Seat No.: _____ Enrolment No.

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VI (NEW) EXAMINATION – WINTER 2018

Subject Code:2161406 **Date:30/11/2018**

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: **03**

(i) How is leakage of halocarbons detected?

(ii) How do CFC's deplete the ozone layer of stratosphere?

(iii) Give safety criteria for selection of refrigerants.

(b) Answer the following: **04**

(i) Work out the R-designation of C_2H_6.

(ii) What are azeotropes? Give examples.

(iii) Two metric tons of water at 0 ^oC is converted to ice at 0 ^oC in 12 hours. Calculate the refrigeration capacity in TR. [C_{pw} = 4.2 kJ/kgK]

(iv) What is 'Green House Effect'?

(c) A cold storage of 10 TR capacity based on simple VCR system of is operating on the following conditions: **07**

Evaporating temperature = - 10 ^oC, Condensing temperature = 36 ^oC

Compressor discharge temperature = 40 ^oC

Avg. Specific heat of superheated vapours = 1.12 kJ/kgK

COP of the system = 4.0

Calculate the following:

i. Mass flow rate of the refrigerant in kg/s.
ii. Compressor power requirement in kW.
iii. Quality of refrigerant entering the evaporator.
iv. Heat rejected at Condenser in kW
v. Carnot COP of the system.
vi. Refrigeration efficiency in %
vii. If ηvol= 90%, calculate actual piston displacement in m^3.

t (^oC)	h_g kJ/kg	h_f kJ/kg	v_g m^3/kg	ρ_f kg/ m^3	C_{Pv} kJ/Kkg
- 10	382	183	0.11	1330	0.84
36	412	250	0.023	1160	1.12
40	420	260	0.019	1140	1.15

Q.2 **(a)** A heat pump based on simple VCRS of 200 kW heating capacity working between evaporating and condensing temperatures of – 10 ^oC and 30 ^oC respectively has COP of 4.5. If the enthalpy of saturated vapours entering the compressor is 400 kJ/kg and the enthalpy of liquid refrigerant entering the expansion valve is 250 kJ/kg, calculate **03**

(i) Compressor power in kW

(ii) Heat rejection ratio (HRR)

(iii) Refrigeration efficiency

(b) In a vapour absorption type refrigeration system, heating, cooling and refrigeration takes place at temperatures of 100°C, 20°C and -10°C respectively. **04**

(i) Find the theoretical COP of the system.

(ii) If the heating temperature is increased to 180°C and the refrigeration temperature is decreased to -30°C, find the percent change in the COP.

(c) Explain the operation of simple VCRS with the help of P-h & T-s diagrams. Explain the effect of the following on the performance of vapour compression cycle: **07**

(i) Liquid sub-cooling

(ii) Compressor volumetric efficiency

(iii) Reduction in suction temperature.

OR

(c) 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)** Define cascade refrigeration system. For a 2-stage cascade refrigeration system, the COP of low and high cascade sides are 1.5 and 4.5 respectively. Calculate the COP of the system. **03**

(b) In an absorption type refrigerator heat is supplied to generator by condensing saturated steam at 2 bar. Calculate the maximum COP possible of the system if the temperature to be maintained inside the refrigerator is – 5 ^{o}C. The atmospheric temperature is 32^{o}C. If the refrigeration load is 5 TR and the actual COP is 90% of maximum COP, calculate the mass of steam required per hour. Assume that only latent heat of condensation of steam is used for heating purpose. Given: Saturation temperature of steam at 2 bar = 120 ^{o}C; h_{fg} = 2230 kJ/kg **04**

(c) Explain the construction and working of simple VAR system based on LiBr –Water. **07**

OR

Q.3 **(a)** Explain the operation and applications of of a 2- stage cascade refrigeration system with a p-h diagram. **03**

(b) "An ideal vapour absorption refrigeration system may be considered as a heat-operated refrigerating machine combining a heat engine and a mechanical refrigerator working together to produce the desired refrigeration effect". Justify the statement with help of schematic diagram and mathematical relations. **04**

(c) Draw a neat diagram of NH_3–Water based practical VARS. Explain the function of various components of this cycle and derive an expression for maximum COP. **07**

Q.4 **(a)** Define 'Draft', 'Blow' and 'Throw' as related to air flow with the help of a neat diagram. **03**

(b) Answer the following: **04**

i. Briefly describe types of supply air outlets in air conditioning.

ii. State important considerations while choosing a fan.

(c) Classify condensers and give the criteria for their selection. A water-cooled condenser is sized to reject 50 kW heat at a condensing temperature of 40°C when the maximum outdoor temperature is 36°C. What will be the approximate condensing temperature **07**

when the outdoor temperature is at 18°C and the load is reduced to 20 kW?

OR

Q.4 **(a)** State fan laws Give measures to improve fan efficiency? A centrifugal fan running at 960 RPM consumes 880W power and delivers 105 cmm of air at 1 atm static pressure. If the fan speed is doubled, calculate **03**
(i) The power required. (ii)Air flow rate in m^3/minute

(b) 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 0.255 g/m^3 of air. Calculate the weight of dust collected by the filter in 10 hours if the air-filtration system handles 500 m^3/minute of air. What is the filtration efficiency of the system? **04**

(c) Explain the principle and working of any one : **07**
(i) Flooded type evaporator with a neat diagram.
(ii) Evaporative condensers

Q.5 **(a)** What are cooling towers? Explain its operation with a neat diagram. **03**

(b) Give the classification of compressors. Explain hermetic compressor. **04**

(c) Define cooling, freezing, refrigeration and chilling. Calculate the refrigeration load expressed in TR which balances the heat loss from the four side walls of a small cold room 3 m × 3.0 m × 2.5 m. The walls are made of 24 cm brickwork, 25 cm hard board and 1.32cm cement. The inside wall temperature is -15°C and outside wall temperature is 30°C. Consider a safety factor of 2 for losses through joints etc. The thermal conductivities of brick, board and cement plaster are 0.62 W/m°C, 0.05 W/m°C and 0.82 W/m°C respectively. **07**

OR

Q.5 **(a)** Explain the following in brief: (i) TEV (ii) IQF **03**

(b) Write brief notes on the following with figures if required: **04**
i. Axial flow fans
ii. Time switches
iii. Automatic humidity control
iv. Types of temperature sensors

(c) Discuss the need for low temperature storage of foods. Give the basic design criteria for cold stores and list basic components of a cold storage plant including safety equipment. What is the need for an 'Ante Room'? **07**

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