

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

Paper ID : 2012338

Roll No.

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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)

- Write down the definition of black body and gray body.
- Write down the effect of temperature and pressure on thermal conductivity.
- Counter flow heat exchanger is most preferred, why?

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/m²°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 m² and the overall heat transfer coefficient is 1050 W/m²°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 $325 \text{ W/m}^2\text{K}$ and the thermodynamics properties of the bearing can be taken as : $k = 45 \text{ W/m-k}$ and thermal diffusivity $\alpha = 1.25 \times 10^{-5} \text{ m}^2/\text{s}$. 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 .

2. 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 : $K = 10 \text{ W/m}^{\circ}\text{C}$, $\rho = 1200 \text{ kg/m}^3$, $c = 2 \text{ kJ/kg}^{\circ}\text{C}$ and $h = 100 \text{ W/m}^2\text{C}$.

