

- Q.5 i. The moist air at 1 atm has 32 °C DBT and 26 °C WBT. Calculate: **4**  
 (a) Partial pressure of water vapour  
 (b) Dew point temperature  
 (c) Relative humidity  
 (d) Enthalpy of mixture
- ii. On a hot summer day, the ambient conditions are 40 °C DBT, 20% RH. A desert cooler is used to increase the RH to 80 %. Show the process on a psychrometric chart and by using it, calculate the temperature of exit air and minimum temperature to which the air can be cooled by a well-designed desert cooler. **6**
- OR iii. Using Dalton's law of partial pressure show that: **6**
- $$\text{Humidity Ratio} = 0.622 \frac{p_v}{p_t - p_v} = W$$
- Where  $p_t$  is total pressure of moist air and  $p_v$  is partial pressure of water vapour.
- Q.6 Attempt any two:
- i. Define central air-conditioning system and room sensible heat factor. How room sensible heat factor line is drawn on psychrometric chart? **5**
- ii. Draw a neat diagram of air-conditioning system for winter season. Explain the working of different components in the circuit. **5**
- iii. A small office hall of 25 persons capacity is provided with summer air conditioning system with the following data: **5**
- Outside conditions = 34 °C DBT and 28°C WBT  
 Inside conditions = 24 °C DBT and 50% RH  
 Volume of air supplied = 0.4 m<sup>3</sup>/min/person  
 Sensible heat load in room = 125600 kJ/h  
 Latent heat load in room = 42000 kJ/h  
 Determine the sensible heat factor of the plant.

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Enrollment No.....

**Faculty of Engineering**  
**End Sem (Even) Examination May-2022**  
**ME3CO16 Refrigeration & Air Conditioning**  
 Programme: B.Tech. Branch/Specialisation: ME

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

Note: 1. 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.  
 2. Use of Psychrometric chart is allowed.

- Q.1 i. The reduced ambient air-cooling system has: **1**  
 (a) One cooling turbine and one heat exchangers  
 (b) One cooling turbine and two heat exchangers  
 (c) Two cooling turbine and one heat exchangers  
 (d) Two cooling turbine and two heat exchangers
- ii. The ratio of heat extracted in the refrigerator to the work done on the refrigerant is called: **1**  
 (a) Relative coefficient of performance  
 (b) Coefficient of performance of refrigerator  
 (c) Coefficient of performance of heat pump  
 (d) Refrigerating efficiency
- iii. The process of undercooling is generally brought about by: **1**  
 (a) Circulating more quantity of cooling water through condenser  
 (b) Using colder water than the main circulating water  
 (c) Employing a heat exchanger  
 (d) Any one of these
- iv. In actual VCRS, the system performance is affected mainly by: **1**  
 (a) Pressure drop and heat transfer in suction line  
 (b) Pressure drop and heat transfer in discharge line  
 (c) Heat transfer in compressor  
 (d) All of these
- v. Absorption of the refrigerant by the absorbent in a vapour absorption refrigeration system is accompanied by: **1**  
 (a) Absorption of heat (b) Release of heat  
 (c) No thermal effects (d) Reduction in volume

[2]

- vi. Hydrogen is used in Electrolux refrigerator so as to \_\_\_\_\_ the vapour pressure ammonia in evaporator: **1**  
 (a) Equalise (b) Increase (c) Reduce (d) None of these
- vii. The process of cooling of air at same humidity ratio is known as: **1**  
 (a) Sensible heating (b) Sensible cooling  
 (c) Humidification (d) Dehumidification
- viii. The degree of saturation is defined as: **1**  
 (a) Mass of water vapour to mass of dry air in the mixture  
 (b) Ratio of actual mass of water vapour to mass of saturated vapour  
 (c) Ratio of actual humidity ratio to humidity ratio of saturated air  
 (d) None of these
- ix. In summer air-conditioning, the air is: **1**  
 (a) Cooled (b) Cooled and dehumidified  
 (c) Heated and humidified (d) Cooled and humidified
- x. In winter air-conditioning, the air is: **1**  
 (a) Heated (b) Heated and dehumidified  
 (c) Heated and humidified (d) Cooled and humidified
- Q.2 i. Discuss the advantages of the dense air refrigeration system and open-air refrigeration system. Also explain the term “tonne of refrigeration”. **4**
- ii. Air enters the compressor of an aircraft cooling system at 100 kPa and 283 K. Air is now compressed to 2.5 bar with an isentropic efficiency of 72 %. After being cooled to 320 K at constant pressure in a heat exchanger, the air then expands in a turbine to 1 bar with an isentropic efficiency of 75 %. The cooling load of the system is 3 tonnes of refrigeration. After absorbing heat at constant pressure, the air re-enters the compressor, which is driven by the turbine. Find the COP of the refrigerator, driving power required & air mass flow rate. **6**
- OR iii. A cold storage plant is required to store 20 tonnes of fish. The fish is supplied at a temperature of 30 °C. The specific heat of fish above freezing point is 2.93 kJ/kg K. The specific heat of fish below freezing point is 1.26 kJ/kg K. The fish is stored in a cold storage which is maintained at -8°C. The freezing point of the fish is -4 °C. The latent heat of fish is 235 kJ/kg. If the plant required 75 kW to drive it, Find the capacity of plant and time taken to achieve cooling. Assume actual C.O.P. of plant is 0.3 of Carnot C.O.P. **6**

[3]

- Q.3 i. What is sub-cooling and superheating? Explain with the help of diagram. **3**
- ii. A simple NH<sub>3</sub> vapour compression system has compressor with piston displacement of 2 m<sup>3</sup>/min, a condenser pressure of 12 bar and evaporator pressure of 2.5 bar. The liquid is sub-cooled to 20 °C by soldering the liquid line to suction line. The temperature of vapour leaving the compressor is 100 °C, heat rejected to compressor cooling water is 5000 kg/hour, and volumetric efficiency of compressor 80%. Compute: Capacity; Indicated power; and C.O.P. of the system. **7**
- OR iii. A simple ammonia-compression system operates with a capacity of 150 tonnes. The condensation temperature in the condenser is 35 °C. The evaporation temperature in brine cooler is -25 °C. The ammonia leaves the evaporator and enters the compressor at -8 °C. Ammonia enters the expansion valve at 30°C. If given conditions are as follows: Suction = 0.118 bar; Discharge = 0.23 bar; Compression index = 1.22; Volumetric efficiency = 75%. Then calculate: **7**
- (a) Power  
 (b) Heat transferred to cylinder water jacket  
 (c) Piston displacement  
 (d) Coefficient of performance
- Q.4 i. Explain the function of absorber, rectifier and analyser in an Absorption refrigeration system. **3**
- ii. Describe, with the help of a schematic and p-h diagram, the working of two stage compression system with water intercooler and liquid flash chamber. **7**
- OR iii. The following data refer to a 10 TR three stage compression system with water inter-cooling: **7**
- Evaporator pressure = 2.5 bar  
 Intermediate pressures = 5 bar and 10 bar  
 Condenser pressure = 15 bar
- Find the power required to drive the system and compare the C.O.P. of this system with that of simple saturation cycle working between same overall pressure limits.

P.T.O.

## Marking Scheme

### ME3CO16 Refrigeration & Air Conditioning

Q.1	i.	The reduced ambient air-cooling system has:	1
		(c) Two cooling turbine and one heat exchangers	
	ii.	The ratio of heat extracted in the refrigerator to the work done on the refrigerant is called:	1
		(b) Coefficient of performance of refrigerator	
	iii.	The process of undercooling is generally brought about by:	1
		(d) Any one of these	
	iv.	In actual VCRS, the system performance is affected mainly by:	1
		(a) Pressure drop and heat transfer in suction line	
	v.	Absorption of the refrigerant by the absorbent in a vapour absorption refrigeration system is accompanied by:	1
		(b) Release of heat	
	vi.	Hydrogen is used in Electrolux refrigerator so as to _____ the vapour pressure ammonia in evaporator:	1
		(c) Reduce	
	vii.	The process of cooling of air at same humidity ratio is known as:	1
		(b) Sensible cooling	
	viii.	The degree of saturation is defined as:	1
		(c) Ratio of actual humidity ratio to humidity ratio of saturated air	
	ix.	In summer air-conditioning, the air is:	1
		(b) Cooled and dehumidified	
	x.	In winter air-conditioning, the air is:	1
		(c) Heated and humidified	
Q.2	i.	Advantages of the dense air refrigeration system and open-air refrigeration system	4
		Tonne of refrigeration	3 marks
			1 mark
	ii.	Find the COP of the refrigerator - 0.293	2 marks
		Driving power required 0.573 kg/sec	2 marks
		Air mass flow rate 35.91 kW	2 marks
OR	iii.	Find the capacity of plant - 48 TR	3 marks
		Time taken to achieve cooling - 722 min.	3 marks
Q.3	i.	Sub-cooling and superheating	2 marks
		Diagram	1 mark
	ii.	Capacity -18 TR	3 marks

OR	iii.	Indicated power -12.38 kW	2 marks	7
		C.O.P. of the system – 5.1	2 marks	
		(a) Power - 148 kW	2 marks	
		(b) Heat transferred to cylinder water jacket – 3838kJ/min	2 marks	
		(c) Piston displacement – 30m <sup>3</sup> /min.	2 marks	
		(d) Coefficient of performance - 3.54	1 mark	
Q.4	i.	Function of absorber, rectifier and analyser in an Absorption refrigeration system	3	7
		As per the explanation		
	ii.	Schematic and p-h diagram,	2 marks	
		Working of two stage compression system with water intercooler and liquid flash chamber	3 marks	
		COP work done and power	2 marks	
	OR	iii.	Power required to drive the system - 8 kW	4 marks
			Compare the C.O.P. - % increase in COP – 6.96%	3 marks
				7
	Q.5	i.	(a) Partial pressure of water vapour - 0.03 bar	1 mark
			(b) Dew point temperature – 24.1 <sup>0</sup> C	1 mark
			(c) Relative humidity – 62.5 %	1 mark
			(d) Enthalpy of mixture – 80.55 kJ/kg	1 mark
	ii.		Calculate the temperature of exit air - 24.8 <sup>0</sup> C	3 marks
			Minimum temperature - 22 <sup>0</sup> C	3 marks
	OR	iii.	Using Dalton's law of partial pressure show that:	6
			As per the explanation	
	Q.6		Attempt any two:	
		i.	Definition of central air-conditioning system and room sensible heat factor	5
			Room sensible heat factor line is drawn on psychrometric chart	
		ii.	Diagram of air-conditioning system	3 marks
			Working of different components in the circuit	2 marks
		iii.	Determine the sensible heat factor of the plant.	5
			SH	1.5 marks
			LH	1.5 marks
			SHF	2 marks

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