M.Tech Thermal Engineering 1st year (1st semester)

Title of Course: Advanced Heat and Mass Transfer
Course Code: TE101
L-T-P Scheme: 3-1-0 **Course Credits: 4**

Introduction:

Heat transfer and mass transfer are kinetic processes that may occur and be studied separately or jointly. Studying them apart is simpler, but both processes are modelled by similar mathematical equations in the case of diffusion and convection (there is no mass-transfer similarity to heat radiation), and it is thus more efficient to consider them jointly. Besides, heat and mass transfer must be jointly considered in some cases like evaporative cooling and ablation. The usual way to make the best of both approaches is to first consider heat transfer without mass transfer, and present at a later stage a briefing of similarities and differences between heat transfer and mass transfer, with some specific examples of mass transfer applications.

Course Objectives:

The objectives of this subject are as follows:

1. To develop the fundamental principles and laws of heat transfer and to explore the implications of these principles for system behavior.
2. To formulate the models necessary to study, analyze and design heat transfer systems through the application of these principles.
3. Apply semi empirical formulae to determine the heat transfer parameters and use different techniques, viz., experimental, analytical and semi empirical methods to design the thermal systems.
4. To develop the problem-solving skills essential to good engineering practice of heat transfer in real-world applications.
5. Design/Construct simple heat transfer equipment by taking to consideration all the three modes of heat transfer

Course Outcomes:

Upon completion of this course, the Students will:

CO1. Have a strong foundation in science and focus in mechanical, electronics, control, software, and computer engineering, and a solid command of the newest technologies.

CO 2.Be able to design, analyze, and test “intelligent” products and processes that incorporate appropriate computing tools, sensors, and actuators.

CO 3. Be able to demonstrate professional interaction and communicate effectively with team members.

CO 4. Be able to work efficiently in multidisciplinary teams.

CO 5. Be prepared for a variety of engineering careers, graduate studies, and continuing education

CO 6. Practice professional and ethical responsibility, and, be aware of the impact of their designs on human-kind and the environment.

Mapping of Course Outcomes and Programme Outcomes

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO1			3			3
CO2			3		3	
CO3			3		3	3
CO4			3		3	
CO5			3		3	
CO6	2		3			3

3 – High; 2 – Medium; 1 – Low

Course Contents:

Review : Review of the basic laws of conduction, radiation and convection.

Conduction : One dimensional steady state conduction with variable thermal conductivity and with internal distributed heat source; local heat source in non adiabatic plate. Extended surfaces-review; optimum fin of rectangular profile; straight fins of triangular and parabolic profiles; optimum profile; circumferential fin of rectangular profile; spines; design considerations. Two dimensional steady state conduction; semi-infinite and finite flat plates temperature field in finite cylinders and in infinite semi cylinders. Unsteady state conduction; sudden changes in the surface temperatures of infinite plate, cylinders and spheres; solutions using Groeber's and Heisler's charts for plates, cylinders and spheres suddenly immersed in fluids.

Radiation : Review of radiation principles; diffuse surfaces and the Lambert's Cosine law. Radiation through non-absorbing media; Hottel's method of successive reflections.

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TEXT BOOKS:

1. YunusA.Cengal, Heat and Mass Transfer – A practical Approach, 3rd edition, Tata McGraw - Hill, 2007.
2. Holman.J.P, Heat Transfer, Tata Mc Graw Hill, 2002.
3. Ozisik. M.N., Heat Transfer – A Basic Approach, McGraw-Hill Co., 1985
4. Incropera F.P. and DeWitt. D.P., Fundamentals of Heat & Mass Transfer, John Wiley & Sons, 2002.
5. Nag.P.K, Heat Transfer, Tata McGraw-Hill, 2002
6. Ghoshdastidar. P.S., Heat Transfer, Oxford University Press, 2004
7. Yadav, R., Heat and Mass Transfer, Central Publishing House, 1995.

Title of Course : Advanced Thermodynamics
Course Code: TE102
L-T-P Scheme: 3-1-0 **Course Credits: 4**

Introduction:

This course will prepare post graduate level engineering students to effectively solve theoretical and applied thermodynamics problems that are directly applicable to situations faced in research and industry. Significant emphasis is placed on the integration of recent thermodynamics-related research into the traditional resources in order to foster critical analysis of current work as it relates to fundamental principles. Multiple forms of assessment will be used throughout the course in order to evaluate student learning. As this is a post graduate-level course, many of the competency-based assessments can be tailored to be useful to your long-term learning goals. In addition, multiple professional skills will be practiced and demonstrated throughout the course, such as engineering communication and teamwork, since these skills are important in all engineering professions.

Course Objectives:

The objectives of this subject are as follows:
1. Apply first and second law analysis to opened and closed systems;
2. Understand the key postulates to thermodynamics and their relationship to equilibrium and properties;
3. Understand and apply the fundamental relation, the Euler equation and the Gibb-Duhem relation;
4. Apply equations of state to make property calculations of real gases;

Course Outcomes:

By the end of this course, students will be able to:
CO1. Describe and calculate thermodynamic properties of single-phase and multi-phase systems
CO2. Apply the laws of statistical and classical thermodynamics to chemically reactive systems, kinetics, and combustion.
CO3. Relate course principles to solve problems regarding gas turbines, combustion, refrigeration, and solar energy.
CO4. Communicate engineering knowledge of thermodynamics through written and verbal means.
CO5. Apply relations between thermodynamic properties (Maxwell relations);
CO6. Analyze multicomponent & multiphase systems, phase equilibrium; and chemical reactions.

Mapping of Course Outcomes and Programme Outcomes

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		3			
CO2			3		3	3
CO3		3				3
CO4			2	3		
CO5	3		3			3
CO6	3	3				

3 – High; 2 – Medium; 1 – Low

Course Contents:

Review of basic thermodynamic principles; entropy; availability; irreversibility; first and second law analysis of steady and unsteady systems;

General thermodynamics relations; Fundamentals of partial derivatives; relations for specific heats; internal energy enthalpy and entropy; Joule - Thompson coefficient; Clapeyron equation.

Multi component systems; Review of equation of state for ideal and real gases; thermodynamic surfaces; gaseous mixtures; fugacity; ideal solutions; dilute solutions; activity; non ideal liquid solutions.

Multi component phase equilibrium ; Criteria of equilibrium; stability; heterogeneous equilibrium; binary vapour liquid systems; the nucleus of condensation and the behaviour of stream with formation of large and small drops; Gibbs Phase rule; higher order phase transitions.

Thermodynamics of chemical reaction (combustion); internal energy and enthalpy - first law analysis and second law analysis; basic relations involving partial pressures; third law of thermodynamics; chemical equilibrium and chemical potential equilibrium constants; thermodynamics of low temperature.

Statistical mechanics - Maxwell - Boltzmann statistics; microstate and macrostates; thermodynamic probability; entropy and probability Bose Einstein statistics; Fermi Dirac statistics.

Elementary concepts of irreversible thermodynamics

TEXT BOOKS:

1. Basic and Applied Thermodynamics, P.K.Nag, TMH
2. Element of Gas Dynamics, Yahya, TMH
3. Fluid Mechanics and Machines, Modi and Seth, Standard Book House
4. Thermodynamics, Sonnatag & Van Wylen, John Wiley & Sons
5. Thermodynamics for Engineers, Doolittle-Messe , John Wiley & Sons
6. Heat Transfer,P.K.Nag,TMH

Title of Course : Advanced Fluid Mechanics
Course Code: TE103
L-T-P Scheme: 3-1-0 **Course Credits: 4**

Introduction:

The subject is to introduce the students to advanced fluid dynamics calculations : two- and three-dimensional flows, analytical theory, graphical methods and computations.
Subject goals: Ideal-fluid flow calculations may provide analytical solutions of simple fluid dynamics problems. Engineering applications include groundwater flow, spillway intake, airfoils, dispersion in rivers. The concepts of streamlines and equi-potentials are derived from the basic principles of fluid mechanics (continuity, Bernoulli, momentum) and a graphical method is developed. The students are exposed to engineering applications and learn to distinguish between ideal-fluid and real-fluid flows. Real fluid flow situations are analysed, including boundary layer flow, dispersion of matter and fluid-structure interactions.

Course Objectives:

The objectives of this subject are as follows:

1. To understanding basic laws, principles and phenomena in the area of fluid mechanics –
2. To solve simplified examples of fluid mechanics –
3. Theoretical and practical preparation enabling students to apply the acquired knowledge and skills in professional and specialist courses
4. Understand the effect of turbulence in external and internal flows
5. Develop insights on the effect of varying density on flow fields
6. Understand supersonic flows and shock waves

Course Outcomes:

By the end of this course, students will be able to:
CO1. Define basic terms, values and laws in the areas of fluids properties, statics, kinematics and dynamics of fluids, and hydraulic design of pipes,
CO2. Describe methods of implementing fluid mechanics laws and phenomena while analysing the operational parameters of hydraulic problems, systems and machines,
CO3. Practically apply tables and diagrams, and equations that define the associated laws
CO4. Calculate and optimise operational parameters of hydraulic problems, systems and machines,
CO5. Explain the correlation between different operational parameters,
CO6. Select engineering approach to problem solving based on the acquired physics and mathematical knowledge.

Mapping of Course Outcomes and Programme Outcomes

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		3			3
CO2					3	3
CO3			3			3
CO4			3	2		
CO5						3
CO6	3		3			1

3 – High; 2 – Medium; 1 – Low

Course Contents:

Basic Equations ;
Deformation and the rate of strain, the deformation tensor, skew-symmetry of the deformation tensor, symmetry of the stress tensor, polar and non-polar fluids, stokesian and Newtonian fluids. Derivation of the general differential equations of continuity, momentum and energy in vector form; Euler and Navier-Stokes equations, integration of the momentum equation; the generalized Bernoulli's equation.

Two Dimensional Irrotational Flow:
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; superposition of uniform stream with above; flow around corners; Rankine ovals, flow around circular cylinders with the without circulation, pressure distribution on the surface of these bodies. Elements of two dimensional aerofoils theory, symmetrical aerofoil theory; lift and moment.

Vortex Motion:
Definitions, vortex lines, surfaces and tubes, vorticity, circulation; Kelvin's circulation theorem, Helmholtz's vorticity theorems; the convection and diffusion of vorticy.

Viscous Flow:
Exact solution, plane Poiselie and Couette flows; Hagen Poiselle flow through pipes. Flows with very small Reynolds number. Flows with very large Reynolds number, elements of two dimensional boundary layer theory; displacement thickness and momentum thickness, skin friction, Blassius solution for boundary layer on a flat plate without pressure gradient; the Karman-Polhausen integral method for obtaining approximate solutions. Drag on bodies; form drag and skin friction drag profile drag and its measurement

TEXT BOOKS:
1. Massey, Mechanics of Fluids, Taylor & Francis.
2. M.M. Das, Fluid mechanics and turbo machines, PHI.
3. S.K. Some & G. Biswas, Introduction to Fluid Mechanics & Fluid Machines, TMH. REFERENCES:
4. Fox &Mcdonald, Introduction to Fluid Mechanics, Wiley.
5. Bansal, Fluid Mechanics and Machinery, Laxmi.
6. C.S.P. Ojha, R. Berndtsson, P.N. Chandramouli, Fluid Mechanics & Machinery, Oxford University Press.

Title of Course : Applied Mathematics for Mechanical Engineers
Course Code: TE104
L-T-P Scheme: 3-1-0 **Course Credits: 4**

Introduction:

This course offers an advanced introduction to numerical linear algebra. Topics include direct and iterative methods for linear systems, eigenvalue decompositions and QR/SVD factorizations, stability and accuracy of numerical algorithms, the IEEE floating point standard, sparse and structured matrices, preconditioning and linear algebra software. Problem sets require some knowledge of MATLAB

Course Objectives:

The course is intended to cover,

1. Basics concepts of mathematics like numerical algebra, probability, simulations specially Monte-Carlo simulations which will help in understanding theoretical concepts of Nanotechnology.
2. Understanding of Monte Carlo integration and Variance reduction techniques
3. Understand and apply the fundamental relation of numeric linear algebra and differential equations
4. Give the students an insight on the effect of continuous distribution and normal distribution

Course Outcomes:

CO1.To know the importance of simulations in nanotechnology.
CO2. Students without mathematics back ground will be able to understand the concept of mathematics.
CO3.To evaluate nanostructured simulations in nanotechnology
CO4. Students are able to understand concept of Probability.
CO5. Students are able to linear algebra and differential equations

Mapping of Course Outcomes and Programme Outcomes

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3					3
CO2			3		3	
CO3			3			3
CO4			3	2		3
CO5			3			

3 – High; 2 – Medium; 1 – Low

Course Contents:

Numerics in general: Interpolation, Gauss elimination, Solution by iteration, least square method.

Numeric Linear Algebra and differential equations: Matrix Eigen value problems: Introduction, Inclusion of Matrix Eigen values, Tridiognalization and RQ factorization. Methods for first order ODEs, Multi step methods, Higher order ODES

Introduction to probability: Probability, Sample space and events- Probability- the axioms of probability, some elementary theorems-conditional probability Baye's theorem Random Variables Discrete and continuous – distribution- distribution function Distribution Binomial and poison distributions and normal distribution – related properties.

Systems, Models, Simulations and the Monte Carlo Methods: Systems, Models, Simulation and the Monte Carlo Methods, Random number generation, Introduction, Congruential Generators, Statistical Tests of Pseudorandom Numbers, Random variate generation, inverse Transform Method, Composition Method, Acceptance-Rejection Method

Monte Carlo integration and Variance reduction techniques: Introduction, Monte Carlo Integration, The Hit or Miss Monte Carlo Method, The Sample-Mean Monte Carlo Method, Efficiency of Monte Carlo Method, Integration in Presence of Noise

TEXT BOOKS:

1. Advanced engineering mathematics, by Erwin Kreyszig, wiley publications
2. Probability and statistics, scham series, Arnold o. allen, academic press
3. Probability and statistics, Arnold o. allen, academic press
4. Probability and statistics for engineers, miller and john e. freund, prentice hall of india
5. A primer for the monte carlo method, llya M. Sobol’ CRC Press

Title of Course : Thermal Engineering Lab
Course Code: TE191
L-T-P Scheme: 3-1-0 **Course Credits: 4**

Introduction:

Heat Transfer laboratory provides fundamental and industrial knowledge about modes of heat transfer, like conduction, convection and radiation, and their application.

Heat Transfer is one of the important subjects which is commonly applied in renewable energy, industrial, commercial and domestic systems. The experiments are designed to provide exposure of practical aspects of the various theoretical concepts developed under the course, Heat and Mass Transfer. The laboratory consists of experiments on various conductive, convective, radiative, boiling and condensing mechanisms of heat transfer.

Course objective:

1. To understanding basic laws, principles and phenomena in the area of thermal engineering
2. To solve simplified examples of thermal engineering
3. Theoretical and practical preparation enabling students to apply the acquired knowledge and skills in professional and specialist courses

Course Outcomes:

At the successful completion of course, the student is able to:
CO1. Practically relate to concepts discussed in the Heat Transfer course.
CO2. Conduct various experiments to determine thermal conductivity and heat transfer coefficient in various materials.
CO3. Select appropriate materials & designs for improving effectiveness of heat transfer.
CO4. Conduct performance tests and thereby improve effectiveness of heat exchangers.
CO5. Conduct performance tests and thereby improve effectiveness of refrigeration and air conditioning systems.

Mapping of Course Outcomes and Programme Outcomes

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2					3
CO2			3			
CO3	3	3	3			3
CO4						
CO5			3			3

3 – High; 2 – Medium; 1 – Low

Course Contents:

1. Performance analysis of four stroke S.I. Engine- Determination of indicated and brake thermal efficiency, specific fuel consumption at different loads, Energy Balance.
2. Performance analysis of four stroke C.I. Engine- Determination of indicated and brake thermal efficiency, specific fuel consumption at different loads, Energy Balance.
3. Performance analysis of an alternate fuel on computerized IC Engine test rig. 4. Calculation of thermal conductivity of metal rods.
5. Experiment on Pin fin Apparatus (free and force convection heat transfer).
6. COP calculation on air conditioning test rig apparatus.

7. COP calculation on simple vapour compression refrigeration test rig.
8. Performance test and analysis of exhaust gases of an I.C. Engine.
9. Dryness fraction estimation of steam
10. Compressibility factor measurement of different real gases.