Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–V • EXAMINATION – SUMMER 2013

Subject Code: 151403 **Date: 16-05-2013**

Subject Name: Food Refrigeration and Air Conditioning

Time: 10.30 am - 01.00 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)** A simple vapour compression refrigeration system operating on R134a is set to operate on the following conditions: **07**

Refrigeration capacity = 10 TR ; Evaporating temperature = - 16 ^oC
COP of the system = 4 ; Condensing temperature = 30 ^oC
Compressor discharge temperature = 36 ^oC
C_{pv} of superheated vapours = 1.054 kJ/kgK
Calculate the following:

(i) Mass flow rate of the refrigerant in kg/s.
(ii) Compressor power requirement in kW.
(iii) Quality of refrigerant at evaporator entry in %.
(iv) Condenser heat rejection in kW
(v) Carnot COP of the system.
(vi) Refrigeration efficiency in %
(vii) If η_{vol}= 90%, calculate actual piston displacement in m^3/s.

Thermodynamic Properties of R134a				
Temperature ^oC	h_f (kJ/kg)	h_g (kJ/kg)	P (bar)	v_g m^3/kg
- 16 ^oC	178.97	389.11	1.5721	0.1256
30 ^oC	241.65	414.94	7.7	0.02667

(b) Name the different components of vapour absorption refrigeration system that replaces the compressor of vapour compression refrigeration system. **07**
In an absorption type refrigeration system, heating, cooling and refrigeration take place in the temperature of 120°C, 25°C and -15°C respectively. Find the theoretical COP of the system. If the heating is increased to 220°C and refrigeration temperature is decreased to -45°C, find the percentage change in theoretical COP.

Q.2 **(a)** Answer the following questions: **07**

(i) What is mechanism of Ozone layer depletion in the stratosphere due to CFCõ presence?
(ii) Prove that 1 TR = 3.5167 kW
(iii) Find out ñRò designations for CO_2 and $CHClF_2$
(iv) What should be economic criteria for selecting refrigerants?
(v) What are slot diffuser outlets?
(vi) What is function condenser in vapour compression system?
(vii) Why actual COP is less than Carnot COP?

(b) Explain the operation of a simple vapour compression system with the help of a block diagram showing all its major components. With the help of P-h diagram explain the effect of **07**

(i) Decrease in evaporator temperature.

(ii) Suction vapour superheating.

OR

(b) Write brief notes on the following: **07**

(i) Radiators (ii) Thermostatic Expansion valve

(iii) Azeotropes (iv) Pressure control elements

(v) Green house effect (vi) Slot diffusers

(vii) Draft

Q.3 **(a)** A Carnot heat engine is drawing 3000 kW heat from a source maintained at 1600 K . The work output from this engine is utilized to drive a Carnot refrigerator whose source temperature is 300K.The total heat flow to the common sink is 3600kW. Represent the entire system by means of a block diagram showing energy flow directions and calculate the reservoir temperature. **04**

(b) State fan laws with the aid of a óPressure-Flowô diagram. Show the representation parameters Fan Total Pressure, Fan Static Pressure, Fan Velocity Pressure, Power Consumption and Fan efficiency on this diagram. A fan was purchase to operate on a fixed RPM. Calculate the percentage increase in air flow flow rate and power consumption if the fan speed is doubled. **05**

(c) State the criteria on should follow for good room air distribution. Define entrainment ratio. An air duct of 10 cm diameter converges to 5 cm diameter at the end of the duct. Air enters this duct at a velocity of 10 m/s and the static pressure at the entry is 30 mm of WC. If the friction loss in this portion of the duct is 0.8 m, calculate the static pressure at the other end of the duct in mm WC. **05**

Q.3 **(a)** Explain the basic elements of air-conditioning control system with the help of a block diagram. Explain the mechanism of automatic temperature, humidity and refrigerant flow control with the help of neat labeled diagrams. **04**

(b) What are fan laws? A constant speed fan installed at a certain location where the air density is 0.97 kg/m^3 delivers air @ 5 m^3/s against a static head of 50 mm WC. Determine the air flow rate, shaft power required in HP to drive the same fan and static head in mm of water column at a location where the air density is 1.20 kg/m^3. Fan motor efficiency as 70%, and g = 10 m/s^2. **05**

(c) Draw labeled diagrams of the following and mention their applications: **05**

(i) Solenoid valves

(ii) Limit switches

(iii) Perforated ceiling panels.

(iv) Centrifugal dust collectors

(v) Centrifugal fans

Q.4 **(a)** Explain the principle, construction and working of a three fluids (NH_3-H_2O-H_2) vapour absorption refrigeration system **07**

(b) Differentiate between chilling and freezing of food with suitable examples. Determine the total heat of product to be removed from a 500 kg frozen peas stored at -18°C inside a cold storage. Initial loading temperature of the peas is 25°C and freezing point at -2.5°C. Latent heat of freezing peas is 300 kJ/kg and sensible heat above and below freezing point is given as 3.2 kJ/kg°C and 1.6 kJ/kg°C. If the desired storage temperature of -18°C is achieved in 5 hours, express the refrigeration load in tonnes of refrigeration. [Given 1 TR = 3.517 kJ/s) **07**

OR

Q.4 **(a)** With labeled diagram, explain the principle, construction and working of a simple vapour absorption refrigeration system. **07**

(b) Ten tonnes of apple having specific heat 3.36 kJ/kg °C is to be cooled from 25°C to 10°C in 24 hours. The heat of respiration per 24 hours is 3100 kJ/t. Three men will work for 4 hours and lighting load is estimated to be 100 W. Air infiltration load is assumed as 4100 kJ in 24 hours. The cold storage measures 8 X 8 X 4 m on inside and is constructed of brick laid in cement mortar. Wall thickness is 45 cm with 1 cm cement plaster and there is 10 cm thick cork insulation on the inside of the four walls. Heat transfer coefficient for the ceiling is 15% more than that of the wall. The outside temperature is 35°C and inside temperature is maintained at 4°C. Calculate the plant capacity needed in tonnes of refrigeration. **07**

[Given that thermal conductivity (k) for brick, cork and cement plaster are 1.9, 0.105 and 1.05 W/m °C. The rate of respiration for men is 0.2 kW. There is no heat transfer through the floor.]

Q.5 **(a)** List out the components of a cold storage and briefly explain the different type of safety devices mentioning function and location of each in the refrigeration cycle. **07**

(b) What do you mean by a hermetically sealed compressor? Explain briefly the principle, construction and working of a centrifugal compressor. **07**

OR

Q.5 **(a)** What is the function of an expansion valve? Classify different expansion valve and briefly explain the working of a thermostatic expansion with help of a labeled diagram. **07**

(b) With suitable labelled diagram, explain the principle and working of an evaporative condenser. **07**

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