-0-3

Course Outcomes

CO1: Concept of Porosity; Pore structure; Permeability

CO2: Brinkman superposition of bulk and boundary effects

CO3: Semiheuristic momentum equations

CO4: Dispersion in a tube

CO5: Continuum and non-continuum treatment of Radiation heat transfer

CO6: Monte Carlo simulation

CO7: Applications: Heat pipes, Fuel cells

Syllabus

Introduction; Fluid mechanics – Darcy momentum equation; Porosity; Pore structure;

Permeability; High Reynolds number flows; Brinkman superposition of bulk and boundary effects; Local volume-averaging method; Homogenization method; Semiheuristic momentum equations; Significance of macroscopic forces; Porous plain media interfacial boundary conditions; Variation of porosity near bounding impermeable surfaces.

Conduction heat transfer Local thermal equilibrium; Local volume averaging for periodic structures; Particle concentrations from dilute to point contact; Areal contact between particles caused by compressive force; Statistical analysis: A variational formulation; A thermodynamic analogy. Convection heat transfer – Dispersion in a tube: Hydrodynamic dispersion; Dispersion in porous media; Local volume averaging for periodic structures; Three dimensional periodic structures; Dispersion in disordered structures: Simplified hydrodynamics, particle hydrodynamics; Properties of dispersion tensor; Experimental determination of D; Dispersion adjacent to bounding surfaces. Radiation heat transfer –Continuum treatment; Radiative properties of single particle; Radiative properties: Dependent and Independent; Volume averaging for independent scattering; Experimental determination of radiative properties; Boundary conditions; Solution methods for equation of radiative transfer; Scaling in radiative heat transfer; Noncontinuum treatment: Monte Carlo simulation; Radiant conductivity; Modelling dependent scattering; Recent developments in the analysis of heat transfer in porous media. Applications: Heat pipes, Fuel cells.

17TF720 NUMERICAL SIMULATIONS AND MODELLING OF TURBULENT FLOWS 3-0-0-3

Course Outcomes

CO1: Understanding Physical description and significance of turbulent flows

CO2: Direct Numerical Simulation

CO3: Large Eddy Simulation, Smagorinsky's model; Appraisal and perspective.

CO4: Reynolds Averaged Equations

CO5: Turbulent Viscosity Models

CO6: Reynolds-Stress Models

Syllabus

Introduction: Physical description and significance of turbulent flows. Transition and onset of turbulence; Turbulent free shear and wall-bounded flows; Challenges and complexities.

Direct Numerical Simulation (DNS): Introduction; Governing Equations; Computational cost; Examples of DNS of channel and free-shear flows. Large Eddy Simulation (LES):

Introduction; Filtering; Filtered conservation equations; Smagorinsky's model; Appraisal and perspective. Reynolds Averaged Equations: Reynolds averaging; Reynolds averaged equations; Closure problem. Turbulent Viscosity Models: Turbulent viscosity hypothesis; Algebraic models; Turbulent-kinetic-energy models; Exact and modelled equations for turbulent-kinetic-energy and its dissipation; Modifications for wall effects and buoyancy-driven flows. Reynolds-Stress Models: Introduction; Closure relations; Examples; Limitations

17TF721 REFRIGERATION AND AIR-CONDITIONING SYSTEMS 3-0-0-3

Course Outcomes

CO1: Understand the basic principles of refrigeration and air conditioning

CO2: Analyze air refrigeration systems, vapor compression refrigeration systems, vapour absorption refrigeration systems, and steam jet refrigeration systems

CO3: Study the psychometric properties of air and utilize the principles of psychometric in the design of air conditioning equipments

CO4: Finally apply this knowledge for the design of refrigeration equipment and air conditioning equipments.

Syllabus

Goff and Gratach method of calculation of moist air properties, mass transfer and evaporation of water into moist air, theory of psychrometer, correlation of w.b.t. with temperature of adiabatic saturation, Lewis number, construction of h.w. psychrometric chart. Review of refrigeration and air conditioning load calculations.Two phase flow, flow regimes, maps, two-phase pressure drop in evaporator and condensers.

Vapour compression, multiple evaporator and compound compression system with and without inter cooling, dual compressors, cascade systems, vapour absorption system-analysis, solid carbon dioxide, principle of production, three stage system with water and flash inter-cooler, pressure snow chambers, regenerative liquid, binary system.

Performance characteristics and capacity control of reciprocating, rotary and centrifugal compressors, screw compressors, hermetically sealed units, analysis of centrifugal compressors.

Direct contact transfer equipment, simple air washer and indirect evaporative cooling, contact mixture principle, enthalpy potential, basic equation for direct contact transfer equipment, graphical and analytical methods for heat and mass transfer analysis of air-washers with heated and chilled water sprays, cooling towers.

Water cooled and air-cooled condensers, performance and heat transfer processes in evaporative condenser, flooded and dry expansion type evaporators, liquid chiller, overall performance of evaporators, capillary tubes, system design factors, pressure and temperature distribution, ASHRAE simplified calculation procedure, expansion valves, operation and performance calculation of thermostatic expansion valve, application of constant pressure expansion valve.

Ice manufacture, design of refrigerated cars and warehouses.

17TF722 NUCLEAR REACTOR THERMAL – HYDRAULICS AND SAFETY 3-0-0-3

Course Outcomes

CO1: Concepts of reactor physics, Neutron Scattering. Thermal and fast reactors

CO2: Understanding Two-Phase Flow Regimes and Two-phase flow models

CO3: Pool Boiling & Flow Boiling Heat Transfer, Critical Heat Flux, Departure from Nucleate Boiling

CO4: Understanding Nuclear Heat Transport systems and mechanisms

CO5: Safety philosophy and Thermal Design Principles

CO6: Thermal-Hydraulics Codes Used for Reactor Accident Analysis

CO7: Thermal-Hydraulics Uncertainty Analysis

Syllabus

Basic concepts of reactor physics, radioactivity. Neutron Scattering. Thermal and fast reactors. Overview of nuclear reactor systems. Sources and distribution of thermal loads in nuclear power reactors.

Flow Regimes in Two-Phase Flow, Two-phase flow models: Homogeneous Equilibrium

Model, Separated and Slip Flow Model, Void Fraction Correlations, Stratified Flow Analysis and Flow Pattern transition, Pool Boiling & Flow Boiling Heat Transfer, Critical Flow, Nuclear

Applications of Fluid Mechanics and Heat Transfer.

Heat generation in reactors, Nuclear Heat Transport, steady and unsteady conduction in reactor elements, Hydraulics of reactor system loops, Hydraulics of heated channels, Safety philosophy, Thermal Design Principles, Single Channel Analysis, Sub-channel analysis, LOCA and LOFA Modelling, modelling of containment loading. Waste management. Indian nuclear power programme.

Review of Thermal-Hydraulics Codes Used for Reactor Accident Analysis, Advanced Safety

Concepts and Upcoming Reactor Safety Methods and next generation reactors.

Thermal-Hydraulics Uncertainty Analysis, Probabilistic safety assessment, regulatory procedure and licensing.

17TF723 FUELS AND COMBUSTION 3-0-0-3

Course Outcomes

CO1: Understanding of the fundamentals of combustion and combustion equipment.

CO2: Study the thermodynamics of reacting systems, conservation of mass and energy in a chemical reaction.

CO3 Understanding of structure and propagation of flames in homogeneous gas mixtures, theories of flame propagation and calculation of flame speeds, flame speed measurements, stability limits of laminar flames.

CO4: Understanding of mechanisms of flame stabilization in laminar and turbulent flows.

CO5: Understanding of burning of condensed phase, general mass burning considerations, and combustion of fuel droplet.

CO6: To study the essential features of combustion process in engines, Pollution and its Control.

Syllabus

Fuels, Importance of combustion, combustion equipment, Thermodynamics of reacting systems; conservation of mass and energy in a chemical reaction; Enthalpy of formation, enthalpy of reaction, adiabatic flame and equilibrium temperature, second law aspects of chemical reactions. Essentials of chemical Kinetics; molarity and order of chemical reaction, general equation for rate of reaction, equation of Arrhenius, activation energy. Structure and propagation of flames in homogeneous gas mixtures, simplified Rankine-Hugoniot relations, properties of Hugoniot curve,

analysis of deflagration and detonation branches, properties of Chapman Jouguet wave; Unstable combustion. Laminar flame structure, theories of flame propagation and calculation of flame speeds, flame speed measurements, stability limits of laminar flames, flammability limits and quenching distance. Burner design; Mechanisms of flame stabilization in laminar and turbulent flows; Flame quenching, diffusion flames, comparison of diffusion with premixed flame, combustion of gaseous fuel jets, Burke and Shumann development. Burning of Condensed Phase: General mass burning considerations, combustion of fuel droplet in a quiescent and convective environment. Introduction to combustion of fuel sprays. Ignition: Concepts of ignition, chain ignition, thermal spontaneous ignition, forced ignition. Essential features of combustion process in engines, flame structure and speed, spray structure, auto-ignition. Combustion Generated Pollution and its Control, Introduction to CAE code (Ch. Eqbm. Analysis).