3/4 B.Tech. FIFTH SEMESTER

ME5T5 **HEAT TRANSFER** **Credits: 4**

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

Objectives:

1. Interpret modes and mechanism of heat transfer
2. Acquire knowledge on boiling and condensation and to solve problems on heat exchangers

Learning outcomes:

At the end of course the students will have:

1. Define modes, mechanisms and conduction heat transfer.
2. Formulate one dimensional steady and transient conduction heat transfer problems and concept of fins.
3. Explain concepts on forced convective heat transfer, significance of non dimensional numbers and free convection heat transfer
4. Solve problems based on boiling, condensation, LMTD and NTU methods.
5. Describe basic concepts of radiation heat transfer including both black body radiation and gray body radiation.

Pre-Requisite

Basic thermodynamics, Applied Thermodynamics and IC Engines and Gas Turbines

UNIT – I

INTRODUCTION :

Modes and mechanisms of heat transfer – Basic laws of heat transfer –General discussion about applications of heat transfer.

CONDUCTION HEAT TRANSFER :Fourier rate equation – General heat conduction equation in Cartesian, Cylindrical and Spherical coordinates.

UNIT – II

SIMPLIFICATION AND FORMS OF THE FIELD EQUATION –

steady, unsteady and periodic heat transfer – Initial and boundary conditions.

ONE DIMENSIONAL STEADY STATE CONDUCTION HEAT TRANSFER :Homogeneous slabs, hollow cylinders and spheres – overall heat transfer coefficient – electrical analogy – Critical radius of insulation

ONE DIMENSIONAL STEADY STATE CONDUCTION HEAT TRANSFER :

Variable Thermal conductivity – systems with heat sources or Heat generation. Extended surface (fins) Heat Transfer – Long Fin, Fin with insulated tip and Short Fin, Application to error measurement of Temperature.

UNIT III

ONE DIMENSIONAL TRANSIENT CONDUCTION HEAT TRANSFER:

Systems with negligible internal resistance – Significance of Biot and Fourier Numbers - Chart solutions of transient conduction systems- Concept of Functional Body

UNIT – IV

CONVECTIVE HEAT TRANSFER :

Classification of systems based on causation of flow, condition of flow, configuration of flow and medium of flow – Dimensional analysis as a tool for experimental investigation – Buckingham Pi Theorem and method, application for developing semi – empirical non- dimensional correlation for convection heat transfer – Significance of non-dimensional numbers – Concepts of Continuity,Momentum and Energy Equations.

FORCED CONVECTION: EXTERNAL FLOWS :Concepts about hydrodynamic and thermal boundary layer and use of empirical correlations for convective heat transfer - Flat plates and Cylinders.

UNIT – V

FREE CONVECTION :

Development of Hydrodynamic and thermal boundary layer along a vertical plate – Use of empirical relations for Vertical plates and pipes.

UNIT VI

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 VII

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.

UNIT VIII

RADIATION HEAT TRANSFER:

Emission characteristics and laws of black-body radiation – Irradiation – total and monochromatic quantities – laws of Planck, Wien, Kirchoff, Lambert, Stefan and Boltzmann– heat exchange between two black bodies – concepts of shape factor – Emissivity – heat exchange between grey bodies – radiation shields – electrical analogy for radiation networks.

Learning resources

Text books:

1. Heat and Mass Transfer, by Sachdeva, New age International,
2. Heat transfer, by J.P.Holman, TMH publications, 2008
3. Heat Transfer, by D.S. Kumar, SK. Kataria & sons,2009

Reference books:

1. Heat Transfer -A Basic Approach, by N.Ozisik , MC Grawhill,1985
2. Heat transfer, by S.P.Sukhatme , , Orient longman Pvt. Ltd. 2005
3. Introduction to Heat Transfer, by lncropera and Dewitt, , Wiley Publishers,2001