CBCS SCHEME

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18AE734

Seventh Semester B.E. Degree Examination, Dec.2023/Jan.2024
Heat and Mass Transfer

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Module-1

1 a. Describe heat transfer and explain its modes with an example. **(12 Marks)**

b. Define the term thermal diffusivity. **(04 Marks)**

c. Explain briefly the combined heat transfer mechanism and coefficient. **(04 Marks)**

OR

2 a. Describe mass transfer and explain its modes with an example. **(12 Marks)**

b. Explain Fourier's law of conduction. **(04 Marks)**

c. Briefly explain Fick's law of diffusion. **(04 Marks)**

Module-2

3 a. State the assumptions and derive the general three dimensional conduction equation in Cartesian coordinates. **(12 Marks)**

b. One end of a long rod is inserted into furnace while the other end projects into ambient air under steady state, the temperature of the rod is measured at tow points 75mm apart and found to 125°C and 88.5°C, while the ambient temperature is 20°C. If the rod is 25mm in diameter and h is $23.36 w/m^2K$. Determine the thermal conductivity of the rod material. **(08 Marks)**

OR

4 a. Obtain temperature distribution equation for system with negligible internal resistance and hence obtain expression for total heat transfer through it in terms of Biot and Fourier number. **(10 Marks)**

b. A 50cm × 50cm copper slab 6.25mm thick has a uniform temperature of 300°C. Its temperature is suddenly lowered to 36°C. Calculate the time required for the plate to reach the temperature of 108°C. Assume $\rho = 9000 kg/m^3$, C = 0.38kJ/kg°C, K = 370W/m°C, $h = 90 w/m^2 °C$. **(10 Marks)**

Module-3

5 a. Obtain an empirical expression in terms of dimensionless numbers for heat transfer co-efficient in the case of forced convection heat transfer. **(12 Marks)**

b. Air at 20°C and atmospheric pressure is flowing over a flat plate at a velocity of 3m/s. If the plate is 30cm wide and at a temperature of 60°C calculate at x = 0.3m.

i) Thickness of velocity and thermal boundary layers
ii) Local and average friction co-efficient
iii) Local and average heat transfer co-efficients
iv) Total drag force on the plate. **(08 Marks)**

OR

6 a. Explain the following :
i) Velocity boundary layer
ii) Thermal boundary layer. **(08 Marks)**

b. Explain the significance of following :
i) Grashoff number
ii) Nusselt number
iii) Prandtl number. **(06 Marks)**

c. A horizontal plate 1m × 0.8m is kept in a water tank with the water surface at 60°C providing heat to warm stagnant water at 20°C. Determine the value of convection heat transfer coefficient. **(06 Marks)**

Module-4

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

b. Explain :
i) Stefan Boltzman law
ii) Black body. **(06 Marks)**

c. Consider two large parallel plates, one at 1000K with emissivity 0.8 and other is at 300K having emissivity 0.6. A radiation shield is placed between them. The shield has emissivity 0.1 on the side facing hot plate and 0.3 on the side facing cold plate. Calculate percentage reduction in radiation heat transfer as a result of radiation shield. **(08 Marks)**

OR

8 a. With assumptions, derive an expression for LMTD for a parallel flow heat exchanger. **(10 Marks)**

b. Exhaust gases flowing through a heat exchanger at the rate of 20kg/min is cooled from 400°C to 120°C by water initially at 10°C specific heat of gases may be taken as 1.13kJ/kgK and overall heat transfer coefficient based on outside diameter as 502.3 kJ/m^2 hr k. If water flow rate is 25 kg/min. Calculate the surface are needed for :
i) Parallel flow ii) Counter flow. Suggest which type of heat exchanger is good. **(10 Marks)**

Module-5

9 a. Write short notes on aerodynamic hating in aerospace engineering. **(06 Marks)**

b. Explain briefly the combustion process in gas turbines and the types of combustion chamber. **(08 Marks)**

c. Write short notes on Rocket thrust chamber. **(06 Marks)**

OR

10 a. Write short note on Ablative heat transfer. **(08 Marks)**

b. The flow rate of hot and cold fluids running through a parallel flow heat exchanger are 0.2 and 0.5 kg/s respectively. The inlet temperature on the hot and cold sides are 75°C and 20°C respectively. The exit temperature of hot water is 45°C. If the individual heat transfer co-efficient on both sides are 650W/m^2K. Calculate the area of heat transfer (for hot and cold fluid, C_p = 4.2 kJ/kg K). **(12 Marks)**

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