Seat No.: _____ Enrolment No.

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER– VI (New) EXAMINATION – WINTER 2019

Subject Code: 2161406 **Date: 11/12/2019**

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) Give main technical criteria for selection of refrigerants based on safety.

(ii) Give measures to prevent Ozone layer depletion.

(iii) How leakage of refrigerants is detected?

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

) Give R designation of NH_3.

i) What is the function of TEV in VCRS?

ii)Show that 10TR = 35.167 kW

v)What are radial flow fans?

(c) Explain the construction and operation of simple Ammonia – Water VAR system. Justify the statement mathematically. In a given vapour absorption system, heating, cooling and refrigeration take place at temperatures of 107^0C, 26^0C & - 30^0C respectively. Calculate the maximum theoretical COP of the system. **07**

Q.2 **(a)** A 100 TR simple vapour compression refrigeration system is operating between evaporating and condensing temperatures of -20°C and 40 °C respectively. Calculate the following: **03**

i. Compressor discharge enthalpy in kJ

ii. Compressor power required per TON of refrigeration.

Properties of Refrigerant							
t (°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)
-20	1.5	181	342.7	0.93	1.56	$0.68x10^{-3}$	0.108
40	9.6	238.5	367	1.13	1.5	$0.789x10^{-3}$	0.0182

Given: Specific heat of refrigerant vapours in the superheated region C_{pv} = 0.65 kJ/kg K

(b) Explain the thermodynamic criteria for selection of refrigerants. A simple vapour compression refrigeration system is operating on the following conditions: **04**

Refrigeration capacity = 50 TR, Evaporating temperature = - 2 °C

Condensing temperature = 42 °C, Compressor discharge temperature = 48 °C,

COP of the system = 4, Calculate the following:

i. Compressor power requirement in kW.

ii. Heat rejection ratio.

iii. Carnot COP of the system.

iv. Refrigeration efficiency in %

(c) Explain VCRS with the help of P-h diagram. A Carnot heat engine is coupled to a Carnot refrigeration system such that the total heat rejected to a common reservoir is 3200 kW. The Carnot heat engine operates from a source maintained at 1500 °C taking 2400 kW of heat from it. The work output generated by this engine is driving a Carnot refrigerator whose source temperature is – 37 °C. Determine the temperature of the common reservoir. **07**

OR

(c) Explain the operation of simple VCR system with the help of T-s diagram. Write down mathematical expressions for refrigeration effect, compressor power, condenser heat rejection and throttling process in terms of known quantities. Explain the effect of the following on the performance of simple vapour compression cycle: **07**

i. Increase in condenser temperature.
ii. Reduction in suction temperature.
iii. Compressor pressure ratio.

Q.3 **(a)** An axial fan running at 840 RPM, consuming 0.15HP delivers 18 m^3/minute air developing 100 Pa static pressure. If the fan speed is doubled, calculate the following: **03**

i. The power required in HP
ii. Static pressure in mm WC
iii. Air flow rate in m^3/minute

(b) Explain the operation of a simple cascade refrigeration system with the help of a schematic diagram and draw its P-h diagram. Write expression for COP of a 2-stage cascade system. **04**

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

i. Time switches
ii. Laws of air movement
iii. RTD sensors
iv. Registers
v. Aspect ratio
vi. Draft
vii. Types of supply air outlets

OR

Q.3 **(a)** State fan laws. For a given fan, calculate the percent increase in volume flow rate and power consumption if the fan speed is increased by 35%. **03**

(b) Explain (a) Induction ratio (b) COP (c) Green house effect (d) Ante room **04**

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

i. Humidistat
ii. Air curtains
iii. Air washers
iv. Thermostats
v. Diffusers
vi. Capillary tubes
vii. HP/LP cut outs

Q.4 **(a)** Explain the operation and application of solenoid valves. **03**

(b) Classify different types of compressors and briefly explain the construction, working principle and advantages of Hermetic compressors. **04**

(c) Classify cold storage systems. Give fundamental design considerations and detailed technical guidelines for a general purpose cold store. **07**

OR

Q.4 **(a)** Explain the following briefly: **03**

i. IQF
ii. Cold chain

(b) Prove that the volumetric efficiency of a single acting reciprocating compressor is given by $\eta_{vol} = 1 + c - c\left(\frac{P_d}{P_e}\right)^{1/n}$. A single acting single stage reciprocating compressor has a bore to stroke ratio of 2:3. It receives refrigerant at 1.2 bar and delivers it at 6 bar. Calculate the power required to drive the compressor in kW and the volumetric efficiency. Take c = 5% and n = 1.33 **04**

(c) Explain cooling, freezing, refrigeration and chilling with examples. 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 × 2.0 m. The walls are made of 24 cm brickwork, 20 cm hard board and 1.5 cm cement. The inside wall temperature is -20°C and outside wall temperature is 37°C. Consider a safety factor of '2' for losses through joints etc. The thermal conductivities of brick, board and cement plaster are 0.6 W/m°C, 0.04 W/m°C and 0.80 W/m°C respectively. **07**

Q.5 **(a)** Give general rules for air flow duct design for air-conditioning systems. Name materials of duct construction that are suitable for food processing plants? **03**

(b) What are the selection criteria of condensers for refrigeration application? Explain the construction and operation of a shell and tube condenser. **04**

(c) What is the function of refrigerant evaporators? Classify refrigerant evaporators and explain the construction and working of flooded evaporator. **07**

OR

Q.5 **(a)** Cold air enters a duct of 80 cm diameter at 12 m/s and leaves at 8 m/s downstream. Calculate the exit diameter of the duct and the velocity head at the exit of the duct in mm of WC. Assume no losses. **03**

(b) Explain operation of a forced draft cooling tower with a neat diagram. **04**

(c) Explain the principle and operation of thermostatic expansion valve with a neat diagram.. Why is TEV a preferred choice as an expansion device? **07**