2/4 B.Tech. FOURTH SEMESTER

AE4T3 **Heat Transfer** **Credits: 4**

Lecture: 4 periods/week **Internal assessment: 30 marks**
Tutorial: 1 periods/week **Semester end examination: 70 marks**

Objectives:

1. To introduce the basic principles of heat transfer.
2. Steady and unsteady one- and two-dimensional heat conduction;
3. Internal and external convection;
4. Basic concepts of radiation.
5. Developing problem solving skills in energy-related areas and understand the role that heat transfer plays in everyday life.

Learning Outcomes:

At the end of course the students will be able to:

1. Calculate heat transfer by conduction, different types of convection and by radiation using classical phenomena. Ability to choose the transfer mode based on general application.
2. Derive steady state and transient conduction, overall heat transfer and heat generation for 1-D & 2-D problems such as (plane wall, cylinder, sphere, extended surfaces and semi infinite-solids etc)
3. Able to predict empirical relations for forced and free convection heat transfers through pipes, tubes, horizontal, vertical and inclined surfaces.
4. Able to explain black body, gray body concepts, heat transfer theories with phase changes, able to size and calculate the performance of different types of heat exchangers. Able to tackle and solve a range of heat transfer problems including finned heat exchangers, cooling by fluids, quenching, insulation and solar radiation.

Prerequisites:
Basic thermodynamics, engineering physics & chemistry

UNIT – I
INTRODUCTION
Modes and mechanisms of heat transfer-Conduction, convection and radiation heat transfer, Basic laws of heat transfer –General discussion about applications of heat transfer.

UNIT – II

CONDUCTION HEAT TRANSFER

Introduction to conduction heat transfer, Fourier's law of Conduction, Thermal Conduction equation – Derivation in Cartesian, Cylindrical and Spherical coordinates. One dimensional steady state conduction in plane wall and composite wall, Overall heat transfer coefficients, Heat generation in plane wall, cylinder and sphere, extended surfaces

UNIT III

STEADY AND UNSTEADY STATE CONDUCTION HEAT TRANSFER: Steady State Conduction-Two dimensional Heat Conduction, Conduction Shape Factor, Unsteady state conduction – Lumped Heat Capacity System, Significance of Biot and Fourier Numbers, Transient Heat flow in a Semi-Infinite Solid, Use of Heisler and Grober Charts.

UNIT – IV

CONVECTION HEAT TRANSFER:

Principles of Convection-Thermal boundary layers, Significance of Non-Dimensional Numbers,

FORCED CONVECTION –Heat Transfer over a Flat Plate, Dimensional Analysis for Forced convection, Empirical Relations for Pipe and Tube Flow

UNIT – V

FREE CONVECTION

Dimensional Analysis for Free convection, Empirical Relations for Free Convection, Heat Transfer on Vertical, Horizontal and Inclined Surfaces, Flow across Cylinders and Spheres.

UNIT VI

RADIATION HEAT TRANSFER:

Radiation Heat Transfer –Nature of Thermal Radiation, Black Body Concepts, Gray body, Radiation Shape Factor, Radiation Heat Transfer between Two Surfaces. Electrical analogy, Re-radiating Surface, Radiation Shields

UNIT VII

HEAT TRANSFER WITH PHASE CHANGE:

BOILING: – Pool boiling – Regimes – Calculations on Nucleate boiling, Critical Heat flux and Film boiling.

CONDENSATION: Film wise and drop wise condensation –Nusselt's Theory of Condensation on a vertical plate – Film condensation on vertical and horizontal cylinders using empirical correlations.

UNIT VIII

HEAT EXCHANGERS:

Classification of heat exchangers – overall heat transfer Coefficient and fouling factor – Concepts of LMTD and NTU methods - Problems using LMTD and NTU methods.

Tables/Codes: Heat and Mass transfer data book / C.P. Kothandaraman, Subramanian/ New Age Pub.

Learning resources

Text books:

1. Ghoshdastidar, “Heat Transfer”, Oxford University Press – II Edition.
2. P.K.Nag, “Heat Transfer”, TMH publications.
3. Holman J.P., “Heat Transfer”, SI Metric Ed., McGraw Hill, ISE, 8th Ed.-1997.
4. Sutton, G.P., "Rocket Propulsion Elements ", John Wiley and Sons, 5th Edn.1986.

References:

1. R.C.SACHDEVA, “Fundamentals of engineering heat and mass transfer”,New Age International publications
2. Christopher A. Long, “Essential Heat Transfer”, Pearson Education.
3. YunusCengel, Boles, “Heat TransferA Practical Approach”, TMH.
4. D.S. Kumar, “Heat and Mass Transfer”, S.K.Kataria& Sons publishers, 2009
5. J. P.HOLMAN, “Heat Transfer”,Tata McGraw-Hill publication, 9th edition 2012