CBCS SCHEME

USN

17AE53

Fifth Semester B.E. Degree Examination, July/August 2021
Heat and Mass Transfer

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions.***

1 a. Explain the following :
i) Conduction ii) Convection iii) Radiation. **(10 Marks)**

b. Explain the types of mass transfer with examples and briefly explain the Fick's law of diffusion. **(10 Marks)**

2 a. Explain Newton's law of cooling and derive the governing equation for convective heat transfer and write the differences between thermodynamics and heat transfer. **(10 Marks)**

b. Explain the Fourier's law of conduction and Stefan Boltzmann law. **(10 Marks)**

3 a. Derive the General heat conduction equation in cylindrical co-ordinates. **(10 Marks)**

b. A furnace wall is made up of three layers of thicknesses 250mm , 100mm and 150mm with thermal conductivities of 1.65K and 9.2W/m^{0}C respectively. The inside is exposed to gases at 1250^{0}C with a convection co-efficient of 25W/m^2 ^{0}C and the inside surface is at 1100^{0}C. The outside surface is exposed to air at 25^{0}C with convection coefficient of 12W/m^2 ^{0}C. Determine i) The unknown thermal conductivity ii) The overall heat transfer coefficient iii) All surface temperatures. **(10 Marks)**

4 a. Derive the expression for instantaneous heat transfer and total heat transfer for lumped heat analysis treatment of heat conduction problem. **(10 Marks)**

b. Consider a flow of water at rate of 0.015 kg/s through a square duct 2cm × 2cm ,whose walls are maintained at 100^{0}C. Determine length of duct required to heat water from 30^{0}C to 70^{0}C. **(10 Marks)**

5 a. Explain briefly boundary layer concept for flow along plate. **(10 Marks)**

b. Calculate the convection heat loss from a radiator 0.5m wide and 1m high maintained at a temperature of 84^{0}C in a room at 20^{0}C. Treat the radiator as a vertical plate. **(10 Marks)**

6 a. Using Buckingham's π theorem, obtain a relationship between N_u , P_r and G_r for free convection heat transfer. **(10 Marks)**

b. Explain the following : i) Velocity boundary layer ii) Thermal boundary layer iii) Thermal entry. **(10 Marks)**

7 a. Derive an expression for LMTD of a parallel flow heat exchanger and state the assumption made. **(10 Marks)**

b. Steam enters and counter flow heat exchanger dry saturated at 10bar and leaves at 350^{0}C. The mass flow rate of the steam is 800 kg/min. The gas enters the heat exchanger at 650^{0}C and the flow rate of mass is 1350 kg/min. If the tubes are 30mm in diameter and 3m long. Determine the number of tubes required. Use the following data for a Steam T_{sat} (10 bar) = 180^{0}C , C_{PS} = 2.71 kJ/kg K , h_s = 600 W/m^2 ^{0}C. For gas C_{pg} = 1kJ/kg K , h_g = 250 w/m^2 ^{0}C. **(10 Marks)**

8 a. Derive and expression for effectiveness of a counter flow heat exchange using NTU method. (10 Marks)

b. In a shell and tube counter flow heat exchanger water flows through a copper tube 20mm ID and 23mm OD while oil flows through the shell. Water enters at 20^0C and comes out at 30^0C while oil enters at 75^0C and comes out at 60^0C. The water and oil side film co-efficients are 4500 and 1250 W/m^2 ^{0}C. The K_{wall} is 355 W/m ^{0}C the fouling factor on the water and oil sides may be taken to be 0.004 and 0.001. If the length of the tube is 2.4m. Calculate the following : i) U ii) The heat transfer rate. (10 Marks)

9 a. Explain the concept of Aerodynamic heating. (10 Marks)
b. Explain the Ablative heat transfer in Aerospace application. (10 Marks)

10 a. The mixture of O_2 and N_2 with their partial pressure in the ratio 0.21 and 0.79 in a container at 25^0C. Calculate the Concentration, Mass density , Mole friction and the Mass fraction of each species for a total pressure of 1 bar. (10 Marks)
b. Explain the heat transfer concept for the following :
i) Rocket thrust chamber.
ii) Gas turbine combustion chamber. (10 Marks)

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