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BME-027

B.TECH. MECHANICAL ENGINEERING (COMPUTER INTEGRATED MANUFACTURING)

01050

Term-End Examination

June, 2014

BME-027 : HEAT AND MASS TRANSFER

Time : 3 hours *Maximum Marks : 70*

Note :

(i) *Answer any **seven** questions.*

(ii) *All questions carry equal marks.*

(iii) *Use of calculator is permitted.*

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1. (a) Explain any two types of Heat-Exchangers with neat diagrams. *4*

(b) Briefly explain different modes of Heat Transfer. *6*

2. Steam at 380°C is flowing in a pipe (k = 100 W/mK) of 8 cm inner diameter and 8·5 cm outer diameter, covered with 10 cm thick insulation of thermal conductivity k = 0·15 W/mK. Heat is lost to the surroundings at 8°C by natural convection and radiation, the combined 'h' being 40 W/m^2 K. Taking the heat transfer co-efficient inside the pipe as 40 W/m^2 K, determine :

(a) the rate of heat loss from the steam per unit length of the pipe, and

(b) the temperature drop across the pipe and the insulation. *10*

3. Steel Ball Bearings ($k = 50$ W/mK, $\alpha = 1{\cdot}3 \times 10^{-5}$ m^2/s) having a diameter of 40 mm are heated to a temperature of 650°C and then quenched in a tank of oil at 55°C. If the heat transfer co-efficient between the ball-bearings and oil is 300 W/m^2 K,

determine :

(a) the duration of time the bearings must remain in oil to reach a temperature of 200°C.

(b) the total amount of heat removed from each bearing during this time.

(c) the instantaneous heat transfer rate from the bearings when they are first immersed in oil and when they reach 200°C. *10*

4. (a) Explain the concept of Boundary Layer with suitable diagram. *6*

(b) Briefly explain the following : *4*

(i) Reynolds Number and Nusselt Number

(ii) Viscosity

(iii) Newtonian fluids

5. (a) Explain the 'Principle of Similarity' applied to Heat Transfer. *5*

(b) Write short notes on Rayleigh's method. *5*

6. Water flows over a flat plate measuring 1 m × 1 m with a velocity of 2 m/s. The plate is at a uniform temperature of 90°C and the water temperature is 10°C. Estimate the length of plate over which the flow is laminar and the rate of heat transfer from the entire plate. The properties of water at 50°C are

$\rho = 988{\cdot}1$ kg/m^3, $v = 0{\cdot}556 \times 10^{-6}$ m^2/s,

Pr = 3·54 and k = 0·648 W/mK. *10*

7. (a) What do you understand by Black body and what are its characteristics ? Explain Black body radiation. *6*

(b) Explain Kirchhoff's law. *4*

8. Determine the view factor F_{12} and F_{21} for the following geometries : *10*

(a) Sphere of diameter D inside a cubical box of Length L = D.

(b) Diagonal portion within a long square duct.

(c) End and side of circular tube of equal length and diameter.

9. (a) How does mass transfer occur in a packed bed ? *5*

(b) What is 'zero order' and 'first order' chemical reaction ? *3*

(c) What is Henry's constant ? *2*

10. (a) Explain the different classifications of Heat Exchanger. *4*

(b) Explain 'Fire Tube Boiler' with neat diagram. *6*