GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3142507
Semester – 4
Subject Name: Fluid Mechanics and Heat Transfer

Type of course: Basic Science

Prerequisite: Nil

Rationale: This course imparts fundamental knowledge regarding fluid, types, properties and basic governing equations in static and moving conditions. The course is also prepared to provide the detailed understating of various modes of heat transfer and its applications in Engineering.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
4	0	2	5	70	30	30	20	150

Content:

Sr. No.	Course Content	Total Hours
1	**Fluids and Their Properties:** Fluid classifications, hypothesis of continuum, shear stress in a moving fluid, molecular structure of material, density, viscosity, surface tension, capillary effect, vapor pressure, compressibility and the bulk modulus, pressure, Pascal's law of pressure at a point, variation of pressure vertically in a fluid under gravity, equality of pressure at the same level in a static fluid, general equation for the variation of pressure due to gravity from a point to point in a static fluid, pressure and head, hydrostatic paradox	8
2	**Static Forces on Surface and Buoyancy:** Fluid static, action of fluid pressure on surface, resultant force and center of pressure on a plane surface under uniform pressure and surface immersed in a liquid, pressure diagrams, forces on a curved surface due to hydrostatic pressure, buoyancy, equilibrium of floating bodies, stability of a submerged body and floating bodies, determination of the metacentric height, determination of the position of the metacenter relative to the center of buoyancy	8
3	**Motion of Fluid Particles and Streams:** Fluid flow, different types of flow, frames of reference, analyzing fluid flow, motion of a fluid particle, acceleration of a fluid particle, discharge and mean velocity, continuity of flow, continuity equations for 2-D flow in Cartesian coordinates of system **The Energy Equation and its Application:** Momentum and fluid flow, Momentum equation for 2-D flow along a stream line, momentum correction factor, Euler's equation of motion along a stream line, mechanical energy of a flowing fluid, Bernoulli's theorem, kinetic energy correction factor, principle of venturimeter, orifice, rotameter	8
4	**Dimensional Analysis and Similarities:** Dimension reasoning, dimensional homogeneity, dimensional analysis using Rayleigh's method, Buckingham π-theorem, use of dimensionless numbers in experimental investigation, geometric similarity, dynamic similarity, kinematic similarity, model testing, model laws, undistorted and distorted models	4

5	**Conduction:** Fourier's law, effect of temperature on thermal conductivity of different solids, liquids and gases, generalized equation in Cartesian and cylindrical coordinates and its reduction to specific cases, One dimensional steady state conduction, heat conduction through plane and composite walls and cylinders, electrical analogy, critical radius of insulation for cylinder, overall heat transfer coefficient **Heat transfer from extended surface:** Types of fin, heat flow through uniform cross-sectional area fin insulated at the tip, efficiency and effectiveness of fin	10
6	**Convection:** Newton's law of cooling, dimensional analysis applied to forced and free convection, dimensionless numbers and their physical significance, empirical correlations for free and forced convection, Continuity, momentum and energy equations, thermal and hydrodynamic boundary layer	8
7	**Radiation:** Absorptivity, reflectivity and transmissivity, black, white and grey body, emissive power, emissivity, Kirchhoff's law, Planck's law, Rayleigh-Jeans' law, Wien's law, Wien's displacement law, Stefan-Boltzmann law, intensity of radiation, radiation heat exchange between black bodies, shape factor, radiation heat exchange between gray bodies, radiation shields	8
8	**Heat exchanger:** Classification, heat exchanger analysis, LMTD for parallel and counter flow exchanger, condenser and evaporator, overall heat transfer coefficient, fouling factor, effectiveness-NTU method for parallel and counter flow heat exchanger	6

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	40	50	0	0	0

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Fluid Mechanics and Fluid Power Engineering by D.S. Kumar, S. K. Kataria & Sons
2. Fluid Mechanics and Hydraulic Machines by R.K. Bansal, Laxmi Prakashan
3. Fluid Mechanics and Hydraulic Machines by R.K. Rajput, S.Chand & Co.
4. Heat and Mass Transfer by P.K. Nag, McGraw Hill
5. Heat and Mass Transfer: Fundamentals and Application by Yunus Cengel, McGraw Hill
6. Fundamental of Heat and Mass Transfer by Incropera and Dewitt, Wiley Publication

Course Outcomes:

Students will be able to:

Sr. No.	CO statement	Marks % weightage
CO-1	study and understand various fluid properties and behavior of fluid in static and dynamic mode, and to make use of dimensional analysis	42
CO-2	classify the heat transfer problems and to apply the principles of steady state one dimensional heat transfer and extended surface	20

CO-3	identify the type of convection problems and to apply concepts of natural and forced convection for related problems	15
CO-4	explain various laws of radiation heat transfer and to determine the radiation heat transfer between black and grey surfaces of simple Mechanical systems	15
CO-5	understand and practice LMTD and effectiveness-NTU method for simple heat exchange device	8

List of Experiments: (at least ten experiments from the following list should be performed)

1. Verification of Bernoulli's theorem
2. To determine metacentric height by metacentric height apparatus.
3. To measure the velocity of flow using orifice meter and venturimeter.
4. To determine the thermal conductivity of given metal rod
5. To determine the thermal conductivity of the given composite walls.
6. To determine Stephan Boltzmann constant experimentally.
7. To determine heat transfer co-efficient by forced convection.
8. To determine heat transfer co-efficient by natural convection.
9. To determine the emissivity of gray body.
10. To measure convective heat transfer co-efficient and effectiveness of the fin under forced convection.
11. To measure convective heat transfer co-efficient and effectiveness of the fin under natural convection.
12. To determine critical radius of insulation.

Major Equipment: Bernoulli's theorem apparatus, Flow measuring devices and arrangements, metacentric height apparatus, Pin fin apparatus, Emissivity measurement apparatus, Composite wall apparatus, Stefan Boltzman apparatus, Natural and force convection apparatus, critical radius apparatus

List of Open Source Software/learning website: http://nptel.ac.in/