CBCS SCHEME

USN 15ME63

Sixth Seinester B.E. Degree Examination, June/July 2019
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 and steam tables are permitted.

Module-1

1 a. State the laws governing three basic modes of heat transfer. **(06 Marks)**

b. Derive the general three-dimensional conduction equation in Cartesian coordinates and state the assumptions made. (to **Marks)**

OR

2 a. Derive an expression for the temperature distribution through the plane wall with uniform thermal conductivity. **(06 Marks)**

b. A metal [K = 45 W/m'Cl steam pipe of 5 cm inside diameter and 6.5 cm outside diameter is lagged with 2.75 cm thickness of high temperature high insulation having thermal conductivity 1.1 W/m°C. convective heat transfer coefficients on the inside and outside surfaces are 4650 W/m^{2}K and 11.5 W/m^{2}K respectively. If the steam temperature is 200°c and the ambient temperature is 25°C. Calculate:

i) Heat loss per metre length of pipe
ii) Temperature at the interfaces
iii) Overall heat transfer coefficient to inside and outside surfaces. (10 **Marks)**

Module-2

3 a. Derive an expression for critical thickness of insulation for a cylinder. **(06 Marks)**

b. The handle of a ladle used for pouring molten metal at 327°C is 30 cm long and is made of 2.5 cm x 1.5 **cm** mild steel bar stock **[K =** 43 W/mKj. In order to reduce grip temperature, it is proposed to make a hallow handle of mild steel plate 0.15 cm thick to the same rectangular shape. If the surface heat transfer coefficient is 14.5 W/m ^{2}K and the ambient temperature is 27°C, estimate the reduction in the temperature of grip. Neglect the heat transfer from inner surface of the hallow shape. **(10 Marks)**

OR

4 a. What is lumped system analysis? Derive the temperature variation using lumped parameter analysis. **(06 Marks)**

b. An iron sphere of diameter 5 cm is initially at a uniform temperature of 225°C. It is suddenly exposed to an ambient at 25°C with convection coefficient of 500 W/m^{2}K.

i) Calculate the centre temperature 2 minute after the start of exposure.
ii) Calculate the temperature at a depth of 1 cm from the surface after 2 minute of exposure.
iii) Calculate the energy removed from the sphere during this period.

Take thermo physical properties of iron sphere K = 60 W/mK, p = 7850 kg/m^3, C 460 J/kg, a = 1.6 x 10^{-5} m^2/s. **(10 Marks)**

Module-3

5 a. Explain the three types of boundary conditions are applied in finite difference representations. **(06 Marks)**

b. Derive the relation between normal intensity and emissive power. (10 **Marks)**

OR

6 a. Explain:

i) Stefan Boltzman law
ii) Kirchoff's law
iii) Planks law **(06 Marks)**

b. Two large parallel plates with E = 0.5 each, are maintained at different temperatures 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 reduction in net radiative heat transfer. **Marks)**

Module-4

7 a. Explain the physical significance of

(i) Prandtl number (ii) Reynolds number (iii) Nusselt number **(06 Marks,**

b. Air at 1 atm pressure and temperature 25°C flowing with a velocity 50 m/s crosses an industrial heater made of long solid rod of diameter 20 mm. The surface temperature of the heater is 457°C. Determine the allowable electrical power density (W/m^3) within the heater per meter length. **(10 Marks)**

OR

8 a. A circular plate of 25 cm diameter with both surfaces maintained at a uniform temperature of 100°C is suspended horizontally in atmospheric air at 20°C. Determine the heat transfer from the plate_ **(10 Marks)**

b. Obtain the fundamental relationship between Nusselt, Prandtle and Reynolds number using Buckingham's rt - theorem for forced convection heat transfer. **(06 Marks)**

Module_5

9 a. Derive an expression for LMTD for a parallel flow heat exchanger. **(06 Marks)**

b. A refrigerator is designed to cool 250 kg/hr of hot fluid of specific heat 3350 J/kg°C at 120°C using a parallel arrangement 1000 kg/hr of cooling water is available for cooling purposes at a temperature of 10°C. If the overall heat transfer coefficient is 1160 W/m^2°C and the surface area of the heat exchanger is 0.25 m^2. Calculate the outlet temperature of the cooled liquid and water and also the effectiveness of the heat exchanger and rate of heat transfer. **Marks)**

OR

10 a. Sketch and explain boiling curve. **(06 Marks)**

b. The outer surface of a vertical tube 80 mm in outer diameter and lm long is exposed to saturated steam at atmospheric pressure. The tube surface is maintained at 50°C by flow of water through the tube. What is the rate of heat transfer to coolant and what is the rate of condensation of steam? **(10 Marks)**

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