Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–V • EXAMINATION – WINTER 2013

Subject Code: 151403 **Date: 29-11-2013**

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) Answer the following questions: **07**

(i) Write 'R' designations for refrigerants CO_2 and CH_4
(ii) Enumerate the safety criteria for selection of refrigerants.
(iii) Define I TON of refrigeration and show that 1 TR = 3.5167 kW.
(iv) Define azeotropes and give examples.
(v) Why is it desirable for refrigerants to have high critical temperatures?
(vi)Why is actual COP always less than Carnot COP?
(vii) What is the main function of expansion valve in refrigeration cycles.

(b) A R134a based simple vapour compression refrigeration system is operating on the following conditions: **07**

Refrigeration capacity = 20 TR, Evaporating temperature = - 12 ^oC
Condensing temperature = 36 ^oC, Compressor discharge temperature = 42 ^oC
Avg. Specific heat of superheated vapours = 1.12 kJ/kgK, COP of the system = 4.5
Calculate the following:
(i) Mass flow rate of the refrigerant in kg/s.
(ii) Compressor power requirement in HP.
(iii) Quality of refrigerant vapours entering the evaporator.
(iv) Heat rejected at Condenser in kW
(v) Carnot COP of the system.
(vi) Refrigeration efficiency in %
(vii) If η_{vol}= 92%, calculate actual piston displacement in lps.

Thermodynamic Properties of R-134a								
t (^oC)	h_g kJ/kg	h_f kJ/kg	s_g kJ/Kkg	s_f kJ/Kkg	v_g m^3/kg	ρ_f kg/ m^3	C_{Pv} kJ/Kkg	P bar
- 12	391.55	184.18	1.7531	0.941	0.1075	1332	0.835	1.8518
36	41778	250.41	1.7129	1.1715	0.02241	1163	1.088	9.1172
42	419.58	259.35	1.7115	1.1903	0.0189	1138	1.138	10.721

Q.2 (a) Draw a neat and labeled diagram of a Vapour Absorption Cycle. Explain in detail the function of various components of this cycle and also write down the expression of its COP. **07**

(b) With the help of a neat flow diagram, explain the operation of a simple vapour compression cycle. Draw P-h & T-s phase diagrams for the cycle indicating various state points. Explain the effect of the following factors on the performance of vapour compression cycle: **07**

(i) Evaporator pressure
(ii) Condenser temperature
(iii) Suction vapour superheat
(iv) Liquid sub-cooling

OR

(b) Explain the operation of a simple vapour compression refrigeration system with the help of a neat flow diagram explaining functions of different components. Also draw P-h & T-s phase diagrams for the process indicating various state points. On the basis of these diagrams, write down expressions for Refrigeration effect and COP of the system. Why is it recommended to slightly superheat the refrigerant vapours before it enters the compressor and sub-cool it at the condenser exit? **07**

Q.3 **(a)** Write brief notes on the following with figures wherever required: **05**

(i) Electronic air filters
(ii) Radial flow fans
(iii) Limit switches
(iv) Automatic humidity control
(v) Aspect ratio of ducts

(b) State general rules for air flow duct design and discuss the materials suitable for duct construction. What materials of construction do you consider suitable for food processing plants? **04**

(c) State fan laws. A fan driven by a 70% efficient constant speed motor delivers 6 m^3/s of air against a static head of 60 mm WC at a location where the specific gravity of air is 0.96. The same fan is operated at a place where the specific gravity of the air is 1.18. Calculate **05**

(i) air flow rate in m^3/s,
(ii) static head in mm WC
(iii) required motor shaft HP

OR

Q.3 **(a)** Write brief notes on the following with figures wherever required: **05**

(i) Wet air filters
(ii) Axial flow fans
(iii) Time switches
(iv) Automatic temperature control
(v) Pressure measurement elements

(b) State general requirements for good room air distribution in air-conditioned space meant for storage of different type food products. With the help of a schematic layout diagram, illustrate the operation of an automatic pressure control device starting from sensor to controller. **04**

(c) Work out mass and energy balance equations for air flowing through ducts. A motor driving a fan is rated at 15 Ampere. When the fan runs at an angular velocity of 15 radian/s, it draws a current of 11 Ampere. Calculate the maximum permissible angular velocity at which the fan could be operated within its rated capacity. What would be the percentage increase in air flow? **05**

Q.4 **(a)** Write down the differences between: **07**

i. Centrifugal compressor & Reciprocating compressor
ii. Plate surface evaporator & Finned tube evaporator
iii. Thermostatic expansion valve & solenoid expansion valve
iv. Air cooled condenser & water cooled condenser

(b) Define and differentiate between freezing, refrigeration and chilling. Draw a typical freezing curve for foods and explain in detail the path followed. **07**

OR

Q.4 **(a)** Define the following. **07**

(i) IQF (ii) COP (iii) DBT
(iv) ODP (v) GWP (vi) WBT (vii) % RH

(b) Enlist different types of freezers used in Food Industry. Explain in detail the immersion freezing technique with the help of a diagram. Also state its advantages. **07**

Q.5 **(a)** Explain the construction and working of an Electrolux refrigeration system. Also write down the expression of its COP. **07**

(b) Enlist the factors responsible for the spoilage of fruits and vegetables. Also explain in detail the methods which can be employed for its control. **07**

OR

Q.5 **(a)** In a vapour absorption system, heating, cooling and refrigeration takes place at temperatures of 100^0C, 20^0C and -50^0C respectively. Find the maximum COP of the system. Also write down the differences between Vapour compression and Vapour absorption cycle. **07**

(b) State the significance of a cold storage of fruits and vegetables. Describe the factors to be considered while designing a cold storage? **07**

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