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Paper Code : ME-604A

AIR CONDITIONING AND REFRIGERATION

Time Allotted : 3 Hours   *Full Marks* : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own

words as far as practicable.

GROUP – A
(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following :   10 × 1 = 10

    i) If Q_s = sensible heat load and Q_L = latent heat load, then

        a) $SHF = Q_L / (Q_S + Q_L)$

        b) $SHF = Q_S / (Q_S + Q_L)$

        c) $SHF = Q_S / (Q_S Q_L)$

        d) none of these.

    ii) The curved lines on a psychrometric chart indicates

        a) dry bulb temperature

        b) wet bulb temperature

        c) specific humidity

        d) relative humidity.

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iii) A one ton of refrigerating machine means that

    a) the total weight of machine is one ton

    b) the quality of refrigerant used is one ton

    c) one ton of water can be converted into ice

    d) the refrigerator can produce one ton of ice at 32°F from one ton of water at 32°F in one day.

iv) While designing the refrigeration system of aircraft prime consideration is that

    a) weight of refrigerant circulated in the system is low

    b) the weight of refrigeration equipment is low

    c) system has high COP

    d) work consumption per ton of refrigeration is low.

v) If wet bulb depression is zero, the relative humidity is equal to

    a) 50%

    b) 25%

    c) 0%

    d) 100%.

vi) The sensible heat factor for auditorium or cinema hall is generally kept as

    a) 0.6

    b) 0.7

    c) 0.8

    d) 0.9.

vii) Equal friction method is a method to design

    a) evaporator

    b) condenser

    c) air distribution duct

    d) compressor.

viii) For one ton refrigerant plant, if C.O.P. of the plant is 5, the heat rejection ratio of the condenser will be

a) 2.2
b) 1.2
c) 2.333
d) 1.333.

ix) Where does the highest temperature of refrigerant occur in vapour compression refrigeration system ?

a) In evaporator

b) Before expansion valve

c) Between compressor and condenser

d) Between compressor and evaporator.

x) Air refrigeration works on

a) Carnot cycle

b) Rankine cycle

c) Reversed Carnot cycle

d) Bell-Coleman cycle.

xi) The desirable property of a refrigerant is

a) low boiling point

b) high critical temperature

c) high latent heat of vaporization

d) all of these.

xii) The heat production from a normal healthy man when asleep is about

a) 20 watts
b) 40 watts
c) 60 watts
d) 80 watts.

GROUP – B
(Short Answer Type Questions)
Answer any *three* of the following. $3 \times 5 = 15$

2. Prove that relative humidity (ϕ) is given by

   $\phi = \mu / \{ 1 - (1 - \mu) (P_{vs} / P_t) \}$; where μ = Degree of saturation, P_{vs} = saturation pressure of vapour in moist air, P_t = total pressure of moist air.

3. Explain any two methods of capacity control in a reciprocating compressor.

4. Derive an expression for the equivalent diameter of circular duct corresponding to a rectangular duct of side 'a' and 'b' for the same pressure loss per unit length when the velocity of the flowing through both the duct is the same. http://www.makaut.com

5. What are the various type of ducts arrangements ? Describe one of them with suitable sketches.

6. Describe how sub cooling can be achieved in vapour compression refrigeration system. Also draw the *p-h* diagram.

7. How do CFCs damage the ozone layer ? What are the desirable properties of refrigerants ?

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GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following.   3 × 15 = 45

8. a) For a corporate office to be air-conditioned, the following conditions are given :

   Outdoor condition ....39°C DBT, 20°C WBT

   Required comfort condition ......20°C DBT, 60% RH

   Seating capacity of office 1200

   Amount of outdoor air supplied .... 0.3 m^2/mint per person.

   If the required condition is achieved first by adiabatic humidification and then by cooling, determine :

   i)   Capacity of the cooling coil in tons

   ii)   Capacity of the humidifier in kg/hr.

   b) What do you mean by By-pass factor for a cooling coil ?   12 + 3

9. a) A reversed heat engine makes 400 kg of ice per hour at – 8°C from feed water at 18°C. Assume specific heat of ice as 2.09 kJ/kg K and latent heat 334 kJ/kg. Determine :

   i)   C.O.P. of the engine

   ii)   Least power requires to run the engine

   b) Define an 'air-conditioning system'. Explain the working principle for the system with a neat sketch.   8 + 7

10. A vapour compressor refrigeration system have following data, refrigeration capacity is 15TR, evaporator temperature is $-10°C$, condenser temperature is 30°C, temperature of refrigerant superheated as vapour in evaporator is $-5°C$, temperature of regrigerant subcooled as liquid in condenser is 25°C, number of cylinder is 2, stroke is equal to 1.2 times of bore. Speed is 960 rpm.

a) Find refrigerating effect per Kg

b) Mass flow rate of refrigerant per min.

c) Theoretical piston displacement per min.

d) Power input to the compressor in kW

e) COP

Take specific heat of liquid is 0.963 kJ/KgK, specific heat of vapour is 0.615 kJ/KgK. Use the following table :

Temperature (°C)	Pressure (bar)	V_g (m³/kg)	h_f (kJ/kg)	h_g (kJ/kg)	S_f (kJ/kgK)	S_g (kJ/kgK)
-10	2.1928	0.07702	190.72	347.96	0.96561	1.5632
30	7.4457	0.02372	229.11	364.96	1.0999	1.5481

11. a) Differentiate between vapour absorption refrigeration system and vapour compression refrigeration system.

b) In a Vapour absorption type refrigerator, heat is supplied to NH_3 generator by condensing steam at 2 bar and 90% dry. The temperature in the refrigerator is to be maintained at $-5°C$. If the refrigeration load is 20 ton and actual COP is 70% of maximum COP. Calculate

i) The maximum COP possible and actual COP

ii) Mass of steam required per hour

You may take the condensing temperature as 30°C, saturation temperature of steam at a pressure of 2 bar is 120.2°C, Latent het of steam at 2 bar is 2201.6 kJ/kg.   5 + 10

12. Write short notes on any *three* of the following :   3 × 5

a) Capillary tube of a refrigerator

b) Specific humidity and Relative humidity

c) Cascade refrigeration system

d) Psychrometer and Psychrometric process

e) Defrosting methods.