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APR-MAY

B. E. (Seventh Semester) Examination, 2020

(Old Scheme)

(Mech. Engg. Branch)

HEAT & MASS TRANSFER

Time Allowed : Three hours

Maximum Marks : 80

Minimum Pass Marks : 28

Note : *All questions are compulsory. Each question carries 16 marks.*

Unit-I

1. (a) Define critical radius of insulation. 2

(b) Derive an expression for one dimensional time dependent heat conduction with internal heat generation and constant thermal conductivity in Cartesian coordinate system. Reduce it as : 14

(i) Poisson equation

(ii) Fourier equation

(iii) Laplace equation

Or

A long hollow cylinder (K = 50 W/mk) has an inner radius of 10 cm, and outer radius of 20 cm. The inner surface is heated uniformly at constant rate of $1{\cdot}16 \times 10^5$ W/m^2 and outer surface is maintained at 30°C. Calculate the temperature of inner surface. 14

Unit-II

2. (a) What is lumped system analysis? 2

(b) Prove that the temperature distribution in a body at time 't' during a Newtonian heating or cooling is given by

$$\frac{T - T_\infty}{T_i - T_\infty} = e^{-B_i F_0}$$

where B_i = Biot Number, F_0 = Fourier Number. 14

Or

A very long 25 mm diameter copper (K = 380 W/mk) rod extends from a surface at 120°C. The temperature of surrounding air is 25°C and the heat

transfer coefficient over the rod is 10 W/m^{2}K. Calculate (i) Heat loss from the rod. (ii) How long the rod should be in order to be considered infinite? 14

Unit-III

3. (a) Explain velocity and thermal boundary layer. 2

(b) Find the following functional expression for free convection heat transfer between a fluid flowing through a tube and its wall using Buckingham π theorem. 14

$$N_{U_L} = f\left(G_{r_L}, P_r\right)$$

Or

Prove that the Reynolds number for flow in a circular tube of diameter 'D' can be expressed as

$$R_{e_D} = \frac{4\dot{m}}{D\mu\pi}$$

where $\dot{m}$ = mass flow rate of fluid;

μ = viscosity of fluid 14

Unit-IV

4. (a) Explain Filmwise and dropwise condensation. 2

(b) The outer surface of a vertical tube 80 mm in outer diameter and 1 m long is exposed to saturated steam at atmospheric pressure. The tube surface is maintained at 50°C by flow of water through the tube. What is the rate of heat transfer to coolant and what is the rate of condensation of steam? 14

Or

Derive for parallel flow heat exchanger.

$$\in = \frac{1-\exp\left[-NTU\left(1+C\right)\right]}{1+C}$$

where C = Capacity ratio = $\frac{C_{min}}{C_{max}}$ 14

Unit-V

5. (a) Define view factor. 2

(b) Derive the generalized mass diffusion equation. Also explain modes of mass transfer. 14

Or

Derive an expression for a rate of radiation exchange, when a radiation shield is inserted between two large parallel plates. 14