**Registration No.:** | | | | | | | | | | |



**Total Number of Pages: 02**

**Course: B.Tech**
**Sub_Code: MEPE3004**

**5th Semester Regular Examination: 2025-26**
**SUBJECT: Refrigeration and Air Conditioning**
**BRANCH(S): MECH**
**Time: 3 Hours**
**Max Marks: 100**
**Q.Code: U353**
**Answer Q1 (Part-I) which is compulsory, any eight from Part-II, and any two from Part-III.**
**The figures in the right-hand margin indicate marks.**

## Part-I

**Q1 Answer the following questions:** **(2 x 10)**

- **a)** Define Unit of refrigeration.
- **b)** State any two limitations of the reversed Carnot refrigeration cycle.
- **c)** What is the purpose of a p–h diagram in refrigeration analysis?
- **d)** What is the function of an intercooler in multistage compression?
- **e)** State two advantages of the improved absorption system over the simple system.
- **f)** Why is lithium bromide used as an absorbent?
- **g)** What is the Peltier effect?
- **h)** State any two requirements of comfort air conditioning.
- **i)** Define bypass factor of a coil.
- **j)** Write any two factors affecting cooling load calculations.

## Part-II

**Q2 Only Focused-Short Answer Type Questions- (Answer Any Eight out of Twelve)** **(6 x 8)**

- **a)** A simple air-cooled system is used for an aeroplane having a load of 16 tonnes. The atmospheric pressure and temperature are 0.9 bar and 10°C respectively. The pressure increases to 1.013 bar due to ramming. The temperature of the air is reduced by 50°C in the heat exchanger. The pressure in the cabin is 1.01 bar and the temperature of air leaving the cabin is 25°C. Determine: Power required to take the load of cooling in the cabin; and C.O.P. of the system. Assume that all the expansions and compressions are isentropic. The pressure of the compressed air is 3.5 bar.
- **b)** Distinguish between a reversed Carnot cycle and a Bell–Coleman cycle.
- **c)** Differentiate between simple, subcooled, and superheated VCR cycles
- **d)** Explain the role of the analyser and rectifier in the ammonia–water absorption system.
- **e)** Explain the principle of thermoelectric refrigeration along with the Seebeck, Peltier, and Thomson effects.
- **f)** Describe the refrigerant designation system and illustrate it with at least three suitable examples.
- **g)** Explain the psychrometric chart and show the representation of key properties (DBT, WBT, RH, SH).
- **h)** 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. If the refrigeration load is 20 tonnes and actual C.O.P. is 70 % of the maximum C.O.P., find the mass of steam required per hour. Take temperature of the atmosphere as 30°C.

**i)** Explain the thermodynamics of the human body with heat balance equation.

**j)** The atmospheric air at 725 mm of Hg, dry bulb temperature 15°C and wet bulb temperature 12°C enters a heating coil whose temperature is 40°C. Assuming bypass factor of heating coil as 0.6, determine dry bulb temperature, wet bulb temperature and relative humidity of the air leaving the coil. Also determine the sensible heat added to the air per kg of dry air.

**k)** Briefly discuss the summer air conditioning system.

**l)** The following data refer to air conditioning of a public hall: Outdoor conditions = 40°C DBT, 20°C WBT, required comfort conditions = 20°C DBT, 50% RH, Seating capacity of hall = 1000, Amount of outdoor air supplied = 0.3 $m^3$/min/person. If the required condition is achieved first by adiabatic humidifying and then cooling, find (i) The capacity of the cooling coil and surface temperature of the coil if the by-pass factor is 0.25; and (ii) The capacity of the humidifier and its efficiency.

## Part-III

### Only Long Answer Type Questions (Answer Any Two out of Four)

**Q3 a)** Describe the Simple Air Cycle System for aircraft. Explain its working principle, components, T-s diagram, and performance analysis. **(8)**

**b)** A Bell–Coleman air refrigeration cycle operates between a pressure ratio of 5:1. Air enters the compressor at 1 bar and –5°C and is compressed isentropically to 5 bar. After cooling at constant pressure, the air enters the expander at 25°C and expands isentropically back to 1 bar. The refrigeration produced is 150 kJ/kg of air circulated. Determine (i) Temperature after compression, (ii) Temperature after expansion, (iii) Work input to the compressor, (iv) Work output from the expander, (v) COP of the system. Take: $C_p$ = 1.005 kJ/Kg K, $\gamma$ = 1.4 **(8)**

**Q4 a)** Discuss the multi-evaporator refrigeration system with suitable schematic. Explain how mass flow rate is controlled in each evaporator. **(8)**

**b)** A vapour compression system with ammonia as the refrigerant works between the pressure limits of 2 bar and 12 bar with three-stage compression. The vapours leaving the water intercoolers at pressures 4 bar and 8 bar are in a saturated state. If the load is 10 TR, find the power required to drive the three compressors and compare the C.O.P. of this system with that of a simple saturation cycle working between the same overall pressure limits. **(8)**

**Q5 a)** Explain the Li Br–water absorption system and discuss its advantages, limitations, and typical applications. **(8)**

**b)** An aqua–ammonia absorption refrigeration system produces 10 kW of cooling at an evaporator temperature of –10°C. The absorber and condenser operate at 30°C, and the generator is maintained at 90°C. The ammonia vapour leaving the generator is dry saturated at 50°C. At the absorber exit (strong solution), $x_s$ = 0.40, $h_s$ = 60 kJ/kg; at the generator exit (weak solution), $x_w$ = 0.12, $h_w$ = 720 kJ/kg. The enthalpy of saturated vapour $NH_3$ at –10°C is 1325 kJ/kg, saturated liquid $NH_3$ at 35°C is 360 kJ/kg, and generator vapour enthalpy is 1420 kJ/kg. Neglect pump work. Determine: (i) mass flow rate of $NH_3$ through the evaporator, (ii) mass flow rates of weak and strong solutions, (iii) heat rejected in absorber + condenser, (iv) heat supplied in the generator, (v) COP of the system. **(8)**

**Q6 a)** Explain the various psychrometric processes (heating, cooling, humidification, dehumidification, mixing) with psychrometric chart representation. **(8)**

**b)** A closed hall of 10 m × 6 m × 4 m contains air-water vapour mixture at 26°C and 50% relative humidity at 1.013 bar. Calculate: a) Specific humidity, b) Partial pressure of water vapour, c) Mass of moisture and dry air in the room, d) If this air is cooled to 8°C, find the amount of moisture removed. **(8)**