Subject Code: 09CH0402
Subject Name: Process Heat Transfer
Semester: 4th

Objectives: To learn to Supervise operation and maintenance of various heat transfer equipments.

Credits Earned: 6 credits

Course Outcomes: After completion of this course, student will be able to:

i. Classify Modes of heat transfer
ii. Derive equations of steady state heat transfer through wall, cylinder and sphere
iii. Explain shell and tube heat exchangers
iv. Explain heat transfer with phase change
v. Calculate radiation based on radiation laws

Pre-requisite of course: Std. X Chemistry, physics, Mathematics

Teaching and Examination Scheme:

Teaching Scheme (Hours)			**Credits**	Theory Marks			Tutorial/ Practical Marks		Total Marks
Theory	Tutorial	Practical		ESE	IA	CSE	VIVA	Term work	
2	0	4	6	50	30	20	25	25	150

Contents:

1	**Introduction to Heat Transfer:** Definition of Heat Transfer and its importance in process industries, Classification of modes of heat transfer, Differentiation of steady and unsteady state of heat transfer.	2
2	**Heat Transfer by Conduction:** Fourier's law of heat conduction with Concepts of (a) Heat transfer rate (b) Heat flux (c) Temperature gradient, Thermal conductivity. Steady state (S.S.) heat conduction through composite wall, S.S. heat conduction through composite cylinder up to three layers, S.S. heat conduction through composite sphere up to three layers, Simple problems by direct use formula. Thermal Conductivity of solids, liquids and gases.	6

3	**Heat Transfer by Convection:** Types of Convection, Free convection, Force convection. Newton's Law of convective heat transfer. Individual and Overall heat transfer coefficient. Simple Problems of Convection Simple Problems of Convection	2
4	**Heat exchangers :** Types of heat exchanger, Double pipe heat exchanger (a) Counter current (b) Co-current, Shell and tube heat exchanger : (a) 1-1 Pass (b) 1-2 Pass (c) 2-4 Pass, Plate type heat exchanger, Finned type(extended surface) heat exchanger, Heat transfer in agitated vessels, L.M.T.D.	6
5	**Heat Transfer with Phase Change:** Heat transfer with phase change, Significance of dimensionless group Prandtl No., Reynold No., Grashoff No., Nusselt No., Phenomena of Boiling Pool and Nucleate boiling), Phenomena of Condensation Drop wise and film wise Condensation and Commonly used Condensers	4
6	**Thermal Radiation:** Definition of radiation, Concepts of radiation Emission of radiation, Wavelength of radiation, Emissive power, Black body, Gray body, White body, Opaque body, Monochromatic wave length, Radiation laws Kirchhoff's Law, Stefan Boltzmann Law, Simple calculations of radiation	4
7	**Evaporation:** Introduction, Characteristics of liquid for evaporation, Single and multi effect evaporation with flow arrangement, Types of evaporators Evaporator capacity and economy, Duhring's rule and its importance.	4
	Total hours	28

References:

- **Text Book**
  1. Unit Operations of Chemical Engineering by McCabe, Warren L., Julian C. Smith, 7th edition distribution co.
- **Reference book**
  1. Unit Operation –II, by Gavhane, K.A., Nirali Prakashan, Pune 2009.
  2. Introduction to Chemical Engineering by L.Badger, Julius T. Banchero, McGraw Hill Publication, New York 2004 (Seventh Edition).
  3. Engineering heat transfer by Gupta & Prakash, Nem Chand & Brothers, New Delhi, 1999 (Seventh Edition).
  4. Process heat transfer by D.Q.Kern ,Tata McGraw Hill Publication, New Delhi, (Reprint 2008).
  5. Introduction to chemical engineering Ghosal Salil k. Tata McGraw Hill Publication, New Delhi, (Reprint 2006).

Suggested Theory distribution:

The suggested theory distribution as per Bloom's taxonomy is as follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process.

Distribution of Theory for course delivery and evaluation					
Remember	Understand	Apply	Analyze	Evaluate	Create
20%	40%	20%	20%	-	-

List of Experiments:

1. Determine the thermal conductivity of Metal Rod
2. Determine the thermal conductivity of composite wall
3. Determine the overall heat transfer co-efficient in Agitated vessel
4. Determine the liquid-liquid overall heat transfer coefficient for shell and tube heat exchanger
5. Determine the overall heat transfer co-efficient for horizontal double pipe heat exchanger.
6. Determine the overall heat transfer co-efficient for vertical double pipe heat exchanger.
7. Calculate the rate of condensation in Drop-wise condensation
8. Calculate the rate of condensation in Film-wise condensation
9. Determine economy of open pan evaporator.
10. Study and compare different types of Evaporators.

Instructional Method:

a. The course delivery method will depend upon the requirement of content and need of students. The teacher in addition to conventional teaching method by black board, may also use any of tools such as demonstration, role play, Quiz, brainstorming, MOOCs etc.
b. The internal evaluation will be done on the basis of continuous evaluation of students in the laboratory and class-room.
c. Practical examination will be conducted at the end of semester for evaluation of performance of students in laboratory.
d. Students will use supplementary resources such as online videos, NPTEL videos, e-courses, Virtual Laboratory.