Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

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

Subject Code: 2153502 Date:08/12/2015

Subject Name: Introduction to 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)** Derive an expression for critical thickness of insulation for cylinder. **07**

(b) Derive an expression for steady state heat conduction through a composite cylinder of three layers. **07**

Q.2 **(a)** Derive an equation for Reynolds analogy. **07**

(b) Discuss the physical significance of the following terms: (i)Prandtl number, (ii) Stanton number, (iii) Biot number, (iv) Grashof number (v) Peclet number (vi) Fourier number (vii) Nusselt number **07**

OR

(b) A vertical cylinder of 20mm diameter and 2m height is maintained at constant temperature of 40^0C. The ambient air temperature is 20^0C. Calculate the amount of heat generated by the cylindrical body. Use the equation: $Nu = 0.12 (Gr \times Pr)^{1/3}$. The properties of air at film temperature can be used as follows: Density = 1.165 kg/m^3, sp. Heat = 1005 J/kgK, thermal conductivity = 0.0267 W/mK, viscosity = 1.866×10^{-5} Ns/m^2. **07**

Q.3 **(a)** Discuss theconcept of black body. Explain in brief various laws of radiation **07**

(b) With the help of a neat sketch explain the working of 1-2 shell & tube heat exchanger and its important parts. **07**

OR

Q.3 **(a)** Discuss construction and working of Plate type Heat Exchanger. **07**

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

Q.4 **(a)** Derive an expression for the logarithmic mean temperature difference in case of co-current flow double pipe heat exchanger. **07**

(b) A chemical plant produces 300metric tonnes of sulphuric acid per day. The acid is to be cooled from 60 ^{0}C to 40 ^{0}C by 500 metric tonnes of water per day which has an initial temperature of 15 ^{0}C. A counter flow cooler consisting of concentric pipe flow 12.5 mm thick, is to be used. The inner pipe through which the acid flows is 7.5 cm bore and the outer one 12.5 bore. The outside diameter of the inner pipe is 10 cm. the physical properties of the fluids at the mean temperature are as follows. **07**

Physical Properties	**Acid**	**water**
Density (kg/m^3)	1800	998.2
Heat capacity, kcal/(kg ^{0}C)	0.35	1
Thermal conductivity, kcal /(hr m ^{0}C)	0.26	0.575
Viscosity , kg / (m hr)	40.3	3.96

OR

Q.4 **(a)** Discuss the calculation of overall heat transfer coefficient from individual coefficient for heat exchanger. **07**

(b) The temperature of oil leaving a co-current flow cooler is to be reduced from **07**

370 to 350 K by lengthening the cooler. The oil and water flow rates and inlet temperature and other dimensions of the cooler will remain constant. The water enters at 285 K and the oil at 420 K. The water leaves the original cooler at 310 K. If the original length is one meter, what must be the new length?

Q.5 **(a)** Explain pool boiling of saturated liquid showing its graph **07**

(b) An evaporator is to be fed with 5000 kg/hr of solution containing 10 % solute by weight. The feed at 40 ^{0}C is to be concentrated to a solution containing 40 % by weight of the solute under an absolute pressure of 1.03 kg/cm^2. Steam is available at an absolute pressure of 3 atm (saturation temperature of 134 ^{0}C). The overall heat transfer coefficient is 1500 kcal/hr m^2 ^{0}C. Calculate (i) heat transfer area that should be provided (ii) the steam requirement. Treat the solution as per pure water for purpose of enthalpy calculation. Data **07**

Temperature (^{0}C)	**Enthalpy , kcal/kg**	
	Vapour	Liquid
40	613.5	40.5
100	639.2	100
134	651.4	134.4

OR

Q.5 **(a)** Explain the construction and working of a falling film evaporator with a neat sketch. **07**

(b) A vertical plate 50cm × 50 cm is exposed to dry saturated steam at atmospheric pressure. The plate is held at 98°C. Compute the rate of heat transfer and mass rate of steam condensation. Lv = 2260 kJ/kg, μ =282 × 10^{-6}kg/m.s ,ρ_l = 960 kg/m3 ,k = 0.68 W/m °C ρ_v,=0.6 kg/m^3 **07**

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