Code No: NR310803 **NR**

III B.Tech I Semester Supplementary Examinations, May 2005
HEAT TRANSFER
(Chemical Engineering)

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

Answer any FIVE Questions
All Questions carry equal marks

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1. A furnace wall is made of 2 successive layers of insulating materials one of foamed fire clay (k = 0.279 + 0.000273T) w/m 0c and red brick (k= 0.7 w/m^oC). The wall temperature inside the furnace wall is 1373 K and outside wall temperature is 323 K. If the thickness of insulation being 12.5cm of foam clay and 50cm of red brick, calculate the amount of heat lost from $100m^2$ of furnace wall. Also calculate the temperature at interface layer.

2. (a) Derive an equation for temperature distribution in a hollow sphere.
   (b) Hot gas at a constant temperature of 400^oC is contained in a spherical shell (2000mm 1D, 50mm thick) made of steel. Mineral wool insulation (k=0.06 w/m-k) of thickness 100mm is wrapped all around it. Calculate the steady rate at which heat will flow out if the outside air is at a temperature of 30^oC. HTC on the inner surface of the steel shell and on the outer surface of the insulation is 15 w/m^2K.

3. (a) How the local and average convection coefficients for flow past a flat plate are related? Derive the relationship.
   (b) Water at 75^0C flows through a 0.005 m diameter tube with a velocity of 1m/s. If the tube wall temperature is 25^0C, make calculations for the heat transfer coefficient. Use the correlation,
   St = 0.023 $Re^{0.2}$ $Pr^{-0.667}$.
   The thermo-physical properties of water are:
   Thermal conductivity is 0.647 W/(m.K) Viscosity is 1.977 kg/h.m
   Density is 1000 kg/m^3 Specific heat 4.187 kJ/(kg.K)

4. (a) Give examples for liquid metals. What are their applications in heat transfer?
   (b) In a condenser, water flows through 100 thin walled circular tubes (inner diameter 22.5mm and length 5m). The mass flow rate of water is 65 kg/s. Water enters at a temperature of 22^0C and leaves at 28^0C. Predict the heat transfer coefficient associated with the water flow.
   Properties of water at bulk temperature are as follows:
   Specific gravity 1.0
   Thermal conductivity 0.6054 W/M^0K
   Specific heat 4.178 KJ/Kg^0K
   Viscosity is 0.893 × 10-3 NS/m^2.

5. (a) Explain about nucleate boiling.
   (b) Explain about Heat Transfer in boiling.

6. (a) State and prove Kirchoff's law of radiation.
   (b) What restrictive conditions are inherent in the derivation of Kirchoff's law?
   (c) Explain the utility of this law.

7. (a) With a neat diagram explain a double pipe heat exchanger.
   (b) Explain with neat diagram the temperature profiles for parallel current and counter current heat exchanger.
   (c) Define capacity and economy of an evaporator.

8. A solution is to be concentrated from 10 % to 50% solids in a single effect evaporator. Steam is available at 2 bar absolute. The vapour space inside the evaporator is at 100 mm Hg vacuum. The feed rate to the evaporator is 25,000 kg/hr. Overall heat transfer coefficient is 2840 W/$m^2 o^C$. Specific heat of solution is 3700 J/Kg^oC. Calculate the area of heating surface required if the feed is at 50^oC. Latent heat of vaporization at steam temperature = 2197 kJ/kg, at temperature in vapour space = 2375 kJ/kg. Specific whose feed solution in 3.77 kJ/kg k.

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