CBCS SCHEME

USN

18AE734

Seventh 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.***

Module-1

1 a. Explain Fourier's law of conduction. (08 Marks)
b. Explain Newton's law of cooling and convective heat transfer coefficient. (08 Marks)
c. Briefly explain Fick's law of diffusion. (04 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. (06 Marks)
i) mass concentration
ii) mole concentration
iii) mass fraction
iv) mole mechanism.
c. Explain combined heat transfer mechanism. (04 Marks)

Module-2

3 a. Derive the three dimensional general heat conduction equation in Cartesian coordinates and state the assumptions. (10 Marks)
b. A wall of furnace is made up of inside layer of silica brick 120mm. Thick covered with a layer of magnetite brick 240mm thick. The temperature at the inside surface of magnetite brick wall are 725°C and 110°C respectively. The contact thermal resistance between the two walls at the interface is 0.0035 °C/W per unit wall area. If thermal conductivity of silica and magnetite brick are 1.7W/m°C and 5.8W/m°C calculate the rate of heat loss per unit area of walls and also temperature drop at the interface. (10 Marks)

OR

4 a. Derive an expression for temperature distribution and heat flow through a fin of uniform cross section with infinitely log fin. (10 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 = 370 W/m°C, $h = 90 W/m^2 °C$. (10 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. Air at 20°C and atmospheric pressure if flowing over a flat plate at a velocity of 3m/s. If the plate is 30cm wide and at a temperature of 60°C. Calculate at x = 0.3m.
i) Thickness of velocity and thermal boundary layers
ii) Local and average friction coefficient
iii) Local and average heat transfer coefficients
iv) Total drag force on the plate (10 Marks)

OR

6 a. Explain the significance of following :
i) Grashoff Number
ii) Nusselt number
iii) Prandtl number
iv) Renolds number (10 Marks)

b. Explain the following :
i) Velocity boundary layer
ii) Thermal boundary layer (10 Marks)

Module-4

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

b. Explain the following :
i) Kirchhoff's law
ii) Stefan – Boltzmann law
iii) Planck's law
iv) Black body (10 Marks)

OR

8 a. With assumption, Derive an expression for LMTD for a parallel flow heat exchanger. (10 Marks)

b. Exhaust gases flowing through a heat exchanger at the rate of 20Kg/min is cooled form 400°C to 120°C by water initially at 10°C. Specific heat of gases may be taken as 1.13kJ/Kg K and overall heat transfer coefficient based on outside diameter as 502.3 kJ/m^{2}hr.K. If water flow rate is 25Kg/min. Calculate the surface area needed for i) Parallel flow ii) counter flow ad suggest which type of heat exchange is good. (10 Marks)

Module-5

9 a. Write a short note on Aerodynamic heating in Aerospace Engineering. (06 Marks)

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

c. Write a short note on Rocket thrust chamber. (06 Marks)

OR

10 Write a short note on :
i) Ablative heat transfer
ii) Diffusive mass transfer
iii) Heat distribution in rocket thrust chamber
iv) Lambert's cosine law. (20 Marks)

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