Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–IV EXAMINATION – WINTER 2015

Subject Code: 140503 Date:01/01/2016

Subject Name: Process Heat Transfer

Time: 02:30pm to 05:00pm 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)**	Explain how does thermal conductivity of gases ,liquid and solids depend upon temperature	**04**
	(b)	What do you mean by convection? how do you differentiate between free and forced convection?	**04**
	(c)	What is Fouling factor? Explain how it affects overall heat transfer coefficient.	**06**
Q.2	**(a)**	Derive an expression for the rate of heat flow through a composite wall, constructed from different material.	**07**
	(b)	A steel pipeline (k=50 W/m K) of ID 100 mm and OD 110 mm is to be covered with two layers of insulation each having a thickness of 50 mm, the thermal conductivity of the first insulation material is 0.06 W/m K and that of the second is 0.12 W/m K. Calculate the loss of heat per meter length of pipe and the interface temperature between the two layers of insulation, when the temperature of the inside tube surface is 250 ^{0}C and that of the outside surface of the insulation is 50 ^{0}C.	**07**
		OR	
	(b)	Explain the critical thickness of insulation. How do you decide the thickness of insulation of electric wires and steam pipes?	**07**
Q.3	**(a)**	Explain Stefan Boltzmann law and planks law with its significance	**07**
	(b)	Lubricating oil used in the gearbox of 14000 rpm high speed blower is being recycled continuously through a double pipe counter flow heat exchanger for cooling .the oil is to be cooled from 70 ^{0}C to 40 ^{0}C at the rate of 1000 kg/hr using water entering at 28 ^{0}C. The water temperature at the exit should not exceed 42^{0}C. The specific heat of oil is 2.05 KJ/Kg C and that of water is 4.17 KJ/Kg C. Calculate the required rate of flow of water, if the heat exchange area is 3.0 m^2, also calculate the overall heat transfer coefficient	**07**
		OR	
Q.3	**(a)**	Explain Reynolds and Colburn analogy along with the significance	**07**
	(b)	Differentiate drop wise and film wise condensation	**07**
Q.4	**(a)**	Explain different modes of heat transfer along with their basic laws.	**07**
	(b)	A hot pipe having surface temperature 245^{0}C is placed a large enclosure, the enclosure walls are at 98^{0}C. The pipe surface can be assumed as black. The total heat transfer coefficient including convection radiation effects is 37 W/m^2 C. Calculate the rate of radiant heat transfer & the convective heat transfer coefficient at the pipe surface.	**07**

OR

Q.4 **(a)** Derive the equation for LMTD and explain its importance **07**

(b) 1000 kg/hr of a dilute solution of sodium hydroxide containing 10% NaOH is to be concentrated to 40% NaOH by weight in a single effect evaporator. The feed is available at 25 ^{0}C . Boiling point of the solution may be considered as 100^{0}C. **07**

Given data:

Specific heat of dilute solution = 4180 J/kgK.

Latent heat of vaporization of water = 2239 kJ/kg.

Saturated steam corresponding to 1.8 bar pressure and 117 ^{0}C is available for heating purpose.

Latent heat of condensation of steam = 2212 kJ/ kg.

If the overall heat transfer coefficient for the system is 850 W/m^2 C.

calculate

i) The quantity of water evaporated.

ii) Steam consumed and steam economy.

iii) Surface area of the evaporation.

Q.5 **(a)** Write a short note on significance of various dimensionless numbers in heat transfer. **07**

(b) Air at 200 kPa and 200 ^{0}C is heated as it flows through a tube with a diameter of 25 mm at a velocity of 10 m/sec. the wall temperature is maintained constant and is 20 ^{0}C above the air temperature all along the length of tube **07**

calculate:

i) The rate of heat transfer per unit length of the tube

ii) Increase in the bulk temperature of air over a 3 m length of the tube.

Following properties of air at mean temperature are available

Cp =1025 J/Kg C.

Viscosity= 2.57 10^{-5} N-s/m^2

K= 0.0386 W/m C.

OR

Q.5 **(a)** Show different types of fins used in heat exchanger **07**

(b) Give the classification of heat exchanger based on flow arrangement. Also discuss in brief about shell and tube heat exchanger. **07**

****