

**REFRIGERATION & HVA
(MEC3131)**

Time Allotted : 2½ hrs

Full Marks : 60

Figures out of the right margin indicate full marks.

*Candidates are required to answer Group A and
any 4 (four) from Group B to E, taking one from each group.*

Candidates are required to give answer in their own words as far as practicable.

Group – A

1. Answer any twelve:

12 × 1 = 12

Choose the correct alternative for the following

- (i) The refrigerant R-744 stand for
(a) Ammonia (b) Carbon dioxide
(c) Methyl chloride (d) Sulphur dioxide
- (ii) 70000 kJ/h heat removal is equivalent to
(a) 2 tonnes of refrigeration (b) 5 tonnes of refrigeration
(c) 2.5 tonnes of refrigeration (d) 7 tonnes of refrigeration
- (iii) If the C.O.P of 2 TR ammonia-water absorption refrigeration plant is 0.5, then heat supplied in the generator is
(a) 1 Kw (b) 3.5 kW
(c) 7 kW (d) 14 kW
- (iv) In gas cycle refrigeration system, the throttle valve of a vapor compression refrigerant system is replaced by
(a) Capillary tube (b) Expander
(c) Reverse throttle valve (d) Absorber and pump
- (v) A boot starp air cooling system has
(a) One heat exchanger (b) Two heat exchanger
(c) Three heat exchanger (d) Four heat exchanger
- (vi) In an evaporative condenser, the heat is lost
(a) By sensible heat (b) By latent heat
(c) By radiated heat (d) Both by sensible and radiated heat.
- (vii) The pressure in capillary tube decreases due to
(a) Frictional resistance offered by tube wall
(b) Acceleration of refrigerant in the tube
(c) Heat transfer from the tube
(d) Both (a) and (b)

- (viii) The curved line of psychrometric chart indicates
 (a) DBT (b) WBT
 (c) Specific humidity (d) Relative humidity
- (ix) DBT, WBT and DPT will be same when the air is
 (a) Unsaturated (b) Completely dry
 (c) They will never be same (d) Saturated
- (x) A Psychrometer measures
 (a) DBT only (b) WBT only
 (c) RH only (d) Both DBT and WBT

Fill in the blanks with the correct word

- (xi) In aqua-ammonia and Li-Br water absorption refrigeration system, the refrigerants are respectively _____.
- (xii) The Coefficient of Performance (COP) of a refrigeration system is defined as the ratio of _____.
- (xiii) Thermostatic expansion valve is used in _____ type evaporators.
- (xiv) In VCERS, the lowest temperature during the cycle occurs after _____.
- (xv) The performance of an air refrigeration system is expressed in terms of _____.

Group - B

2. (a) A refrigeration cycle uses Freon-12 as the working fluid. The temperature of the refrigerant in the evaporator is -10°C . The condensing temperature is 40°C . The cooling load is 150 W and the volumetric efficiency of the compressor is 80%. The speed of the compressor is 720 r.p.m. Calculate the mass flow rate of the refrigerant and the displacement volume of the compressor.

Properties of Freon-12:

Temperature($^{\circ}\text{C}$)	Saturation Pressure (MPa)	Enthalpy (kJ / kg)		Specific Volume (m^3/kg) Saturated vapor
		Liquid	Vapor	
-10	0.22	26.8	183.0	0.08
40	0.96	74.5	203.1	0.02

[[CO4](Apply/IOCQ)]

- (b) Sketch the T-s and p-h diagrams for the vapor compression cycles when the vapor after compression is (i) dry saturated (ii) wet.

[[CO2](Understand/LOCQ)]

4 + 8 = 12

3. (a) An ammonia refrigerator works between -6.7°C and 26.7°C , the vapour being dry at the end of isentropic compression. There is no under-cooling of liquid ammonia and the liquid is expanded through a throttle valve after leaving the condenser.

Sketch the cycle on the T-s and p-h diagram.

Calculate the refrigeration effect per kg of ammonia and the theoretical coefficient of performance of the unit with the help of the properties given below:

Temperature (°C)	Enthalpy (kJ / kg)		Entropy (kJ/kgK)	
	Liquid	Vapour	Liquid	Vapour
-6.7	152.18	1437.03	0.6016	5.4308
26.7	307.18	1467.03	1.1515	5.0203

[[CO4](Apply/IOCQ)]

- (b) An ammonia refrigerating machine fitted with an expansion valve works between the temperature limits of -10°C and 30°C . The vapour is 95% dry at the end of isentropic compression and the fluid leaving the condenser is at 30°C . If the actual coefficient of performance is 60% of the theoretical, find the ice produced per kW hour at 0°C from water at 10°C . The latent heat of ice is 335 kJ/kg . The ammonia has the following properties:

Temperature (°C)	Enthalpy (kJ / kg)		Entropy (kJ/kgK)	
	Liquid	Vapour	Liquid	Vapour
30	323.08	1145.79	1.2037	4.9842
-10	135.37	1297.68	0.5443	5.4770

[[CO4](Apply/IOCQ)]

6 + 6 = 12

Group - C

4. (a) Explain the working of Bell-Coleman cycle air refrigeration with P-V and T-S diagram. [[CO2](Analyse/IOCQ)]
 (b) With the help of a neat diagram, explain the working of a vapor absorption refrigeration system. [[CO2](Analyse/IOCQ)]
- 6 + 6 = 12**
5. An aircraft moving with speed of 1000 km/h uses simple gas refrigeration cycle for air-conditioning. The ambient pressure and temperature are 0.35 bar and -10°C respectively. The pressure ratio of compressor is 4.5 . The heat exchanger effectiveness is 0.95 . The isentropic efficiency of compressor and expander are 0.8 each. The cabin pressure and temperature are 1.06 bar and 25°C . Determine temperature and pressure at all point of the cycle. Also find the volume flow rate through compressor inlet and expander outlet for 100TR . [[CO6](Evaluate/HOCQ)]

12

Group - D

6. (a) Describe, with a sketch, a centrifugal compressor. [[CO3](Remember/LOCQ)]
 (b) Explain the dry expansion evaporator with the help of a neat sketch. [[CO3](Remember/LOCQ)]
- 6 + 6 = 12**
7. (a) With neat sketch describe the working principle of evaporative condenser. [[CO3](Remember/LOCQ)]
 (b) Discuss the capacity control systems for centrifugal compressor. State the advantages and disadvantages of centrifugal compressor over reciprocating compressor. [[CO5](Apply/IOCQ)]

6 + 6 = 12

Group - E

8. (a) The following data refer to summer air conditioning of a building
Outside design conditions = 45°C DBT, 27°C WBT
Inside design conditions = 23°C DBT, 50%RH
Room sensible heat gain = 80000 kJ/h
Room latent heat gain = 19000 kJ/h
By-pass factor of the cooling coil used = 0.2.
The return air from the room is mixed with the outside air before entry to the cooling coil in the ratio of 4:1 by mass. Determine (i) Apparatus dew point of the cooling coil. (ii) Entry and exit condition of air for cooling coil. (iii) Fresh air mass flow rate (iv) Refrigeration load on the cooling load. [[CO5](Evaluate/HOCQ)]
- (b) What is a psychrometer? [[CO1](Remember/LOCQ)]
- 10 + 2 = 12**
9. (a) At a certain locality, the DBT of air is 30°C and the relative humidity is 40%. Determine the specific humidity and the dew point (DPT) and wet bulb temperatures (WBT) of air. If this air is cooled in an air washer using recirculated spray water and having a humidifying efficiency of 0.9, what are DBT and DPT of air leaving the air washer? [[CO5](Apply/IOCQ)]
- (b) Write a short note on (i) Relative Humidity (ii) Degree of saturation (iii) Adiabatic saturation process. [[CO1](Remember/LOCQ)]
- 6 + 6 = 12**
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Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	35.42	41.67	22.91