B.E. (Mechanical Engineering) Eighth Semester (C.B.S.)

Elective-II : Refrigeration & Air Conditioning

P. Pages : 4 **NRJ/KW/17/4724**

Time : Three Hours * 0 2 7 9 * Max. Marks : 80

Notes :
1. All questions carry marks as indicated.
2. Solve Question 1 OR Questions No. 2.
3. Solve Question 3 OR Questions No. 4.
4. Solve Question 5 OR Questions No. 6.
5. Solve Question 7 OR Questions No. 8.
6. Solve Question 9 OR Questions No. 10.
7. Solve Question 11 OR Questions No. 12.
8. Assume suitable data whenever necessary.
9. Illustrate your answers whenever necessary with the help of neat sketches.
10. Use of Refrigeration Table, Steam Table, Psychometry chart is permitted.

1. a) Discuss the effect of variable suction and discharge pressures on the performance of vapour compression system. **4**

b) A vapour compression refrigeration machine, with R - 12 as refrigerant, has a capacity of 12 TR operating between $-28^{o}C$ & $26^{o}C$. The refrigerant is subcooled by 4ºC before entering the expansion valve and vapour is superheated by 5ºC before leaving the evaporator. The machine has a six cylinder, single acting compressor with stroke equal to 1.25 times the bore. **10**

It has a clearance of 3% of the stroke volume. Determine :
1) Theoretical power required
2) Co-efficient of performance
3) Volumetric efficiency
4) Base & stroke of the cylinder.

The speed of compressor is 1000 rpm, specific heat of liquid refrigerant = 0.963 kJ/kg k and specific heat of superheated vapour = 0.615 kJ/kg k.

OR

2. a) One metric ton of ice is produced per day, from water at 35ºC. Ice temperature is $-10^{o}C$. An ammonia refrigeration plant provides refrigerating effect to above. Temperature of evaporator & condenser is $-20^{o}C$ and $40^{o}C$ respectively. Temperature of refrigerant leaving the evaporator is 0ºC and that leaving the condenser is 30ºC. Determine : **10**
1) Refrigeration capacity of plant in TR
2) Mass flow rate of refrigerant
3) Power of compressor in KW if overall efficiency is 80%.
4) COP

Specific capacity of water is 4.2 kJ/kg k and of ice is 2.1 kJ/kg k. Latent heat of fusion of ice is 320 kJ/kg.

b) Explain Lithium - Bromide vapour absorption refrigeration system. **4**

3. a) What are the advantages of compound compression with intercooler over single stage compression? **3**

b) A compound refrigeration system using R - 12 as refrigerant consists of three evaporators of capacities 20 TR, 30TR and 10 TR with individual, expansion valves and individual compressors. **10**

The temperature in the three evaporators is to be maintained at $-10^{\circ}C$, $5^{\circ}C$ and $10^{\circ}C$ respectively. The vapours leaving the evaporators are dry and saturated. The condenser temperature is 40ºC and the liquid refrigerant leaving the condenser is subcooled to 30ºC. Assuming isentropic compression in each compressor. Find :

i) The mass of refrigerant flowing through each evaporator.
ii) The power required to drive the system.
iii) The COP of the system.

OR

4. a) In a 15 TR NH_3 refrigeration plant, compression is carried out in two stage with water and flash intercooler and water subcooler, condenser pressure are 12 bar, 3 bar and 6 bar respectively. If the limiting temperature for intercooler and subcooling is 20ºC determine the following : **10**

i) COP of the plant
ii) Power required for LP and HP compressor.
iii) The swept volume for each compressor if the volumetric efficiency of each compressor is 80%. Assume the compression to be isentropic in both compressors.

b) Discuss in short Darking of a thermostatic expansion valve. **3**

5. a) In a boot strap air refrigeration cycle of 10TR capacity used in an aeroplane. The ambient temperature & pressure are 20ºC & 0.85 bar respectively. The pressure of air increases from 0.85 bar to 1 bar due to ramming action of air. The pressure of air discharge from main compressor is 3 bar. The discharge pressure of air from the auxiliary compressor is 4 bar. The isentropic efficiency of each of the compressor is 80%, while that of turbine is 85%, 50% of the enthalpy of air discharged from the main compressor is removed in the first heat exchanger and 30% of the enthalpy of air discharged from the auxiliary compressor is removed in the secondary heat exchanger using rammed air. Assuming ramming action to be isentropic, the required cabin pressure of 0.9 bar and temperature of air leaving the cabin not more than 20ºC find : **10**

i) Power required to operate a system
ii) The C.O.P. of the system,

Take $v = 1.4$ & $C_{p_{air}} = 1 kJ/kg\,k$.

b) Explain the working of reduced ambient air refrigeration system. **3**

OR

6. Write short notes on **any three.** **13**

i) Vortex tube refrigeration system

ii) Thermoelectric refrigeration system

iii) Steam jet refrigeration system

iv) Advantages & disadvantages of air refrigeration system.

7. a) Explain Joule - Thomson coefficient & inversion curve. **4**

b) Explain cascade refrigeration system. **4**

c) Explain Linde method of liquification of air. **5**

OR

8. a) Explain the application of cryogenics. **4**

b) Dry air at 30ºC and 1 bar is to be liquified by simple Linde system. The air is compressed isothermally at 30ºC and 200 bar. If the make-up air is supplied at 30ºC & 1 bar, find the mass of air liquified per kg of air compressed. **9**

9. a) A retail shop located in a city at 30 ºN latitude has the following loads **12**
Room sensible = 58.15 kw
Room latent heat = 14.54 kw
The summer outside & inside design conditions are :
Outside : 40ºC DBT, 27ºC WBT
Inside : 25ºC DBT, 50% RH
$70\,m^3/min$ of ventilation air is used.
Determine the following if the by pass factor of cooling coil is 0.15 :
i) Ventilation load
ii) Grand total heat
iii) Effective sensible heat factor
iv) Apparatus dew - point
v) Dehumidified air quantity
vi) Condition of air entering & leaving apparatus.
Assume a bypass factor of 0.15 for the cooling coil.

b) What is chemical dehumidification. **2**

OR

10. Air conditioning system is to be designed for a room with the following data. **14**
Outside design conditions $-40^{\circ}C$ DBT, 28ºC WBT
Inside design conditions $-25^{\circ}C$ DBT, 50% RH
Solar heat gain through glass - 5.52 kw,
occupants - 25,
Sensible heat gain per person - 58 w
latent heat gain per person - 58 w,
Internal lighting load - 15 lamps of 100 w,
10 fluorescent tubes of 80 w
sensible heat gain from other sources = 11.63 kw.
Infiltrated air - $15\,m^3/min$
Solar heat gain through walls, roof & floor - 5.87 kw.
It 25% fresh air & 75% recirculated air is mixed & passed through the conditioner coil, find
a) The amount of total air required in m^3/hr.
b) The dew point temperature of coil
c) The condition of supply air to the room
d) The capacity of the conditioning plant
Assume BPF = 0.2

11. a) Explain equal friction method of duct design for air distribution system. What are its main advantages? **4**

b) Define drop, throw & spread related to air outlets. **3**

c) Derive an expression for the equivalent diameter of circular duct corresponding a rectangular duct of sides 'a' & 'b' for the same pressure loss per unit length when the quantity of air passing through both the ducts is same. **6**

OR

12. a) Explain in short about selection criteria of air distribution outlets for an air conditioning system. **5**

b) Explain the utility of duct friction charts. **4**

c) What do you mean by Air filter. Explain the various types of air filter. **4**

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