CBCS SCHEME

USN | | | | | | | | | | | **15ME63**

Sixth Semester B.E. Degree Examination, June/July 2018
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, steam table are permitted.

Module-1

1 a. What do you mean by boundary condition of 1^{st}, 2^{nd} and 3^{rd} kind? **(06 Marks)**

b. Explain briefly the mechanism of conduction, convection and radiation of heat transfer. **(06 Marks)**

c. A mild steel tank of wall thickness 20 mm is used to store water at 95°C. Thermal conductivity of mild steel is 45 W/m °C, and the heat transfer coefficient inside and outside the tank are 2850 W/m^2 °C and 10 W/m^2 °C respectively. If surrounding air temperature 20°C, calculate Rate of heat transfer per unit area of the tank. **(04 Marks)**

OR

2 a. Derive the general three dimensional heat conduction equation in Cartesian coordinate and state the assumption made. **(08 Marks)**

b. The wall of a house in cold region consists of three layers, an outer brick work 15 cm thick, the inner wooden panel 1.2 cm thick, the intermediate layer is insulator of 7 cm thick. The 'k' for brick and wood are 0.7 and 0.18 W/mK. The inside and outside temperature of wall are 21 and – 15°C. If insulation layer offer twice the thermal resistance of the brick wall, calculate (i) heat loss per unit area (ii) 'k' of insulator. **(08 Marks)**

Module-2

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

b. Differentiate between effectiveness and efficiency of fins. **(04 Marks)**

c. A rod [k = 200 W/mK] 5 mm in diameter and 5 cm long has its one end maintained at 100°C. The surface of the rod is exposed to ambient air at 25°C with convection heat transfer coefficient of 100 W/m^{2}K. Assuming other end is insulated. Determine (i) the temperature of rod at 20 mm distance from the end at 100°C (ii) Heat dissipation rate from the surface of rod (iii) Effectiveness. **(06 Marks)**

OR

4 a. Derive the expression for temperature variation and heat flow using Lumped Parameter Analysis. **(06 Marks)**

b. Explain significance of Biot and Fourier number. **(04 Marks)**

c. The average heat transfer coefficient for flow of 100°C air over a flat plate is measured by observing the temperature time history of a 3 cm thick copper slab exposed to 100°C air, in one test run, the initial temperature of slab was 210°C and in 5 min the temperature is decreased by 40°C. Calculate the heat coefficient for this case. Assume ρ = 9000 kg/m^3 ; C = 0.38 kJ/kgK , K = 370 W/mK. **(06 Marks)**

Module-3

5 a. Explain formulation of differential equation 1-D steady heat conduction. (06 Marks)
b. Explain different solution method used in numerical analysis of heat conduction. (06 Marks)
c. Explain applications and computation error of numerical analysis heat conduction. (04 Marks)

OR

6 a. Define (i) Blackbody (ii) Planks law (iii) Wein displacement law (iv) Lamberts law. (06 Marks)
b. Prove that emissive power of the black body in hemispherical enclosures in π terms of intensity of radiation. (06 Marks)
c. The temperature of black surface of 0.2 m^2 area is 540°C. calculate (i) the total rate of energy emission (ii) the intensity of normal radiation (iii) the wavelength of maximum monochromatic emission power. (04 Marks)

Module-4

7 a. Explain with neat sketches (i) Velocity Boundary layer (ii) Thermal boundary layer. (08 Marks)
b. Air flows over a flat plate at 30°C, 0.4m wide and 0.75m long with a velocity of 20m/s. Determine the heat transfer from the surface of plate assuming plate is maintained at 90°C.
Use $N_{UL} = 0.664\, R_e^{0.5}\, Pr^{0.33}$ for laminar
$N_{UL} = \left[0.036\, R_e^{0.8} - 0.836\right] Pr^{0.333}$ for turbulent. (08 Marks)

OR

8 a. Explain the physical significance of the following dimensionless number:
(i) Reynold's number (ii) Prandtl number (iii) Nusselt number
(iv) Stantor number. (06 Marks)
b. A stream pipe 5 cm in diameter is lagged with insulating material of 2.5 cm thick. The surface temperature is 80°C and emissivity of the insulating material surface is 0.93. Find the total heat loss by natural convection and radiation. The temperature of the air surrounding the pipe is 20°C. Also find the overall heat transfer coefficient. (10 Marks)

Module-5

9 a. Derive expression for LMTD for parallel flow heat exchanger and state the assumption made. (08 Marks)
b. Water enters a counter flow heat exchanger at 15°C flowing at a rate of 1300 kg/h. It is heated by oil [c_p = 2000 J/kgK] flowing at the rate of 550 kg/h with an inlet temperature of 94°C for an area 1 m^2 and overall heat transfer coefficient of 1075 W/m^2K. Determine the total heat transfer and outlet temperature of water and oil. (08 Marks)

OR

10 a. Explain different regimes of pool boiling with neat sketches. (08 Marks)
b. Draw saturated stream at a pressure of 2.0 bar condenses on the surface of vertical tube of height 1 m. The tube surface is kept at 117°C. Estimate the thickness of the condensate film and heat transfer coefficient at a distance of 0.2 m from the upper end of the tube. Assume the condensate film to be laminar. Also calculate the average heat transfer coefficient over the entire length of the tube. (08 Marks)

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