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14MTP21

Second Semester M.Tech Degree Examination, Dec.2015/Jan.2016
Advanced Heat Transfer

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer any FIVE full questions.***
2. ***Heat transfer data handbook, steam tables are permitted.***

1 a. An exterior wall of a house consists of a 10.16cm layer of common brick having thermal conductivity 0.7W/m.K. it is followed by a 3.8cm layer of gypsum plaster with thermal conductivity of 0.48W/m.K. What thickness of loosely packed rock wool insulation (K = 0.065 W/m.K) should be added to reduce the heat loss through the wall by 80%. **(10 Marks)**

b. A 1m long, 5cm diameter, cylinder placed in an atmosphere of 40^0C is provided with 12 longitudinal straight fins (K = 75W/m.K), 0.75mm thick. The fins protrude 2.5cm from the cylinder surface. The heat transfer coefficient is 23.3 W/m^2 K. Calculate the rate of heat transfer if the surface temperature of cylinder is at 150^0C. **(10 Marks)**

2 a. A 50mm thick iron plate is initially at 225^0C. Its both surfaces are suddenly exposed to an environment at 25^0C with convection coefficient of 500W/m^2 K.
i) Calculate the centre temperature, 2 minute after the start of exposure.
ii) Calculate the temperature at the depth of 10mm from the surface, after 2 minutes of exposure.
iii) Calculate the energy removed from the plate per square meter during the period.
Take thermophysical properties of iron plate, K = 60W/m.K , ρ = 7850 kg/m^3 , C = 460J/kg , $\alpha = 1.6 \times 10^{-5}$ m^2/s. **(10 Marks)**

b. What is conduction shape factor? A spherical tank 0.5m in diameter contains a radioactive material is buried in the earth (K = 0.8W/m.K) at a depth of 1.25m from the earth surface to centre of sphere. The tank surface is maintained at uniform temperature of 100^0C as a result of radioactive decay, while the earth surface is at uniform temperature of 10^0C. Calculate the rate of heat generation in the tank. **(10 Marks)**

3 a. State and prove Kirchoff's law of radiation. **(06 Marks)**

b. Explain with a neat sketch, the concept of "Black Body". **(04 Marks)**

c. A spherical liquid oxygen tank 0.3m in diameter is enclosed concentrically in a spherical container of 0.4m diameter and the space in between is evacuated. The tank surface is at -183^0C and has an emissivity of 0.2. The container surface is at 15^0C and has an emissivity of 0.25. Determine the net radiant heat transfer rate and rate of evaporation of liquid oxygen if its latent heat is 220 kJ/kg. **(10 Marks)**

4 a. Derive an expression for momentum transfer equation for flow over flat plate. **(12 Marks)**

b. Atmospheric air at 400K flows with a velocity of 4 m/s along a flat plate 1m long, maintained at an uniform temperature of 300K. The average heat transfer coefficient is estimated to be 7.75W/m^2 K. Using Reynolds Colburn analogy, calculate the drag force exerted on the plate per meter width. **(08 Marks)**

5 a. Using dimensional analysis for forced convection heat transfer process, obtain the correlation in terms of Nusselt number, Reynold number and Prandtl number. **(10 Marks)**

b. Air at 30^0C is flowing across a tube with a velocity of 25m/s. The tube could be either a square with a side of 5cm or a circular cylinder of diameter 5cm. Compare the rate of heat transfer in each case if the tube surface temperature is 124^0C. **(10 Marks)**

6 a. A vertical plate 0.5m high and 1m wide is maintained at uniform temperature of 124^0C. It is exposed to ambient air at 30^0C. Calculate the heat transfer rate from the plate. **(10 Marks)**

b. An ornament space heater is in the form of a 60cm diameter sphere, which is freely suspended in a large room. The surface of the sphere is maintained at 100^0C and the room air is at 20^0C. Calculate the convective heat transfer rate. **(10 Marks)**

7 a. Derive an expression for LMTD for counter flow heat exchanger. State the assumptions made. **(10 Marks)**

b. Water enters a counter flow, double pipe heat exchanger at 15^0C, flowing at the rate of 1300kg/h. It is heated by oil (C_p = 2000J/ kg K) flowing at the rate of 550 kg/h from an inlet temperature of 94^0C. For an area of $1m^2$ and an overall heat transfer coefficient of $1075 W/m^2$ K, determine the total heat transfer and the outlet temperatures of water and oil. **(10 Marks)**

8 a. Distinguish between :

i) Nucleate boiling and film boiling.

ii) Drop wise condensation and film wise condensation. **(10 Marks)**

b. The bottom of a copper pan, 300mm in diameter is maintained at 120^0C by an electric heater. Calculate the power required to boil water in this pan. What is the evaporation rate? Estimate the critical heat flux. **(10 Marks)**

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