

**Duration: 3hrs**

**[Max Marks: 80]**

- N.B. :** (1) Question No 1 is Compulsory.  
(2) Attempt any three questions out of the remaining five.  
(3) All questions carry equal marks.  
(4) Assume suitable data, if required and state it clearly.  
(5) Use of Refrigerant tables, Friction charts, Psychometrics chart, and Steam table are permitted.

**Q.1** Attempt **any Five** of the following **[20]**

- Define ton of refrigeration. Differentiate between Heat pump and Refrigerator
- Explain construction and working of simple vapor absorption refrigeration system with neat sketch.
- Explain the function of reversing valve used in heat pump.
- State the various applications of HVACR and explain any one application
- Classify refrigerants compressor. Explain working of hermetically sealed compressor
- State and Define any four psychrometric properties.
- Explain with neat sketches the bootstrap air refrigeration system.

**Q.2** a) Draw a neat component diagram of vapor compression Refrigeration **[08]**  
system. Apply Steady flow energy Equation to each component and analyze cycle with neat p-h and T-s Diagram.

- b) An air cooling system for a jet plane cockpit operates on the simple cycle. **[12]**  
The cockpit is to be maintained at  $25^{\circ}\text{C}$ . The ambient air pressure and temperature are 0.35 bar and  $-15^{\circ}\text{C}$  respectively. The pressure ratio of the jet compressor is 3. The plane speed is 1000 kilometres per hour. The pressure drop through the cooler coil is 0.1 bar. The pressure of the air leaving the cooling turbine is 1.06 bar and that in the cockpit is 1.0325 bar. The cockpit cooling load is 58.05 TR.

Determine

- Temperature and pressure at all the points.
- Mass of air circulated per minute
- COP

- Q.3** a) Define Air Conditioning. State the factor which affects air conditioning process. Show on psychrometric chart different psychrometric process achieved by Air washer [08]
- b) R-22 refrigeration system operates between  $-15^{\circ}\text{C}$  and  $40^{\circ}\text{C}$ . The flow rate of refrigerant through the system is  $0.2\text{ kg/s}$ . At the entry of the compressor the refrigerant is dry and saturated. Use P-h Chart [12]
1. Draw P-h and T-s diagram
  2. Find out Pressure and enthalpy value at all salient points.
  3. Heat extracted by Evaporator
  4. Heat rejected by Condenser
  5. Compressor Work
  6. Actual COP
  7. Ideal COP

Take  $C_p$  at  $40^{\circ}\text{C} = 0.82\text{ kJ/kg K}$  and  $C_p$  at  $-15^{\circ}\text{C} = 0.64\text{ kJ/kg K}$ .

- Q.4** a) For HVACR application, Length of duct is  $37\text{ m}$ ,  $Q = 4\text{ m}^3/\text{s}$  and  $D = 850\text{ mm}$ . Calculate friction loss for total length of duct by using relation and friction chart. [08]
- b) For a sample of air leaving  $28^{\circ}\text{C}$  DBT, Humidity ratio  $0.016\text{ kg/kg}$  of dry air at barometric pressure of  $760\text{ mm}$  of Hg. Determine following properties by using psychrometric relations and Verify your result with psychrometric chart [12]
1. Partial pressure of water vapour
  2. Relative humidity
  3. Dew point temperature
  4. Vapour density,
  5. Enthalpy

**Q.5** a) Define the effective temperature. Draw Comfort Chart. What are factors affecting thermal comfort? [08]

b) In a conference room for seating of 100 persons, [12]

Application : Summer Air Conditioning

Inside condition : 22°C, DBT, 60% RH

Outside condition : 40°C DBT, 27°C WBT

Sensible load per person : 80W

Latent load per person : 50W

Light and fans : 15000 W

Glass and walls : 15000 W

Air infiltration : 20 m<sup>3</sup>/min

Assuming 40 % fresh air and 60% of recirculated air are mixed before passing through the Cooling coil.

1. Identify and Show psychrometric process required for above application on psychrometric chart.
2. Draw neat diagram showing arrangement of cooling coil.
3. Determine Mixing Condition temperature.
4. Estimate Total load.
5. Calculate RSHF.

**Q.6** Write a notes on following (any Four) [20]

1. Air handling Unit
  2. Summer air Conditioning and Winter air Conditioning
  3. Type of Insulation Material used in HVACR
  4. Types of Condenser
  5. Ice plant
  6. Duct design methods
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