Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–V EXAMINATION – WINTER 2015

Subject Code: 151403 **Date:17/12/2015**

Subject Name: Food Refrigeration and Air Conditioning

Time: 10:30am to 1:00pm **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. Define 1TON of refrigeration and show that 1TR = 3.5167 kW
ii. What are safety criteria for selecting refrigerants?
iii. Differentiate between rotary & reciprocating compressors.
iv. Determine "R" designations for C_2H_6 and CCl_2F_2.
v. What is the function of condenser in VCS?
vi. Why is Carnot COP greater than actual COP in VCS?
vii. What are axial flow fans?

(b) Explain the working of vapour absorption refrigeration system with the help of a neat diagram. In a vapour absorption system, heating, cooling and refrigeration takes place at temperatures of 105^0C, 25^0C & -35^0C respectively. Calculate the maximum theoretical COP of the system. **07**

Q.2 (a) A 50 TON simple vapour compression system based on R134a is operating at evaporating and condensing temperatures of -15°C and 35°C respectively. The COP of the system is 4.2. Calculate the following: **07**

(i) Mass flow rate of the refrigerant in kg/s.
(ii) Compressor power requirement in HP.
(iii) Condenser heat rejection in kW
(iv) Quality of refrigerant entering evaporator.
(v) Carnot COP
(vi) Refrigeration efficiency in %
(vii) Heat rejection ratio

Properties of R134a			
Temperature °C	Absolute Pressure, bar	h_f (kJ/kg)	h_g (kJ/kg)
- 15 °C	1.6	180	390
35 °C	9.2	250	418

(b) How does the working of an actual refrigerator differ from a Carnot refrigerator? A Carnot heat engine is coupled to a Carnot refrigeration system such that the total heat rejected to a common reservoir is 3000 kW. The Carnot heat engine operates from a source maintained at 1527 ^{o}C taking 2100 kJ/s of heat from it. The work output generated by this engine is driving a Carnot refrigerator whose source temperature is – 77 ^{o}C. Represent such a coupling by means of a block diagram indicating various streams of heat flow and energy balance. Determine the temperature of the common reservoir. Comment on the feasibility of such a coupling in actual practice. **07**

OR

(b) Explain the functions of different components of a simple vapour compression refrigeration system with the help of a neat flow diagram. Also draw T-s diagram for the vapour compression cycle indicating various state points. Why is it desirable to slightly superheat the vapours before it enters the compressor? If the condensed refrigerant liquid exiting the condenser is slightly sub-cooled, how will it affect the volumetric efficiency and COP of the system? **07**

Q.3 **(a)** Explain the following: **07**

(i) Fan laws
(ii) Static pressure
(iii) Centrifugal fans
(iv) Solenoid valves

For a given fan, calculate the percent increase in volume flow rate and power consumption if the fan speed is increased by 50%.

(b) Answer the following: **07**

(i) State essential requirements of good room air distribution and control for a cold room.
(ii) Name different types of supply air outlets used in air-conditioning.
(iii) What is aspect ratio?
(iv) What are air washers?

An air-filtration system receives dusty air from a plant having a dust loading of 0.003 kg/m^3 of air. The exhaust air has a dust loading of 0.250 g/m^3 of air. Calculate the weight of dust collected by the filter in 8 hours if the air-filtration system handles 400 m^3/minute of air. What is the filtration efficiency of the system?

OR

Q.3 **(a)** Explain fan characteristics with the help of a neat diagram. How can we improve fan efficiency? A centrifugal fan running at 920 RPM consumes 840W power and delivers 102 cmm of air at 101 kPa static pressure. If the fan speed is doubled, calculate **07**

(i) The power required.
(ii) Static pressure in Pa.
(iii) Air flow rate in cmm.

(b) Explain the working of the following: **07**

i. Centrifugal dust collectors
ii. Room thermostat
iii. Automatic humidity controller
iv. Time switches
v. Slot Diffusers
vi. Humidistat
vii. Limit switches

Q.4 **(a)** Explain the function of following refrigeration system controls: **07**

(i) Low pressure cut out
(ii) High pressure cut out
(iii) Water regulating valve
(iv) Relays
(v) Liquid-line solenoid valve
(vi) Time switches
(vii) Thermostat

(b) Classify different types of compressors and briefly explain the construction and working principle of a screw compressor. **07**

OR

Q.4 **(a)** Explain different components of a cold storage and name the safety devices and their purpose. Calculate the refrigeration load in tons of refrigeration which is required to compensate the heat loss from the four side walls of a cold room measuring 2.5 m × 3.0 m × 3.0 m. The walls of the cold room are made of 25 cm brick, 25 cm block board and 1cm cement. The inside wall temperature is -20°C and outside wall temperature is 27°C. [Consider a safety factor of '2.5' for losses through joints etc. The thermal conductivities of brick, block board and cement plaster are 0.66 W/m°C, 0.05 W/m°C and 0.88 W/m°C respectively. **07**

(b) What are hermetically sealed compressors? State its advantages over open type compressors? Explain the working of centrifugal compressor with a neat sketch. **07**

Q.5 **(a)** Explain the working of evaporative condensers. An air-cooled condenser is sized to reject 15 kW heat at a condensing temperature of 50°C when the maximum outdoor temperature is 35°C. What will be the approximate condensing temperature when the outdoor temperature is at 15°C and the load is reduced to 8 kW? **07**

(b) What is IQF? Explain in detail the immersion freezing technique with the help of a neat diagram. Also state its advantages and limiting factors. **07**

OR

Q.5 **(a)** Classify different types of evaporators and briefly explain the principle, construction and working of a shell and tube type evaporator. **07**

(b) Discuss the advantages of low temperature storage of foods. Define and differentiate between freezing, deep freezing, refrigeration, cooling, air-conditioning and chilling. Draw a typical freezing curve for foods and explain it. **07**

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