Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

M.E. SEMESTER III–EXAMINATION – WINTER 2015

Subject code: 2733905 Date: 04/12/2015

Subject Name: Solar Refrigeration and Air-conditioning

Time: 2:30 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 solar energy and solar refrigeration data book is permitted after verification.**

Q.1 **(a)** Explain the working and analysis of thermoelectric refrigerator with neat and clean sketch. **07**

(b) An NH_3 vapour compression refrigerating machine works between 25^0C and -20^0C. The NH_3 leaves the compressor in dry and saturated condition. Liquid NH_3 is under cooled to 21.5^0C before passing through throttle valve. An average specific heat of liquid NH_3 is 1.13 Kcal/Kg ^0C. Find the theoretical C.O.P. of machine (Use theoretical approach only). NH_3 vapour compression refrigerating machine produces 30 tons of ice from and at 0^0C in a day. If actual C.O.P. of system is 75% of theoretical C.O.P., then calculate how much power (in H.P.) to be developed by the solar rankine cycle to operate NH_3 vapour compression refrigerating machine. Take latent heat of fusion of ammonia is 80 Kcal/Kg. **07**

The properties of NH_3 are as follows :

Temperature (^0C)	Liquid		Vapour	
	h_f (Kcal/Kg)	s_f (Kcal/ Kg^{0}K)	h_f (Kcal/Kg)	s_f (Kcal/ Kg^{0}K)
25	128.1	1.0976	406.8	2.0324
-20	78.2	0.9175	395.5	2.1710

Q.2 **(a)** A cylindrical parabolic collector is used for heating water. The concentrator has an aperture of 1.3 m and a length of 3.7 m while absorber tube (inner diameter = 3.8 cm, outer diameter = 4.2 cm) has a concentric glass cover (inner diameter = 5.5 cm, outer diameter = 6.3 cm) around it. Consider, wind speed = 5.5 m/sec, mass flow rate of water = 0.09 Kg/sec, mean temperature of absorber tube = 140^0C, temperature attained by cover is 60^0C, ambient temperature is 20 ^0C. Take inlet and outlet temperature of water is 138^0C and 142^0C respectively. Assume flow through absorber tube is fully developed. Find (i) heat transfer coefficient between absorber tube and cover (ii) heat transfer coefficient on outside of cover (iii) heat transfer coefficient on inside surface of absorber tube. (iv) Concentration ratio. **08**

(b) Explain the principle and working of intermittent absorption solar refrigeration system with neat and clean sketch. **06**

OR

(b) Draw the neat sketch of pressure-Temperature-Concentration measuring device and explain its component, working and importance. **06**

Q.3 **(a)** Discuss in brief the various methods to improve the performance of solar operated H_2O-LiBr vapour absorption refrigeration system. **07**

(b) Explain the working and thermodynamic modeling of rankine cycle solar cooling system with neat sketch. **07**

OR

Q.3 **(a)** Explain the working of absorption heat pump system with integral refrigerant storage using neat and clean layout of system. **07**

(b) Explain the thermodynamic modeling of jet ejector pump refrigeration system and discuss the methods to improve the performance. **07**

Q.4 **(a)** Explain the analysis of sensible heat storage device for the situation (i) well mixed (ii) thermal stratification. **07**

(b) Derive an expression for heat removal efficiency factor and instantaneous efficiency for flat plate solar collector using approximate method and state the assumption. **07**

OR

Q.4 **(a)** The temperature in hot water stratified tank are to be determined by assuming that the tank consists of two equal well mixed sections with inlets at top and in between the two sections. The following data are given :- **07**

Hour	Mass flow rate (Kg/h)	Inlet temperature to tank, T_{f0} (^{0}C)	Mass flow rate for load (Kg/h)	Ambient Temperature, T_a (^{0}C)
13:00-14:00	2000	80	240	23
14:00-15:00	2000	76	220	22

Take mass of water in tank = 5000 Kg, $(UA)_{t1} = (UA)_{t2}$ = 30 KJ/hr ^{0}C, make up water enters at 20^{0}C at the same rate as the rate of withdrawal to load, at 13:00 hr T_{L1}=75.10 ^{0}C and T_{L2}=65.98 ^{0}C. Calculate the values of T_{L1} and T_{L2} at 15:00 hr. Neglect the value of heat capacity of tank.

(b) Derive an expression of heat removal factor and instantaneous efficiency for cylindrical parabolic collector. **07**

Q.5 **(a)** Explain the liquid desiccant solar cooling system for industrial cooling with neat and clean sketch. **07**

(b) With the help of neat sketch, explain the working of solar regenerator for hot and humid climate. **07**

OR

Q.5 **(a)** Define (i) sorbent (ii) adsorption and explain the advantages of liquid desiccant material over the solid desiccant material. **07**

(b) Draw neat sketch and explain an experimental setup of open and forced flow solar regenerator. **07**

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