CEPC2005 HEAT TRANSFER (3-0-0)

Overall course Objective: The objective of course is to teach the basics of heat transfer by conduction, convection, and radiation. The students will learn about the various laws related to conduction, convection, and radiation. The students will also learn about evaporators, condensers and heat exchangers principles, equations, and types.

Course Outcomes

On completion of the course, the students would have

CO1: Estimate steady state and transient heat transfer rates from/to object such as tanks, pipes, building etc.

CO2: Develop equations for different types of convection and solve for heat transfer rate by convection.

CO3: Carry out thermal analysis of heat exchanger using LMTD and effectiveness method.

CO4: Estimate steam economy, capacity of single and multiple effect evaporators.

CO5: Estimate the rate of radiation heat transfer with and without participating medium. Ability to identify the roll of re-radiating surface, radiation shields, boiling and condensation.

Course Articulation Matrix

COs	POs											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	3	1	1	2	3	-	2	3	1	1
CO2	3	2	3	1	1	2	3	-	2	3	1	1
CO3	3	2	3	1	1	2	3	-	2	3	1	1
CO4	3	2	3	1	1	2	3	-	2	3	1	1
CO5	3	2	3	1	1	2	3	-	2	3	1	1

Module I: (10 hrs)

Introduction: Modes of heat transfer, basic laws of heat transfer, analogy between heat flow and electrical flow. Conduction: The Fourier heat conduction equation, Steady-state one dimensional heat conduction through plane wall, cylindrical wall, spherical wall and composite structures. Heat transfer from extended surfaces, unsteady state heat conduction through a semi-infinite slab, critical insulation of thickness.

Module II: (09 hrs)

Convection: Introduction to convection: Natural and forced convection, Natural Convection: Grashoff number, natural convection from vertical and horizontal surfaces. Forced convection, The convective heat transfer coefficient, introduction to thermal boundary layer,

Dimensionless numbers in heat transfer and their significance, Dimensional analysis, Analogy between heat and momentum transfer, Reynold's Prandtl and Colburn analogies.

Module III: (07 hrs)
Heat transfer to liquid metals, heat transfer for tubes in cross flow. Heat exchangers: Types of heat exchangers, log-mean temperature difference, energy balances, overall heat transfer coefficients, heat exchanger effectiveness, Fouling factors, design and description of heat transfer equipment.

Module IV: (12 hrs)
Evaporation: Types of evaporators, capacity and economy of evaporators, boiling point elevation and Duhring's rule, material and energy balance for evaporators, methods of feeding, capacity and economy of multiple effect evaporators. Heat Transfer with phase change: Heat transfer from condensing vapours: film and dropwise condensation, derivation and practical use of Nusselt equation, condensation of superheated vapours, effect of non-condensable gases on ratio of condensation. Heat transfer to boiling liquids. Boiling of a saturated liquid. Maximum heat flux and critical temperature, minimum flux and film boiling, sub cooled boiling.

Module V: (07 hrs)
Heat transfer by radiation: Thermal radiation, black body radiation, Kirchhoff's law, emissivity, grey body, laws of black body radiation, geometric factor, radiation in enclosures with black surfaces and grey surfaces. Large parallel plates, concentric, cylindrical, spheres. Combined heat transfer by conduction, convection, and radiation.

Books:
1. Process Heat Transfer by D Q Kern, McGraw-Hill.
2. Heat Transfer: A Practical Approach, 2nd ed. by Y A Cengel, McGraw-Hill.

Reference Books:
1. Unit Operations of Chemical Engineering, 7th ed. by W L McCabe, J C Smith, and P Harriott, McGraw-Hill.
2. Heat Transfer, 10th ed. by J Holman and S Bhattacharyya, McGraw-Hill.

Web learning References:
1. Heat Transfer by Dr. Anil Verma, Department of Chemical Engineering, IIT Guwahati (Link: https://nptel.ac.in/courses/103/103/103103032/)