



- Notes :
1. Answer **any three** question from Section A and **any three** question from Section B.
 2. Assume suitable data wherever necessary.
 3. Illustrate your answer necessary with the help of neat sketches.
 4. Use of slide rule logarithmic tables, Steam tables, Mollier's Chart, Drawing instrument, Thermodynamic table for moist air, Psychrometric Charts and Refrigeration charts is permitted.

SECTION – A

1. a) Describe a simple vapour compression refrigeration system with superheated vapour after compression. Show the entire system on T-S & P-h planes. **7**
 - b) A simple NH_3 vapour compression system has compressor with piston displacement of $2 \text{ m}^3/\text{min}$, a condenser pressure of 12 bar and evaporator pressure of 2.5 bar. The liquid is sub-cooled to 20°C by soldering the liquid line to suction line. The temperature of vapour leaving the compressor is 100°C , heat rejected to the compressor cooling water is 5000 kJ/hr. and volumetric efficiency of compressor is 0.8. Compute,
a) Indicated power & b) C.O.P of the system. **7**
2. The refrigerant system using R-12 as refrigerant consists of three evaporators and capacities 20 TR, 30 TR & 10 TR with individual expansion valves and individual compressors. The temperature in the three evaporators is to be maintained at -10°C , 5°C & 10°C respectively. The vapours leaving the evaporators are dry and saturated. The condenser temperature is 40°C and the liquid refrigerant leaving the condenser is subcooled to 30°C . Assuming isentropic compression in each compressor, Find, **13**
 - a) The mass of refrigerant is flowing through each evaporator.
 - b) The power required to drive the system.
 - c) C.O.P of system.
3. a) Explain with neat sketch a practical vapour absorption refrigeration system. Discuss the advantages of vapour absorption refrigeration system over vapour compression refrigeration system. **6**
 - b) In an absorption type refrigerator, the 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 . Find the maximum C.O.P possible. **7**
If the refrigeration load is 20 tonnes and actual COP is 70% of the maximum C.O.P, find the mass of steam required per hour. Take temperature of the atmosphere as 30°C .
4. a) Explain working principle of thermoelectric refrigeration system. What are the fields of applications? **7**
 - b) What is a cascade system? What are its merits? Discuss. **6**
5. a) Draw a neat diagram of lithium bromide water absorption system and explain it's working. **6**

- b) A cascade refrigeration system is designed to supply 10 tonnes of a refrigeration at an evaporator temperature of -60°C and a condenser temperature of 25°C . The load at -60°C is absorbed by a unit using R-22 as the refrigerant and is rejected to a cascade condenser at -20°C . The cascade condenser is cooled by a unit using R-12 as the refrigerant and operating between -30°C evaporating temperature and 25°C condenser temperature. The refrigerant leaving the R-12 condenser is subcooled to 20°C , but there is no subcooling of R-22 refrigerant. The gas leaving both the evaporators is dry and saturated and the compressions are isentropic. Neglecting losses, determine:
- Compression ratio for each unit.
 - Quantity of refrigerant circulated per minute for each unit.
 - C.O.P of each unit.
 - C.O.P of whole system.
 - Theoretical power required to run the system.

SECTION – B

- Classify refrigerants used in refrigeration system. Why CFC refrigerants are to be phased out? What are the recent trends to replace these CFC refrigerants? 7
 - Describe with the neat sketch Bootstrap cycle of air refrigeration system and draw its T-S diagram. 6
- State the detailed classification of an evaporators and explain with the neat sketch flooded evaporators. 6
 - Discuss the capacity control systems for reciprocating and centrifugal compressors. 7
- Explain the designation systems for refrigerant. 7
 - What points are considered in selecting a compressor for a refrigeration system 6
- Discuss selection criteria of condenser for a refrigeration system. Explain with neat sketch evaporative condenser. 7
 - Explain the ozone depletion and a global warming issues. Discuss why CFC's are to be phased out. 6
- The reduced ambient system of air refrigeration for cooling an aircraft cabin consists of two cooling turbines one heat exchanger and one fan. The first cooling turbine is supplied with the ram air at 1.1 bar and 15°C and delivers after expansion to the heat exchanger at 0.9 bar for cooling the air bled off from the main compressor at 3.5 bar. The cooling air from the heat exchanger is sucked by a fan and discharged to the atmosphere. The cooled air from the heat exchanger is expanded upto 1 bar in the second cooling turbine and discharged into air cabin to be cooled. The air from the cabin is exhausted at 22°C . The refrigerating capacity required is 10 tonnes. If the compression index for the main compressor is 1.5 and the expansion index for both the cooling turbines is 1.35, determine:- 14

 - Mass flow rate of cabin air.
 - Cooling capacity of the heat exchanger and flow rate of the ram air when compressed air is to be cooled to 60°C in the heat exchanger and temperature rise in the heat exchanger for the ram air is not to exceed 30 K.
 - Combined output of both cooling turbines driving the air fan with transmission efficiency of 60%. &
 - C.O.P of refrigerating system considering only power input to the compressor.
