

PCME4305 HEAT TRANSFER (3-0-0)

Module-I

(15 hours)

1. Introduction:

Modes of heat transfer: conduction, convection, and radiation, Mechanism & basic laws governing conduction, convection, and radiation heat transfer; Thermal conductivity, Thermal conductance & Thermal resistance, Contact resistance, convective heat transfer coefficient, radiation heat transfer coefficient, Electrical analogy, combined modes of heat transfer. initial conditions and Boundary conditions of 1st, 2nd and 3rd Kind.

2. Heat Conduction:

The General heat conduction in Cartesian, polar-cylindrical and polar-spherical coordinates, Simplification of the general equation for one and two dimensional steady/transient conduction with constant/ variable thermal conductivity with / without heat generation.

Solution of the one dimensional steady state heat conduction problem in case of plane walls, cylinders and spheres for simple and composite cases. Critical insulation thickness, Heat transfer in extended surfaces (pin fins) without heat generation, Long fin, short fin with insulated tip and without insulated tip and fin connected between two heat sources. Fin efficiency and fin effectiveness.

Conduction in solids with negligible internal temperature gradient (Lumped heat analysis).

Solution of Cartesian problems in two dimensions (steady state conduction with constant thermal conductivity and no heat generation) by variable separation method. Numerical methods for heat conduction analysis.

Act

Module-II

(15 hours)

3. Convective Heat Transfer:

(a) Introduction to convective flow - forced and free. Dimensional analysis of forced and free convective heat transfer. Application of dimensional analysis, physical significance of Grashoff, Reynolds, Prandtl, Nusselt and Stanton numbers.

(b) Conservation equations for mass, momentum and energy for 2-dimensional convective heat transfer in case of incompressible flow, Hydrodynamic and thermal boundary layers for flow over a flat plate. Critical Reynolds number; general expressions for drag coefficient and drag force Reynolds-Colbourn analogy. Thermal boundary layer; general expression for local heat transfer coefficient; Average heat transfer Coefficient; Nusselt number. Flow inside a duct- velocity boundary layer, hydrodynamic entrance length and hydrodynamically developed flow; flow through tubes (internal flow). Use of empirical relations for solving turbulent conditions for external and internal flow.

4. Mechanism of heat transfer during natural convection, Experimental heat transfer correlations for natural convection in the following cases

(a) Vertical and horizontal plates

(b) Inside and outside flows in case of tubes

5. Heat transfer for boiling liquids and condensing vapours :

Types of condensation, use of correlations for condensation on vertical flat surfaces, horizontal tube and; regimes of pool boiling, pool boiling correlations. Critical heat flux, concept of forced boiling. Numerical problems.

Module-III

(10 hours)

6. Radiative heat exchange :

Introduction, Radiation properties, definitions of various terms used in radiation heat transfer; Absorptivity, reflectivity & transmissivity. Emissive power & emissivity, Kirchoff's identity, Planck's relation for monochromatic emissive power of a black body, Derivation of Stefan-Boltzmann law and Wien's displacement law from Planck's relation, Radiation shape factor, Relation for shape factor and shape factor algebra. Heat exchange between black bodies through non-absorbing medium. Gray bodies and real bodies, Heat exchange between gray bodies. Radiosity and Irradiation, Electrical analogy and radiation network for 2-body and 3-body radiations exchange in non-absorbing medium, Radiation shields.

7. Heat Exchangers :

Introduction, Types of heat exchanger, The overall heat transfer coefficient and fouling factors, LMTD and ϵ - NTU analysis of heat exchangers.

Text Books :

1. Fundamentals of Engineering Heat and Mass Transfer: R.C.Sachdeva, New Age International Publishers, 4th Edition
2. Heat Transfer : J.P.Holman, TMH Publications
3. Basic Heat Transfer by Necati Ozisik, Mcgrawhills Publications

References :

- 1 Heat Transfer: P.S.Ghosdastidar, Oxford University Press
2. Heat Transfer by P.K. Nag, TMH
3. Heat Transfer by S.P. Sukhatme, TMH
4. Heat Transfer: A.F.Mills and V.Ganesan, Pearson Education, 2nd Edition
5. Heat and Mass Transfer: Domkundwar and Arora, Danpatrai and sons
6. Heat Transfer : R.K.Rajput, Laxmi Publications
7. Heat and Mass Transfer: A Practical Approach, Y.A.Cengel, Tata Macgraw Hills Education Private Limited