CBCS SCHEME

USN

15AE53

Fifth Semester B.E. Degree Examination, Aug./Sept. 2020
Heat and Mass Transfer

Time: 3 hrs. Max. Marks: 80

Note: ***1. Answer any FIVE full questions, choosing ONE full question from each module.***
2. Use of heat transfer data hand book is permitted.

Module-1

1 a. Explain the type of mass transfer with examples. **(06 Marks)**
b. Derive an equation for radiation exchange between two bodies. **(06 Marks)**
c. Briefly explain Fick's law of diffusion. **(04 Marks)**

OR

2 a. State Fourier's Law of conduction and formulate an equation of heat transfer through conduction. **(06 Marks)**
b. Explain combined heat transfer mechanism. **(06 Marks)**
c. Derive an equation for radiation heat transfer coefficient. **(04 Marks)**

Module-2

3 a. A copper rod 25mm diameter, k = 380w/mk, extends horizontally from a plane heated wall at 150°C. Temperature of surrounding air is 30°C and heat transfer coefficient between the surface of the rod and the surrounding is $10 w/m^2k$. Determine the rate of heat loss from the rod. How long the rod should be, to be considered as infinite? **(06 Marks)**
b. A steel plate of $\alpha = 1.2 \times 10^{-5} m^2/s$, k = 43w/m k and thickness 2L = 10cm, initially at a uniform temperature of 250°C is suddenly immersed in an oil bath at T_a = 45°C. Convection heat transfer coefficient between the fluid and the surface is $700 w/m^2C$. Determine :
i) Time taken by the center plane to cool to 100°C
ii) Fraction of the energy removed during this time. **(06 Marks)**
c. Formulate Biot number and Fourier time. **(04 Marks)**

OR

4 a. Derive an expression for the temperature distribution in a solid as a function of time using lumped heat analysis for unsteady state heat transfer. **(06 Marks)**
b. Derive an expression for temperature distribution and heat flow through a fin of uniform cross section with the end insulated. **(06 Marks)**
c. Derive the three dimensional general heat conduction equation in cylindrical coordinates. **(04 Marks)**

Module-3

5 a. Derive an equation in term of dimensionless numbers for heat transfer coefficient in the case of forced convection heat transfer. **(08 Marks)**
b. A flat plate is kept in an air stream at a temperature of 20°C. The velocity of air is 3m/s. The plate measures 50cm × 20cm and is maintained at a uniform temperature of 100°C. Compare the heat loss from the plate, when the air flour parallel to 50cm side and parallel to 20cm side. Also determine the percentage increase in heat loss. **(08 Marks)**

OR

6 a. In a thermal conductivity measuring experiment, 2 identical long rods are used. One rod is made up of aluminium with K = 200w/m-k. The other rod is a specimen. One end of both the rod is fixed to a wall at 100°C, while the other end is suspended in air at 25°C. The steady temperature at the same distance along the rods were measured and found to be 75°C on aluminium and 60°C on the specimen rod. Find the thermal conductivity for the specimen. Assume that the fin is insulated at the tip. **(08 Marks)**

b. Three 10mm diameter rods A, B and C protrude from a steam bath at 100°C to a length of 25cm into the atmosphere at 20°C. The temperature at the other ends are found to be 26.27°C for A, 32°C for B and 36.96°C for C. Neglecting the effect of radiation and assuming a surface heat transfer coefficient as 23w/m^{2}K, evaluate their thermal conductivity. **(08 Marks)**

Module-4

7 a. Derive an expression for E – NTU relation for a counter flow heat exchanger. **(08 Marks)**

b. Obtain an expression for the rate of heat transfer when radiation shield is introduced between two parallel plates. **(06 Marks)**

c. What is fouling factor in heat exchanger and what is the effect of it on heat exchanger? **(02 Marks)**

OR

8 a. With assumptions, derive an expression for LMTD for a counter flow heat exchanger. **(08 Marks)**

b. 8000kg/hr of air at 105°C is cooled by passing it through a counter flow heat exchanger. Find the exit temperature of air, if water enters at 15°C and flows at a rate of 7500 kg/hr. The heat exchanger has heat transfer area of 20m^2 and overall heat transfer coefficient corresponding to this area is 145w/m^{2}K. Take C_P of air as 1kJ/kg.K and that of water as 4.18kJ/kg.K. **(08 Marks)**

Module-5

9 a. A circular plate of 25cm diameter with both surfaces maintained at a uniform temperature of 100°C is suspended horizontally in atmospheric air at 20°C. Determine the heat transfer the plate. **(08 Marks)**

b. Write a short note on ablative heat transfer. **(08 Marks)**

OR

10 a. The flow rate of hot and cold fluids running through a parallel flow heat exchanger are 0.2 and 0.5kg/s respectively. The inlet temperature on the hot and cold siders are 75°C and 20°C respectively. The exit temperature of hot water is 45°C. If the individual heat transfer. Coefficient on both sides are 650w/m^{2}K, calculate the area of heat transfer. (for hot and cold fluid, C_p = 4.2kJ/kg.k). **(08 Marks)**

b. Write a short note on aerodynamic heating. **(08 Marks)**

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