Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE – SEMESTER – V (NEW) EXAMINATION – WINTER 2015

Subject Code: 2153613 **Date:08/12/2015**

Subject Name: Basics of heat transfer

Time:10:30am to 1:00pm **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)** A furnace is constructed with a 229 mm thick layer of fire brick, 115 mm thick layer of insulation brick and 229 mm thick layer of building brick. The inside temperature is 1223 K & the outside temperature is 323 K. Thermal conductivity of fire brick, Insulation brick, & building brick are 6.05, 0.581, & 2.33 W/(m.K) respectively. **07**

Find out heat loss per unit area & temperature at the interface.

(b) What is critical radius? Why it is necessary? Derive expression of critical radius for Spherical shape. **07**

Q.2 **(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 Transient heat conduction 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)** In an oil cooler, 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) What is boiling? Mention different modes of boiling. Explain boiling point regimes with boiling curve. **07**

OR

Q.3 **(a)** Derive the expression for exchange of radiation energy between two parallel plates with different emissivities. **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**

Q.4 **(a)** Explain Kirchoff's law of radiation and his concept of a Black body. **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	
	Vapour	liquid
313 K		170
373 K	2676	419
407 K	2725	563

OR

Q.4 **(a)** What is evaporation economy? Which are the different method for increase economy? Explain any one in detail. **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

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

Q.5 **(a)** Explain Shell and Tube heat exchanger with its basic parts. **07**

(b) A chemical plant produces 400 metric tons of H_2SO_4 per day (24 hours). The acid is to be cooled from 333 K to 313 K by 600 metric tons of water per day (24 hours) 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 and outside diameter of inner pipes are 75 mm and 90 mm respectively. The inside diameter of outer pipe is 130 mm. Thermal conductivity of the pipe material is 46.52 W/(m.K). Calculate the overall Heat transfer coefficient. **07**

The physical properties of the fluids are:

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 extended surface with different types. What is fin efficiency? What is fin effectiveness? **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

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