CBCS SCHEME

USN | | | | | | | | | | 15AE53

Fifth Semester B.E. Degree Examination, July/August 2022
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 heat transfer and different modes of heat transfer with an example. **(08 Marks)**

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

OR

2 a. Explain Fourier's law of conduction and the term thermal conductivity. **(06 Marks)**

b. Explain Newton's of cooling and convective heat transfer coefficient. **(06 Marks)**

c. Explain combined heat transfer coefficient. **(04 Marks)**

Module-2

3 a. Derive the three dimensional general heat conduction equation in Cartesian coordinates and state the assumptions. **(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 $23.36 W/m^2K$. Determine the thermal conductivity of the rod material. **(08 Marks)**

OR

4 a. Derive an expression for instantaneous heat transfer and total heat transfer using lumped heat analysis for unsteady state heat transfer to a body from the surroundings. **(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 $\rho = 9000 kg/m^3$, c = 0.38kJ/kg °C.
Take K = 370W/m °C, $h = 90 W/m^2$ °C. **(08 Marks)**

Module-3

5 a. Obtain dimensionless numbers for forced convection using Buckingham's Pi theorem with usual notations. **(08 Marks)**

b. Dry air at atmospheric pressure and 20°C is flowing with a velocity of 3 m/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 layers
(iv) Rate of heat transfer from the plate between x = 0 and x = x by convection. **(08 Marks)**

OR

6 a. Explain the significance of the following :
(i) Grashoff number
(ii) Nusselt number
(iii) Prandtl number
(iv) Reynolds number **(08 Marks)**

b. Explain velocity boundary layer theory and thermal boundary layer theory with suitable figures. **(08 Marks)**

Module-4

7 a. Explain the following :
(i) Kirchoff's law
(ii) Stefan-Boltzmann law
(iii) Planck's law
(iv) Black body
(v) Lamberr's cosine law **(10 Marks)**

b. 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. Write a short note on Aerodynamic heating. **(04 Marks)**

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

c. Write a note on Rocket thrust chamber. **(04 Marks)**

OR

10 a. Explain mass transfer and the modes of mass transfer. **(08 Marks)**

b. Write a short note on:
(i) Ablative heat transfer
(ii) Application of mass transfer. **(08 Marks)**

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