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

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VI (NEW) - EXAMINATION – SUMMER 2016

Subject Code:2161406 **Date:13/05/2016**

Subject Name: Food Refrigeration & Air - Conditioning

Time: 10:30 AM to 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) What is the function of expansion valve in simple VCR system?
(ii) Define 1TR and show that 1TR =3.5157 kW
(iii) State the safety criteria for refrigerant selection
(iv) What is green house effect?
(v) Why CFC/HCFC are harmful for our environment?
(vi) Give R designation of $C_2Cl_3F_3$
(vii) What are azeotropes?

(b) Draw P-h & T-s phase diagrams for the operation of a simple vapour compression cycle indicating various state points. Using these diagrams write an expression for COP of the cycle. Explain the effect of the following factors on the performance of vapour compression cycle: **07**

(i) Condenser temperature
(ii) Suction vapour superheating

Q.2 (a) A R134a based simple vapour compression refrigeration system is operating on the following conditions: **07**

Refrigeration capacity = 100 TR,
Evaporating temperature = - 10 ^oC
Condensing temperature = 40 ^oC,
Compressor discharge temperature = 44 ^oC
Average specific heat of superheated vapours = 1.15 kJ/kgK,
COP of the system = 4.0
Calculate the following:
(i) Mass flow rate of the refrigerant.
(ii) Compressor power requirement..
(iii) Dryness fraction of refrigerant entering the evaporator.
(iv) Heat rejection ratio.
(v) Carnot COP of the system.
(vi) Refrigeration efficiency in %
(vii) Enthalpy of refrigerant exiting the expansion valve in kJ.

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
- 10	393	187	1.733	0.95	0.10	1326	0.842	2
40	420	256	1.712	1.19	0.0199	1147	1.12	10
44	422	262	1.70	1.2	0.018	1129	1.156	11.3

(b) State the principle of operation of VAR systems. Explain the simple VAR system based on NH_3 – Water with the help of a neat flow diagram. **07**

OR

(b) State the advantages and limitations of VAR system over VCR systems. Explain the construction and working of simple VAR system based on LiBr –Water with the help of a neat flow diagram. **07**

Q.3 **(a)** Explain the construction and working of "Domestic Electrolux Refrigerator" with the help of a neat flow diagram. In a VARS, heating cooling and refrigeration take place at 97 ^{o}C, 27 ^{o}C and – 3 ^{o}C respectively. Calculate the maximum COP of the system. **07**

(b) Give a classification of refrigerant compressors and write notes on the following: **07**
(i) Hermatic compressors
(ii) Screw compressors
(iii) Scroll compressors

OR

Q.3 **(a)** What is cascade refrigeration system? Explain the operation of a two stage cascade refrigeration system with the help of a neat flow diagram and draw its P-h diagram. Write expression for COP of a 2-stage cascade system in terms of COP's of the coupled systems. **07**

(b) Draw a schematic diagram of a reciprocating compressor and explain its operation with the help of actual P-V diagram. Calculate the volumetric efficiency of a single acting reciprocating compressor using the following given data: **07**
Swept volume = 0.01 m^3
Clearance Volume = 0.0005 m^3
Pressure ratio= 6
Index of polytropic compression = 1.3

Q.4 **(a)** Classify refrigerant condensers and explain the construction and operation of an evaporative condenser with a neat flow diagram. **07**

(b) Enumerate different types of expansion devices used in VCR systems and explain the principle and operation of thermostatic expansion valve with a neat diagram. **04**

(c) A fan running at 720 RPM delivers 10 cmm of air developing a static pressure of 15 MM of WC and consumes $\frac{1}{12}$ HP. If the fan speed is doubled, calculate **03**
(i) Air flow rate
(ii) Static pressure
(iii) Power consumption

OR

Q.4 **(a)** Compare air-cooled and water-cooled condensers. What are cooling towers? With the help of a neat diagram explain the construction and working of a forced draft cooling tower. **07**

(b) Classify refrigerant evaporators and explain the construction and working of flooded evaporator with a neat flow diagram. **04**

(c) For a fixed fan calculate the percentage increase in air flow rate and power consumption if fan speed is increased by 75%. **03**

Q.5 **(a)** Write brief notes on the following supported by diagrams if needed: **07**

(i) FAN laws
(ii) Solenoid valve
(iii) Limit switches
(iv) Electronic air filter
(v) Air washer
(vi) Membrane type humidistat
(vii) Type of supply air outlets

(b) Classify cold storages and explain in detail the fundamental design considerations of a cold storage plant suitable for fruits and vegetables. What is IQF? **07**

OR

Q.5 **(a)** A pre-cooling room of size 40m x 20m x 4m is to pre-cool 1000 tones of fresh vegetables from an initial temperature of 35 ^{o}C to 20 ^{o}C in 18 hours. The outside air is at 35 ^{o}C and 50% RH. The floor and roof are exposed to unconditioned ambient space. Additional data available is: **07**

A. U for walls, floor and roof = 2 W/m^2 K
B. Lighting load = 4000 W
C. No. of persons working inside the cold room for 24 hours =25
D. Heat gain per person = 200 W
E. Sp. Heat of vegetables = 4 kJ/kgK
F. Density of air = 1.18 kg/m^3
G. No. of air changes per 24 hour = 16
H. Chilling factor = 0.85
I. Inside and outside air enthalpy = 94 kJ/kg and 45 kJ/kg respectively.

Design the cold room on 24 hour operation basis. Assume any other data if needed and clearly mention it.

(b) Write brief notes on the following supported by diagrams if required: **07**

(i) Radiators
(ii) Criteria for fan selection
(iii) Sensing elements for temperature measurement
(iv) Room air distribution requirements
(v) Aspect ratio
(vi) Induction ratio
(vii) Types of fans and blowers.

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