CBCS SCHEME

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17AE53

# Fifth Semester B.E. Degree Examination, Aug./Sept.2020
# 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 examples. **(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. **(08 Marks)**

b. Explain combined heat transfer mechanism. **(04 Marks)**

c. Define the term:
(i) Mass concentration
(ii) Molar concentration
(iii) Mass fraction
(iv) Mole fraction **(08 Marks)**

## Module-2

3 a. State the assumptions and derive the general heat conduction equation in Cartesian coordinates for rectangular element. **(10 Marks)**

b. A square plate heater (size 15 cm × 15 cm) is inserted between two slab. Slab A is 2 cm thick (K = 50 W/m°C) and slab B is 1 cm thick (K = 0.2 W/m°C). The outside heat transfer coefficients on both sides of A and B are 200 and 50 $W/m^{2}°C$ respectively. Temperature of surroundings air is 25°C. If the rating of heater is 1 KW. Find:
(i) Maximum temperature in the system
(ii) Outer surface temperature of two slab **(10 Marks)**

**OR**

4 a. Derive an expression for heat flow through a fin of uniform cross section with infinitely long fin. **(10 Marks)**

b. A 50 cm × 50 cm copper slab 6.25 mm 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 = 0.38 kJ/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 10°C and at a pressure of 100 kPa is flowing over a plate at a velocity of 3 m/s. If the plate is 30 cm wide and at a temp of 60°C. Calculate the following at x = 0.3 m.
(i) Boundary layer thickness (ii) Local friction coefficient
(iii) Local shearing stress (iv) Total drag force
(v) Thermal boundary layer thickness (vi) Local convection heat transfer coefficient
(vii) Heat transfer from the plate **(10 Marks)**

**OR**

6 a. Explain the significance of following:
(i) Grashoff number
(ii) Nusselt number
(iii) Prandtl number **(06 Marks)**

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

c. Calculate the convection heat loss from a radiator 0.5 m wide and 1m high maintains at a temperature of 84°C in a room at 20°C. Treat the radiator as a vertical plate. **(06 Marks)**

## Module-4

7 a. Derive an expression for radiation heat exchanger between two parallel infinite gray surface. **(10 Marks)**

b. Two parallel large plates with emissivity ($\in$) = 0.5 each, are maintained at different temperature and are exchanging heat only by radiation. Two equally large radiations shields with surface emissivity 0.05 are introduced in parallel to the plates. Find the percentage of reduction in net radiative heat transfer. **(10 Marks)**

**OR**

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

b. In a counter flow double pipe heat exchanger from 25°C to 65°C by an oil with a specific heat of 1.45 kJ/kgK and mass flow rate of 0.9 kg/s. the oil is cooled from 230°C to 160°C. If the overall heat transfer coefficient is 420 $W/m^2{}^\circ C$. Calculate the following:
(i) The rate of heat transfer
(ii) Mass flow rate of water
(iii) The surface area of heat exchanger **(10 Marks)**

## Module-5

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

**OR**

10 a. Explain mass transfer and modes of mass transfer. **(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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