CBCS SCHEME

USN

18AE734

Seventh Semester B.E. Degree Examination, June/July 2023
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. State the laws governing three basic modes of heat transfer. **(08 Marks)**

b. Explain Heat transfer and its modes with example. **(12 Marks)**

OR

2 a. Explain mass transfer and its modes example. **(12 Marks)**

b. State and explain Ficks law of diffusion. **(04 Marks)**

c. Define the term mass concentration and molar concentration. **(04 Marks)**

Module-2

3 a. Derive the general three dimensional conduction equations in Cartesian coordinates and state the assumption mode. **(12 Marks)**

b. A 40 × 40cm copper slab 5mm thick at a uniform temperature of 250°C, suddenly has its surface temperature lowered to 30°C. Find the time which the slab temperature becomes 90°C, $\rho = 900 kg/m^3$, specific heat (c) = 0.38 kJ/kg K, K = 370 W/m–K and convective heat transfer coefficient (h) = $90 W/m^2 - K$. **(08 Marks)**

OR

4 a. Derive an expression for instantaneous heat transfer and total heat transfer for lumped heat analysis treatment of heat conduction problem. **(12 Marks)**

b. A stainless steel rod of outer diameter 1cm originally at a temperature of 320°C is suddenly immersed in a liquid at 120°C for which the convective heat transfer coefficient is $100 W/m^2 K$. Determine the time required for the rod to reach a temperature of 200°C. **(08 Marks)**

Module-3

5 a. Obtain an empirical expression in terms of dimensionless numbers for heat transfer coefficient in the case of forced convection heat transfer. **(10 Marks)**

b. Define clearly and give expression for

i) Reynolds numbers
ii) Prandtl number
iii) Nusselt number
iv) Stanton number. **(10 Marks)**

OR

6 a. Explain the following :

i) Velocity boundary layer
ii) Thermal boundary layer
iii) Thermal entry length. **(10 Marks)**

b. Dry air at atmospheric pressure and 20°C is following with a velocity of 3m/s along the length of a long flat plate, 0.3m wide, maintained at 100°C. Calculate the following quantities at X = 0.3m.
   i) Boundary layer thickness
   ii) Average friction coefficient
   iii) Thickness of thermal boundary layer
   iv) Rate of heat transfer from the plate between X = 0 and X = X by convection. **(10 Marks)**

Module-4

7 a. Hot oil is to be cooled by water in a 1 – shell – pass and 8-tube-passes heat exchanger. The tubes are thin walled and are made of copper with an inner diameter of 1.4cm. The length of each tube pass in the heat exchanger in 5m and the overall heat transfer coefficient is 310W/m^2 °C water flows through three tubes at a rate of 0.2Kg/s and the oil through the shell at a rate of 0.3Kg/s. The water and the oil enter at the temperature of 20°C and 150°C respectively. Determine the rate of heat transfer in the heat exchanger and the outlet temperature of the water and oil. **(10 Marks)**

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

OR

8 a. 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. **(10 Marks)**

b. Obtain an expression for the rate of heat transfer when radiation shield is introduced between two parallel plates. **(10 Marks)**

Module-5

9 a. A mixture of O_2 and N_2 with their partial pressure in the ratio 0.21 to 0.79 in a container at 25°C. Calculate the molar concentration, the mass density, the mole fraction and the mass fraction of each species for a total pressure of 1 bar. **(10 Marks)**

b. Explain the heat transfer concept for the following :
   i) Rocket thrust chamber
   ii) Gas-turbine combustion chamber **(10 Marks)**

OR

10 a. Explain the following :
   i) Ablative heat transfer
   ii) Aerodynamic heating **(12 Marks)**

b. The flow rates of hot heat exchanger are 0.2 and 0.5Kg/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]. **(08 Marks)**

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