CBCS SCHEME

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15AE53

Fifth Semester B.E. Degree Examination, Dec.2019/Jan.2020
Heat and Mass Transfer

Time: 3 hrs. Max. Marks: 80

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

Module-1

1 a. Explain the modes of heat transfer with their corresponding basic equations. **(06 Marks)**
b. Define the term thermal diffusivity. **(02 Marks)**
c. Explain combined heat transfer mechanism. **(04 Marks)**
d. Briefly explain the boundary conditions of 1st, 2nd and 3rd kind. **(04 Marks)**

OR

2 a. Explain mass transfer and modes of mass transfer. **(08 Marks)**
b. Explain:
i) Convective heat transfer coefficient
ii) Radiation heat transfer coefficient
iii) Combined heat transfer coefficient
iv) Mass and Molar concentration. **(08 Marks)**

Module-2

3 a. State the assumptions and derive the general three dimensional conduction equation Cartesian coordinates. **(08 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 two points, 75mm apart and found to be 125°C and 88.5°C, while the ambient temperature is 20°C. If the rod is 25mm in diameter and h is 23.36W/m^2K. Determine the thermal conductivity of the rod material. **(08 Marks)**

OR

4 a. Derive an expression for temperature distribution and heat flow through a fin of uniform cross section with end insulated. **(08 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 ρ = 9000kg/m^3, c = 0.38kJ/kg°C. Take K = 370W/m°C, h = 90W/m^2°C. **(08 Marks)**

Module-3

5 a. Explain briefly boundary layer concept for flow along a flat plate. **(08 Marks)**
b. Calculate the convection heat loss from a radiator 0.5m wide and 1m high maintained at a temperature of 84°C in a room at 20°C. Treat the radiator as a vertical plate. **(08 Marks)**

OR

6 a. What do you mean by velocity boundary layer thermal boundary layer? **(05 Marks)**
b. Explain the significance of following:
i) Grashoff Number
ii) Nusselt Number
iii) Prandtl Number. **(06 Marks)**

c. A plate of length 750mm and width 250mm has been placed longitudinally in a stream of crude oil which flows with a velocity of 5m/s. If the oil has a specific gravity of 0.8 and kinematic viscosity of 1 stroke. Calculate:
   i) Boundary layer thickness at the middle of plate
   ii) Shear stress at the middle of plate
   iii) Friction drag on one side of the plate. **(05 Marks)**

Module-4

7 a. Explain the concept of black and gray bodies. **(04 Marks)**

b. State and explain
   i) Kirchoff's law
   ii) Stefan-Boltzman's law
   iii) Planck's law. **(06 Marks)**

c. Two large parallel plates with emissivity of 0.5 are maintained at different temperature and exchange heat only by radiation. Two equally large radiation shields with surface emissivity 0.05 are introduced in parallel to the plates. Find the percentage reduction in net radiative heat transfer. **(06 Marks)**

OR

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

b. Exhaust gases (C_p = 1.12kJ/kg K) flowing through a tubular heat exchanger at the rate of 1200 kg/hr is cooled from 400°C to 120°C. The cooling is affected by water (C_p = 4.2kJ/kg K) that enters the system at 10°C at the rate of 1500kg/hr. If the overall heat transfer coefficient is 500kJ/m^2 hr°C, what heat exchange area is required to handle the load for parallel flow and counter flow arrangement? **(08 Marks)**

Module-5

9 a. Explain diffusive mass transfer with neat diagram. **(05 Marks)**

b. Write a short note on aerodynamic heating. **(05 Marks)**

c. 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 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). **(06 Marks)**

OR

10 a. State and explain Fick's law of diffusion. **(05 Marks)**

b. Briefly explain the species conservation equation. **(05 Marks)**

c. Write a short note on Ablative heat transfer and the principle of Rocket propulsion. **(06 Marks)**

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