Code No: 136CA **R16**

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

B. Tech III Year II Semester Examinations, November/December - 2020

HEAT TRANSFER

(Mechanical Engineering)

Time: 2 hours **Max. Marks: 75**

Answer any five questions

All questions carry equal marks

1.a) Derive general heat conduction equation in radial coordinates and state the assumption made.

b) A pipe carrying steam at 250 ^{0}C has an internal diameter of 12 cm and the pipe thickness is 7.5 mm. The conductivity of the pipe material is 49 W/m K the convective heat transfer coefficient on the inside is 85 W/m^2 K. The pipe is insulated by two layers of insulation one of 5 cm thickness of conductivity 0.15 W/m K and over it another 5 cm thickness of conductivity 0.48 W/m K. The outside is exposed to air at 35 ^{0}C with a convection coefficient of 18 W/m^2 K. Determine the heat loss for 5 m length. Also determine the interface temperatures and the overall heat transfer coefficient based on inside and outside areas. [8+7]

2. A truncated cone like solid has its circumferential surface insulated. The base is at 300 ^{0}C and the area along the flow direction at x is given by A = 1.3 (1 – 1.5x). Where x is measured from the base in the direction of flow in m and A is in m^2. If the thermal conductivity is 2.6 W/m K and the plane at x = 0.2 m is maintained at 100 ^{0}C, determine the heat flow and also the temperature at x = 0.1 m. Calculate the temperature gradients at the three sections. [15]

3. Derive an expression for heat dissipation in a straight triangular fin. [15]

4. A cylinder of radius 0.2 m generates heat uniformly at 2 × 106 W/m^3. If the thermal conductivity of the material has a value of 200 W/m K, determine the maximum temperature gradient. Also find the centre temperature if the surface is at 100 ^{0}C. What is the value of heat flux at the surface and heat flux per m length? [15]

5.a) Air flows over a flat plate of 80 m × 0.5 m at a velocity of 2 m/s. The temperature of air is 50 ^{0}C, calculate i) the boundary layer thickness, ii) the drag coefficient both at a distance of 0.8 m from the leading edge of the plate, and iii) the drag force on the plate over the entire length. Take ρ = 1.003 kg/m^3 and α=17.95 × 10^{-6} m^2 /s for air at 50 ^{0}C.

b) Define (i) boundary layer thickness, (ii) velocity and momentum displacement thickness, and (iii) enthalpy and conduction thicknesses. [8+7]

6. Wind blows at 20 kmph parallel to the wall of adjacent rooms. The first room extends to 10 m and the next one to 5 m. The wall is 3.2 m high. The room inside is at 20 ^{0}C and the ambient air is at 40 ^{0}C. The walls are 25 cm thick and the conductivity or the material is 1.2 W/m K. On the inside convection coefficient has a value of 6 W/m^2 K. Determine the heat gain through the walls of each room. [15]

7.a) Derive equation of LMTD for counter flow heat exchanger.

b) A cross flow heat exchanger with both fluids unmixed is used to heat water flowing at a rate of 20 kg/s from 25 ^{0}C to 75 ^{0}C using gases available at 300 ^{0}C to be cooled to 180 ^{0}C. The overall heat transfer coefficient has a value of 95 W/m^2 K. Determine the area required. For gas Cp = 1005 J/kg K. [8+7]

8. A vertical tube, 1.2 m long and having 50 mm outer diameter is exposed to steam at 1.2 bar. If the tube surface is maintained at 85 ^{0}C by flowing cooling water through it, determine the rate of heat transfer to the cooling water and the rate of condensation of steam. If the tube is held in horizontal position, estimate the condensation rate. [15]

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