Syllabus for Bachelor of Technology

Chemical Engineering

Subject Code: 01CH0253

Subject Name: Heat Transfer Operations

B.Tech. Year - II

Objective: To understand various modes of Heat Transfer employed in the industries and various equipments used to carry out the operation of heat transfer.

Credits Earned: 6 Credits

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

1. To build basic knowledge of the heat transfer.
2. To review the practical importance and relevance of energy transfer and its conservation in chemical industry.
3. To utilize the technological methods related to heat transfer in process plant.
4. To study a detailed overview of heat transfer equipment and problems associated at preliminary stage of design.
5. To build a bridge between theoretical and practical concept used in industry.

Pre-requisite of course: None

Teaching and Examination Scheme

Teaching Scheme (Hours)			Credits	Theory Marks			Tutorial/ Practical Marks		Total Marks
Theory	Tutorial	Practical		ESE (E)	CSE	Internal (I)	Viva (V)	Term work (TW)	
4	2	2	6	50	20	30	25	25	150

Contents:

Unit	Topics	Contact Hours
1	**Heat Conduction** Introduction to heat transfer, Fourier's law of heat conduction, thermal conductivity, steady-state conduction, resistances in series, computation of heat flow through: cylinder, spheres; critical radius of insulation. Introduction to unsteady state heat conduction.	8
2	**Heat Transfer Coefficient & Convective Heat Transfer (without Phase change)** Concept of heat transfer by Convection: Natural and Forced Convection, Heat Transfer Coefficient (Individual & Overall), Film theory of Heat Transfer, LMTD, Heat Transfer between Fluids separated by plane wall, cylinder; concept of Thermal Boundary Layer, Dimensionless groups used in Heat transfer. **Forced Convective H.T:** correlations for heat transfer coefficient in pipe flow: Laminar & Turbulent Pipe flow, correlations for heat transfer on flat plate: Laminar & Turbulent flow, Momentum & Heat Transfer Analogies: Reynolds Analogy, Prandtl Analogy, Chilton-colburn Analogy. **Natural Convective H.T:** Physical significance of dimensionless groups in Free convection, combined Free & Forced Convection.	12
3	**Convective Heat Transfer (with Phase change) & Evaporation** Condensation: Heat Transfer due to condensing vapours, Filmwise and dropwise condensation – Film condensation on a vertical plate (Nusselt's Theory), Boiling: Pool boiling of Saturated Liquid, Nucleate Boiling & Film Boiling. Introduction to Evaporation, single & multiple- effect evaporators, agitated-film evaporators, evaporator capacity, evaporator economy, BPE and Duhring's rule, enthalpy balances for single effect evaporator, methods of feeding, capacity and economy of multiple effect evaporators.	10
4	**Radiation Heat Transfer** Concept of thermal radiation, Blackbody Radiation, Absorptivity, Reflectivity, Transmissivity, Black body, Grey Body, Laws of Black Body Radiation: Kirchhoff's law, Stephen – Boltzmann's law, Wien's Displacement Law, Energy exchange between: two parallel planes, two parallel planes of different emissivity, Radiation Shape Factor, Radiation shield.	8
5	**Heat Exchangers** Heat Exchangers: Introduction, Industrial use, types of Heat exchange, Co-current, Counter-current & cross-current, Use of LMTD, Effectiveness, NTU method for Heat Exchange design.	8
	Total Hours	**46**

References:

1. "Unit Operations of Chemical Engineering", McCabe W L, Smith J C, Harriott P, 7th Ed. McGraw Hill, 2005.
2. "Heat Transfer-Principles & Applications" Binay K Dutta, PHI Learning Private Ltd,
3. "Heat Transfer", J. P. Holman, McGraw Hill, Tenth Edition

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%	35%	25%	15%	5%	-

List of Experiments:

1. To determine the Thermal Conductivity of the given Metal Rod.
2. To determine Thermal Conductivity of the given Composite wall.
3. To determine Heat Transfer coefficient by Forced Convection.
4. To determine Emissivity of grey body.
5. To determine Stephan Boltzmann constant experimentally.
6. To determine overall H.T. coefficient of Shell & Tube type Heat Exchangers.

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