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

Elective - II : Refrigeration & Air Conditioning

P. Pages : 3 **NIR/KW/18/3668**

Time : Three Hours * 1 4 3 7 * 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 Refrigeration table, steam table & Chart is permitted.

1. a) With schematic, compare heat engine, heat pump & refrigerating machine. **5**

b) One metric ton of ice is produced per day, from water at 35ºC. Ice temperature is -10ºC. An ammonia refrigeration plant provides refrigerating effect to above. Temperature of evaporator & condenser is - 20ºC & 40ºC respectively. Temperature of refrigerant leaving the evaporator is 0ºC and that leaving the condenser is 30ºC. **9**

Determine:

i) Refrigeration capacity of plant in TR.
ii) Mass flow rate of refrigerant.
iii) Power of compressor in kW if overall efficiency is 80%.
iv) 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.

OR

2. a) Discuss in brief working of three fluid refrigerator machine. **5**

b) A vapour compression refrigeration machine, with R-12 as refrigerant, has a capacity of 12TR operating between -28ºC and 26ºC. The refrigerant is subcooled by 4ºC before entering the expansion valve and the 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. It has a clearance of 3% of the stroke volume. Determine **9**

i) Theoretical power required ii) Co-efficient of performance
iii) Volumetric efficiency iv) Bore & stroke of cylinder.

The speed of compressor is 1000 rpm,

specific heat of liquid refrigerant = 0.963 kJ/kg K.& $C_{P_{vapour}} = 0..615\ kJ/kg\ K$

3. a) What are the advantages of multi-staging of compressor in refrigeration system. **3**

b) A two stage compression ammonia refrigeration system operates between overall pressure limits of 14 bar & 2 bar. The temperature of the desuperheated vapour & subcooled liquid refrigerant are limited to 30ºC. The flash tank separates dry vapour at 5 bar pressure and the liquid refrigerant then expands to 2 bar. Estimate the COP of the machine and power required to drive the compressor if $\eta_{mechanical}$ = 80% & load on the evaporator is 10TR. **10**

OR

4. a) What are different types of compressors and explain hermetic compressor. **4**

b) The refrigeration system using R-12 as refrigerant consists of three evaporators of capacities 20TR, 30TR and 10TR with individual expansion valves and individual compressors. **9**

The temperature in the three evaporators is to be maintained at -10ºC, 5ºC and 10ºC respectively. The vapours leaving the evaporators are dry & 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.

5. a) In a regenerative aircraft refrigeration cycle the desired refrigeration load is 25TR. The ambient conditions are 0.9 bar pressure and 15ºC temperature. It is then rammed isentropically till the pressure rises to 1.4 bar. The air coming out of main compressor is at a pressure of 5 bar. 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 are 90% & 80% respectively. Find out (i) mass of air bled from cooling turbine which is used for regenerative cooling. (ii) Power required (iii) COP of system. **9**

Take temperature of air leaving to atmosphere from regenerative Heat exchanger at 100ºC.

b) Explain steam jet refrigeration with neat sketch. **5**

OR

6. a) Explain in short working of vortex tube refrigeration system. **5**

b) In a bootstrap aircraft refrigeration cycle of 10TR capacity used in an aeroplane. The ambient temperature & pressure are 20ºC and 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 discharges from the 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 main compressor is removed in the first heat exchanger and 30% of the enthalpy of air discharged from 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 **9**

1) Power required to operate the system

2) COP

3) Mass flow rate of air

Take $\nu = 1.4,\ C_P = 1\ kJ/kg\ K.$

7. a) Explain with advantages cascade refrigeration system with neat sketch. **5**

b) Explain the Claude's system used for liquification of air. **5**

c) Discuss various applications of cryogenics in detail. **3**

OR

8. a) What is Joule-Thompson coefficient and inversion curve? **5**

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. **8**

9. a) A retail shop located in a city at 30ºN latitude has the following loads **10**
Room sensible heat = 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 of air 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) Dehumidification air quantity
vi) Condition of air entering & leaving apparatus

b) Explain comfort charts and its uses. **3**

OR

10. A conference room for seating 100 persons is to be maintained at 22ºC DBT & 60% RH. The outdoor conditions are 40ºC DBT & 27ºC WBT. The various loads in the auditorium are as follows: sensible & latent heat loads per person 80W & 50W respectively lights & fans - 15000 W, sensible heat gain through glass, walls, ceilings etc 15000 W. The air infiltration is 20m^3/min and fresh air supply is 100 m^3/min. Two third of recirculated room air & one third of fresh air are mixed before entering the cooling coils. The by pass factor of the coils is 0.1. Determine apparatus dew point, the grand total heat, effective room sensible heat and Amount of recirculated air. **13**

11. a) What are grills and diffusers? Explain the criteria for choosing them for a certain application. **5**

b) Explain the following **5**
1) Throw 2) Drop 3) Spread

c) Explain the utility of friction chart. **3**

OR

12. a) What do you mean by air filter? Explain the various types of air filter. **4**

b) Explain in short about the selection criteria of air distribution outlets for an Air conditioning system. **5**

c) With the help of neat sketch describe loop perimeter duct design. **4**

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