Seat No.: _____ **Enrolment No._____**

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–V- EXAMINATION – SUMMER 2016

Subject Code: 151403 **Date: 21/05/2016**

Subject Name: Food Refrigeration & Air - Conditioning

Time: 02:30 PM to 05:00 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 chemical formula of R134a and R12?
(ii) Why Carnot COP greater than actual COP in VCS?
(iii) Define 1 TR.
(iv) What is the function of evaporator in VCS?
(v) Define volumetric efficiency.
(vi) State safety criteria for selecting refrigerants.
(vii) Define azeotropes with an example.

(b) A 30 TR cold storage plant is working on simple vapour compression cycle with a HCFC refrigerant with the following operating conditions: **07**

Evaporating temperature = -5°C
Condensing temperature = 40°C
Refrigeration efficiency = 80%.
Calculate the following in SI units:

(a) Mass flow rate of the refrigerant.
(b) Condenser heat rejection
(c) Rated compressor power if it is 95 % efficient
(d) Actual COP of the system.
(e) Compressor suction volume.
(f) Quality of the refrigerant entering the evaporator in %
(g) Power consumption in kW/TR

Thermal Properties of Refrigerant							
t (^{o}C)	P (bar)	h_f (kJ/kg)	h_g (kJ/kg)	s_f (kJ/kgK)	s_g (kJ/kgK)	v_f (m^3/kg)	v_g (m^3/kg)
-5	4.21	194.18	403.5	0.98	1.76	0.77×10^{-3}	0.055
40	15.335	249.7	416.5	1.167	1.7	0.9×10^{-3}	0.015

Average specific heat of refrigerant vapors in superheated region = 0.852 kJ/kg K.

Q.2 **(a)** Explain vapour absorption refrigeration system with a neat flow diagram and name the components that replace the compressor of a vapour compression refrigeration system. State the function of hydrogen gas in Electrolux refrigeration system? In a vapour absorption system, heating, cooling and refrigeration takes place at temperatures of 110 ^{0}C, 27 ^{0}C & - 27 ^{0}C respectively. Calculate the maximum theoretical COP of the system. **07**

(b) Describe simple vapour compression refrigeration system with the help of a neat flow diagram supplementing with P-h & T-s phase diagrams. Explain the effect of the following on performance of a simple VCR system: **07**

(i) Drop in evaporator pressure

(ii) Suction vapour superheat.

OR

(b) Explain the principle and operation of vapour compression based refrigeration system. Draw P-h, T-s and h-s phase diagrams of a simple vapour compression cycle showing state points. Write down expressions for refrigeration effect, compressor power, condenser heat rejection and expansion process. If the liquid refrigerant exiting the condenser is sub-cooled, what will be its effect on volumetric efficiency and COP of the system? **07**

Q.3 **(a)** Explain fan characteristics with an appropriate graphical representation. Demonstrate that the equation for fan power "$W = k \rho D^5 N^3$" is dimensionally consistent, where k is a numerical constant. A fan running at 780 RPM consumes 75W power and delivers 15 m^3/m air at 114 Pa static pressure. If the fan speed is tripled, calculate **07**

(i) The power required.

(ii) Static pressure.

(iii) Air flow rate.

(b) Explain the following briefly: **07**

(i) Centrifugal dust collectors

(ii) Room thermostat

(iii) Automatic humidity controller

(iv) Time switches.

(v) Air washer

(vi) Aspect ratio

(vii) Radiator

OR

Q.3 **(a)** State fan laws. A fan driven by an 82% efficient constant speed motor delivers 6.5 m^3/s of air against a static head of 76 mm WC at a location where the specific gravity of air is 0.96. The same fan is operating at a location where the specific gravity of the air is 1.12. Determine **07**

(i) Air flow rate.

(ii) Static head in mm WC

(iii) Motor shaft power.

(b) Discuss the following briefly: **07**

(i) Types of supply air outlets used in air-conditioning

(ii) Viscous air filters (iii) Humidistat

(iv)Slot Diffusers (v) Solenoid valves

(vi) Axial flow fans (vii) Limit Switches

Q.4 **(a)** Classify different types of cold storages used in Food Industry. Explain in detail the immersion freezing technique with the help of a neat diagram. Also state its advantages and disadvantages. **07**

(b) Hundred tones of freshly harvested vegetables are to be cooled from 28 ^{0}C and 8 ^{0}C in 24 hours in a cold storage. The average heat of respiration of vegetables is 800 kcal per 24 hours. Five men will work for 5 hours within the cold store and lighting load is estimated to be 150 Watt. The Cold storage inner dimensions are 8m X 8m X 5m. The walls are constructed of bricks and cement mortar. The wall thickness is 42 cm and there is 12 cm thick PUF insulation on the inside of the four walls. The cement plaster is 1.2 cm thick. The heat transfer coefficient for the ceiling is 15% more than that of the walls. The outside temperature is 37 ^{0}C and the inside is maintained at 2 ^{0}C. Calculate the refrigeration capacity required in TR. **07**

The following data are given:

Rate of respiration for one man = 160 kcal/h
Air infiltration load = 1200 kcal/24 hours.
Specific heat of vegetables = 0.85 kcal/kg ^{0}C
Thermal conductivity of brick = 0.44 kcal h^{-1} m^{-1}.$^0C^{-1}$
Thermal conductivity of PUF = 0.025 kcal h^{-1}.m^{-1}.$^0C^{-1}$
Thermal conductivity of cement plaster = 0.24 kcal h^{-1} m^{-1} $^0C^{-1}$

Assume any other suitable consideration and ignore heat transfer through the floors.

OR

Q.4 **(a)** Define and differentiate between freezing, refrigeration and chilling. What is IQF? Draw a typical freezing curve for foods and explain the thermal path followed. **07**

(b) What is cold storage? Explain the different components of a cold storage and enumerate safety devices and their purpose. Define sensible heat and latent heat of food products? One tonne of an assorted food is first cooled from 37 ^{0}C to 8 ^{0}C and then further cooled and frozen to -20 ^{0}C. Calculate the total refrigeration load in TR. **07**

Freezing point of assorted food = -3 ^{0}C
Latent heat of fusion = 250 kJ/kg.
Specific heat of assorted food above freezing point = 3.6 kJ/kgK
Specific heat of assorted food below freezing point = 1.78 kJ/kgK.

Q.5 **(a)** Classify compressors. Differentiate between positive and non- positive displacement type compressors citing advantages and disadvantages of each with practical examples. **07**

(b) Explain Controlled atmosphere storage (CAS) and Modified atmosphere storage (MAS) giving examples from food industry. **07**

OR

Q.5 **(a)** Differentiate between: **07**

i. Evaporative condenser & water cooled condenser
ii. Flooded evaporator & Finned tube evaporator
iii. Thermostatic expansion valve & Capillary tube.
iv. Screw compressor and reciprocating compressor

(b) What are hermetically sealed compressors? State its advantages over open type compressors? Explain the principle of operation of thermostatic expansion valves in conventional refrigeration system. **07**

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