Registration No. : | | | | | | | | | | |

Total number of printed pages – 4

B. Tech

PCME 4305

Sixth Semester Regular Examination – 2015

HEAT TRANSFER

BRANCH : MECH

QUESTION CODE : J 489

Full Marks – 70

Time : 3 Hours

*Answer Question No. **1** which is compulsory and any **five** from the rest.*
The figures in the right-hand margin indicate marks.

1. Answer the following questions : 2×10

   (a) How are Fourier's law and Ohm's law similar ?

   (b) Why are metals good thermal conductors, while non-metals are poor conductors of heat ?

   (c) Define fin effectiveness. When is the use of fins not justified ?

   (d) How do viscosities of a liquid and gas vary with temperature ?

   (e) What do you mean by hydraulic boundary layer and thermal boundary layer ?

   (f) Why are heat transfer coefficients for natural convection much less than those in forced convection ?

   (g) Explain Kirchoff's law.

   (h) State and explain reciprocity theorem in radiation heat transfer case.

   (i) Differentiate between surface resistance and shape resistance.

   (j) What do you mean by fouling factor ? What are the causes of fouling ?

2. a) Define the following : 5

   (i) LMTD method

   (ii) NTU method

   (iii) Effectiveness of heat exchanger.

P.T.O.

(b) Steam in the condenser of a steam power plant is to be condensed at a temperature of 30°C with cooling tower entering at 14°C and leaving at 22°C. The surface area of the tubes is 45 m^2, and overall heat transfer coefficient is 2200 W/m^2K. Determine the mass flow rate of cooling water needed and rate of condensation of steam. Take latent heat of condensation / vaporization of steam at 30°C is 2430 kJ/kg. 5

3. (a) What is shape factor ? Show that 5

$$A_2F_{12} = \frac{1}{\pi}\int_{A_1}\int_{A_2}\frac{\cos\phi_1\cos\phi_2}{r^2}\,dA_1dA_2$$

(b) A long rod 20 mm in diameter is to be heated from 427°C to 527°C. it is placed concentrically in a long cylindrical furnace which has an inside diameter of 160 mm. the inner surface of a furnace is at a temperature of 1093°C and has an emissivity of 0.85. If the surface of rod has an emissivity of 0.6, Estimate the time required for the heating operation. Take the density of steel as 7800 kg/m^3 and specific heat 0.67 kJ/kgK. 5

4. (a) What is pool boiling ? How is forced boiling convection boiling different from pool boiling ? 5

(b) What are the two modes of condensation phenomena ? Explain those. 5

5. (a) Air at 2 bar and 200°C is heated as it flows at a velocity of 12 m/s through a tube with a diameter of 3 cm. A constant heat flux condition is maintained at a wall temperature is 20°C above air temperature all along the length of the tube. Calculate i) the heat transfer per unit length of tube ii) the increase in bulk temperature of air over a 4 m length of the tube. Properties of air at 200°C are Pr=0.681, $\mu = 2.57\times10^{-5}$ kg/ms, k=0.0386 W/mK and $c_p = 1.005$ kJ/kgK. 5

b) Define the following : 5

(i) Reynolds number

(ii) Grashof numberi

(iii) Prandtl number

(iv) Nusselt number.

6. (a) If a fin is thin and long and tip loss is negligible, show that the heat transfer from the fin is given by 5

$Qo = mk A \theta_o \tanh mL$

Where $m = (hP / kA)^{1/2}$

(b) A hollow cylinder with inner radius 30 mm and outer radius 50 mm is heated at the inner surface at a rate of 10^5 W/m^2 and dissipates heat by convection from the outer surface into a fluid temperature 100°C with a heat transfer coefficient of 400 W/m^{2}K. There is no energy generation and the thermal conductivity of the solid is assumed to be constant at 15 W/mK. Calculate the temperatures of the inside and outside surfaces of the cylinder. 5

7. (a) Define the following : 5

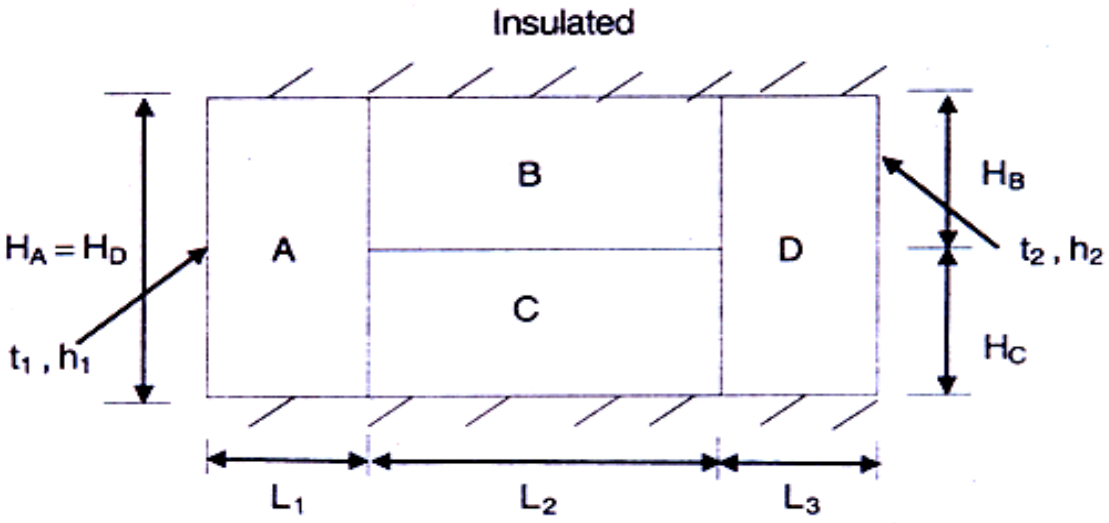
(i) Thermal resistance

(ii) Overall heat transfer coefficient

(iii) Thermal diffusivity

(iv) Biot number

(b)



A composite wall having unit length normal to the plane of paper is insulated at the top and bottom as shown in figure. It is composed of four different materials A,B,C,D. The dimension of are $H_A = H_D = 3$ m, $H_B = H_C = 1.5$ m, $L_1 = L_3 = 0.05$ m, $L_2 = 0.1$m

The thermal conductivities of the materials are $k_A = k_D = 50$ W/mK, $k_B = 10$ W/mK, $k_C = 1$ W/mK.

The fluid temperatures and heat transfer coefficients (see figure) are $T=200°C$, $h_1= 50\ W/m^2K$, $T_2= 25°C$, $h_2=10\ W/m^2K$.

Assuming 1-D conduction i) Sketch the thermal circuit of the system ii) Determine the rate of heat transfer through wall iii) overall heat transfer coefficient. 5

8. Write short notes on any **two** of the following : 5×2

(a) Types of Heat Exchangers

(b) Lumped heat analysis

(c) Modes of heat transfer.