

UCH402: HEAT TRANSFER

L	T	P	Cr
3	1	2	4.5

Course Objective:

To understand the fundamentals of heat transfer mechanisms in fluids and solids and their applications in various heat transfer equipment in process industries.

Heat Transfer: Introduction, Applications, Relation between heat transfer and thermodynamics, Transport properties, Heat transfer coefficients.

Conduction: Fourier's law, Thermal conductivity, Heat conduction equations: Rectangular, cylindrical and spherical coordinates, Composite wall structure, Insulation and its optimum thickness, Extended surfaces, Unsteady state conduction.

Convection: Newton's law of cooling, Boundary layer theory, Heat transfer in laminar and turbulent flows inside tubes, Colburn analogy, Heat transfer by external flows across: Cylinders, tube bank and spheres, Natural convection, Convection with phase change: Boiling and condensation.

Radiation: Basic equations, Emissivity, Absorption, Black and gray body, Thermal radiation between two surfaces.

Heat Exchangers: Classification of heat exchangers, LMTD and ϵ -NTU methods, Heat exchangers: Double pipe, shell and tube, air-cooled, plate type, Fouling.

Evaporators: Classification, Single and multiple effect evaporators, Enthalpy balance, Performance of evaporators: Capacity and economy, Methods of feeding.

Reactor Heating and Cooling Systems: Time required for heating and cooling of agitated batch reactors, Helical cooling coils, Jacketed vessels.

Laboratory Work:

Thermal conductivity of a metal rod, Thermal conductivity of insulating power, Emissivity measurement, Parallel flow/counter flow heat exchanger, Heat transfer through composite wall, Drop wise & film wise condensation, Heat transfer through a pin-fin, Heat transfer in natural convection, Heat transfer in forced convection, Critical heat flux, Stefan-Boltzman's law of radiation, Heat flow through lagged pipe, Shell and tube heat exchanger.

Course Learning Outcomes (CLO)

Upon completion of this course, the students will be able to:

1. solve conduction, convection and radiation problems
2. design and analyse the performance of heat exchanger and evaporators
3. calculate heating and cooling requirements for reactors.

Text Books:

1. McCabe, W.L., Smith J.C., and Harriott, P., *Unit Operations of Chemical Engineering*, McGraw-Hill (2005).
2. Holman, J.P., *Heat Transfer*, Tata McGraw-Hill Education (2008).

Reference Books:

1. Kern, D.Q., *Process Heat Transfer*, Tata McGraw-Hill (2008).
2. Frank, P.I. and David, P.D., *Fundamentals of Heat and Mass Transfer*, John Wiley & Sons (2007).
3. Cengel, Y.A., *Heat and Mass Transfer*, Tata McGraw-Hill Publishing Company Limited (2007).
4. Alan, S.F., Leonard, A.W. and Curtis, W.C., *Principles of Unit Operations*, Wiley India (P) Ltd., (2008).

Evaluation Scheme:

S. No.	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	35
3	Sessional (may include lab/tutorials/ assignments/ quizzes)	40