Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME – SEMESTER III (NEW) – • EXAMINATION – SUMMER 2016

Subject Code: 2733005 **Date:03/05/2016**

Subject Name: Advanced Heat Transfer

Time:10:30 am to 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)**	Describe the factors affecting the performance of an evaporator.	**07**
	(b)	Enlist the steps required for the designing of Spiral flow heat exchanger.	**07**
Q.2	**(a)**	Define: fin efficiency and fin effectiveness, explain the construction and working of finned tube heat exchanger.	**07**
	(b)	What is condensation? Write the difference between horizontal and vertical condenser.	**07**
		OR	
	(b)	Starting from Fourier's law of heat conduction, derive equation of thermal conductivity and thermal resistance of material in case of conductive heat transfer.	**07**
Q.3	**(a)**	An average convective heat transfer coefficent for flow of 90°C air over a flat plate is measured by observing the temerature time history of a 40 mm thick copper slab (ρ = 9000 kg/m^3 , C_P = 0.38 kJ/kg °C , K = 370 W/m °C) exposed to air maintained at 90°C. In one test run, the initial temperature of the plate was 200°C, and in 4.5 minutes the temperature decreased by 35°C, Determine the heat transfer coefficient for this case. Neglect internal thermal resistance.	**07**
	(b)	Derive the expression for overall heat transfer coefficient "h" from Nusselt theory for filmwise condensation in case of vertical tube surface.	**07**
		OR	
Q.3	**(a)**	Calculate the amount of steam required for concentrating the solution of caustic soda (NaOH) from 28% w/w of solids to 40% w/w of solids in a single effect evaporator. The feed rate is 25000 kg/hr and its temperature is 60°C. The absolute pressure in the evaporator is 0.2 kg/cm^2. (Boiling point 60°C). Saturated steam is available at 1.4 kg/cm^2 (108.7 ^{o}C) is to be used as heating medium. The elevation in boiling point is 25 ^{o}C. If the overall heat transfer coefficient is 670 Kcal/ (hr. m^2. ^{o}C), calculate the heating surface required for the desired operation. The enthalpy data for various streams are as follows: Vapor at 0.2 kg/cm^2 = 623 kcal/kg, 28 % NaOH at 60°C = 50 kcal/kg, 40% NaOH at 85°C = 90 kcal/kg, Latent heat of steam at 1.4 kg/cm^2 = 534 kcal/kg.	**07**
	(b)	Determine the tube and shell side heat transfer coefficient, overall heat transfer coefficient and pressure drop in case vertical thermosyphon reboiler.	**07**
Q.4	**(a)**	Discusss the characteristics of fluidized bed gasifier in detail.	**07**

(b) A surface having an area of 1.5 m^2 and maintained at 300 °C exchanges heat by radiation with another surface at 40 °C. The volume of factor due to the geometric location and emissivity is 0.52. Determine heat lost by radiation, value of thermal resistance and equivalent conduction co-efficient. **07**

OR

Q.4 **(a)** Starting with the assumptions, derive the equation for finding the tube and shell side heat transfer coefficient, overall heat transfer coefficient and pressure drop in case of kettle type reboiler. **07**

(b) Discuss different types of feed arrangement in multiple effect evaporator with neat sketch. **07**

Q.5 **(a)** Discuss unsteady state heat conduction and explain lumped heat capacity system in case of unsteady state conduction. **07**

(b) Discuss the concept of pool boiling in case of heat transfer in boiling liquids. **07**

OR

Q.5 **(a)** A horizontal 1-4 heat exchanger (condenser) is used to condense 45000 kg/hr of mixed light hydrocarbon vapors. The condenser to operate at 10 bar. The vapor will enter the condenser saturated at 60 °C and the condensation will be completed at 45 °C. The average molecular weight of vapor is 52. The enthalpy of the vapor is 596.5 kJ/kg and the condensate 247 kJ/kg. Cooling water is available at 30 °C and the temperature rise is limited to 10°C. Plant standards require tubes of 20 mm od, 16.8 mm id, 4.88 m long of admiralty brass. Use square pitch tube arrangement with P_t=1.25d_O. The vapors are to be totally condensed and no sub cooling is required. Take temperature correction factor F_t=0.92. Based on overall heat transfer coefficient = 900 W/m^2°C, Calculate (1) Number of tubes (2) Shell Diameter (3) Tube side heat transfer coefficient and (4) Shell side heat transfer coefficient. **14**

Use square pitch (n_1 = 2.263, K_1 = 0.158)

Physical properties of condensate at 47°C are:

μ_L=0.16 mNs/m^2, ρ_L=551 kg/m^3, K_L=0.13W/m°C, Specific heat of water at 35°C = 4.18 kJ/kg C, Density of water = 993 kg/m^3, Thermal conductivity of water = 0.628 W/m °C.

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