GUJARAT TECHNOLOGICAL UNIVERSITY

PRODUCTION ENGINEERING

ENGINEERING THERMODYNAMICS & HEAT TRANSFER

SUBJECT CODE: 2132502

B.E. 3RD SEMESTER

Type of course: Engineering Science

Prerequisite: N.A.

Rationale: Engineering Thermodynamics and Heat Transfer is the first course on Thermal Science and Engineering. It studies various energy interactions notably heat and work transfer. It is based on certain laws of nature which are never seen to be violated. Heat transfer is involved in production engineering processes be it casting, welding, machining or heat treatment of materials. The heat transfer modes namely conduction, convection and radiation are based on fundamental laws and its knowledge enhances the understanding of energy transfer in manufacturing processes.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE Viva (V)	PA (I)	
4	2	0	6	70	30	20	30	150

Content:

Sr. No.	Topics	Teaching Hrs.	Module Weight age
1	BASIC CONCEPT AND FIRST LAW: Basic concepts - concept of continuum, macroscopic approach, thermodynamic systems - closed, open and isolated. Property, state, path and process, quasi-static process, work, modes of work, Zeroth law of thermodynamics – concept of temperature and heat. Concept of ideal and real gases. First law of thermodynamics – application to closed and open systems, internal energy, specific heat capacities, enthalpy, steady flow process with reference to various thermal equipments.	10	15%
2	SECOND LAW AND ENTROPY : Second law of thermodynamics – Kelvin's and Clausius statements of second law. Reversibility and irreversibility. Carnot theorem, Carnot cycle, reversed carnot cycle, efficiency, COP. Thermodynamic temperature scale, Clausius inequality, concept of entropy, entropy of ideal gas, principle of increase of entropy.	10	15%
3	THERMODYNAMIC AVAILABILITY: Basics – Energy in non-flow processes : Expressions for the Exergy of a closed system-Equivalence between mechanical energy forms and Exergy – Flow of energy associated with heat flow – Exergy consumption and entropy generation. Exergy in steady flow processes : Expressions for Exergy in steady flow processes – Exergy dissipation and entropy generation.	5	10%
4	PROPERTIES OF PURE SUBSTANCE:	5	10%

	Properties of pure substances – Thermodynamic properties of pure substances in solid, liquid and vapour phases, phase rule, P-V, P-T, T-V, T-S, H-S diagrams, PVT surfaces, thermodynamic properties of steam. Calculations of work done and heat transfer in non-flow and flow processes.		
5	CONDUCTION: Basic Concepts – Mechanism of Heat Transfer – Conduction, Convection and Radiation – Fourier Law of Conduction - General Differential equation of Heat Conduction — Cartesian and Cylindrical Coordinates – One Dimensional Steady State Heat Conduction – Conduction through Plane Wall, Cylinders and Spherical systems – Composite Systems – Conduction with Internal Heat Generation – Extended Surfaces – Unsteady Heat Conduction – Lumped Analysis – Use of Heislers Chart.	8	15%
6	CONVECTION: Basic Concepts –Heat Transfer Coefficients – Boundary Layer Concept – Types of Convection – Forced Convection – Dimensional Analysis – External Flow – Flow over Plates, Cylinders and Spheres – Internal Flow – Laminar and Turbulent Flow – Combined Laminar and Turbulent – Flow over Bank of tubes – Free Convection – Dimensional Analysis – Flow over Vertical Plate, Horizontal Plate, Inclined Plate, Cylinders and Spheres.	6	15%
7	PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS : Nusselts theory of condensation-pool boiling, flow boiling, correlations in boiling and condensation. Types of Heat Exchangers – Heat Exchanger Analysis – LMTD Method and NTU - Effectiveness – Overall Heat Transfer Coefficient – Fouling Factors.	6	10%
8	RADIATION : Basic Concepts, Laws of Radiation – Stefan Boltzman Law, Kirchhoff's Law –Black Body Radiation –Grey body radiation - Shape Factor Algebra – Electrical Analogy – Radiation Shields –Introduction to Gas Radiation	6	10%

Reference Books:

1. Engineering Thermodynamics by P.K. Nag, McGraw-Hill Education
2. Fundamentals of Thermodynamics by Borgnakke & Sonntag, 7th Ed. Wiley India (P) Ltd.
3. Thermodynamics – An Engineering Approach by Yunus Cengel & Boles, McGraw-Hill Education
4. Engineering Thermodynamics by Gordon Rogers and Yon Mayhew, Pearson Education Ltd.
5. Heat and Mass Transfer: Fundamentals and Applications, 5/e Yunus A. Cengel & Michael a. Boles 5th Ed
6. Heat Transfer P. S. Ghoshdastidar Oxford University Press, USA 2012.
7. J.P. Holman, "Heat Transfer", McGraw Hill, 2003.
8. Heat and Mass Transfer R. C. Sachdeva, New Age International, New Delhi.4th Ed
9. HEAT AND MASS TRANSFER, 3/E 3rd Edition, P.K.Nag. Tata Mcgraw Hill Education Private Limited

Course Outcome:

After learning the course the students should be able to

- Apply the First Law of thermodynamics in various engineering situations.
- Identify and compute energy exchange in the thermodynamics processes (in terms of various forms of energy, heat and work).
- Apply the concepts of path dependence/independence and reversibility/irreversibility of various thermodynamic processes and represent these in terms of changes in thermodynamic state.
- Apply the steady-flow energy equation or the First Law of Thermodynamics to a system of thermodynamic components (heaters, coolers, pumps, turbines, pistons, etc.) To estimate required balances of heat, work and energy flow.
- Analyse all mode of heat transfer for real time cases (1D, 2D, 3D) in steady and unsteady state.
- Design simple heat exchanger and predict its performance.

List of Open Source Software/learning website:

http://nptel.iitm.ac.in/courses.php

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.