BIME-034

B.Tech. – VIEP – MECHANICAL ENGINEERING (BTMEVI)

Term-End Examination

00885 **December, 2014**

BIME-034 : HEAT AND MASS TRANSFER

Time : 3 hours *Maximum Marks : 70*

Note : *Attempt any **five** questions. Assume missing data suitably, if any. Use of scientific calculator is allowed. Use of heat and mass transfer data book is permitted.*

1. (a) Derive the expression for temperature distribution and heat flow through cylindrical system. 7

(b) Derive an expression for temperature distribution for sphere with uniform heat generation. 7

2. (a) Derive an expression for overall heat transfer coefficient for a composite wall. 5

(b) A steam pipe with ID and OD as 100 mm and 140 mm (k = 50 W/mK) is covered with two layers of insulation 35 mm and 50 mm thick. The inner surface of the pipe is 300°C and the surface temperature of insulation is 50°C. The thermal conductivities of insulation materials are 0·16 and 0·085 W/mK. Determine the heat loss from the pipe and the layer contact temperature. 9

3. (a) One end of a long rod is inserted into a furnace and the other end projects into the air at 20°C. Under steady state conditions, the temperature of the rod measured at two points 100 mm apart was found to be 120°C and 100°C. If the diameter of the rod is 25 mm and the thermal conductivity of the fin is 120 W/mK, make the calculations for surface heat transfer coefficient. *7*

(b) An alloy plate of 300 × 300 × 4 mm size at 210°C is suddenly quenched into liquid oxygen at – 183°C. Determine the time required for the plate to reach a temperature of – 60°C. Take
$h = 20{,}000$ kJ/hr m^2K, $C = 0{\cdot}8$ kJ/kg K,
$\rho = 3{,}000$ kg/m^3, $k = 214$ W/mK. *7*

4. (a) Define LMTD and derive an expression for LMTD of a parallel flow heat exchanger. *6*

(b) Hot fluid ($C_p = 1{\cdot}045$ kJ/kg K) entering the counter flow Hx at 1000°C has a mass flow rate of 1 kg/s and cold fluid ($C_p = 4{\cdot}48$ kJ/kg K) leaves at 850°C and has a mass flow rate of 0·25 kg/s. Determine the exit temperature of the hot fluid and inlet temperature of the cold fluid. Take $U = 88{\cdot}5$ W/m^2K, $A = 10\ m^2$. *8*

5. (a) Derive an expression for radiation heat exchange between two large parallel planes. 7

(b) The net radiation from the surface of the two parallel plates maintained at temperatures T_1 and T_2 is to be reduced by 79 times. Calculate the number of screens to be placed between the two surfaces to achieve this reduction in heat exchange assuming ζ of screen as 0·05 and that of surfaces as 0·8. 7

6. (a) Explain the concept of thermal boundary layer over a flat plate. Define Reynolds and Nusselt numbers. 7

(b) Air at 30°C flows with a velocity of 3 m/s over a plate 1·0 × 0·6 m. The top surface of the plate is maintained at 90°C. Determine the heat lost by the plate. Take properties of air at mean tamperature : ρ = 1·06 kg/m^3, v = 18·97 × 10^{-6} m^2/s, C_p = 1·005 kJ/kg K, k = 0·02894 W/mK. 7

7. (a) What are the types of condensation processes ? Briefly explain the dropwise condensation. 6

(b) Define Biot and Fourier numbers. Explain the significance of these numbers in unsteady state heat conduction. 4

(c) Explain diffusion mass transfer. 4