01965

B.Tech. MECHANICAL ENGINEERING (BTMEVI)

Term-End Examination

June, 2012

BIME-034 : HEAT AND MASS TRANSFER

Time : 3 hours *Maximum Marks : 70*

Note: *Attempt any five questions. Assume suitable missing data if any.*

1\. (a) Derive general three dimensional heat conduction equation in cylindrical coordinate. 7

(b) Two long rods of the same diameter, one made of brass (k = 85 w/mK) and the other made of copper (k = 375 w/mK) have one of their ends inserted into the furnace. Both rods are exposed to the same temperature. At a distance of 105 mm away from the furnace end the temperature of the brass rod is 120°C. At what distance from the furnace end, the same temperature would be attained by the copper rod ? 7

2\. (a) Derive the equation for heat discription by a fin with an insulted tip 7

$$\theta = \sqrt{hpKA}\,(T_o - T_\infty)\ \tanh\,(mL)$$

by integrating the convective losses along its surface.

(b) Explain and derive the expression for fin efficiency and fin effectiveness. 7

3\. (a) What is significance of critical thickness of insulation ? Derive an expression for the critical radius of a sphere. 7

(b) Derive an expression for the overall heat transfer coefficient of three layer composite cylinder. Assume convection at inner and outer surface. 7

4\. (a) Derive an expression for NTU - effectiveness for a counterflow heat exchanger. 7

(b) In a solar assisted air-conditioning system, 0.5 kg/s of ambient air at 270 K is to be preheated by the same amount of air leaving the system at 295 K. If a counter flow heat exchanger has an area of $30m^2$ and the overall heat transfer coefficient is estimated to be $25 w/m^2K$; determine the outlet temperature of the preheated air. Take Cp for air as 1000 J/kgK. 7

5\. (a) Derive a general expression for shape factor (F_{12}) between the two surfaces (1 and 2) exchanging radiation heat transfer. 7

(b) Two very large parallel planes with emissivities 0.3 and 0.8 exchange radiative energy. Determine the percentage reduction in radiative energy transfer when a polished aluminium radiation shield (ϵ = 0.04) is placed between them. **7**

6. (a) What is nucleate boiling ? **7**

   (b) Explain Fick's law of diffusion. What is mass diffusivity ? **7**

7. Write short note on the following : **3.5x4=14**

   (a) Black body

   (b) Wien's displacement law

   (c) Nusselt Number

   (d) Biot Number.
