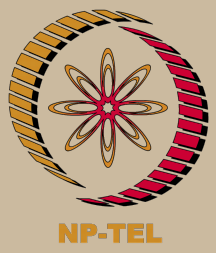
Heat Transfer - Web course



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Chemical Engineering

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COURSE OUTLINE

The course will introduce the fundamental concepts of various modes of heat transfer. It will further elaborate these concepts with theories and applications to the solutions of practically relevant chemical engineering problems. Some aspects of process design principles of various heat transfer equipment will be taken up in the later part of this course. Finally, to present a physical picture of the convection process, heat transfer in boundary layer flows will be addressed. Even though the course is primarily designed to meet the requirements of an undergraduate chemical engineering course on heat transfer, it will be useful for the practicing engineers to refresh with fundamental and technical information.

COURSE DETAIL

S.No.	Topics	No. of Hours
1	**Introduction** 1.1 Modes of heat transfer 1.1.1 Conduction 1.1.2 Convection 1.1.3 Radiation 1.2 Material properties of importance in heat transfer 1.2.2 Thermal conductivity 1.2.2 Specific heat capacity	2
2	**Conduction: One Dimensional** 2.1 Steady state conduction through constant area 2.2 Thermal contact resistance 2.3 Steady state heat conduction through a variable area 2.3.1 Cylinder 2.3.2 Sphere 2.4 Heat conduction in bodies with heat sources	6
3	**Convective Heat Transfer: One dimensional** 3.1 Principle of heat flow in fluids and concept of heat transfer coefficient 3.2 Individual and overall heat transfer coefficient 3.2.1 Heat transfer between fluids separated by a flat solid wall 3.2.2 Heat transfer between fluids separated by a cylindrical wall 3.3 Enhanced heat transfer: concept of fins 3.3.1 Analytical solution of different cases 3.3.2 Fin efficiency 3.4 Thermal insulation	6
4	**Forced Convective Heat Transfer** 4.1 Principle of convection 4.2 Forced convection mechanism: Flow over a flat horizontal plate 4.3 Flow through a pipe or tube 4.3.1 Turbulent flow 4.3.2 Laminar flow 4.3.3 Flow through a non-circular duct 4.3.4 Flow over a flat plate 4.3.5 Flow over cylinders and spheres 4.3.5.1 Flow across a cylinder	6

	4.3.5.2 Flow across a sphere 4.3.5.3 Flow across a bank of tubes 4.4 Momentum and heat transfer analogies 4.4.1 Reynolds analogy 4.4.2 The Chilton-Colburn analogy 4.4.3 The Prandtl analogy 4.4.4 The Van Karman analogy	
5	**Heat Transfer by Natural Convection** 5.1 Introduction 5.2 Empirical correlations for natural-convective heat transfer 5.2.1 Natural convection around a flat vertical plate 5.2.2 Natural convection around a horizontal cylinder 5.2.3 Natural convection around a horizontal flat surface 5.2.4 Natural convection around sphere 5.2.5 Natural convection in enclosure 5.3 Combined natural and forced convection	3
6	**Heat Transfer in Boiling and Condensation** 6.1 Heat transfer during boiling 6.2 Boiling of saturated liquid 6.2.1 Nucleation boiling 6.2.2 Maximum heat flux 6.2.3 Film boiling 6.3 Heat transfer during condensation 6.4 Film condensation 6.5 Condensation for horizontal tube 6.5.1 Condensation outside horizontal tube or bank of tube 6.5.1.1 Condensation on a single horizontal tube 6.5.1.2 Condensation on a vertical tube of N horizontal tubes 6.5.1.3 Condensation inside a horizontal tube 6.6 Condensation for packed and fluidized bed 6.6.1 Packed bed 6.6.2 Fluidized bed	4
7	**Radiation Heat Transfer** 7.1 Basic definition pertaining to radiation 7.1.1 Emissive power 7.1.2 Radiosity 7.1.3 Irradiation 7.1.4 Absoptivity, reflectivity, and transmissivity 7.2 Blackbody radiation 7.2.1 Planck's law 7.2.2 Wien's law 7.2.3 The Stefan-Boltzmann law for blackbody 7.2.4 Special characteristic of blackbody radiation 7.2.5 Kirchhoff's law 7.3 Grey body 7.4 Radiative heat exchanger between surfaces 7.4.1 View factor 7.4.2 Relation between view factors 7.5 Heat exchange between non blackbodies 7.6 Radiation shield 7.7 Electrical network for radiation through absorbing and transmitting medium 7.8 Radiation combined with conduction and convection	5
8	**Heat Exchangers** 8.1 Elements of shell and tube heat exchanger 8.2 Thermal design of heat exchangers 8.2.1 Overall heat transfer coefficient 8.2.2 Fouling factor or dirt factor 8.2.2 Temperature profiles in heat exchangers 8.2.4 Why multi-pass exchangers 8.2.5 LMTD correction factor 8.2.6 Individual heat transfer coefficient 8.2.7 Pressure drop in the heat exchanger 8.2.7.1 Correlation for tube side pressure drop	5

	8.2.7.2 Correlation for shell side pressure drop 8.2.8 Heat transfer effectiveness and number of transfer units 8.2.9 Calculation and designing of the heat exchanger 8.2.9.1 Double-pipe heat exchanger 8.2.9.1 Shell and tube heat exchanger	
9	**Evaporators** 9.1 Solution properties 9.1.1 Concentration 9.1.2 Foaming 9.1.3 Degradation due to high temperature 9.1.4 Scaling 9.1.1 Equipment material 9.2 Evaporator 9.2.1 Natural circulation evaporator 9.2.2 Forced circulation evaporator 9.2.3 Falling film evaporator 9.3 Performance of steam heated tubular evaporators 9.3.1 Capacity and economy 9.3.2 Single and multiple effect evaporators 9.3.3 Boiling point elevation 9.4 Temperature profile in an evaporators 9.5 Heat Transfer coefficient 9.6 Method of feeding: Multiple effect evaporators 9.7 Enthalpy balance 9.7.1 Single effect evaporator 9.7.2 Effect of heat of dilution 9.7.3 Multiple effect evaporator	3
	Total	40

References:

1. Holman J. P., "Heat Transfer", Mc Graw-Hill, 9th. Ed., 2002
2. Dutta B. K., "Heat Transfer: Principles and Applications", PHI, 2001
3. Kern D. Q., "Process Heat Transfer", Tata Mc Graw-Hill Edition, 1997
4. McCabe, W. L., Smith, J. C., and Harriott, P., "Unit Operations of Chemical Engineering", McGraw-Hill, 6th. Ed., 2001
5. Coulson, J.M., Richardson, J.F., "Chemical Engineering", Vol. I., Pergamon and ECBS, 1970.
6. Chapman, A.J. "Heat Transfer", 4th edn. Maxwell Macmillan International Edition, 1984.
7. Holman, J.P., "Heat Tansfer", 9th edn. The McGraw-Hill Companies, 2008.