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

*Total number of printed pages – 2*

B. Tech

PCME 4305(New)

# Sixth Semester (Back) Examination – 2013

## HEAT TRANSFER

**BRANCH : MECH**

**QUESTION CODE : B267**

**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. (a) Define the following : 2×5
   (i) Stoke's law
   (ii) Fin effectiveness chart
   (iii) Thermal boundary layer
   (iv) Critical heat flux
   (v) Types of heat exchanger
   (b) State the reasons in two sentences : 2×5
   (i) A good conductor of electricity is also a good conductor of heat
   (ii) Dropwise condensation is preferred over filmwise condensation
   (iii) When an iron rod is heated up it looks red
   (iv) Counter flow heat exchange is more effective than parallel flow heat exchange
   (v) Pond and well water is felt colder and warmer in Summer and Winter respectively.
2. (a) Derive an expression for the critical thickness of insulation for a conducting wire. 5
   (b) A plastic pipe (k = 0.5 W/m-K) carries a fluid such that convective heat transfer coefficient is 300 $W/m^2$ K. The average fluid temperature is 100 °C. The pipe has an inner diameter of 3.0 cm and an outer diameter of 4.0 cm. If the heat transfer rate through the pipe per unit length is 500 W/m, calculate the outside surface temperature of the pipe and the overall heat transfer coefficient. 5



P.T.O.

3. Three 8.75 mm diameter rods A,B, and C protrude from a steam bath at 100°C to a length of 25 cm into the atmosphere at 20°C. The temperatures at the other ends are found to be 26°C for A, 32.00°C for B and 36°C for C. Neglecting the effects of radiation and assuming the surface film coefficient of heat transfer as 23 W/m$^2$K, evaluate their thermal conductivities. 10

4. Water flows over a flat plate measuring 1m × 1m 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 as follows.
Density = 998.1 kg/m$^3$, Kinematic viscosity = 0.556 × 10$^{-6}$ m$^2$/s, Prandtl No = 3.54, Thermal conductivity = 0.648 W/m-K. 10

5. A 15 cm outer diameter steel pipe lies 2.0 m vertically and 8.0 m horizontally in a large room with an ambient temperature of 30°C. If the pipe surface is at 250°C and the emissivity of the steel is 0.60, calculate the total rate of heat loss from the pipe to the atmosphere. Properties of air at 140°C are: density = 0.854 kg/m$^3$, Specific heat = 1.01 kJ/kg-K, thermal conductivity = 0.035 W/m-K, Prandtl no = 0.654, Kinematic viscositey = 27.8 × 10$^{-6}$m2/s. 10

6. An enclosure having dimensions of 1.2 m × 1.5 m with a height of 2.0 m. The walls and ceilings are maintained at 250°C and the floor is at 130°C. The walls and ceilings have an emissivity of 0.82 and the floor 0.8. Determine the net radiation to the floor. 10



7. (a) Water $C_P$ = 4.18 kJ/kg-K, is heated at the rate of 1.5 kg/s from 40°C to 70°C by an oil ($C_P$ = 1.9 kJ/kg-K,) entering at 110°C and leaving at 70°C in a parallel flow heat exchanger. If overall heat transfer coefficient = 420 W/m$^2$K, calculate the surface area required. 5

   (b) In a counter flow heat exchanger if $\Delta T_{inlet} = \Delta T_{outlet}$, show that LMTD = $\Delta T_{inlet} = \Delta T_{outlet}$ 5

8. Write short notes of the following : 2.5 × 4
   a) Fourier's law of heat conduction
   b) Lamberts Cosine law
   c) Kirchoff's Law
   (d) Newton's law of cooling.