



(3 Hours)

[Total Marks 80]

Note: 1) Question no. 1 is compulsory.

- 2) Attempt any **three** questions out of the remaining **five** questions.
- 3) Clearly mention the assumptions made if any.
- 4) Use of Refrigerant Tables, P-h chart, Friction chart, Psychrometric Chart and Steam table is permitted.

Q.1 Answer any **Four** of the following:

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- a) List down the types of aircraft air cooling systems. Draw T-s Diagram for Simple Air Evaporative Cooling System
- b) Draw VCR Cycle on P- h diagram with sub-cooling of liquid refrigerant in condenser & explain the processes involved in the cycle.
- c) What is Bypass factor? Explain it for heating and cooling coil.
- d) Define & explain RSHF, GHSF and ERSHF.
- e) What is Human Comfort? Explain with the help of ASHRAE Comfort Chart.
- f) In a refrigeration plant working on Bell-Coleman cycle, air is compressed to 5 bar from 1 bar. Its initial temperature is 10°C. After compression, the air is cooled upto 20°C in a cooler before expanding back to a pressure of 1 bar. Determine Theoretical COP & Net Refrigeration Effect of the plant. Take  $\gamma = 1.4$  for air.

Q.2 a) The following data refers to Simple Air Refrigeration Cycle of 20TR capacity.

Ambient air temperature & pressure = 20°C & 0.8 bar

Ram air pressure = 0.9 bar

Compressor outlet pressure = 3.6 bar

Temperature of air leaving H.E. = 60°C

Pressure of air leaving the turbine = 1 bar

Temperature of air leaving the cabin = 27°C

Compressor & Turbine efficiency = 80% & 75% respectively

Assume no pressure drop in H.E. & isentropic ramming process. Calculate;

- (i) Mass of air circulated per minute.
- (ii) Power required.
- (iii) COP.

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b) Classify Ducts & derive an expression for an equivalent diameter of a circular duct for rectangular duct for same frictional loss per unit length when quantity of air flowing through both ducts is same.

08

Q.3 a) A Vapour Compression Refrigeration System using  $\text{NH}_3$  works between -15°C and 40°C as evaporator and condenser temperature respectively. The vapour is superheated by 5°C before entering compressor & liquid is sub-cooled by 5°C before leaving the condenser. Using P-h chart, determine;

- (i) COP
- (ii) Mass of Refrigerant per TR
- (iii) Piston Displacement per TR using Volumetric efficiency = 80%
- (iv) Heat rejected in the condenser per TR
- (v) Ideal COP

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- b) Explain Sensible Heating, Sensible Cooling, Humidification and Dehumidification process. 04  
c) Classify Cooling Towers & explain its application. Define Range & Approach. 04

Q.4 a) The specific humidity of atmospheric air at 28°C DBT and barometric pressure of 760 mm of Hg is 0.016 Kg/Kg of dry air. Determine the following without using Psychrometric chart;  
(i) Partial pressure of water vapour.  
(ii) Relative Humidity.  
(iii) Dew Point Temperature.  
(iv) Specific Enthalpy. 08

- b) Derive an expression for COP of an Ideal Vapour Absorption Refrigeration System. 06  
c) Describe various psychrometric processes in an Air washer. 06

Q.5 a) The following data is given for Summer air conditioning of a building:

Outside design conditions = 43°C DBT, 27°C WBT

Inside design conditions = 25°C DBT, 50%RH

Room Sensible Heat Gain = 84,000 kJ/hr

Room Latent Heat Gain = 21,000 kJ/hr

By-Pass Factor of cooling coil = 0.2

The return air from the room is mixed with the outside air before entering the cooling coil in the ratio

of 4:1 by mass. Determine;

- (i) Apparatus Dew Point of the cooling coil.  
(ii) Inlet & Outlet conditions of air for cooling coil.  
(iii) Fresh air mass flow rate.  
(iv) Refrigeration load on the cooling coil in TR. 14

- b) Classify Refrigerants with example of each type. Which refrigerants are considered environment friendly? Explain. 06

Q.6) Write short note on any **Four** of the following: 20

- a) BEE Star Rating System.  
b) Types of Compressors & Expansion Devices.  
c) Thermoelectric Refrigeration.  
d) Green Buildings.  
e) Vortex Tube Refrigeration.  
f) Deep Sea Water Air Conditioning.

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