

(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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- List down the types of aircraft air cooling systems. Draw T-s Diagram for Simple Air Evaporative Cooling System
- Draw VCR Cycle on P- h diagram with sub-cooling of liquid refrigerant in condenser & explain the processes involved in the cycle.
- What is Bypass factor? Explain it for heating and cooling coil.
- Define & explain RSHF, GHSF and ERSHF.
- What is Human Comfort? Explain with the help of ASHRAE Comfort Chart.
- 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;

- Mass of air circulated per minute.
- Power required.
- COP.

12

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 NH<sub>3</sub> 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;

- COP
- Mass of Refrigerant per TR
- Piston Displacement per TR using Volumetric efficiency = 80%
- Heat rejected in the condenser per TR
- Ideal COP

12

- 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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