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

Total number of printed pages – 3

B. Tech

PCME 4305

Sixth Semester Examination – 2013

HEAT TRANSFER

BRANCH : MECHANICAL

QUESTION CODE : A 278

Full Marks – 70

Time : 3 Hours

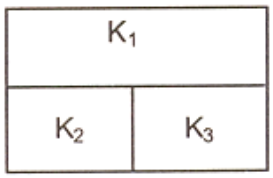
*Answer Question No. **1** which is compulsory and any **five** from the rest.*
The figures in the right-hand margin indicate marks.

1. Answer the following questions : 2×10

(a) How steady state heat conduction differs from transient heat conduction ?

(b) Why a good conductor of electricity is also a good conductor of heat ?

(c) Draw the equivalent electrical circuit of the following system and find the equivalent conductivity.



(d) When a fin is considered to be a long fin ?

(e) Why dropwise condensation is preferred over filmwise condensation ?

(f) When a fluid flow through a tube is said to be fully developed ?

(g) Write the physical significance of Grashoff's Number.

P.T.O.

(h) Write two methods of minimizing the radiation heat loss.

(i) Why counter flow heat exchange is more effective than parallel flow heat exchanger ?

(j) Define a grey surface.

2. The walls of a house are 4 m high, 5 m wide and 0.3 m thick and made from brick (k= 0.6 W/m-K). The temperatures of air inside and outside of the house are 20°C and –10°C respectively. There are heat transfer coefficients of 10 W/m^2-K and 30 W/m^2-K on inside wall and outside wall respectively. Calculate the inside and outside surface temperatures of the wall and the total heat flux through the wall. 10

3. Steel balls (k = 50 W/m-K, thermal diffusivity = 1.3×10^{-5} m^2/s) having a diameter of 40 mm are heated to a temperature of 650°C and then quenched in a oil tank at 55°C. If the heat transfer coefficient between the ball and the oil is 300 W/m^{2}K, determine the time the ball would reach the temperature of 200°C, the total amount of heat removed from each ball. 10

4. A 0.3 m long glass plate is hung vertically in the air at 27°C while its temperature is maintained at 77°C. Calculate the boundary layer thickness at the trailing edge of the plate and the average heat transfer coefficient. The air properties may be assumed at the film temperature. The correlation for boundary layer thickness and heat transfer coefficient are as follows : 10

$\Delta = 3.93 \times (0.952 + Pr)^{1/4}(1/Pr^{1/2}Gr^{1/4})$ and $Nu = 0.508\ Pr^{1/2}(0.952 + Pr)^{-1/4}Gr^{1/4}$

5. (a) Prove that the emissive power of a black body is Pi times the intensity of the emitted radiation. 5

(b) Two large parallel plates at T_1 = 800°C and T_2 = 600°C have emissivities 0.5 and 0.8 respectively. A radiation shield having an emissivity of 0.1 0n both the sides is placed between the plates. Calculate the heat transfer rate by radiation per sqm. With and without the radiation shield. 5

6. A shell and tube steam condenser is to be constructed of 2.5 cm OD and 2.2 cm ID single pass horizontal tube with steam condensing at 54°C outside the tube.

The cooling water inlet and outlet temperatures are 18°C and 36°C and the flow rate is 0.7 kg/s. The heat transfer coefficient for the condensation steam is 8000 W/m²C. Calculate the tube length. Calculate the condensation rate per tube. Water properties may be taken as C_p = 4.18 kJ/kg, $\mu = 0.86 \times 10^{-3}$ kg/m-s, k = 0.61 W/m-°C 10

7. Answer the following :

   (a) Derive the relation between the heat transfer coefficient and the drag coefficient for a flow over flat plate. 4

   (b) Discuss the different regimes for forced convective boiling. 2

   (c) Derive the critical thickness of insulation and state its significance. 4

8. Discuss the usefulness of the following charts/tables : 2.5 × 4

   (a) Effectiveness – NTU chart

   (b) Fin effectiveness chart

   (c) Black body radiation function chart

   (d) Chart for correction factor for cross flow heat exchanger.