CBCS SCHEME

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17AE53

Fifth 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. Explain Heat Transfer and its modes with an example. **(10 Marks)**
b. Explain Boundary layer characteristics and its types. **(06 Marks)**
c. Briefly explain Fourier's Law of Conduction. **(04 Marks)**

OR

2 a. Briefly explain Stefan Boltzmann Law. **(04 Marks)**
b. Explain Combined Heat Transfer Mechanism. **(06 Marks)**
c. Define the term : i) Mass Transfer ii) Mass Concentration iii) Molar Fraction iv) Momentum Transfer v) Fick's Law of Diffusion. **(10 Marks)**

Module-2

3 a. State the assumptions and derive the general heat conduction equation in Cartesian Co-ordinator for rectangular element. **(10 Marks)**
b. A wall of furnace is made up of inside layer of silica brick 120mm. Thick covered with a layer of magnesite brick 240mm thick. The temperature at the inside surface of silica brick wall and outside surface of magnesite 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 magnesite brick are 1.7W/m°C and 5.8 W/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 variation and heat flow using lumped parameter analysis. **(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 number for heat transfer co - efficient in the case of free convection heat transfer. **(10 Marks)**
b. Air at 20°C and atmospheric pressure is flowing over a flat plate at a velocity of 3m/s of 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 co-efficient.
iv) Total drag force on the plate. **(10 Marks)**

OR

6 a. Explain the following :
i) Thermal boundary layer ii) Velocity boundary layer. **(08 Marks)**

b. A horizontal plate 1m × 0.8m is kept in a water tank with the top surface at 60°C providing heat to warm stagnant water at 20°C. Determine the value of convection coefficient. Repeat the problem for heating on bottom surfaces. **(12 Marks)**

Module-4

7 a. State and explain : i) Kirchhoff's law ii) Wien's displacement
iii) Lambert's Cosine Law iv) Planck's Law. **(08 Marks)**

b. Two very large parallel planes with emissivities 0.3 and 0.8 exchange radiative energy. Determine the percentage reduction in radiative energy transfer when a polished aluminum radiative shield $\varepsilon = 0.04$ is placed between them. **(12 Marks)**

OR

8 a. With the assumptions, derive an expression for LMTD for a parallel flow heat exchanger. **(10 Marks)**

b. Exhaust gases (C_p = 1.12 kJ/kg k) flowing through a tubular heat exchange 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 1500 kg/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? **(10 Marks)**

Module-5

9 Write a short note on :
a. Gas turbine combustion chamber.
b. Aerodynamic heating.
c. Ablative heat transfer.
d. Principle of Rocket propulsion. **(20 Marks)**

OR

10 a. Explain Mass transfer and its modes with an example. **(10 Marks)**
b. Briefly explain the species conservation equation. **(06 Marks)**
c. Explain briefly Fick's Law of diffusion. **(04 Marks)**

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