



GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3170102

SUBJECT NAME: Theory of Heat Transfer

B.E. 7th SEMESTER

Type of course: Professional Elective Course

Prerequisite: Basics of Engineering Thermodynamics, Basics of Fluid Mechanics

Rationale: In any area of industrial applications, heat is transferred from one substance to another substance because of temperature difference. As an Aeronautical Engineer, students should know in which parts of an aircraft the temperature difference occur and by which means. It also helps to understand the thermal stresses developed on the body or element.

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	<p>Steady State Conduction Heat Transfer: Fourier's law of heat conduction, effect of temperature on thermal conductivity of metals, refractory and building materials, liquid and gases, derivation of generalized equation in Cartesian coordinates and its reduction to specific cases, three dimensional heat conduction equations in cylindrical and spherical co-ordinates One dimensional steady state conduction, heat conduction through plane and composite walls, hollow and composite cylinders, hollow and composite spheres, electrical analogy, overall heat transfer coefficient Critical thickness of insulation,</p> <p>Transient heat conduction: lumped capacitance method for bodies of infinite thermal conductivity, time constant, one dimensional transient heat conduction in plane wall with finite conduction and convective resistances</p>	10
2	<p>Heat Transfer Extended Surface: Types of fin, heat flow through rectangular fin, infinitely long fin, fin insulated at the tip and fin losing heat at the tip, efficiency and effectiveness of fin, Biot number, Numericals</p>	06
3	<p>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, Blasius solution for laminar boundary layer, General solution for Von-Karman integral momentum equation</p>	07



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4	Radiation: Absorptivity, reflectivity and transmissivity, black, white and grey body, emissive power and emissivity, laws of radiation – Planck, Stefan- Boltzmann, Wein's displacement, Kirchoff, intensity of radiation and solid angle, Lambert's cosine law. Radiation heat exchange between black bodies, shape factor, heat exchange between non-black bodies- infinite parallel planes, radiation shield, heat exchange between two grey surfaces, electrical analogy.	10
5	Heat Exchangers: Types, heat exchanger analysis, LMTD for parallel and counter flow exchanger, condenser and evaporator, overall heat transfer coefficient, fouling factor, correction factors for multi pass arrangement, effectiveness and number of transfer unit for parallel and counter flow heat exchanger, introduction to heat pipe, compact heat exchangers, numericals	8
6	Two-phase heat transfer: Boiling and Condensation*: Boiling of liquids, Pool boiling curve, modes of pool boiling, correlation for pool boiling, condensation of vapor, film wise and drop wise condensation, condensation on flat surfaces and horizontal tubes	4

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
5%	25%	30%	25 %	10%	5%

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. Heat & Mass Transfer - R.K. Rajput, S.Chand Publication
2. Heat & Mass Transfer R. C. Sachdeva, New Age International, New Delhi
3. Heat & Mass Transfer - P.K. Nag, Tata McGraw Hill, New Delhi.
4. Heat & mass transfer - D.S. Kumar, S.K. Kataria & Sons
5. Heat & Mass Transfer - Arora & Domkundwar, - Dhanpat rai and Co., NewDelhi
6. Heat and Mass Transfer: Fundamentals and Application by YunusCengel, McGraw Hill
7. Fundamental of Heat and Mass Transfer by Incropera and Dewitt, Wiley Publication

Course Outcome:

After learning the course the students should be able to:



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Sr. No.	CO statement	Marks % weightage
CO-1	To classify the heat transfer problems and to apply the principles of steady state one dimensional heat transfer, extended surface and unsteady state conduction for commonly encountered Mechanical engineering problems.	32
CO-2	To identify the type of convection problems and to apply concepts of natural and forced convection for related problems and to know about the role of dimensional analysis for model and prototypes	22
CO-3	To explain various laws of radiation heat transfer and to determine the radiation heat transfer between black and grey surfaces of simple Mechanical systems	20
CO-4	To practice LMTD and effectiveness-NTU method for simple heat exchangedevice	16
CO-5	To identify types of boiling and condensation heat transfer process and to use the same to estimate heat transfer coefficient for simple cases	10

List of Experiments:

1. To determine the thermal conductivity of the given composite walls.
2. To determine critical radius of insulation.
3. To determine the emissivity of gray body.
4. To determine heat transfer co-efficient by forced convection.
5. To determine heat transfer co-efficient by natural convection.
6. To measure convective heat transfer co-efficient and effectiveness of the fin under forced convection.
7. To measure convective heat transfer co-efficient and effectiveness of the fin under natural convection.
8. To determine heat transfer co-efficient for transient heat transfer process.
9. Concentric tube heat exchanger
10. To determine the overall heat transfer co-efficient of shell and tube type heat exchangers.
11. To study film and drop wise condensation and to determine the film co-efficient

Major Equipment: Shell and tube heat exchanger, Pin fin apparatus, Emissivity measurement apparatus, Composite wall apparatus, Natural and force convection apparatus, transient heat transfer apparatus, critical radius apparatus, film and drop wise condensation apparatus

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