GUJARAT TECHNOLOGICAL UNIVERSITY

BRANCH NAME: Aeronautical Engineering
SUBJECT NAME: Theory of Heat Transfer
SUBJECT CODE: 2170102
B.E. 7th SEMESTER

Type of course: Engineering Science

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 of an aircraft**.**

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)	
					PA	ALA	ESE	OEP		
4	0	2	6	70	20	10	20	10	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	**BASIC CONCEPTS OF HEAT TRANSFER AND CONDUCTION:** 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, transient heat conduction- lumped heat capacity analysis	**10**	30%
2	**HEAT TRANSFER THROUGH FINS:** 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	**6**	15%
3	**INTRODUCTION TO BOUNDARY LAYER:**	**4**	10%

	Continuity, momentum and energy equations, thermal and hydrodynamic boundary layer, blasius solution for laminar boundary layer.		
4	**CONVECTION:** Types of convection, Dimensional analysis applied to forced and free convection, dimensionless numbers and their physical significance, empirical correlations for free and forced convection	**4**	10%
5	**INTRODUCTION TO 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.	**6**	15%
6	**HEAT EXCHAGNERS:** 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**	15%
7	**BOILING AND CONDENSATION:** Boiling regimes, bubble growth, nucleate boiling, critical heat flux, film pool boiling, forced convection boiling. Film wise and drop wise condensation, laminar film condensation on vertical plate, turbulent film condensation, film condensation on tubes.	**4**	5%

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,
2. Heat and mass transfer S. Chand & Co. New Delhi

3. Heat & Mass Transfer R. C. Sachdeva, New Age International, New Delhi
4. Heat & Mass Transfer - P.K. Nag, Tata McGraw Hill, New Delhi.
5. Heat & mass transfer - D.S. Kumar, S.K. Kataria & Sons
6. Heat & Mass Transfer - Arora & Domkundwar, - Dhanpat rai and Co., NewDelhi

Course Outcome:

After learning the course the students should be able to:

To know about the basic fundamentals of heat transfer
To understand the modes of heat transfer
To understand the nature of day to day life heat transfer applications
To know about the basics of boiling and condensation over the aircraft at high altitudes
To know about the role of dimensional analysis for model and prototypes

List of Experiments:

1. Heat transfer through composite wall
2. Thermal conductivity of insulating powder
3. Emissivity measurement of test plate
4. Heat transfer through natural convection
5. Heat transfer through force convection
6. Heat transfer through pin fin
7. Concentric tube heat exchanger
8. Shell and tube heat exchanger
9. critical heat flux

Design based Problems (DP)/Open Ended Problem:

Apart from above experiments a group of students has to undertake one open ended problem/design problem.
Few examples of the same are given below.

1. Develop a model for understanding Dropwise & filmwise condensation
2. Unsteady state heat transfer

Major Equipment:

experimental setups to perform above experiments

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.