Seat No.: _____ **Enrolment No._____**

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–V (NEW) - EXAMINATION – SUMMER 2016

Subject Code:2153613 **Date:09/05/2016**

Subject Name:Basics of 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)** An ice box has walls constructed at a 10 mm layer of cork-board contained between two wooden walls, each of 20 mm. **07**

a) Find heat removed per unit area if the inner wall surface is kept at 263 k & outer is 303 k.

b) Find out the zone in the wall where the temperature is 293 k.

Thermal conductivity of cork board and wood are 0.041 W/mk and 0.105 W/mk respectively.

(b) Derive the expression for unsteady state heat conduction for Spherical shape. **07**

Q.2 **(a)** A flat furnace wall is constructed of a 114 mm layer of sil-o-cel brick having thermal conductivity of 0.138 W/(m.K) backed by a 229 mm layer of common brick having conductivity 1.38 W/(m.K). The temperature of inner face of the wall is 1033 K and that of outer face is 349 K. **07**

(a) What is the heat loss through the wall?

(b) Supposing that the contact between two brick layers is poor and that a contact resistance of 0.09 K/W is present, what would be the heat loss?

(b) What is critical radius? Derive expression of critical radius for cylindrical shape. **07**

OR

(b) Explain the effect of temperature on thermal conductivity of solids, liquid and gas with proper reason. **07**

Q.3 **(a)** 216 kg/h of hot oil enters a thin metal pipe of diameter 25 mm. An equal mass of cooling water flows through the annular space between the pipe and a larger concentric pipe; the oil and water moving in opposite directions. The oil enters at 420 K and is to be cooled to 320 K. If the water enters at 290 K, what length of pipe will be required? Take oil side and water side coefficients to be 1.6 kW/m^2 K and 3.6 kW/m^2 K respectively, and the specific heats to be 2.0 kJ/kg K and 4.18 kJ/kg K for oil and water, respectively. Neglect scale and metal wall resistance. **07**

(b) Explain pool boiling point regimes with boiling curve. **07**

OR

Q.3 **(a)** What is condensation? Explain different types of condensation. **07**

(b) Write equations for the following analogies and explain the terms involved with their SI units: **07**

a) Reynold analogy

b) Prandalt analogy

c) Von-karman analogy

Q.4 **(a)** Explain different laws for radiation. **07**

(b) A single-effect evaporator is to be fed with 5000 kg/h solution containing 10% solute by weight. The feed at 313 K is to be concentrated to a solution containing 40% by weight of the solute under an absolute pressure of 101.325 kPa. Steam is available at an absolute pressure of 303.975 kPa (saturation temp. of 407 K.) The overall heat transfer coefficient is 1750 W/(m^2 K). **07**

Cp of feed= 4.187 kJ/(kg*K)

Calculate:

1) The heat transfer area
2) The economy of the evaporator.

Temperature, K	Enthalpy, kJ/kg	
	Vapor	liquid
313 K		170
373 K	2676	419
407 K	2725	563

OR

Q.4 **(a)** Explain different feeding method of multiple effect evaporation. **07**

(b) Calculate the stable film boiling heat transfer coefficient assuming the film boiling of saturated water at atmospheric pressure on an electrically heated, horizontal, platinum wire of 1.6 mm diameter with an excess temperature of 255 K, Also calculate the heat/power dissipated per unit length of heater. **07**

DATA:

ρ_l = 957.9 kg/m3 , λ= 2257 kJ/kg

ρ_v= 31.54 kg/m3, C_{pv} = 4.64 kJ/(kg*K), k_v= 58.3 * 10-3 W/(m*K),

μ_v= 18.6 * 10-6 kg/(m*s) , e=1, σ= 5.68 * 10-8 W/(m^2.K^4)

$$h_c = 0.62[(k_v{}^3 \rho_v(\rho_l - \rho_v)g(\lambda + 0.40C_{pv}\Delta T)/(D\mu_v\Delta T)]^{0.25}$$

Q.5 **(a)** Explain Plate type heat exchanger with its advantage and disadvantage. **07**

(b) A chemical plant produces 300 metric tons of H_2SO_4 per day. The acid is to be cooled from 333 K to 313 K by 500 metric tons of water per day which has an initial temperature of 290 K. A counter flow cooler consisting of concentric pipes 12.5 mm thick, is to be used. The inside diameter of inner pipe and outer pipes are 75 mm and 125 mm respectively. Thermal conductivity of the pipe material is 46.52 W/(m.K). Calculate the overall Heat transfer coefficient. Acid flows through inner pipe. **07**

The physical properties of the fluids are:

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Properties	Acid	Water
Density, kg/m^3	1800	998.2
Heat capacity, KJ/(kg.K)	1.465	4.187
Thermal conductivity, W/(m.K)	0.302	0.669
Viscosity, kg/(m.s)	0.0112	0.0011

OR

Q.5 **(a)** Explain 1-2 shell and tube heat exchanger in detail with neat diagram. **07**

(b) 1) Write Dittus Boelter equation to compute heat transfer coefficient. Explain all the terms with their SI units. **04**

2) Explain with pertinent diagram the terms hydrodynamic and thermal boundary layers. **03**

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