Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY
BE SEM-IV Examination-Nov/Dec-2011

Subject code: 140503 **Date: 30/11/2011**

Subject Name: Process Heat Transfer

Time: 02.30 pm -5.00 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)** From Fourier's law derive expression for heat transfer by conduction through cylindrical surface. **07**

(b) A furnace is constructed with 22 cm of fire brick, 12cm of insulating brick and 25 cm of building brick. The inside temperature is 940°C and the outside temperature is 60°C. Thermal conductivity of the materials are 1.395, 0.2093 and 0.7558 W/m°K respectively. Find the heat loss per unit area and the temperature at the junction of the fire brick and insulating brick. **07**

Q.2 **(a)** Derive expression for Rate of heat transfer between two fluids flowing in counter flow in double pipe heat exchanger. **07**

(b) Crude oil flows at the rate of 100 kg/hour through the inside pipe of a double pipe heat exchanger and is heated from 30°C to 90°C. The heat is supplied by Kerosene initially at 200°C flowing through the annular space. If the temperature of approach (minimum temperature difference) is 10°C , determine the heat transfer area for co-current flow and the kerosene flow rate. **07**

C_p of crude oil =2.1 kj/kgºC

C_p of Kerosene =2.51 kj/kgºC

U_o = 465 W/m^2 ºK

OR

(b) 9100 kg. of Ethyl alcohol is to be heated from 10°C to 80°C per hour. The heating medium is condensing steam at 1.41 kg/cm^2 at 110°C.The overall coefficient of heat transmission, however, varies linearly with temperature from 110 W/m2°K at 10°C to 455 at 80 °C. Obtain the surface area of the heat exchanger. Specific heat of alcohol is 2.721kj/kg °C. **07**

Q.3 **(a)** Discuss Kirchoff's law of radiating power of a body. Explain what is Black body and Grey body. **07**

(b) Two very large parallel planes with emmissivities 0.4 & 0.75 are engaged in radiative heat transfer Calculate the rate of heat transfer. If a highly polished Aluminium screen with emissivity .04 is placed between them, calculate reduction in heat transfer. **07**

OR

Q.3 **(a)** Discuss Pool boiling. Explain various regimes of Pool boiling. What is critical flux? How knowledge of critical flux is useful? **07**

(b) Derive the expression for time required in an agitated vessel to raise the temperature of liquid mass m with mean specific heat C_p from temperature T_a to T_b by condensing steam at temperature T_s. **07**

Q.4 **(a)** Discuss various types of feed arrangement used in multiple effect evaporator with their merits and demerits. **07**

(b) It is desired to concentrate 5000 kg/hr of a solution from 10% to 25 % solids in a single effect evaporator. Steam is available at 110 °C and the vapor space is maintained at 410 mm of Hg. The boiling point of water corresponding to the vapor space pressure is 84°C. The solution has a boiling point elevation of 10°C. The enthalpies of feed and thick liquor are 375 and 335 kj/kg respectively and the enthalpy of the vapor is 2721 kj/ kg. The feed enters at its boiling point corresponding to the vapor space pressure. **07**

λ_s = 2235 kj/kg.

(a) Calculate the steam consumption per hour.

(b) If the available heat transfer area is 35 m^2, estimate the heat transfer coefficient.

OR

Q.4 **(a)** Discuss capacity and economy of evaporator with reference to single and multiple effect evaporator. **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. **07**
$\mu = 282 \times 10^{-6}$ kg/m.s $\rho = 960$ kg/m^3 $k = 0.68$ W/m °C

Q.5 **(a)** With a neat sketch explain construction and working of a 1-2 Shell & Tube heat exchanger. **07**

(b) Show different types of fins used in heat exchanger. **07**

OR

Q.5 **(a)** Explain **07**

(i) Variation of Thermal conductivity with temperature.
(ii) Analogy between Transfer Process

(b) Explain **07**

(i) LMTD Correction factor
(ii) Fouling factor

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