(Pages : 2) **2459**

Reg. No. : ....

Name : ....

Sixth Semester B.Tech. Degree Examination, May 2013
(2008 Scheme)
08.604 : Heat and Mass Transfer (MU)

Time : 3 Hours Max. Marks : 100

Instructions *: 1) Answer **all** questions from Part **A** and **one** full question from each Module of Part B.*

*2) Heat and Mass Transfer data book is **permitted**.*

PART – A **(10×4=40 Marks)**

1. Define thermal conductivity. What are the factors affecting thermal conductivity of a material.
2. A spherical shell, inside radius r_1, outside radius r_2, is heated at the inner surface electrically at a rate of $q_1 (W/m^2)$; outside surface dissipates heat by convection with a convective heat transfer coefficient h_2, into ambient at temperature T_a. Write down the boundary conditions.
3. What is meant by lumped capacity analysis ? Which are the underlying assumptions ?
4. Write short notes on hydrodynamic and thermal boundary layers.
5. Explain critical thickness of insulation with the help of a diagram showing heat transfer rate as a function of insulation thickness.
6. What is meant by film condensation and drop-wise condensation ?
7. How do you define the NTU of a heat exchanger ? What does it represent ?
8. Explain Planck's distribution of radiation.
9. What is radiation shape factor ? Write down the reciprocity relation and the summation rule applied to radiation shape-factor.
10. Explain Fick's law of diffusion.

P.T.O.

PART – B

MODULE – 1

11. a) Derive from fundamentals, the expression for heat transfer rate in one dimensional steady state conduction through a spherical shell. **10**

b) Consider a 20 mm thick plate with uniform heat generation of 80 MW/m^3. The left and right faces are kept at constant temperatures of 160°C and 720°C respectively. The plate has a constant thermal conductivity of 200 W/mK. Determine the expression for temperature distribution in the plate and the location and the value of maximum temperature. **10**

12. a) Derive the expression for heat transfer rate through a plane slab whose thermal conductivity varies linearly with temperature as $K(T)=K_o(1+\beta T)$. **12**

b) The inner surface of a nickel-steel cylinder (K = 19 W/mk) of inner diameter = 10 mm and outer diameter = 70 mm is maintained at 110°C, while the outer surface is held at 50°C. Calculate the heat loss per metre length of the pipe. **8**

MODULE – 2

13. a) Obtain the dimensionless numbers for forced convection using dimensional analysis. **10**

b) A steel fin (k = 5.4 W/mk) with a cross section of an equilateral triangle, 5 mm side is 80 mm long. It is attached to a plane wall maintained at 400°C. The ambient air temperature is 50°C and unit surface conductance is 90 W/m^2k. Calculate the heat dissipation rate by rod. **10**

14. a) Derive an expression for LMTD of parallel flow heat exchanger. **10**

b) Air at 1 bar and 20°C flows through a 6 mm ID, 1m long smooth pipe, whose surface is maintained at a constant heat flux, with velocity of 3 m/s. Determine the heat transfer coefficient if the exit bulk temperature of air is 80°C. Also determine the exit wall temperature. **10**

MODULE – 3

15. a) State and prove Wien's displacement law. **10**

b) Two large parallel planes facing each other and having emissivities 0.3 and 0.5 are maintained at 827°C and 527°C respectively. Determine the rate at which heat is exchanged between the two surfaces by radiation. If a radiation shield of emissivity 0.05 on both sides is placed parallel between the two surfaces, determine the percentage reduction in the radiant heat exchange rate. **10**

16. a) Oxygen gas at 25°C and a pressure of 2 bar is flowing through a rubber pipe of inside diameter 25mm and wall thickness 2.5mm. The diffusivity of oxygen through rubber is 0.21×10^{-9} m^2/s and the solubility of oxygen in rubber is 3.12×10^{-3} $kmol/m^3$ bar. Find the loss of oxygen by diffusion per metre length of pipe. **10**

b) Discuss the dimensionless parameters used in convective mass transfer and their physical significance. **10**
