REFRIGERATION & AIR CONDITIONING
(MECH 3132)

Time Allotted : 3 hrs   **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and
<u>any 5 (five)</u> from Group B to E, taking <u>at least one</u> from each group.

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

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

    (i)   Power input to a reciprocating compressor becomes minimum when the compression is
          (a) isenthalpic   (b) isochoric   (c) adiabatic   (d) isothermal.

    (ii) A simple saturated refrigeration cycle has the following state points: enthalpy after compression = 425 kJ/kg; enthalpy before compression = 375 kJ /kg; enthalpy after throttling = 125 kJ/kg. The C.O.P is
          (a) 5   (b) 6   (c) 3.5   (d) 6 insufficient data.

    (iii) During vapour compression refrigeration cycle heat is rejected by the refrigerant in
          (a) condenser   (b) evaporator   (c) throttle valve   (d) condenser.

    (iv) Chemical formula of R 113 refrigerant is
          (a) $C_2Cl_3F_3$ (b) CCl_4 (c) CCl_2F_2 (d) $CHClF_2$.

    (v)   Assuming the refrigerant vapour to behave as an ideal gas and with perfect intercooling, the optimum intermediate pressure of a refrigeration system that operates between 4 bar and 16 bar is equal to
          (a) 10 bar   (b) 8 bar   (c) 6 bar   (d)4 bar.

    (vi) The temperature at which the water vapour present in the air starts forming water particles with the pressure remaining constant is
          (a) DBT   (b) WBT   (c) Saturation Temperature   (d) DPT.

    (vii) Component that is not used in vapour absorption refrigeration system is
          (a) Condenser   (b) Evaporator
          (c) Compressor   (d) Throttle valve.

    (viii) In lithium Bromide absorption refrigeration system the refrigerant is
          (a) water   (b) lithium-bromide   (c) ammonia   (d) bromide.

(ix)   A psychrometer measures
(a) DBT only   (b) WBT only
(c) RH only   (d) both DBT and WBT.

(x)   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.

Group – B

2.   (a)   A vapour compression refrigerator uses methyl chloride (R-40) and operates between temperature limits of - 9°C and 44 °C. At entry to the compressor, the refrigerant is dry saturated and after compression it acquires a temperature of 60°C. Find the C.O.P of the refrigerator. The relevant properties of methyl chloride are as follows :

Saturation Temperature in °C	Enthalpy in kJ/kg		Entropy in kJ/kg K	
	Liquid	vapour	Liquid	vapour
-9	44.4	456.7	0.181	1.636
44	130	480.6	0.482	1.585

(b)   Write the chemical name, formula of the following refrigerant
(i) R12   (ii) R123   (iii) R134   (iv) R22.

8 + 4 = 12

3.   (a)   A cold storage plant is required to store 22 tonnes of fish. The temperature of the fish, when supplied, is 25°C. The required storage temperature of fish is -9°C. The specific heat of fish above the freezing point is 2.93 kJ/kg°C, while the specific heat of fish below the freezing point is 1.25 kJ/kg°C. The freezing point of fish is -3°C and the latent heat of fish is 232 kJ/kg.
If the cooling is achieved within 8 hours, find: (1) Capacity of the refrigerating plant;(ii) Carnot cycle C.O.P. between this temperature range; (ii) If the actual C.O.P. is 1/3 rd of the Carnot C.O.P. find the power required to run the plant

(b)   With reference to a simple vapour compression cycle, discuss the effect of (i) suction pressure and (ii) discharge pressure, on the cycle performance (Draw suitable thermodynamic plots).

6 + 6 = 12

Group – C

4.   (a)   In an absorption type refrigerator the heat is supplied to NH_3 generator by condensing steam at 2.5 bar and 90% dry to saturated liquid state after condensation. The temperature to be maintained in the refrigerator is -6°C. The temperature of the atmosphere is 35°C. Find the maximum C.O.P possible. If the refrigeration load is 25 tonnes and actual C.O.P is 75% of maximum C.O.P, find the mass flow of steam required per hour.

(b)   Discuss the advantages of vapour absorption refrigeration system over vapour compression refrigeration system.

7 + 5 = 12

5.   (a)   A Bell-Coleman refrigerator operates between pressure limits of 1 bar and 8 bar. Air is drawn from the cold chamber at 9°C, compressed and then it is cooled to 29°C before entering the expansion cylinder. Expansion and compression follow the law $pv^{1.35}$ = constant. Draw the p-v and T-s diagram. Determine: (i) Work done per kg of air flow. (ii) Theoretical C.O.P. For air take γ = 1.4, C_p = 1.003kJ/kg-K.

(b)   Explain the term "tonne of refrigeration".

7 + 5 = 12

Group – D

6.   (a)   Derive an expression for the volumetric efficiency of a single stage single acting reciprocating compressor.

(b)   A single-stage, single acting reciprocating compressor has a bore of 250 mm and a stroke of 350 mm. It receives vapour refrigerant at 1 bar and delivers it at 5.5 bar. If the compression and expansion follows the law $pv^{1.4}$ = Constant and the clearance volume is 5 per cent of the stroke volume, Determine: (i) The power required to drive the compressor, if it runs at 500 r.p.m. and (ii) The volumetric efficiency of the compressor.

6 + 6 = 12

7.   (a)   Draw a neat sketch of an automated expansion valve and explain it working.

(b)   Write a short note on evaporative condenser.

7 + 5 = 12

Group – E

8.   (a)   An air-water vapour mixture enters an adiabatic saturator at 30°C and leaves at 25°C, which is the adiabatic saturation temperature. The pressure remains constant at 101 kPa. Determine the relative humidity and the humidity ratio of the inlet mixture.

(b)   What is apparatus dew point? What is a cooling tower? How is it specified?

7 + (2 + 3) = 12

9.   (a)   An air conditioning system is designed under the following conditions:
Outdoor condition: 30° C DBT, 75% RH
Required Indoor condition: 22° C DBT, 70% RH
Seating capacity of hall: 1200.
Amount of outdoor air supplied : 0.3 m³ / min per person
The required condition is achieved first by adiabatic humidification, and then by cooling:

Estimate (a) the capacity of the cooling coil in tonnes (b) the capacity of the humidifier in kg/h.

Plot the process on the psychrometric chart and attach with answer script.

(b)   Write a short note of Specific humidity.

10 + 2 = 12

Department & Section	Submission link:
ME	https://classroom.google.com/c/MjQ4MTg3MzY5NzQ4/a/Mjc0NzM1MDcyNjUz/details