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10AU65

Sixth Semester B.E. Degree Examination, Jan./Feb. 2021
Heat and Mass Transfer

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer any FIVE full questions, selecting atleast TWO questions from each part.***
2. ***Heat transfer data book and steam tables are permitted***

PART – A

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

b. Derive the general three dimensional heat conduction equation in Cartesian co-ordinate system. **(08 Marks)**

c. A wall of a furnace is made up inside layer of silica brick 120mm thick covered with a layer of magnesite brick 240mm thick. The temperature at the inside surface of silica brick wall and outside surface of magnesite brick walls are 725^{0}C and 110^{0}C respectively. The contact thermal resistance between two walls at the interface is 0.0035^{0}C/w per unit wall area. If the thermal conductivities of silica and magnesite bricks are 1.7w/m ^{0}C and 5.8 w/m ^{0}C. Calculate i) The rate of heat loss per unit area of walls.
ii) The temperature drop at the interface. **(06 Marks)**

2 a. Clearly define : i) Fin efficiency ii) Fin effectiveness. **(04 Marks)**

b. Derive an expression for temperature distribution for rectangular fin, with the tip insulated. **(08 Marks)**

c. A wire of 6.5mm diameter at a temperature of 60^{0}C is to be insulated by a material having K = 0.174 w/m ^{0}C. Convection heat transfer coefficient h_o = 8.722 w/m^2 ^{0}C. The ambient temperature is 20^{0}C. For maximum heat loss what is the maximum thickness of insulation and heat loss per meter length? Also find the percentage increase in the heat dissipation. **(08 Marks)**

3 a. Define : i) Biot number and ii) Fourier number. **(04 Marks)**

b. Show that the temperature distribution under lumped system analysis is given by $\frac{T-T_\infty}{T_1-T_\infty} = e^{-BiFo}$. **(08 Marks)**

c. A thermocouple the function of which can be approximated as a 1mm diameter sphere is to measure the temperature of a gas stream. The properties of the function are ρ = 8500 kg/m^3 , C = 320 J/kg K and K = 35 w/m K. The heat transfer co-efficient between the junction and the gas is 210 w/m^2 K. Determine how long it will take for the thermocouple to read 99% of the initial temperature difference. **(08 Marks)**

4 a. Briefly explain :
i) Hydrodynamic boundary layer ii) Thermal boundary layer. **(04 Marks)**

b. Define i) Nusslet number ii) Prandtl number iii) Grashoff Number. **(06 Marks)**

c. A 15cm outer diameter steel pipe lies 2m vertically and 8m horizontally in a large room with an ambient temperature of 30^{0}C. If the pipe surface is at 250^{0}C and the emissivity of steel is 0.6. Calculate the total rate of heat loss from the pipe to the atmosphere. Properties of air at 140^{0}C are ρ = 0.854 kg/m^3 , C_p = 1.01 kJ/kg K , K = 0.035 w/m K , P_r = 0.684 and V = 27.8 × 10^{-6} m^2/sec. **(10 Marks)**

PART – B

5 a. Air at 20^0C and atm flows over a flat plate at 40m/s. The Plate is 80cm long and is maintained at 60^0C. Assuming unit depth in Z – direction, calculate the heat transfer rate from the plate. Properties of air at 40^0C are : $P_r = 0.7$, $K = 0.02723$ w/m K , $C_p = 1.007$ kJ/kg K and $\mu = 1.906 \times 10^{-5}$ kg/ms. **(10 Marks)**

b. The crank case of an IC engine measuring 0.8m × 0.2m may be assumed at a flat plate. The engine runs at a speed at 25m/sec and the crank case is cooled by the air flowing past it at the same speed. Calculate the heat loss from the crank surface maintained at 85^0C to the ambient air at 15^0C. Due to road induced vibration, the boundary layer becomes turbulent from the leading edge itself. **(10 Marks)**

6 a. Derive an expression for LMTD of a counter flow heat exchanger. **(10 Marks)**

b. The flow rates of hot and cold water streams running through a parallel flow heat exchanger are 0.2kg/sec and 0.5kg/sec respectively. The inlet temperature on the hot and cold sides are 75^0C and 20^0C respectively. The exit temperature of hot water is 45^0C. if the individual heat transfer coefficient on both sides are 650 w/m^2 ^{0}C. Calculate the area of the heat exchanger. **(10 Marks)**

7 a. With the help of boiling curve, explain the different regimes of boiling. **(08 Marks)**

b. With neat sketch, explain i) Film condensation ii) Drop wise condensation. **(06 Marks)**

c. Water at atmosphere pressure is to be boiled in a polished copper pan, the diameter of the pan is 350mm and is kept at 115^0C. Calculate the following : i) Power of the burner ii) Rate of evaporation in kg/sec iii) Critical heat flux for these condition. **(06 Marks)**

8 a. With usual notation, prove that the emissive power of a diffuse surface is equal to π times intensity of radiation. **(08 Marks)**

b. Clearly define : i) Black body ii) Planck's law iii) Weins displacement. **(06 Marks)**

c. Determine the radiant heat exchange in w/m^2 between two large parallel steel plates of emissive power 0.8 and 0.5 held at a temperature of 1000 K and 500 K respectively. If then copper plate of emissivity 0.1 is introduced as a radiation shield between the two plates. **(06 Marks)**

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