III B. TECH -I SEMESTER
HEAT TRANSFER

Course Code: ME5T3 **Credits: 3**
Lecture: 3 periods/week **Internal assessment: 30 marks**
Tutorial: 1 period/week **Semester end examination: 70 marks**

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

Upon completion of this course the student will be able to:

1. Describe modes of heat transfer.
2. Formulate one dimensional steady and transient conduction heat transfer problems and explain 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-Requisites: Applied Thermodynamics

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 - Variable Thermal conductivity – systems with and without heat generation.

EXTENDED SURFACE (FINS) HEAT TRANSFER –

Long Fin, Fin with insulated tip and Short Fin, Application to error measurement of Temperature.

ONE DIMENSIONAL TRANSIENT CONDUCTION HEAT TRANSFER:

Systems with negligible internal resistance – Significance of Biot and Fourier Numbers Chart solutions of transient conduction systems.

UNIT III

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

UNIT IV
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.
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 V
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 Y.A Cengel, A J Ghajar, Mc Graw Hill education,2011.
2. Heat transfer, by J.P.Holman, TMH publications, 2008 .
3. Heat and Mass Transfer, by Sachdeva, New age International.

Reference Books:

1. Engineering Heat & Mass transfer by Mahesh.M.Rathor ,University science press ,2006
2. Heat Transfer -A Basic Approach, by N.Ozisik , MC Grawhill,1985
3. Heat transfer, by S.P.Sukhatme , Orient longman Pvt. Ltd. 2005
4. Introduction to Heat Transfer, by lncropera and Dewitt, Wiley Publishers,2001
5. Heat Transfer, by D.S. Kumar, SK. Kataria & sons,2009

Data book to be allowed in examination:

- C.P.Kothandaraman & S. Subramanyam, Heat and Mass Transfer Data Book, New Age International Publishers – Sixth edition