Code :R5320306 **R5**

III B.Tech II Semester(R05) Supplementary Examinations, April/May 2011
HEAT TRANSFER
(Mechanical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE questions
All questions carry equal marks
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1. (a) What is Fourier's law of heat conduction? Explain.
   (b) A brick (k=1.2 W/m K) wall 0.15 m thick separates hot combusition gases of a furnace from the outside ambient air which is at 25 ^{0}C. The outer surface temperature of the brick wall is found to be 100 ^{0}C. If the natural convection heat heat transfer coefficient on the brick wall is 20 W/m^2 K and its emisssivity is 0.8, calculate the inner surface temperature of the brick wall.
2. (a) Derive the general heat conduction equation for n composite slabs.
   (b) A plane wall is constructed of a material having thermal conductivity that varies as the square of the temperature according to the relation $K = K_0 \ (1+ \beta T^2)$. Derive an expression for the heat transfer in such a wall.
3. (a) Explain the lumped heat capacity analysis?
   (b) An aluminum sphere weighing 5.5kg and initially at a temperature of 290^{0}C is suddenly immersed in a fluid at 15^{0}C. The convective heat transfer coefficient in 59 W/m^{2}k. Estimate the time required to cool the aluminum to 95^{0}C.
4. (a) Air at a pressure of 8 kN/m^2 and a temperature of 250^{0}C flows over a flat plate 0.3 m wide and 1 m long at a velocity of 8 m/s. If the plate is to be maintained at a temperature of 78^{0}C. Estimate the rate of heat to be removed continuously from the plate.
   (b) Discuss briefly effect of turbulence on boundary layers.
5. (a) What is the criterion for deciding laminar or turbulent flow in case of free convection?
   (b) Air flow through a long rectangular duct (30 cm × 20 cm) used in air conditioning maintains the outer duct surface temperature at 5^oC. If the duct is installed vertically in a room at 25^oC, find the heat gain by the duct.
6. Saturated steam at atmospheric pressure condenses on a horizontal copper tube of 25 mm inner diameter and 29 mm outer diameter through water flows at the rate of 25 kg/min entering at 30^oC and leaving at 70^oC. Making necessary assumptions, calculate
   (a) The condensing heat transfer coefficient
   (b) The inside heat transfer coefficient
   (c) The length of the tube.
7. (a) How is the mean temperature difference between the two fluids in a multi-pass heat exchanger estimated? What is the correction factor?
   (b) Sketch the temperature distribution of hot and cold fluids along the length of heat exchanger for parallel flow arrangement and derive the expression for LMTD.
8. A thermocouple of emissivity 0.9 is used to measure the temperature of a gas flowing in large duct whose walls are at 200^oC. The thermocouple records a temperature of 500^oC. Calculate the error between the thermocouple temperature and the gas temperature taking h = 140 W/m^{2}K. If the thermocouple is now placed inside a shield ($\varepsilon = 0.3$) having inside diameter five times the outer diameter of the couple, and the thermocouple still records 500^oC, calculate the reduction in error between thermocouple temperature and the gas temperature.

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