Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME - SEMESTER– II (Old course)• REMEDIAL EXAMINATION – SUMMER 2015

Subject Code: 1723903 Date:14/05/2015

Subject Name: Thermal Equipment Design

Time: 02:30 pm to 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.**
4. **Use of Steam table, Property table and Refrigeration table are permitted.**

Q.1 **(a)** What is a heat exchanger? How are heat exchangers classified? **07**

(b) The flow rate of hot and cold water streams running through a parallel flow heat exchanger are 0.2 kg/s and 0.5 kg/s respectively. The inlet temperatures on the hot and cold sides are 75^0C and 20^0C respectively. The exit temperature of hot water is 45^0C. if the individual heat transfer coefficients on both sides are 650 W/m$^{2\,0}$C, calculate the area of the heat exchanger. **07**

Q.2 **(a)** What is baffle plate? Explain the importance and types of baffles with sketch. **07**

(b) In a counter flow double pipe heat exchanger, water is heated from 25^0C to 65^0C by an oil^{0}C with a specific heat of 1.45kJ/kg K and mass flow rate of 0.9 kg/s. the oil is cooled from 23^0C to 160^0C. if the overall heat transfer coefficient is 420 W/m^{20}C, calculate the following : **07**

i. The rate of heat transfer
ii. The mass flow rate of water, and
iii. The surface area of the heat exchanger.

OR

(b) A double pipe heat exchanger is employed to heat raw water ($\dot{m}_c$ = 4.85 kg/s) from 20^0C to 60^0C using waste hot water ($\dot{m}_h$ = 2.81 Kg/s) cooled in the process from 95^0C to 75^0C.The hot water flows in the inner tube (ID = 40 mm, OD = 48 mm) with 32 nos. of longitudinal carbon steel fins (Fin Width = 0.89mm, Fin Height = 12.7mm & Root Width = 4 mm) in counter flow to the raw water which flows in annulus (ID = 75mm,OD = 89mm). Calculate the efficiency of the fin. Consider K_{fin} = 60 W/m ^{0}K. **07**

Q.3 **(a)** Write a short note on shell and tube type condenser. **07**

(b) The following are the values measured on a shell-and-tube ammonia condenser: **07**

Velocity of water flowing through the tubes, V m/s	1.30	0.55
Overall heat transfer co-efficient , U_0 W/m^{2}K	2350	1610

Water flowed inside the tubes while refrigerant condensed outside the tubes (OD-48mm, ID-44mm, K = 60 W/m K.). Using the concept of Wilsonôs plot, determine the condensing heat transfer coefficient. What is the value of overall heat transfer coefficient when the velocity of water is 0.262 m/s?

OR

Q.3 **(a)** What is evaporation? How are evaporators classified? **07**

(b) Steam at atmospheric pressure enters the shell of a surface condenser in which the water flows through a bundle of tubes of diameter 25 mm at the rate of 0.05 kg/s. The inlet and outlet temperatures of water are 15^0C and 70^0C respectively. The condensation of steam takes place on the outside surface of the tube. If the overall heat transfer coefficient is 230 W/m^{20}C, calculate the following, using NTU method : **07**

(i) The effectiveness of the heat exchanger
(ii) The length of the tube and
(iii) The rate of steam condensation.

Take the latent heat of vaporization at 100^0C = 2257 kJ/kg.

Q.4 **(a)** List out the assumptions made for Regenerator heat transfer analysis **07**

(b) A boiler is equipped with a regenerator rotating at 4 rpm and having the flue gas (hot) and air (cold) flow areas with disk sector angles of 1950and 1650 respectively. The rotor with 2 m diameter and 0.4 m height is turned by a shaft of 0.2 m diameter. The matrix material has the following characteristics: **07**

Density = 7800 kg/m^3 Packing density =1200 m^2/m^3

Specific heat = 0:44 kJ/kgK Porosity = 0:76

The flue gas and airstream flowing in counter flow have the following characteristics:

	Flue Gas	Air
Heat transfer coefficient (W/m^2 .K)	60	50
Isobaric specific heat (kJ/kg.K)	1.11	1.005
Mass flow rate (kg/s)	8.3	6.9
Inlet temperature (^{0}C)	320	26

Assuming that 10% of the rotor face is covered by radial seals, calculate the regenerator effectiveness and heat transfer rate from the flue gas stream to the airstream.

OR

Q.4 **(a)** Write short note on Rotary type regenerator. **07**

(b) Air at 1 atm and 127^0C and with a velocity of 10 m/s flows across the compact heat exchanger as shown in Figure 1. And exists with a mean temperature of 27^0C.The core is 0.6 m long. Calculate the total frictional pressure drop between the air inlet and outlet and the average heat transfer coefficient on the air side. **07**

Q.5 **(a)** Explain the functions of different elements of artificial draught cooling towers. **07**

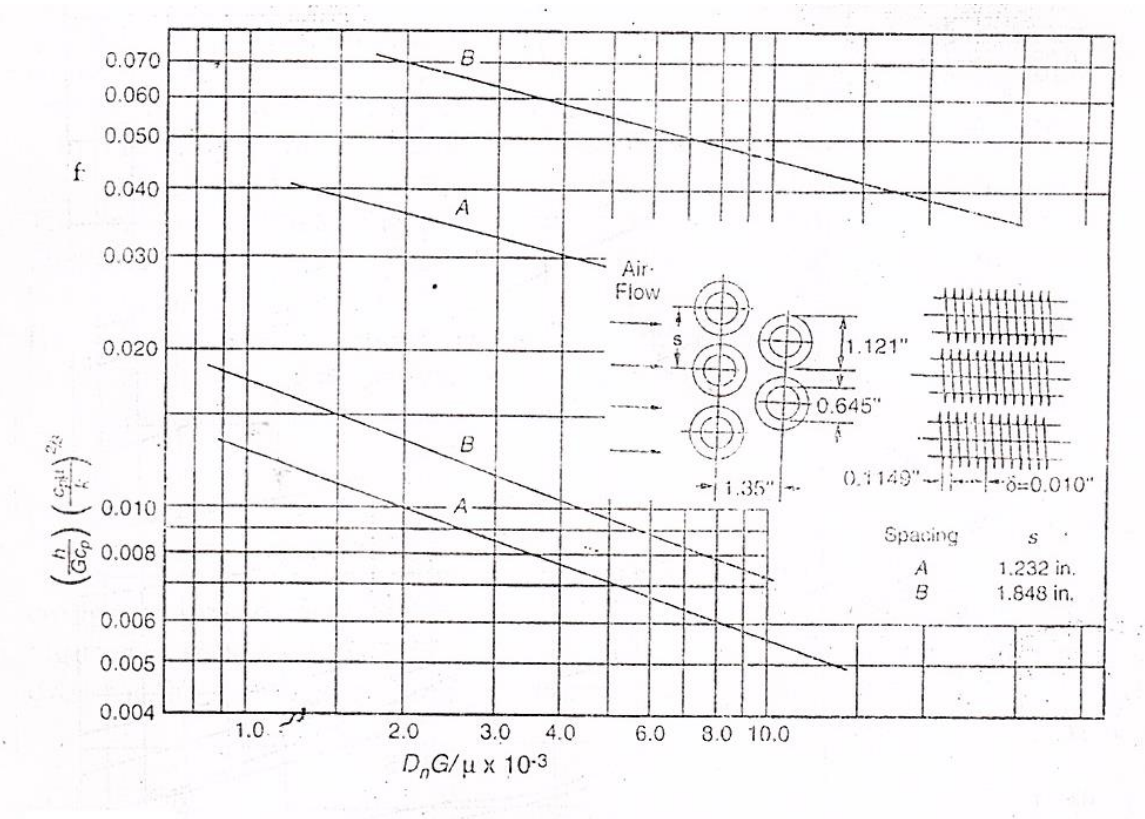
(b) Derive the equation to calculate the chimney height in a natural draft cooling tower. **07**

OR

Q.5 **(a)** How can thermal performance of a cooling tower be improved? **07**

(b) A chiller plant system (capacity 500kW) with COP at 4.5 is designed with a cooling tower, the design entering and leaving condenser water temperature of the cooling tower are 37°C and 32°C respectively, the design wet bulb temperature of the outdoor air is 28°C, what are: **07**

a) the cooling tower coefficient
b) the required condenser water and air mass rate (in kg/s) in the cooling tower
c) the required height of the fill



Heat transfer and friction factor for flow across finned-tube matrix. Surface CF-8.7-5/8 J: tube OD = 1.638 cm; fin pitch = 3.43/cm; fin thickness = 0.0254 cm; fin area/total area = 0.862; air-passage hydraulic diameter, D_h = 0.5477 cm (A), 1.1673 cm (B); free-flow area/frontal area, σ = 0.443 (A), 0.628 (B); heat transfer area/total volume = 323.8 m^2/m^3 (A), 215.6 m^2/m^3 (B).

Figure 1

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