CBCS SCHEME

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17AE53

Fifth Semester B.E. Degree Examination, Feb./Mar. 2022
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. Explain the modes of heat transfer with their corresponding basic equations. **(12 Marks)**

b. Explain combined heat transfer mechanism. **(06 Marks)**

c. Define the term thermal diffusivity. **(02 Marks)**

OR

2 a. Explain mass transfer and modes of mass transfer with examples. **(10 Marks)**

b. Define the following terms used in mass transfer :
i) Mass concentration
ii) Molar concentration
iii) Mass fraction
iv) Mole fraction
v) Mass diffusion velocity. **(10 Marks)**

Module-2

3 a. Derive the three dimensional general heat conduction equation in Cartesian coordinates. **(12 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 temperature distribution and heat flow through an infinitely long fin of uniform cross section. **(12 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 $\rho = 9000\ kg/m^3$. $C_p = 0.38kJ/kg°C$. Take $k = 370W/m°C$, $h = 90\ W/m^2°C$. **(08 Marks)**

Module-3

5 a. Obtain an empirical expression in terms of dimensionless numbers for heat transfer co-efficient in the case of free convection heat transfer. **(12 Marks)**

b. Air at 10°C and at a pressure of 100 KPa is flowing over a plate at a velocity of 3m/s. If the plate is 30cm wide and at a temperature of 60°C. calculate the following at x = 0.3m.
i) Boundary layer thickness
ii) Local friction co-efficient
iii) Totals drag force
iv) Thermal boundary layer thickness
v) Local convection heat transfer co-efficient
vi) The heat transfer from the plate. **(08 Marks)**

OR

6 a. Explain the following :
i) Velocity boundary layer
ii) Thermal boundary layer. **(04 Marks)**

b. Explain the significance of following :
i) Granshoff number
ii) Nusselt number
iii) Prandtl number. **(06 Marks)**

c. Derive Bernoulli's equation for compressible flow undergoing.
i) Isothermal process
ii) Adiabatic process. **(10 Marks)**

Module-4

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

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

OR

8 a. Explain the concept of black and gray bodies. **(05 Marks)**

b. State and explain :
i) Kirchoff's law
ii) Planck's Law
iii) Stefan – Boltzman law. **(09 Marks)**

c. Obtain an expression for the rate of heat transfer when radiation shield is introduced between two parallel plates. **(06 Marks)**

Module-5

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

b. Write a short note on :
i) Aerodynamic heating
ii) Ablative heat transfer
iii) The principle of Rocket propulsion. **(12 Marks)**

OR

10 a. Explain diffusion mass transfer with neat diagram. **(08 Marks)**

b. Briefly explain the species conservation equation. **(06 Marks)**

c. State and explain Fick's law of diffusion. **(06 Marks)**

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