SARVAJANIK UNIVERSITY

Sarvajanik College of Engineering and Technology, Surat

Bachelor of Technology (B.Tech)

B.Tech. Semester III

Subject Name:Heat Transfer **Subject Code:BTCH13305**

Type of course: **Professional Core Course**

Prerequisite: Students having adequate knowledge of Thermodynamics Mathematical background is also essential in this respect

Rationale: Heat transfer is a necessary process in virtually all forms of energy generation and use; from coal fired to nuclear power stations, from automobile engines to rocket motors, from refrigerating cold stores to air conditioning space vehicles. This subject is intended to make students aware about mechanisms involved in heat transfer process in many of aforementioned applications. This ultimately will enable the students to design the equipments for heat process viz., shell and tube heat exchangers, evaporators, condensers.

Teaching and Examination Scheme:

TEACHING SCHEME				Theory Marks			Practical Marks		Total
L	T	P	C	TEE	CA1	CA2	TEP	CA3	150
3	0	2	4	60	15	25	30	20	

CA1: Continuous Assessment (assignments/projects/open book tests/closed book tests **CA2:** Sincerity in attending classes/class tests/ timely submissions of assignments/self-learning attitude/solving advanced problems **TEE:** Term End Examination **TEP:** Term End Practical Exam (Performance and viva on practical skills learned in course) **CA3:** Regular submission of Lab work/Quality of work submitted/Active participation in lab sessions/viva on practical skills learned in course

Content:

Sr. No.	Topics	Teaching Hrs.	Module Weightage (%)
1.	**Introduction to heat transfer**: Overview of applications of heat transfer in different fields of engineering Modes of heat transfer with examples and governing laws, Electrical analogy to heat flow **Heat Transfer by Conduction:** Mechanism of heat conduction,Fourier's law of heat conduction, General conduction equation in cartesian, cylindrical and spherical co-ordinates, thermal conductivity of solids, liquids and gases, effect of temperature on thermal conductivity, Formulation of heat transfer problems without generation of heat, Boundary conditions, Heat conduction through composite slab, cylindrical and spherical shells., Critical and Optimum thickness of Insulation. Unsteady State heat Conduction	10	22

2.	**Heat transfer by convection**: Mechanism, thermal and velocity boundary layers, boundary layer thickness, relationship between hydrodynamic and thermal boundary layer thickness for flow over flat plates, the convective heat transfer coefficient, dimensionless numbers in heat transfer and their physical significance **Natural Convection:** Natural convection from vertical and horizontal surfaces under laminar and turbulent conditions for plates, cylinders. **Forced Convection:** Heat transfer by convectionwithout phase change, Correlation equations for heat transfer in laminar and turbulent flow for external and internal flows for constant heat flux and wall temperature conditions- flow in a circular tube Analogy between momentum and heat transfer: Development of Reynold's, Prandtl and Colburn analogy	8	18
3.	**Boiling and Condensation:** Pool boiling - Boiling curve, hysteresis in the boiling curve, mechanism of nucleate boiling, Forced convection boiling - Brief over view of internal forced convection boiling. Condensation: Physical mechanisms, types of condensation, factors affecting condensation	6	13
4.	**Evaporation:** Principle of Evaporation, types of evaporators- their construction and operation, Single effect and multiple effect evaporators, Performance of evaporators, capacity and economy of evaporators, Overall heat transfer coefficient, effect of liquid head and boiling point elevation. Material and energy balances for single effect and Multiple effect evaporator	7	16
5.	**Heat Exchangers:** Classification of heat exchangers, Shell and tube heat exchanger, fouling, concept of overall heat transfer coefficient, LMTD, correction factor for LMTD, Temperature – distance plots for different flow arrangements in single and multi-pass heat exchangers. Determination of area, length, number of tubes required for a given duty in different configurations using LMTD method of analysis. Concept of Effectiveness- NTU method. **Extended Surfaces** different types of fins, fin efficiency, applications of extended surfaces	8	18
6.	**Heat transfer by radiation:** Introduction- theories of radiation,	6	13

	electromagnetic spectrum, thermal radiation, spectral emissive power, surface emission- total emissive power, emissivity. Radiative properties, Emission, irradiation, absorptivity, reflectivity and transmissitivity. Concept of black and grey body, radiation intensity, Laws of black body radiation, non-black surfaces- Grey, white and real surface, radiation between black surfaces and gray surfaces		

Suggested Specification table with Marks (Theory/Practical):

% Distribution of Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
25	25	20	15	15	-

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

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

Reference Text Books:

Sr. No.	Title of book /article	Author(s)	Publisher and details like ISBN	Year of publication	Publication Edition
1.	Unit Operations of Chemical Engineering	McCabe W L, Smith J C, Harriott P	McGraw Hill,	2005	7th
2.	Process Heat Transfer	D. Q. Kern,	ISBN13-978-0074632178, McGraw Hill Education	2017	--
3.	Engineering Heat Transfer	Gupta Prakash	ISBN13- 978-185240725, Nem Chand	2012	8th
4.	Chemical Engineering Vol. 1	J. M. Coulson & J. F. Richardson	Butterworth-Heinemann	1999	6th
5.	A Textbook Of Heat And Mass Transfer Si Units	R.K.Rajput	S. Chnad	2018	--

Course Outcome:

Sr. No.	CO Statement After learning this subject, students will be able to	Marks % weightage
CO-1	Analyze problems involving steady state and unsteady state heat	20

	conduction in simple geometries.	
CO-2	Evaluate heat transfer coefficients for natural and forced convection by applying empirical equations	20
CO-3	Solve simple thermal radiation heat transfer problems	10
CO-4	Analyse the heat transfer processes involved in boiling and condensation	10
CO-5	Perform basic calculations of heat exchangers to determine relevant design parameters	20
CO-6	Classify the types of evaporators and calculate relevant design parameters of evaporators	10

Mapping with POs:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO-1	3	3	2	3	2	1	2	2	3	3	2	3	2	2	3
CO-2	3	3	2	3	2	1	2	2	3	3	2	3	3	2	3
CO-3	3	3	3	3	2	1	2	2	3	3	2	3	2	2	3
CO-4	3	3	2	3	2	1	2	2	3	3	2	3	2	1	3
CO-5	3	3	3	3	2	1	2	2	3	3	2	3	2	2	3
CO-6	2	2	2	3	2	1	2	2	3	3	2	3	2	1	3
Rationale *	**17**	**17**	**14**	**18**	**12**	**6**	**12**	**12**	**18**	**18**	**12**	**18**	**13**	**10**	**18**

Rationale*: Explaining why it is matching this particular program outcome

LIST OF PRACTICALS: (Minimum 10 to be performed.)

1. Determine Thermal Conductivity and Thermal Resistance in Composite wall by Heat Conduction
2. Determine Thermal Conductivity of insulation material in Composite Cylinder (Lagged Pipe) by Heat Conduction

3. Determination of heat transfer coefficient by natural convection
4. Study Unsteady state phenomena
5. Determine Critical Heat flux
6. Determine Emissivity of Test plate via thermal radiation
7. Determine overall heat transfer co-efficient (U) in Agitated vessel and study yhe effect of Agitation on value of U
8. Determine overall heat transfer co-efficient (U) in Plate type heat exchanger
9. Determine overall heat transfer co-efficient (U) in Dropwise and Filmwise condensation
10. Study Shell and Tube Heat Exchanger
11. Study Triple Effect Evaporator

Major Equipment:

1. Composite wall
2. Lagged pipe
3. Natural convection set up
4. Emissivity measurement
5. Unsteady state conduction set up
6. Critical heat flux set up
7. Agitated vessel
8. Shell and tube heat exchanger
9. Plate type heat exchanger
10. Drop wise and film wise condensation
11. Multiple effect evaporator

List of Open Source/learning website:

- https://vlab.amrita.edu
- https://nptel.ac.in/courses/103/103/103103032/
- https://nptel.ac.in/courses/103/105/103105140/
- https://nptel.ac.in/courses/103/101/103101137/

List of Open Source Software: DWSIM