CBCS SCHEME

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17AE53

Fifth Semester B.E. Degree Examination, Dec.2024/Jan.2025
Heat and Mass Transfer

Time: 3 hrs. Max. Marks: 100

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

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

Module-1

1 a. Explain different modes of heat transfer. **(12 Marks)**

b. Define the following terms used in mass transfer.
i) Mass concentration
ii) Mole concentration
iii) Mass fraction
iv) Mole fraction. **(08 Marks)**

OR

2 a. Explain different modes of mass transfer. **(08 Marks)**

b. Explain Ficks law of diffusion. **(08 Marks)**

c. Explain significance of Sherwood and Lewis number in mass transfer analogy. **(04 Marks)**

Module-2

3 a. State the assumptions and derive the general heat conduction equation in Cartesian coordinates for rectangular element. **(10 Marks)**

b. A square plate heater (size 15 cm × 15 cm) is inserted between two slab. Slab A is 2 cm thick (K = 50 W/m°C) and slab B is 1 cm thick (K = 0.2 W/m°C). The outside heat transfer coefficients on both sides of A and B are 200 and 50 $W/m^2°C$ respectively. Temperature of surroundings air is 25°C. If the rating of heater is 1 KW. Find:
(i) Maximum temperature in the system
(ii) Outer surface temperature of two slab **(10 Marks)**

OR

4 a. Derive an expression for heat flow through a fin of uniform cross section with infinitely long fin. **(10 Marks)**

b. A 50 cm × 50 cm copper slab 6.25 mm 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 = 9000 kg/m^3, c = 0.38 kJ/kg°C. Take K = 370 W/m°C, h = 90 $W/m^2°C$. **(10 Marks)**

Module-3

5 a. Obtain dimensionless numbers for natural convection using Buckingham's Pi theorem with usual notations. **(10 Marks)**

b. Water at 50°C enters a 1.5cm diameter and 3m long tube with a velocity of 60m/min. The tube wall is maintained at a constant temperature of 90°C. Calculate the total heat transferred if exit temperature is 64°C. **(10 Marks)**

OR

6 a. Explain hydrodynamic boundary layer theory and thermal boundary layer theory with suitable figures. **(08 Marks)**

b. Air flows through a long rectangular (30cm height × 60cm width) air conditioning duct maintains the outer duct surface temperature at 15°C. If the duct is uninsulated and exposed to air at 25°C, calculate the heat gained by the duct per meter length, assuming it to be horizontal. **(12 Marks)**

Module-4

7 a. Derive an expression for radiation heat exchanger between two parallel infinite gray surfaces. **(10 Marks)**

b. Two parallel large plates with emissivity ($\in$) = 0.5 each, are maintained at different temperature and are exchanging heat only by radiation. Two equally large radiations shields with surface emissivity 0.05 are introduced in parallel to the plates. Find the percentage of reduction in net radiative heat transfer. **(10 Marks)**

OR

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

b. In a counter flow double pipe heat exchanger from 25°C to 65°C by an oil with a specific heat of 1.45 kJ/kgK and mass flow rate of 0.9 kg/s. the oil is cooled from 230°C to 160°C. If the overall heat transfer coefficient is 420 W/m^2°C. Calculate the following:

(i) The rate of heat transfer
(ii) Mass flow rate of water
(iii) The surface area of heat exchanger **(10 Marks)**

Module-5

9 a. Explain heat distribution in rocket thrust chamber. **(08 Marks)**

b. Explain ablative heat transfer. **(06 Marks)**

c. Explain aerodynamic heating in Aerospace engineering. **(06 Marks)**

OR

10 a. Briefly explain the species conversation equation. **(10 Marks)**

b. The flow rates of hot and cold fluids running through a parallel flow heat exchanger are 0.2 and 0.5 Kg/s respectively. The inlet temperatures 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. **(10 Marks)**

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