(Following Paper ID and Roll No. to be filled in your Answer Books)

Paper ID : 2012338 Roll No. | | | | | | | | | |

B.TECH.

Regular Theory Examination (Odd Sem-V) 2016-17

HEAT AND MASS TRANSFER

Time : 3 Hours *Max. Marks : 100*

Note :i) All symbols have usual meaning.

ii) Assume any relevant data, if missing.

Section - A

1 Attempt all parts. All parts carry equal marks. Write answer of each part in short. (10×2=20)

a) Write down the definition of black body and gray body.

b) Write down the effect of temperature and pressure on thermal conductivity.

c) Counter flow heat exchanger is most preferred, why?

d) Write down the significance of Reynold's and Nusselt number.

e) What are the uses of heat pipe?

f) What is the difference between pool boiling and flow boiling?

g) Write a short notes on solar radiation.

h) What is greenhouse effect?

i) Define all radiative properties of the surface and also explain relation between them.

j) Discuss the mechanism of thermal conduction in gases, liquids and solids.

Section - B

Note: Attempt any five questions from this section (5×10=50)

2. A steam pipe of 5 cm inside diameter and 6.5 cm outside diameter is covered with a 2.75 cm radial thickness of high temperature insulation (k = 1.1 W/m.K). The surface heat

transfer coefficient for inside and outside surfaces are 4650 $W/m^2.K$ and 11.5 $W/m^2.k$ respectively. The thermal conductivity of the pipe material is 45 W/m.K. If the steam temperature is 200°C and ambient air temperature is 25°C, determine :

a) Heat transfer per meter length of pipe.

b) Temperature at the interface.

c) Overall heat transfer coefficient.

3. A person is found dead at 5 p.m. in a room where temperature is 20°C. The temperature of the body is measured to be 25°C when found, and the heat transfer coefficient is estimated to be 8 $W/m^2.K$. Modelling the human body a 30 cm diameter, 1.70 m long cylinder, calculates actual time of death of the person. Take thermo physical properties of the body :

K = 6.08 W/m.K Density = 900 kg/m^3 C = 4000 J/kg.K

4. Write down the significance of NTU method in heat exchanger. Derive an expression of effectiveness for counter flow heat exchanger by using NTU method.

5. What do you mean by Lump System Analysis? Derive the following expression for transient heat conduction

$$\frac{T(t)-T_\infty}{T_i-T_\infty}=\exp(-Bi.F_O)$$

Where symbols have their usual meaning. Discuss the physical significance of Biot No. and Fourier No.

6. A steam condenser is transferring 250 KW of thermal energy at a condensing temperature of 65°C. The cooling water enters the condenser at 20°C with a flow rate of 7500 kg/hr. Calculate the LMTD. If overall heat transfer coefficient for the condenser surface is 1250 W/m^2 °C. What surface area is required to handle this load? What error would be introduced if the arithmetic mean temperature difference is used rather than the log-mean temperature difference?

7. Derive an expression for Nusselt number for turbulent flow over flat plate using Colburn analogy.

8. Derive Reciprocity theorem and write down the salient features of shape factor.

9. A chemical having specific heat of 3.3 kJ/kg-K flowing at the rate of 20000 kg/hr enters a parallel flow heat exchanger at 120°C. The flow rate of cooling water is 50000 kg/hr with an inlet temperature of 20°C. The heat transfer area is 10 m^2 and the overall heat transfer coefficient is 1050 W/m^{20}C. Determine :

   - The effectiveness of the heat exchanger.
   - The output temperature of water and chemical.

   Specific heat of the water is 4.186 kJ/kg.

Section - C

Note: Attempt any two questions from this section (2×15=30)

10. a) Derive an expression for energy equation of thermal boundary layer over flat plate.

    b) Derive an expression of effectiveness for parallel flow heat exchanger by using NTU method.

11. a) Write a short notes on condensation. Describe various regimes of boiling.

b) What is time constant? The steel ball bearings of 40 mm diameter and initially at uniform temperature of 600°C are quenched in an oil bath maintained at 50°C temperature. The heat transfer coefficient between the ball bearing and oil is 325 W/m^2K and the thermodynamics properties of the bearing can be taken as : k = 45 W/m-k and thermal diffusivity $\alpha = 1.25 \times 10^{-5}$ m^2/s. Determine :

- The time duration for which bearing must remain in oil to attain 225°C temperature.
- The instantaneous heat transfer rate from the bearings when they are first immersed in oil and when they reach 225°C.

12. a) What is the significance of Heisler chart? Describe various types of Heisler chart. What is characteristic length?

b) An egg with mean diameter of 40 mm and initially at 20°C is placed in a boiling water pan for 4 minutes and found to be boiled to the consumer's taste. For

how long should a similar egg for same consumer be boiled when taken from a refrigerator at 5°C. Take the following properties for egg : K = 10 W/m°C, $\rho = 1200$ kg/m^3, c = 2 kJ/kg°C and h = 100 W/m^2 °C.