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

Elective - II : Refrigeration & Air-Conditioning

P. Pages : 3 **KNT/KW/16/7586**

Time : Three Hours * 0 2 2 5 * 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. Diagrams and chemical equations should be given whenever necessary.
10. Illustrate your answers whenever necessary with the help of neat sketches.
11. Use of non programmable calculator is permitted.
12. Use of Psychrometry, T-S Chart and Steam & Refrigeration Table is permitted.

1. a) Explain working of three fluid refrigerator working on vapour absorption principle. **4**

b) A simple ammonia – compression system operates with a capacity of 150 tonnes. The condensation temperature in the condenser is 35ºC. The evaporation temperature in brine cooler is – 25ºC. The ammonia leaves the evaporator and enters the compressor at – 8ºC. Ammonia enters the expansion valve at 30ºC. Wire drawing through the compressor valves : Suction = 0.118 bar; Discharge = 0.23 bar, compression index = 1.22, & volumetric efficiency = 0.75. Determine : **10**

1) Heat transferred to cylinder water jacket.
2) Piston displacement
3) Coefficient of performance.

2. a) Explain Global Warming & Ozone depletion potential. **4**

b) A freezer of 20 TR capacity has evaporator and condenser temperatures of – 30ºC & 25ºC respectively. The refrigerant R – 12 is subcooled by 4ºC before it enters the expansion valve and superheated by 5ºC before leaving the evaporator. The compression is isentropic and clearance is to be neglected. If a six cylinder, single acting compressor with stroke equal to base running at 1000 rpm, is used. Determine : **10**

1) C.O.P. of the refrigeration system.
2) Mass of refrigerant to be circulated per minute.
3) Theoretical piston displacement per minute.
4) Base & stroke of the compressor.

Sketch T-s & P-h diagrams for the cycle.

3. a) Explain flooded evaporators. **4**

b) In a 15TR ammonia plant, compression is carried out in two stages with water & flash intercooling & water subcooling the particulars of the plant are as follows : **9**

Condenser pressure = 12 bar,
Evaporator pressure = 3 bar
Flash intercooler pressure = 6 bar
Limiting temperature for intercooling & subcooling = 20ºC

Estimate (a) the C.O.P. of the plant (b) Power required (c) the swept volume of each compressor, if the volumetric efficiency of each compressor is 80%.

4. a) Explain thermostatic expansion valve. **4**

b) A single compressor system using R – 12 as refrigerant has three evaporators of capacity 18TR, 27TR, & 9TR of refrigeration. The temperatures in the three evaporators are to be maintained at – 5ºC, 0ºC & 7ºC respectively. The system is provided with individual expansion valves & back pressure valves. The condenser pressure is 9.61 bar. The liquid refrigerant leaving the condenser is subcooled to 30ºC. The vapours leaving the evaporators are dry & saturated. Assuming isentropic compression, determine the following **9**

1) Mass of refrigerant flowing through each evaporator.
2) Power required to drive the compressor.
3) COP of the system.

5. a) Discuss in brief working of steam jet refrigeration system. **4**

b) In a regenerative aircraft refrigeration cycle, the desired refrigeration load is 25TR. The ambient conditions are 0.9 bar pressure & 15ºC temperature. It is then rammed isentropically till the pressure rises to 1.4 bar. The air coming out of main compressor is at 5 bar pressure. It is cooled by a heat exchanger whose effectiveness is 60%. Air from this heat exchanger is further cooled to 60ºC in the regenerative heat exchanger. The cabin is to be maintained at 1 bar and 25ºC. Isentropic efficiency of compressor & turbine arc 90% & 80% respectively. Find out (i) mass of air bled from cooling turbine which is used for regenerative cooling. (ii) Power required (iii) C.O.P. of the system. Take temperature of air leaving to atmosphere from regenerative heat exchanger at 100ºC. **10**

6. a) Derive C.O.P. for Reversed Joule cycle. **4**

b) In a bootstrap air refrigeration system, ambient air at 0.8 bar & 20ºC enters the aircraft which after isentropic ram compression is at 1.1 bar. The compression ratio in the main compressor is such that the discharge pressure from compressor is 4.1 bar. The compressed air bled from main compressor is cooled by ram air in the primary heat heat exchanger with an effectiveness of 0.65. During the heat exchanger these is a pressure drop of 0.1 bar. The air from the heat exchanger is subsequently compressed in an auxiliary compressor upto a pressure of 5 bar. The compressed air is further cooled in a secondary heat exchanger by ram air with an effectiveness of 0.5 before entering the cooling turbine. The exit pressure of cooling turbine & cabin pressure are 1.01 bar and cabin temperature is 25ºC. Assuming an isentropic efficiency for both compressor as 0.85 and isentropic efficiency for turbine as 0.8 & ram efficiency as 0.9 calculate : **10**

1) The Mass flow of air, if cooling load is 20TR.
2) The temperature at outlet of cooling turbine.
3) Net power input requirement.
4) C.O.P. of the systems.

7. a) What is cryogenics & state the different application. **6**

b) What is Joule – Thompson coefficient & explain inversion curve in detail. **7**

8. a) Explain cascade refrigeration system. **5**

b) Dry air at 30ºC & 1 bar is to be liquified by simple linde system. The air is compressed isothermally at 30ºC & 200 bar. If the make up air is supplied at 30ºC and 1 bar, find the mass of air liquified per kg of air compressed. **8**

9. Short notes on **any three.** **13**

a) Air Washers.

b) Factor affecting human comfort.

c) Mechanism of body heat loss.

d) Window air conditioner.

10. Following design data is available for air conditioning system of a restaurant : **13**

i) Outdoor conditions = 34ºC DBT & 28ºC WBT
ii) Indoor conditions = 24ºC DBT & 50% RH
iii) Solar heat gain through walls, roof & floor = 4.7 KW.
iv) Solar heat gain through glass areas = 4.4 KW
v) Occupants = 25
vi) Sensible heat gain / person = 85 W.
vii) Latent heat gain / person = 105 W
viii) Internal lighting load = 15 lamps of 100 watts capacity each plus 10 fluorescent fixtures of 80 watts each.
ix) Sensible heat gain from other sources = 11.6 KW.
x) Infiltration air = $14\,m^3/min$
xi) Coil by pass factor = 0.15.

If return & outdoor air are adiabatically mixed in the ratio of 3 : 2 (by mass) & then passed through the conditioner, determine :

a) Condition of supply air
b) Apparatus dew point
c) Capacity of air conditioning plant.

11. a) Explain the term drop, throw & spread. **4**

b) Discuss static regain method of duct design in detail. **5**

c) What are the grills & diffusers & explain criteria for choosing them for a particular application. **4**

12. a) With the help of neat sketch describe loop perimeter duct design. **6**

b) 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 ducts is same. **7**

****