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**Question Paper Code : A 3837**

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2010

Sixth Semester

Mechanical Engineering

ME 340 — HEAT AND MASS TRANSFER

(Regulation 2001)

Time : Three hours

Maximum : 100 marks

(Use of HMT Data Hand Book and Steam Tables permitted)

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define fin efficiency and fin effectiveness.
2. List down the three types of boundary conditions.
3. What do you understand by specular and diffuse reflection?
4. State the Kirchoff's law of radiation.
5. Explain clearly the difference between natural convection heat transfer and forced convection heat transfer.
6. Define boundary layer thickness.
7. Write the force balance equation on a volume element for filmwise condensation on a vertical plane surface.
8. What are parallel flow and counterflow heat exchangers?
9. Draw the temperature variations in parallel flow and counter flow heat exchangers.
10. Indicate the limitations of Fick's Laws.

PART B — (5 × 16 = 80 marks)

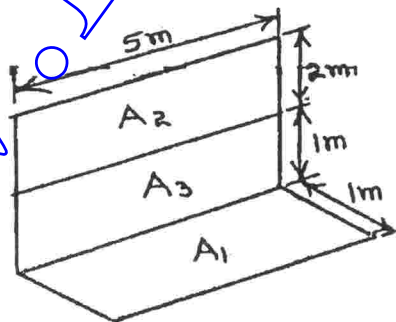
11. (a) (i) Obtain an expression for the general heat conduction equation in Cartesian coordinates. (8)
- (ii) An exterior wall of a house is covered by a 0.1 m layer of common brick ( $k = 0.7 \text{ W/m}^\circ\text{C}$ ) followed by a 0.04 m layer of gypsum plaster ( $k = 0.48 \text{ W/m}^\circ\text{C}$ ). What thickness of loosely packed rock wool insulation ( $k = 0.065 \text{ W/m}^\circ\text{C}$ ) should be added to reduce the heat loss or gain through the wall by 80%? (8)

Or

- (b) (i) Find out the amount of heat transferred through an iron fin of length 50 mm, width 100 mm and thickness 5 mm. Assume  $k = 58 \text{ W/m}^\circ\text{C}$  and  $h = 12 \text{ W/m}^2 \text{ C}$  for the material of the fin and the temperature at the base of the fin as  $80^\circ\text{C}$ . Also determine the temperature at tip of the fin if the atmosphere temperature is  $20^\circ\text{C}$ . (8)
- (ii) An electrical wire of 10 m length and 1 mm diameter dissipates 200 W in air at  $25^\circ\text{C}$ . The convection heat transfer coefficient between the wire surface and air is  $15 \text{ W/m}^2 \text{ K}$ . Calculate the critical radius of insulation and also determine the temperature of the wire if it is insulated to the critical thickness of insulation. (8)
12. (a) (i) Explain absorptivity, reflectivity and transmissivity. (6)
- (ii) Two large parallel planes at 800 K and 600 K have emissivities of 0.5 and 0.8 respectively. A radiation shield having an emissivity of 0.1 on one side and an emissivity of 0.05 on the other side is placed between the plates. Calculate the heat transfer rate by radiation per square meter with and without the radiation shield. Comment on the results. (10)

Or

- (b) (i) Determine the view factors  $F_{1-2}$  and  $F_{2-1}$  for the figure shown below. (8)



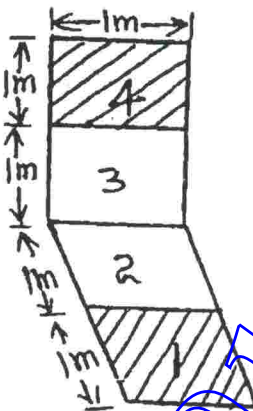
- (ii) Discuss the radiation characteristics of carbon dioxide and water vapour. (8)

13. (a) (i) Distinguish between a black body and gray body and specular and diffuse surfaces. (4)

(ii) Describe the phenomenon of radiation from real surfaces. (12)

Or

(b) (i) Calculate the shape factor  $F_{14}$  for the figure shown below. (8)



(ii) Explain how the radiation from solids differ from that of the gases. (8)

14. (a) (i) What is Reynold's analogy? Describe the relation between fluid friction and heat transfer. (4)

(ii) Air at  $25^\circ\text{C}$  flows over  $1\text{ m} \times 3\text{ m}$  ( $3\text{ m}$  long) horizontal plate maintained at  $200^\circ\text{C}$  at  $10\text{ m/s}$ . Calculate the average heat transfer coefficients for both laminar and turbulent regions. Take  $Re$  (critical) =  $3.5 \times 10^5$ . (12)

Or

(b) (i) Define Reynold's, Nusselt and Prandtl numbers. (6)

(ii) A steam pipe  $10\text{ cm}$  outside diameter runs horizontally in a room at  $23^\circ\text{C}$ . Take the outside surface temperature of pipe as  $165^\circ\text{C}$ . Determine the heat loss per unit length of the pipe. (10)

15. (a) The molecular weights of the two components  $A$  and  $B$  of a gas mixture are  $24$  and  $28$  respectively. The molecular weight of gas mixture is found to be  $30$ . If the mass concentration of the mixture is  $1.2\text{ kg m}^{-3}$ , determine the following :

(i) Density of component  $A$  and  $B$ . (4)

(ii) Molar fractions. (4)

(iii) Mass fractions and (4)

(iv) Total pressure if the temperature of the mixture is  $290\text{ K}$ . (4)

Or



- (b) (i) State Fick's law of diffusion. (4)
- (ii) Explain briefly three modes of mass transfer. (4)
- (iii) Air at 1 atm and 25°C, containing small quantities of iodine, flows with a velocity of 6.2 m/s inside a 35 mm diameter tube. Calculate mass transfer coefficient for iodine. The thermophysical properties of air are :  $\nu = 15.5 \times 10^{-6} \text{ m}^2/\text{S}$ ;  $D = 0.82 \times 10^{-5} \text{ m}^2/\text{S}$ . (8)

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