Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–IV • EXAMINATION – SUMMER • 2014

Subject Code: 140503 Date: 23-06-2014

Subject Name: Process Heat Transfer

Time: 10:30 am - 01:00 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)** Water flows at 60 ^{o}C inside a 2.5 cm inside diameter tube such that h_i=3500 W/m^2 ^{o}C. The tube has a wall thickness of 0.8 mm with a thermal conductivity of 16 W/m^2 ^{o}C. The outside of the tube loses heat by free convection with h_o= 7.6 W/m^2 ^{o}C. Calculate the overall heat transfer coefficient and heat loss per unit length to surrounding air at 30 ^{o}C. **07**

(b) Calculate the critical radius of insulation for asbestos with k=0.17 W/m ^{o}C surrounding a pipe and exposed to room air at 30 ^{o}C with h=3 W/m^2 ^{o}C. Calculate the heat loss from a 210 ^{o}C, 5 cm diameter pipe when covered with the critical radius of insulation and without insulation. **07**

Q.2 **(a)** Explain the general laws of heat transfer. **07**

(b) Explain the significance of Prandtl No., Nusselt No., Grashof No., Graetz No. and Peclet No. **07**

OR

(b) Explain the Chilton-Colburn analogy. **07**

Q.3 **(a)** Air at a temperature of 250 ^{o}C flow over a flat plate 0.3 m wide and 1 m long at a velocity of 8 m/s. If the plate is to be maintained at 78 ^{o}C, calculate the rate of heat to be removed continuously from the plate. Kinematic viscosity of air=3.9*10^{-4} m^2/s, Thermal conductivity of air=36.4*10^{-3} W/m K, Prandtl No.=0.69 **07**

(b) List the various radiation laws and explain the Kirchoff's law briefly. **07**

OR

Q.3 **(a)** Define : Black body, White body, Grey body, Transparent body, Transmittivity, Absorptivity, Reflectivity. **07**

(b) Calculate the heat transfer coefficient for water boiling at 1 atm pressure in a pan with a flat copper bottom which is maintained at 115 ^{o}C. For water at 100 ^{o}C, density of liquid = 598.4 kg/m^3, density of vapor = 0.598 kg/m^3, heat capacity=4211 J/kg K, viscosity=2.78*10^{-4} kg/m s, Prandtl No. for liquid=1.75, latent heat of vaporization=2257 J/g, Surface tension=58.9*10^{-3} N/m, an empirical constant C_{sf}=0.0128 **07**

Q.4 **(a)** Compare drop wise condensation and film wise condensation. **07**

(b) Calculate the heat transfer coefficient for water at 60 ^{o}C flowing through a 0.625 cm diameter tube with a velocity of 0.9 m/sec. The tube wall temperature is 40 ^{o}C. Viscosity of water = 2.167 kg/m hr, thermal conductivity = 2.27 kJ/m hr K, heat capacity=4.187 kJ/Kg K. **07**

OR

Q.4 **(a)** Classify the multiple effect evaporators based on mode of feed supply and explain the advantage and limitations of each. **07**

(b) Discuss the concept of Boiling Point Elevation. **07**

Q.5 **(a)** Derive the expression for LMTD for parallel flow arrangement. **07**

(b) Find the overall coefficient of heat transfer between water and oil if the water flows through a copper pipe 1.8 cm ID and 2.1 cm OD while the oil flows through the annulus between this pipe and a steel pipe. The water and oil side film coefficients are 4650 and 1280 W/m K. the fouling factors on the water and oil sides may be taken to be 0.000344 and 0.00086 respectively. The thermal conductivity of the tube wall is 349 W/m K. **07**

OR

Q.5 **(a)** List the basic parts of shell and tube heat exchanger and discuss the fouling of heat exchanger. **07**

(b) Discuss the classification of heat exchanger briefly. **07**

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