



Reg. No. :

M/E

Name :

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

Time : 3 Hours

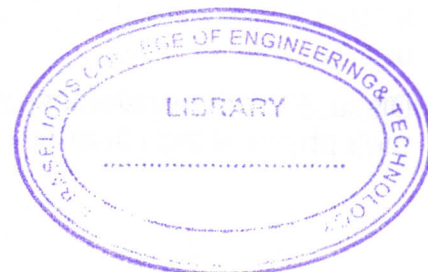
Max. Marks : 100

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.



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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 $K(T) = K_0(1 + \beta T)$. 12
- b) The inner surface of a nickel-steel cylinder ($K = 19 \text{ W/mk}$) 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 ($k = 5.4 \text{ W/mk}$) 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 $90 \text{ W/m}^2\text{k}$. 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, 1 m 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 $0.21 \times 10^{-9} \text{ m}^2/\text{s}$ and the solubility of oxygen in rubber is $3.12 \times 10^{-3} \text{ kmol/m}^3 \text{ bar}$. 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