Refrigeration and Air Conditioning
(ME-304, May 2007)

Time: 3 Hrs
Max Marks: 60

Note: Section A is compulsory. Attempt any four questions from Section B and any two from Section C.

Section-A

1. a) Define the term COP of a refrigeration system. What are factors affecting COP of a refrigeration system?
   b) Enumerate the desirable properties of refrigerants commonly employed in refrigeration and air conditioning applications.
   c) Explain the effect of sub-cooling on the performance of vapour compression refrigeration system.
   d) Differentiate between an air conditioner working on reverse cycle in winter to produce heating effect and an air conditioner employing an electric heating filament to produce required heating effect. Which air conditioner will you prefer and why?
   e) Enumerate five distinctions between the vapour compression and vapour absorption refrigeration system.
   f) Enumerate the characteristics requirements of refrigerant, absorber and mixture in vapour absorption refrigeration systems.
   g) What are the modifications required for an existing R-12 refrigeration system to be retrofitted to R-134a refrigerant?
   h) What do you understand by the term 'By pass factor' of a cooling coil?
   i) Differentiate between specific humidity and relative humidity.
   j) Differentiate between working of window and split air conditioners.

Section-B

2. A simple air cooled system is used for aero plane having load of 10 TR. The atmosphere pressure and temperature are 0.9 bar and 10ºC. The pressure gets increased to 1 bar due to ramming and to 3.5 bar in the compressor. The temperature of the air is reduced by 50ºC in the heat exchanger. The pressure in the cabin is 1.03 bar and the temperature o be maintained in the cabin is 25ºC. Determine mass flow rate of air, power required to take up the load of the cabin, COP of the system. Assume all expansions and compressions to be isentropic.
3. Give the brief description of any two of the following refrigeration and air conditioning: (a) Hermetically sealed Reciprocating compressors, (b) Shell and Tube condensers, (c) Package air conditioning units.
4. A simple R-134a heat pump for space heating operates between temperature limits of 15ºC and 50ºC. The heat to be pumped in the conditioned space is 100 MJ/hour. Determine the mass flow rate of the refrigerant, theoretical piston displacement of the compressor, power required to drive the compressor and COP of the system. Assume $C_{PVapour}$ = 0.996 KJ/kg K and specific volume of R-134a saturated vapour at 15ºC as 0.04185 m^3/kg.
5. A compound refrigeration system using R-12 as refrigerant consists of three evaporators of capacities 20 TR at 10 TR at -5ºC, 0ºC and 5 ºC respectively. The vapors leaving the evaporator are dry and saturated. The system is provided with individual expansion valves and flash intercoolers. The condenser temperature is 40ºC and the liquid refrigerant is sub-cooled by 10ºC in the sub cooler. Assuming isentropic compression at each stage, determine mass of refrigerant through each compressor, power required to drive the system, COP of the system.
6. How do traditional CFCs and HCFCs affect ozone layer? Describe briefly the effects of ozone depletion on environment?

Section-C

7. The following data refer to summer air conditioning of an installation:
   Outside design conditions: 38ºC DBT and 27ºC WBT.
   Inside design conditions: 27ºC DBT and 21ºC WBT
   Room sensible heat gain: 46.5 KJ/sec
   Room latent heat gain: 17.5 KJ/sec
   The air supplied through ventilation and infiltration in the system is 25 m^3/min. the outside air to be conditioned is passed through the cooling coil whose ADP is 15ºC, while the quality of re circulated air from the building is 60%. The conditioned fresh air is mixed with re circulated air after the coil. Determine condition of the air after the coil and before the re circulated air mixes with it, condition of air entering the hall, mass of fresh air entering the cooling coil and refrigeration load on the cooling coil.
8. a) 0.004 kg of water vapor per kg of atmospheric air is removed and temperature of air after removing the water vapour becomes 20ºC. Determine the relative humidity and dew point temperature. Assume initial air temperature as 30ºC and 55%RH.
   b) Give a brief account of Vortex refrigeration system giving suitable sketches. Compare the vortex refrigeration system with conventional vapour compression refrigeration systems.
9. a) A restaurant with capacity of 100 persons is to be air conditioned with the following conditions: Outside: 30ºC DBT, 70% R.H. ; Desired inside conditions: 23ºC DBT, 55% R.H.; Quantity of air supplied: 0.5 m^3/min/person. The desired condition is achieved by cooling and dehumidification and then by heating. Determine the capacity of cooling coil in tons of refrigeration, capacity of heating coil, amount of water removed in dehumidifier. By pass factor of heating coil if its surface temperature is 35ºC.
   b) What do you understand by the term Azeotropes? How do see the performance of Azeotropes as compared to CFCs and HCFCs?