CBCS SCHEME

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18AE734

Seventh Semester B.E. Degree Examination, Feb./Mar.2022
Heat and Mass Transfer

Time: 3 hrs. Max. Marks: 100

Note: **1.** ***Answer any FIVE full questions, choosing ONE full question from each module.***
2. ***Heat Transfer data hand book is permitted.***

Module-1

1 a. Explain different modes of heat transfer. **(06 Marks)**

b. Explain briefly the different fluxes of mass transfer. **(06 Marks)**

c. Compare Fick's law, Fourier's law and Newton's law of viscosity and show that $\frac{\dot{m}A}{A} = \frac{C_{A_1} - C_{A_2}}{\frac{L}{D}}$. **(08 Marks)**

OR

2 a. Explain different modes of mass transfer. **(06 Marks)**

b. Explain three thermal boundary condition. **(06 Marks)**

c. Define the following terms with their units:
(i) Thermal conductivity (ii) Specific heat
(iii) Heat flux. (iv) Overall heat co-efficient. **(08 Marks)**

Module-2

3 a. Derive the general heat conduction equation in cylinder co-ordinates in one dimensional. **(10 Marks)**

b. A composite wall is as shown in Fig. Q3 (b). Calculate the rate of heat loss from it.
$K_A = 18.88$ W/m-K ; $K_B = 2.77$ W/m-K ; $K_C = 2.32$ W/m-K ;
$K_D = 1.9$ W/m-K ; $K_E = 1.16$ W/m-K ; $K_F = 1.37$ W/m-K ;
$h_i = 8500$ W/m-K ; $h_O = 2000$ W/m-K ; $T_{inside} = 900°C$, $T_{Outside} = 40°C$ **(10 Marks)**

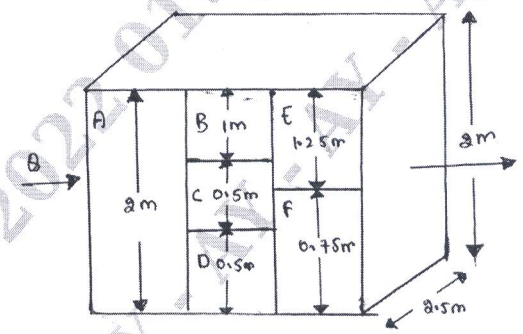

Fig. Q3 (b)

OR

4 a. Derive one dimensional, steady state heat conduction without heat generation through plane slabs. **(10 Marks)**

b. Thin fins of brass whose K = 75 W/m-°C are welded longitudinally on a 5 cm diameter brass cylinder which stands vertically and is surrounded by air at 20°C. The heat transfer coefficient from metal surface to the air is 17 W/m^2 - °C. If 16 uniformly spaced fins are used each 0.8 mm thick and extending 1.25 cm from the cylinder, what is the rate of heat transfer from the cylinder per metre length to the air when the cylinder surface is maintained at 150°C. **(10 Marks)**

Module-3

5 a. Using Buckingham's π theorem, obtain a relationship between Nu, Pr and Gr for free convection heat transfer. **(10 Marks)**

b. A vertical cylinder of 30 cms diameter and 2 m high with surface temperature of 30°C is placed in air calculate the heat loss when it is placed in a 36 km/hr wind at 10°C. Also calculate the rate of heat transfer if the above object is a square in cross section having same height, surface temperature, volume and exposed to same velocity of air steam. **(10 Marks)**

OR

6 a. Explain the development of hydrodynamic and thermal boundary layer when a fluid flows over a flat plate. **(10 Marks)**

b. Considering the body of a man as a vertical cylinder of 300 mm diameter and 160 cm height. If the temperature of the body is to be maintained at 36°C, find the heat generated by the body in 24 hours. Ambient temperature is 14°C. **(10 Marks)**

Module-4

7 a. Obtain an expression for effectiveness and N.T.U. for counter flow heat exchange. **(10 Marks)**

b. Calculate outside tube area for a single pass steam condenser to handle 3500 kg/hr of dry saturated steam at 50°C. The tube has 25 mm outer diameter and 22 mm inner diameter and the tube material has $K = 105 \frac{W}{m-K}$. The average water velocity in each tube is limited to 2 m/sec. Assume steam side film co-efficient 5235 W/m^2-K and inlet and outlet water temperatures as 15 and 25°C respectively. Take h_{fg} at 50°C as 2382.9 kg-K. **(10 Marks)**

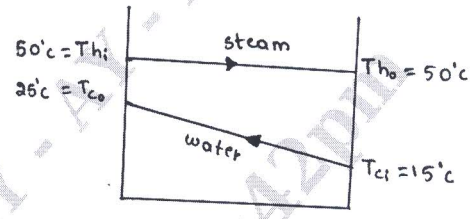

Fig. Q7 (b)

OR

8 a. Distinguish between:
(i) Black body and Gray body. (ii) Emissivity and monochromatic emissivity.
(iii) Emissive power and Radiosity. (iv) Radiosity and irradiation.
(v) Absorptivity and Transmissivity. **(10 Marks)**

b. Two large parallel planes are at 1000 K and 600 K. Determine the heat exchange per unit area.
(i) If the surfaces are back.
(ii) If the hot one has an emissivity of 0.8 and the cooler one 0.5.
(iii) If a large plate is inserted between these two having an emissivity of 0.2. What is the temperature of this large plate and also find the percentage reduction in heat transfer with this large plate? **(10 Marks)**

Module-5

9 a. With a neat sketch of typical combustion chamber explain flame tube cooling. **(10 Marks)**

b. Explain the following: (i) Aerodynamic heating (ii) Ablative heat transfer. **(10 Marks)**

OR

10 a. With a neat sketch, explain Rocket thrust chamber and explain problems associated to heat transfer. **(10 Marks)**

b. Discuss the heat transfer problems and possible solution in nozzle and turbine blade of gas turbine engine. **(10 Marks)**

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