Total No. of Questions: 6 *Total No. of Printed Pages:3*

Enrollment No.....

Faculty of Engineering

End Sem Examination May-2024

ME3CO37 Refrigeration & Air Conditioning

Programme: B.Tech. Branch/Specialisation: ME

Duration: 3 Hrs. **Maximum Marks: 60**

Note: All questions are compulsory. Internal choices, if any, are indicated. Answers of Q.1 (MCQs) should be written in full instead of only a, b, c or d. Assume suitable data if necessary. Notations and symbols have their usual meaning. Use of Refrigerant Table & Psychrometric Chart is permitted.

Q.1 i. What is refrigeration? **1**

(a) Refrigeration is the process of removing heat from a substance and cooling it to a temperature or below the actual temperature

(b) Refrigeration is the process of adding heat from a substance and cooling it to a temperature

(c) Refrigeration is used to increase the level of humidity in the air by adding heat

(d) None of these

ii. Which of the following is the common application of air standard refrigeration system? **1**

(a) Cold storage (b) Car air conditioning system

(c) Domestic refrigerators (d) Aircraft air conditioning

iii. In any compression refrigeration system there are how many pressure conditions? **1**

(a) 1 (b) 2 (c) 3 (d) 4

iv. In a refrigeration cycle, in which of the following heat absorption takes place? **1**

(a) Evaporator (b) Condenser

(c) Expansion valve (d) Compressor

v. Which of the following is correct about VARS and VCRS? **1**

(a) VARS use mechanical energy, and VCRS use heat energy

(b) VARS use heat energy, and VCRS use mechanical energy

(c) Both use mechanical energy

(d) Both use heat energy

P.T.O.

vi. The compressor from VCRS is replaced by which of the following in the VARS? **1**
(a) Absorber, pump
(b) Generator, pressure reducing valve
(c) Absorber, pump, generator, and pressure reducing valve
(d) Absorber, rectifier, generator, and pressure reducing valve

vii. What do vertical and uniformly spaced lines indicate on the psychrometric chart? **1**
(a) DPT (b) WBT
(c) DBT (d) Specific humidity

viii. Relative humidity is represented as _____. **1**
(a) m_v / m_a (b) m_a / m_v
(c) p_s / p_v (d) m_v / m_s

ix. Which of the following types of filters used in the air conditioning system is made of cloth that is discarded on getting dirty? **1**
(a) Viscous type filters
(b) Dry filter
(c) Spray washers
(d) Electric precipitators

x. If the direction of the wind is at 90° to one of the faces, positive pressure will be produced on _____. **1**
(a) Windward face (b) Leeward face
(c) Two windward faces (d) Two leeward faces

Q.2 i. Define the unit of refrigeration. **2**
ii. Explain any two methods of producing low temperature. **3**
iii. Derive the expression for COP of reverse Carnot cycle. **5**
OR iv. Derive the expression for COP of reverse Brayton cycle. **5**

Q.3 i. Explain any two desirable properties of refrigerants. **2**
ii. Explain the working of simple VCRS with superheated vapor at the end of compression with system diagram and p-h diagram, also derive the expression for its COP. **8**
OR iii. A simple VCRS based on refrigerant R 134 a operates between -25 °C and 50 °C. Assuming isentropic compression find the following: **8**
(a) COP of the system (b) Work input to the compressor
(c) Area of superheat horn (d) Throttling losses

Q.4 i. What is flash tank? Explain with diagram. **4**
ii. Explain the working of two Stage VCRS with flash intercooling using system & pressure enthalpy diagram. **6**
OR iii. Explain the working of practical VARS with diagram. **6**

Q.5 i. Explain comfort chart. **4**
ii. Explain cooling & dehumidification process with diagram. **6**
OR iii. Define: **6**
(a) Relative humidity
(b) Saturated vapour pressure
(c) Dry bulb temperature

Q.6 Attempt any two:
i. Explain the working of basic summer air conditioning system. **5**
ii. Explain the process of calculation of winter air conditioning load. **5**
iii. Explain RSHF & GSHF. **5**

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Marking Scheme
Refrigeration & Air Conditioning (T) -ME3CO37 (T)

Q.1	i.	A		**1**
	ii.	D		**1**
	iii.	B		**1**
	iv.	A		**1**
	v.	B		**1**
	vi.	C		**1**
	vii.	C		**1**
	viii.	C		**1**
	ix.	B		**1**
	x.	A		**1**

Q.2	i.	Definition of TR	1 Mark
		Value of TR	1 Mark
	ii.	Each one method	(1.5 Mark*2)
	iii.	PV & T-S diagram	2 Marks
		Derivation for COP	3 Marks
OR	iv.	P-V ST-S diagram	2 Marks
		Derivation for COP	3 Marks
Q.3	i.	Each Properties	(1 Mark*2)
	ii.	Block diagram of VCRS	2 Marks
		Working of VCRS	2 Marks
		P-h diagram	1 Mark
		Expression for COP	3 Marks
OR	iii.	As given cs p-h & F-S diagram 2 Marks	
		(a) COP	1.5 Marks
		(b) work input	1.5 Marks
		© Area of superheat	1.5 Marks
		(d) Throttling losses	1.5 Marks
Q.4	i.	Definition of Hash tank	2 Marks
		Explanation with diagram	2 Marks
	ii.	Diagram of two stage VCR with flash interceding	2 Marks
		Ph diagram	2 Marks
		Working of system	2 Marks
OR	iii.	Diagram Practical VARS	2 Marks
		Working	2 Marks
		Parts and function	2 Marks
Q.5	i.	Definition and uses of comfort chart	(2 Marks*2)
	ii.	Definition of process	2 Marks
		Plot of process on psychometry chart	1 Mark
		Mathematical expression of process	3 Marks
OR	iii.	Define a) Relative humidity	2 Marks
		Saturated vapour pressure	2 Marks
		DBT	2 Marks
Q.6		Attempt any two:	
	i.	Block diagram of summer A/C	2 Marks
		Working of summer A/C	3 Marks
	ii.	What are winter A/C loads	2 Marks
		Explanation	3 Marks
	iii.	RSHF & Plot	2.5 Marks
		GSHF & Plot	2.5 Marks

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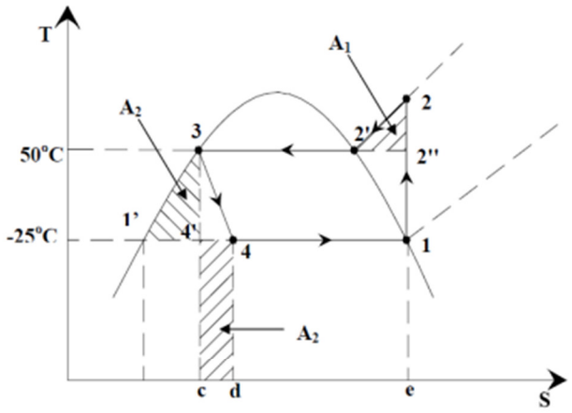

Using refrigerant R134a property data, required properties at various state points are:

State Point	T (°C)	P (bar)	h (kJ/kg)	s (kJ/kg.K)	Quality
1	-25.0	1.064	383.4	1.746	1.0
2	**60.7**	13.18	436.2	1.746	Superheated
3	50.0	13.18	271.6	1.237	0.0
4	-25.0	1.064	271.6	**1.295**	**0.4820**
1'	-25.0	1.064	167.2	**0.8746**	0.0
2'	50.0	13.18	423.4	1.707	**1.0**
2"	50.0	10.2	430.5	1.746	Superheated
4'	-25.0	1.064	257.1	1.237	0.4158

a) **COP = $(h_1-h_4)/(h_2-h_1)$ = 2.1174**

b) **Work input to compressor, $W_c = (h_2-h_1)$ = 52.8 kJ/kg**

NUMERICALS SOLUTION

Q.3 iii

c) Superheat horn area, area A_1:

Area A_1 = Area under 2-2' − Area under 2"-2'

Area under 2-2': Tds = (dh-vdP) = dh = $h_2-h_{2'}$ (dp = 0)

⇒ **Area under 2-2' =** $h_2-h_{2'}$ = 12.8 kJ/kg

Area under 2"-2' = Tds = Tc ($s_{2''}-s_{2'}$) = 12.6 kJ/kg

Superheat horn area = Area A_1 = (12.8 – 12.6) = 0.2 kJ/kg

d) Throttling loss, Area A_2 (assuming the saturated liquid line to coincide with isobar at condenser pressure):

Area A_2 = Area under 3-1'−Area under 4'-1' = $(h_3-h_{1'}) - T_e(s_3-s_{1'})$ ($s_3 = s_{4'}$)

Throttling area = (271.6–167.2) – 248.15(1.237–0.8746) = 14.47 kJ/kg

Alternatively:

Throttling area = Area under 4-4' = $T_e(s_4-s_{4'})$ = 248.15(1.295–1.237) = 14.4 kJ/kg

Check:

$W_{sss} = W_{Carnot}$+Area A_1+Area A_2

$W_{Carnot} = (T_c-T_e)(s_1-s_{4'})$ = 75(1.746-1.237) = 38.2 kJ/kg

W_{ccc} = 38.2+14.4+0.2 = 52.8 kJ/kg