Printed Pages-02 Sub Code: NME-504

PAPER ID: 4049 Roll No.

B.TECH.

ODD SEMESTER EXAMINATION (2017-18)

HEAT & MASS TRANSFER

Time: 3 Hours **Total Marks: 100**

Note: Be precise and scientific in writing.

SECTION – A

1. Attempt ALL questions in brief. **(2X10= 20)**

a. What do you understand by overall heat transfer coefficient?
b. What is the significance of heat transfer?
c. Explain effectiveness and efficiency of fin.
d. Explain the significance of heisler's charts.
e. Define Gray body.
f. Define Prandtl number.
g. What is intensity of radiation?
h. What is radiation shield?
i. Define condensation and their types.
j. How heat exchangers are classified?

SECTION – B

2. Attempt any THREE parts of the following. **(10X3= 30)**

a. A furnace wall is composed of 220 mm of fire brick, 150 mm of common brick, 50 mm of 85% magnesia and 3mm of steel plate on the outside. if the inside surface temperature is 1500°C and outside surface temperature is 90°C, estimate the temperature between layers and calculate the heat loss in Kj/h-m^2 . Assume, k (for fire brick) = 4kJ/m-h. °C, k (for common brick) = 2.8kJ/m-h. °C, k (for 85% magnesia) =2.4kJ/m-h. °C, k (steel) =240kJ/m-h. °C.

b. Derive an expression of rectangular fin in case of heat dissipation from an infinite long fin. What are advantages and application of fins?

c. Castor oil at 25°c flows at a velocity of 0.1 m/s past a flat plate, in a certain process. If the plate is 4.5 m long and is maintained at a Uniform temperature of 95°c, calculate the following using exact solution:

i. The hydrodynamic and thermal boundary layer thicknesses on one side of the plate,
ii. The total drag force per unit width on one side of the plane,
iii. The local heat transfer coefficient at the trailing edge, and the heat transfer rate

d. Explain diffuse emitter and radiation shape factor.

e. Define pool boiling and also explain regimes of pool boiling with the help of diagram.

SECTION – C

3. Attempt any ONE part of the following. **(10X1= 10)**

a. A carbon steel plate (K = 45 W/m°K) 600 mm x 900mm x 25 mm is maintained at 310°C. Air at 15°C blows over the hot plate. If convection heat transfer coefficient is 22 W/m^2°C and 250 W is lost from the plate surface by radiation, calculate the inside plate temperature.

b. Derive a general heat conduction equation in case of cylindrical co-ordinate.

4. Attempt any ONE part of the following. (10X1= 10)

a. Prove that for a body whose thermal resistance is zero, the temperature required for cooling or heating can be obtained from the relation $(t-t_a)/(t_i-t_a) = \exp[-B_i F_a]$, where the symbols have their usual meanings

b. A large metal plate of thickness 5cm is initially at 460°C. It is suddenly exposed to fluid at 100°C with a convection coefficient of 142.5W/m^2.K. Find the time needed for its mid plane to reach a temperature of 316°C and surface temperature at the same instant of time. Take k= 21.25W/m K and = $1.2*10^{-5}$ m^2/sec.

5. Attempt any ONE part of the following. (10X1= 10)

a. Derive the equation for boundary layer thickness.

b. A 350mm long glass plate is hung vertically in the air at 24°C white its temperature is maintained at 80°C. Calculate the boundary layer thickness at the trailing edge of the plate. If a similar plate is placed in a wind tunnel and air is blown over it at a velocity of 5 m/s, find the boundary layer thickness at its trailing edge. Also determine the average heat transfer coefficient, for natural and forced convection for the above mentioned data.

6. Attempt any ONE part of the following. (10X1= 10)

a. A small convex object of area A_1, temperature T_1 and emissivity ϵ_1 is enclosed within a large enclosure at temperature T_2 and emissivity ϵ_2. Derive an expression for the net heat exchange between the two objects.

b. Consider two large parallel plates one at t_1=27°c with emissivity ϵ_1=0.8 and other at 227°c with emissivity ϵ_2=0.4. An aluminum radiation shield with an emissivity, ϵ_s=0.05 on both sides is placed between the plates. Calculate the percentage reduction in heat transfer rate between the two plates as a result of shield. Use $\sigma=5.67\times10^{-8}$ W/m^2K^4.

7. Attempt any ONE part of the following. (10X1= 10)

a. In a counter- flow double pipe heat exchanger, water is heated from 25°c to 65°c by oil with a specific heat of 1.45KJ/Kg K and mass flow rate of 0.9 Kg/s. The oil is cooled from 230°c to 160°c. If the overall heat transfer co efficient is 42070W/m°c, calculate the following

i. the rate of heat transfer
ii. the mass flow rate of water and
iii. the surface area of the heat exchanger

b. Derive an expression for effectiveness by NTU method for parallel flow.