

Subject Code: 01CH1407
Subject Name: Heat Transfer
B.Tech. Year: II (Semester IV)

Objective: To teach the fundamental concepts of heat transfer viz., conduction, convection, radiation, boiling and condensation and its application in the chemical process industries.

Credits Earned: 4 Credits

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

1. Understand various modes of heat transfer phenomenon.
2. Determine heat transfer coefficient for natural and forced convection.
3. Apply the concept of heat transfer in phase change.
4. Design the heat exchangers and evaporators.

Pre-requisite of course: Basic of Mathematics, Physics.

Teaching and Examination Scheme

Teaching Scheme (Hours)			Credits	Theory Marks			Tutorial/ Practical Marks		Total Marks
Theory	Tutorial	Practical		ESE (E)	IA (I)	CSE (C)	Viva (V)	Term work (TW)	
3	0	2	4	50	30	20	25	25	150

Contents:

Unit	Topics	Contact Hours
1	Heat Transfer through Conduction Introduction to heat transfer, Fourier's law of heat conduction, thermal conductivity, steady-state conduction, resistances in series, heat flow through: composite wall, cylinder and spheres; critical radius of insulation. Introduction to unsteady state heat conduction.	8
2	Heat Transfer through Convection Forced Convection: Introduction, Heat transfer coefficient (Individual and overall), LMTD, NTU method, Correlations for heat transfer coefficient in laminar & turbulent pipe flow and flat plate, Momentum & Heat Transfer Analogies: Reynolds Analogy, Prandtl Analogy, Chilton-Colburn Analogy. Natural Convection: Introduction, Physical significance of dimensionless groups in Free convection, combined Free & Forced Convection.	8



3	Condensation and Boiling 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.	6
4	Heat Transfer through Radiation 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, Radiation Shape Factor, Radiation shield.	8
5	Heat Exchanger and Evaporation Heat Exchanger: Introduction, Types of heat exchanger, design of double pipe heat exchanger and shell & tube heat exchanger. Evaporation: Introduction, Types of evaporators: single and multiple effect evaporators.	8
	Total hours	38

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. Calculate the rate of condensation in Film-wise and Drop-wise condensation
5. To determine the emissivity of given body.
6. To determine Stefan-Boltzmann constant experimentally.
7. To determine heat transfer coefficient of shell & tube type heat exchangers.
8. To study the performance of spiral tube and fin tube heat exchanger.
9. To study the heat transfer in vertical and horizontal condenser
10. To study the heat transfer in open pan evaporator

References:

1. "Unit Operations of Chemical Engineering", W. L. McCabe, J. C. Smith, P. Harriott, 7th Ed. McGraw Hill, 2005.
2. "Heat Transfer-Principles & Applications" Binay K Dutta, PHI Learning Private Ltd, 2011.
3. "Heat Transfer", J. P. Holman, McGraw Hill, Tenth Edition, 2001.
4. "Process Heat Transfer, Doland.Q. Karn, Echo Point Books and Media, 2019.

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%	-

Instructional Method:

- 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.
- The internal evaluation will be done on the basis of continuous evaluation of students in the laboratory and class-room.
- Practical examination will be conducted at the end of semester for evaluation of performance of students in laboratory.
- Students will use supplementary resources such as online videos, NPTEL videos, e-courses, Virtual Laboratory

Design Based Problems (DP)/ Open Ended project (OEP) :

In the beginning of the session, subject faculty will allot an OEP / DP to the students. Students will be free to choose a topic of their choice which will be relevant to the syllabus and they will either prepare a working model/ report / presentation / poster on their topic.

Web Resources:

- <https://nptel.ac.in/courses/103103145>
- <https://nptel.ac.in/courses/103103035>