CBCS SCHEME

USN

17AE53

Fifth Semester B.E. Degree Examination, June/July 2024
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 the following :
i) Conduction
ii) Convection
iii) Radiation. **(10 Marks)**

b. Explain the types of mass transfer with examples and briefly explain the Fick's law of diffusion. **(10 Marks)**

OR

2 a. Explain Newton's law of cooling and derive the governing equation for convective heat transfer and write the differences between thermodynamics and heat transfer. **(10 Marks)**

b. Explain the Fourier's law of conduction and Stefan Boltzmann law. **(10 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 $\rho = 9000\ kg/m^3$, c = 0.38 kJ/kg°C. Take K = 370 W/m°C, h = 90 $W/m^2°C$. **(10 Marks)**

Module-3

5 a. Explain briefly boundary layer concept for flow along plate. **(10 Marks)**

b. Calculate the convection heat loss from a radiator 0.5m wide and 1m high maintained at a temperature of 84^0C in a room at 20^0C. Treat the radiator as a vertical plate. **(10 Marks)**

OR

6 a. Using Buckingham's π theorem, obtain a relationship between N_u , P_r and G_r for free convection heat transfer. **(10 Marks)**

b. Explain the following :

i) Velocity boundary layer

ii) Thermal boundary layer

iii) Thermal entry. **(10 Marks)**

Module-4

7 a. Derive an expression for radiation heat exchanger between two parallel infinite gray surface. **(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. **(08 Marks)**

c. Explain aerodynamic heating in Aerospace engineering. **(04 Marks)**

OR

10 a. Obtain species conservation equation using conventional notations. **(10 Marks)**

b. Ambient air at 20°C, flows past a flat plate with a sharp leading edge at 3m/sec. The plate is heated uniformly throughout its entire length and it is maintained at a surface temperature of 40°C. Calculate the distance from leading edge at which the flow in the boundary layer changes from laminar to turbulent. Assume transition occurs at a critical Reynolds number of 5×10^5. Determine :

i) Thickness of hydrodynamic and thermal boundary layer at transition point

ii) Local and average heat transfer coefficient

iii) Total drag per unit width on one side of plate

iv) Convective heat flow from plate to ambient air considering unit width of the plate. **(10 Marks)**

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