GUJARAT TECHNOLOGICAL UNIVERSITY

MECHANICAL ENGINEERING (19)
HEAT TRANSFER
SUBJECT CODE: 2151909
B.E. 5th SEMESTER

Type of course: Core course

Prerequisite: Thermodynamics

Rationale: The course is prepared to provide the detailed understating of heat transfer principles

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
				Theory Marks			Practical Marks			
L	T	P	C	ESE (E)	PA (M)		PA (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	0	2	5	70	20	10	20	10	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	**Fundamental:** Modes of heat transfer, effect of temperature on thermal conductivity of different solids, liquids and gases, derivation of generalized equation in Cartesian, cylindrical and spherical coordinates and its reduction to specific cases, General laws of heat transfer	**3**	7
2	**Conduction:** Fourier's law, One dimensional steady state conduction, heat conduction through plane and composite walls, cylinders and spheres, electrical analogy, critical radius of insulation for cylinder and sphere, overall heat transfer coefficient. **Transient heat conduction**- lumped heat capacity analysis, time constant, transient heat conduction in solids with finite conduction and convective resistances **Heat transfer from 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, Estimation of error in temperature measurement in a thermometer well	**10**	24
3	**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 of Von-Karman integral momentum equation	**9**	21
4	**Radiation:** Absorptivity, reflectivity and transmissivity, black, white and grey body, emissive power and emissivity, laws of radiation – Planck, Stefan-Boltzmann, Wein's displacement, Kirchhoff's law, 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 and infinite long concentric cylinders,	**9**	21

	radiation shield, heat exchange between two grey surfaces, electrical analogy		
5	**Heat exchanger:** Classification, 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 of heat pipe and compact heat exchanger	**7**	17
6	**Two-phase heat transfer:** Boiling of liquids, Pool boiling curve, different types of pool boiling, condensation of vapor. Film wise & drop wise condensation.	**4**	10

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
15	**25**	**20**	**15**	**15**	**10**

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 by P.K. Nag, McGraw Hill
2. Heat and Mass Transfer: Fundamentals and Application by Yunus Cengel, McGraw Hill
3. Fundamental of Heat and Mass Transfer by Incropera and Dewitt, Wiley Publication
4. Heat Transfer by Mills and Ganesan, Pearson Education
5. Heat Transfer by J P Holman , McGraw Hill
6. Heat and Mass Transfer by R K Rajput, S.Chand Publication
7. Heat Transfer: Principles and Applications by Dutta, Binay K, PHI Publication

Course outcome:

After learning the course the students should be able to:

- Understand basic concept of heat transfer
- Able to do basic calculations involving heat transfer as is typical for a mechanical engineer. This includes conduction, convection and radiation heat transfer as well as heat exchanger design.
- Apply scientific and engineering principles to analyze and design aspects of engineering systems that relate to conduction, convection and radiation heat transfer.

List of laboratory experiments: (Any 10 of the following experiments)

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

Design based Problems (DP)/Open Ended Problem:

- Calculate cooling capacity of domestic refrigerator
- Study the effect of circulation of fan in a room having air conditioner
- Analyze the performance of electric water heater with different flow rate
- Comparison of composite wall made of different materials

Major equipment:

- Apparatus to determine thermal conductivity of metal rod
- Guarded hot plate method apparatus
- Composite wall apparatus
- Double pipe heat exchanger
- Shell and tube heat exchanger
- Pin fin apparatus
- Emissivity measurement apparatus
- Stefan Boltzmann apparatus
- Natural and force convection apparatus

List of Open Source Software/learning website:

- nptel.ac.in
- www.learnerstv.com
- cosmolearning.org

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.