Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE – SEMESTER V • EXAMINATION – WINTER - 2012

Subject code: 151403 Date: 12-01-2013

Subject Name: Food Refrigeration and 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 R12 and R22?
(ii) Write performance indices for simple vapour compression system.
(iii) What are axial flow fans?
(iv) What is the function of expansion valve in VCS?
(v) Why is Carnot COP greater than actual COP in VCS?
(vi) Define I TON of refrigeration.
(vii) State the economic criteria for selecting refrigerants.

(b) Freshly harvested berries at 18ºC are loaded in 250 kg batches into containers for chilling and held for 12 h in a cold store operating at -2ºC. The cold store holds an average of 2.5 tonnes of food and measures 3 m high by 10 m x10 m. The walls and roof are insulated with 300 mm of polyurethane foam, and the floor is constructed from 450 mm of concrete. The ambient air temperature averages 15ºC and the soil temperature 9ºC. An operator spends an average of 45 min/day moving the containers in the store and switches on four 100 W lights when in the store. Each container weighs 50 kg. Determine whether a 10 kW refrigeration plant would be suitable for the cold store. Take a factor of safety = 2. **07**

[Additional data:
$k_{insulation}$ = 0.026 W/(m.K), $k_{concrete}$ = 0.87 W/(m.K), $C_{p(berries)}$ = 778 J/(kg.K), $C_{p(container)}$ = 480 J/(kg.K), the heat produced by the operator is 240 W, and the average heat of respiration of berries is 0.275 J/(kg.s)]

Q.2 **(a)** A simple vapour compression cycle operating on R-12 based refrigerant develops 20 TR refrigeration effect when set to operate at evaporating and condensing temperatures of – 5°C and 40°C respectively. Determine the following : **07**

(i) Mass flow of refrigerant in kg/s
(ii) Compressor piston displacement in liter per second.
(iii) Compressor power required in kW per TON of refrigeration.
(iv) Condenser heat rejection in kW.
(v) Carnot COP of the cycle.
(vi) Actual COP of the cycle.
(vii) Refrigeration efficiency in %.

R-12 Properties								
t (^oC)	h_g kJ/kg	h_f kJ/kg	s_g kJ/Kkg	s_f kJ/Kkg	v_g m^3/kg	v_f m^3/kg	C_P kJ/Kkg	P bar
- 5	349.32	195.39	1.557	0.983	0.0649	$0.707X10^{-3}$	0.635	2.6096
40	367.14	238.53	1.540	1.13	0.0181	$0.798X10^{-3}$	0.788	9.6065

(b) Explain the functions of different components of a simple vapour compression refrigeration system with the help of a neat flow diagram. Also draw P-h & T-s diagrams for the process indicating various state points. Why is it desirable to slightly superheat the vapours before it enters the compressor? **07**

OR

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

(i) Azetropes (ii) Safety criteria for refrigerants
(iii) Volumetric efficiency (iv) Liquid sub-cooling
(v) Cryogenic fluids (vi) Compression ratio
(vii) Green house effect

Q.3 **(a)** List different types of air filters used in air conditioning systems. With the help of neat diagrams explain the construction and working of **04**
(i) Electronic air filters (ii) Centrifugal dust collectors

(b) State fan laws with the help of 'Pressure Versus Flow' diagram. For a fixed fan, calculate the percentage increase in volume flow rate and power consumption if the fan speed is doubled. **05**

(c) What are the basic sensing elements used for measurement of temperature, pressure and humidity in air-conditioning systems. With the help of a schematic layout diagram explain operation of an automatic temperature control device indicating feedback, amplifier, sensor, comparator, actuator indicator, controller etc. **05**

OR

Q.3 **(a)** An industrial air-filtration system receives dust laden air from a milk powder production factory having a dust loading of 2.5 kg per 100 m^3 of air. The exhaust air has a dust loading of 250 g per 100 m^3 of air. Calculate the weight of dust collected by the filter in 24 hours if the air-filtration system handles 350 m^3 per minute of air. What is the filtration efficiency of the system? **04**

(b) With the help of neat and labeled diagrams explain the construction and working of the following: **05**
(i) Air Washer.
(ii) Solenoid valve

(c) Write brief notes on the following: **05**
(i) Limit Switches

(ii) Air handling units
(iii) Induction or entrainment ratio
(iv) Aspect ratio

Q.4 **(a)** Name the different components of a vapour absorption refrigeration (VAR) system that replaces the compressor of a vapour compressor refrigeration system and state their respective functions. Explain the function of hydrogen gas in Electrolux refrigeration system, with help of a labeled diagram. **07**

(b) What do you mean by a hermetically sealed compressor? Briefly explain the construction and working of a screw compressor. **07**

OR

Q.4 **(a)** Briefly explain Individual quick freezing (IQF) of peas. **07**
1000 kg of lean poultry is first cooled from 30 to 4 ^{0}C, thereafter it is cooled and frozen to -18 ^{0}C. Calculate the total heat load.
[Additional data: Freezing point of poultry is -2.8 ^{0}C and latent heat of fusion is 246.8 kJ/kg. Specific heat of poultry above and below freezing point is 3.21 kJ/kg.^{0}C and 1.71 kJ/kg.^{0}C respectively]

(b) Classify different types of condenser and briefly explain the principle, construction and working of an air cooled condenser. **07**

Q.5 **(a)** Explain the construction and working of a simple ammonia-water absorption refrigeration system with neat sketch. **07**

(b) What are the various sources of cooling loads that are taken into consideration in a cold storage? Briefly explain different types of safety devices used in a cold storage with their proper location and function. **07**

OR

Q.5 **(a)** What do you mean by cascade refrigeration? Draw the schematic representation and P-h diagram for a two stage cascade system. **07**

(b) In an absorption type refrigeration system, heating, cooling, and refrigeration take place in the temperature of 110^{o}C, 10^{o}C and-10^{o}C. Find the theoretical COP of the system. If the heating temperature is increased to 150^{o}C and the refrigeration temperature is decreased to -30^{o}C. Find the percentage change in COP. **04**

(c) It is proposed to design a cold storage for maintaining certain vegetables under frozen conditions at -18^{o}C. The ambient temperature in summer 40^{o}C and the estimated energy transfer as heat into the cold storage through doors walls and roof is 5 kJ/s. Determine the actual power required to operate a refrigeration plant for maintaining the cold storage if the refrigeration efficiency is 90%. **03**

****