CBCS SCHEME

USN | | | | | | | | | | 15AU62

Sixth Semester B.E. Degree Examination, Dec.2019/Jan.2020
Heat and Mass 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 and Mass Transfer data hand book is allowed.***
3. ***Assume suitable missing data.***

Module-1

1 a. Obtain 3 dimensional heat conduction equation in Cartesian co-ordinate system. **(08 Marks)**

b. A Furnace wall is made of inside silica brick (K = 1.6 W/m°C), outside magnesia brick inner and outer surfaces are exposed to temperatures 820°C and 120°C, find the near flow through the wall per unit area. Assume a contact resistance of 0.002 m^2°C/W. determine the rate of heat transfer and draw the temperature profile through the wall. The inside and outside heat transfer coefficients are 35 W/m^2°C and 12 W/m^2°C respectively. **(08 Marks)**

OR

2 a. Obtain logmean area for cylinder and geometric mean area for sphere. **(08 Marks)**

b. A thin metal sphere of diameter 300mm is used to store a liquefied gas at −200°C to reduce heat leakage from atmosphere at 30°C, it is insulated by two layers of insulation each 30mm thick. The first layer of insulating material has a thermal conductivity of 0.06 W/m°C and second layer has the thermal conductivity of 0.6 W/m°C. Determine the heat leakage (i) when better insulator is next to the sphere (ii) When better conductor is immediately next to the sphere. **(08 Marks)**

Module-2

3 a. Obtain critical radius of insulation for cylinder and sphere. **(08 Marks)**

b. A composite slab is made up of 2 materials A and B. Layer A of 5cm thick and layer B is of 10cm thick. The outer surface of 'A' is maintained at 600°C and that of 'B' is maintained at 30°C. The thermal conductivities of A and B vary with temperature as follows:
$K_A = 0.05\ (1 + 0.008T)$; $K_B = 0.04\ (1 + 0.0075T)$. Determine the steady state heat flux through the composite slab. **(08 Marks)**

OR

4 a. Obtain temperature distribution equation for lumped heat analysis and hence obtain equation for total heat transfer in it. **(08 Marks)**

b. A 2m long 0.2m dia steel cylinder (K = 40 W/m °C, $\alpha = 1 \times 10^{-5}$ m^2/s) initially at 400°C is suddenly immersed in water at 50°C. If h = 200 W/m^2 °C. Calculate 20 min after immersion. (i) The center temperature (ii) The surface temperature (iii) The heat transferred to water during 20 mins. **(08 Marks)**

Module-3

5 a. Using dimensional analysis show that for free convection heat transfer $N_u = B\ Gr^a\ Pr^b$ with usual notations. **(08 Marks)**

b. A circular hot plate 15cm in diameter is maintained at 160°C in atmospheric air of 20°C. Calculate convection neat loss from both surfaces of the plate, when the upper surface is heated and lower surface is cooled and the plate is kept in horizontal position. **(08 Marks)**

OR

6 a. Explain significance of following dimensionless numbers i) Reynolds's number ii) Prandtl number iii) Nusselt number iv) Stanton number. **(08 Marks)**

b. Air at 25°C and atmospheric pressure flows across a heated cylinder of diameter 7.5cm. If the velocity of air flows at 1.2 m/sec and the cylinder surface is maintained at 95°C. Compute heat transfer rate. **(08 Marks)**

Module-4

7 a. Derive an expression for LMTD for counter flow heat exchanger. **(08 Marks)**

b. A counter flow heat exchanger of heat transfer Area = $12.5m^2$ is to cool oil with C_p = 2000 J/kg K with water C_p = 4170 J/kg K. The oil enters at 100°C and at the flow rate of 2kg/s, while water enters at 20°C at the flow rate of 0.48kg/s. the overall heat transfer coefficient is 400 W/m^2 K. Calculate the exit temperature of water and heat transfer rate. **(08 Marks)**

OR

8 a. Explain regimes of pool boiling for water. **(08 Marks)**

b. A stream condenser consists 625 tubes with 1.25cm outer diameter and 3m long arranged in a 25×25 array. Saturated at vapour temperature = 50°C (P = 12.35KPa) condenses on the outer surface of the tubes, which are maintained at water temperature = 30°C. Calculate : i) The average heat transfer co-efficient ii) The total rate of heat transfer iii) The rate of condensation. **(08 Marks)**

Module-5

9 a. Explain: i) Lambert's cosine law ii) Planck's law iii) Wien's law iv) Kirchoff's law. **(08 Marks)**

b. Two concentric spheres 200mm and 300mm in diameters with space between them evacuated are to be used to store liquid at −153°C in a room at 27°C. The surface of sphere is polished with aluminium having emissivity of 0.03. If latent heat of liquid air is 0.21×10^6 J/kg. Find rate of evaporation of liquid air. **(08 Marks)**

OR

10 a. A pipe carrying steam having an outside diameter of 20cm runs in a large room and is exposed to air at a temperature of 30°C. The pipe surface temperature is 400°C. Calculate the loss of heat to surroundings per meter length of pipe due to thermal radiation. The emissivity of the pipe surface is 0.8. What would be the loss of heat due to radiation if the pipe is enclosed in a 40cm diameter brick of emissivity 0.91? **(08 Marks)**

b. A radiation shield is provided between 2 large parallel iron plate to reduce heat transfer between them by 8 times. If the emissivity of the iron is 0.65, what should be emissivity of the shield material. **(08 Marks)**

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