Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME – SEMESTER III (NEW) – EXAMINATION – WINTER-2016

Subject Code: 2733005 Date:25/10/2016

Subject Name: Advanced Heat Transfer

Time:02:30 pm to 05:00 pm Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Differentiate between convective and radiation heat transfer. Also explain natural convection heat transfer between stationary fluid and solid in detail. **07**

(b) A steel ball of 5 cm in diameter an initially at a uniform temperature of 450 ^{o}C is suddenly placed in a controlled environment in which the temperature is maintained at 100 ^{o}C. The convection heat transfer co-efficient is 10 W/m^2 ^{o}C. Calculate the time required for the ball to attain a temperature of 150 ^{o}C. The steel density at 150 ^{o}C is 7800 kg/m^3. The specific heat and thermal conductivity of steel is 0.46 kJ/kg ^{o}C and 35 W/m ^{o}C respectively. **07**

Q.2 **(a)** Discuss the thermal resistance and capacity formulations for un-steady state conduction. **07**

(b) Discuss the advantages of spiral flow heat exchangers over conventional shell and tube heat exchangers. Also mention the process design steps for spiral plate heat exchanger. **07**

OR

(b) List out different types of coolers for heat transfer in solid and explain any one detail. **07**

Q.3 **(a)** Give classification of evaporators and discuss method of feeding in multiple effect evaporator. **07**

(b) A single effect, vertical short – tube evaporator is used to concentrate a syrup from 10% to 40% solids at the rate of 2000 kg of feed per hour. The feed enters at 30 ^{o}C and a reduced pressure of 0.33 kg/cm^2 is maintained in the vapor space. At this pressure, the liquor boils at 75 ^{o}C. Saturated steam at 115 ^{o}C is supplied to the steam chest. No sub-cooling of the condensate occurs. Calculate the steam requirement and number of tubes having inside diameter 0.0221 meter if the height of the calandria is 1.5 meter. The following data are given. **07**

Specific heat of liquor = 0.946 kcal/kg ^{o}C; latent heat of steam at 0.33 kg/cm^2 = 556.5 kcal/kg; boiling point of water at this pressure = 345 K. The overall heat transfer coefficient = 2150 kcal/h m^2 ^{o}C and latent heat of saturated steam at 115 ^{o}C = 529.5 kcal/kg.

OR

Q.3 Discuss process design steps of vertical Thermosyphon type reboiler. **14**

Q.4 **(a)** Discuss in detail: Multi-component condensation. **07**

(b) Discuss the laminar film condensation on the vertical plate. Also state all assumptions made for determination of heat transfer coefficient. **07**

OR

Q.4 A copper pan of 35 cm diameter contains water and its bottom surface is maintained at 115 ^{o}C by an electrical heater. Calculate the power required to boil water in this pan and the rate at which the water evaporates from the pan due to the boiling process. Also make calculations for the heat flux for these conditions. The relevant fluid and vapor properties are as given below. **14**
$\mu_f = 2.83 \times 10^{-4}$ kg/m s; $h_{fg} = 2.256 \times 10^6$ J/kg; $\rho_f = 958.4$ kg/m^3; $\rho_g = 0.598$ kg/m^3; $\sigma = 58.9 \times 10^{-3}$ N/m; $C_{pf} = 4217$ J/kg K; $P_{rf} = 1.75$ and the surface fluid constant for the water – copper combination $C_{sf} = 0.013$

Q.5 **(a)** Discuss the construction and working of falling film type evaporator. **07**

(b) Discuss transverse fin cross flow cooler for air – water system. **07**

OR

Q.5 **(a)** Discuss design, construction and working of fluidized bed heating system. **07**

(b) Discuss film boiling and Leidenfrost phenomena. **07**

****