CBCS SCHEME

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15ME63

Sixth Semester B.E. Degree Examination, Dec.2019/Jan.2020
Heat Transfer

Time: 3 hrs. Max. Marks: 80

Note:* 1. *Answer any FIVE full questions, choosing ONE full question from each module.
2. *Use of Heat transfer data hand book is permitted.*

Module-1

1 a. Elaborate basic laws governing modes of heat transfer. **(06 Marks)**

b. Explain what do you mean by thermal contact resistance. **(02 Marks)**

c. The surface of a spherical container with 0.4 m outer diameter is at –195°C. Two layers of insulation each of 2.5 cm thickness is added. The thermal conductivities of the materials are 0.004 and 0.03 W/mK. The contact resistances are each of 5×10^{-4} m^2°CW. The outside is exposed to air at 30°C with a convection coefficient of 16 W/m^2K. Determine the heat gain and the temperatures at various surfaces and also the drops due to contact resistance. **(08 Marks)**

OR

2 a. Explain the types of boundary conditions involved in heat transfer problems. **(06 Marks)**

b. Write down the general heat conduction equation in (i) cylindrical coordinate system (ii) spherical coordinate system. **(02 Marks)**

c. A composite slab is made of three layers 15 cm, 10 cm and 12 cm thickness. The first layer is of material with K = 2.5 W/mK, and occupies 60% of area and the rest is of K = 1.45 W/mK. The second layer is made of material 12.5 W/mK for 50% area and remaining is of material with K = 18.5 W/mK. The third layer is of single material with K = 0.76 W/mK. The slab is exposed to warm air at 26°C and cold air at –20°c on the other side. The convective coefficients are 15 and 20 W/m^2K on the inside and outside respectively. Determine heat flow and interface temperatures. **(08 Marks)**

Module-2

3 a. Derive the equation of temperature distribution for long fin with usual notations. **(08 Marks)**

b. Circumferential fins of constant thickness of 1 mm are fixed on a 50 mm pipe at a pitch of 9 mm. The fin length is 20 mm. The wall temperature is 130°C. The K = 210 W/mK. The convective coefficient is 50 W/m^2K. Determine heat flow and effectiveness. **(08 Marks)**

OR

4 a. Derive equation of temperature distribution using lumped parameter model. **(08 Marks)**

b. A concrete wall initially at 30°C is exposed to gases at 900°C with h = 85 W/m^2K. The thermal diffusivity is 4.92×10^{-7} m^2/s. the K of material is 1.28 W/mK. Determine the temperature of the surface and temperatures at 1 cm depth and also 5 cm depth after 1 hr. Also estimate the heat flow at the surface at the instant. **(08 Marks)**

Module-3

5 a. Derive solution to differential equation for steady two dimensional conduction with usual notations. **(08 Marks)**

b. A plate 1m × 2m side has both its 2m sides and one 1m side at 100°C. The temperature along the fourth side is given by $T = 400\sin\left(\frac{\pi x}{1}\right) + 100$ where x is in m from the corner and t is in °C. Determine temperature taking 1m on x direction and 2m on y direction at following locations (i) (0.25, 0.5) (ii) (0.25, 1) (iii) (0.5, 1.5) (iv) (0.5, 2.0) **(08 Marks)**

OR

6 a. Define and explain the following:
i) Black body
ii) Shape factor
iii) Wein's displacement law
iv) Kirchoff's law **(08 Marks)**

b. Two large parallel planes are at 1000 K and 600 K. Determine the heat exchange per unit area.
(i) If surfaces are black
(ii) If the hot one has an emissivity of 0.8 and cooler one 0.5
(iii) If a large plate is inserted between these two, having emissivity of 0.2. **(08 Marks)**

Module-4

7 a. Explain formation of hydrodynamic and thermal boundary layers. **(08 Marks)**

b. A flat heater of circular shape of 0.2 m dia with a heat generation of 1.2 KW/m^2 is kept in still air at 20°C with heated surface facing downward and inclined at 15° to the horizontal. Determine heat transfer coefficient. **(08 Marks)**

OR

8 a. Write the importance of the following:
(i) Grashoff number
(ii) Prandtl number
(iii) Reynolds number
(iv) Stanton number **(08 Marks)**

b. Nitrogen at −20°C gets heated as it flows through a pipe of 25 mm dia at a flow rate of 13.72 kg/hr at 1 atm pressure. Determine the value of pipe temperature at the exit where pipe is heated with uniform heat flux of 500 W/m^2 and pipe is 4m long. Take Cp of nitrogen as 1030 J/kgK. **(08 Marks)**

Module-5

9 a. Sketch and explain regimes of pool boiling. **(08 Marks)**

b. Water at atmospheric pressure is boiling on a brass surface heated from below. If the surface is at 108°C, determine the heat flux and compare the same with critical heat flux. **(08 Marks)**

OR

10 a. Derive CMTD for parallel flow heat exchanger. **(08 Marks)**

b. In a shell and tube heat exchanger/condenser, the tube bank is 10 rows deep with ID of tube 20 mm and OD 25 mm. the tubes are arranged in square array of 50 mm pitch. Water flows across the tubes with V = 0.5 m/s. Sea water flows inside with 1 m/s. The water is cooled from 50°C to 30°C and sea water temperature changes from 15°C to 25°C. Assuming same properties for both side water, determine overall heat transfer coefficient. The tubes are of brass with K = 60.6 W/mK. Assume tube length of 4m. **(08 Marks)**

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