Ref. No.: Ex/ME(M2)/PC/B/T/412/2025

B.E MECHANICAL ENGINEERING FOURTH YEAR FIRST SEMESTER EXAMINATION, 2025

REFRIGERATION AND AIR CONDITIONING

Time: Three hours **Full Marks-100**

Answer any five questions. Assume any unfurnished data suitably.

Use of Refrigerant Tables, Steam Table and Psychrometric Chart are permitted. For Problems on air-conditioning using Psychrometric charts, the students will have to attach the charts with their answer scripts.

Q: 1(a) 300 kg of fish at 5°C is to be frozen at –2°C. The specific heat of fish above freezing point is 4.182 kJ/kg-K and the latent heat of fusion is 234.5 kJ/ kg. Freezing point is –2°C. A refrigerator is used for this purpose which rejects heat in the ambient at 40°C. The COP of the refrigerator is 60% of the COP of a Carnot refrigerator operating between the same temperatures limits. How much power must be required to remove the heat in 10 hours? **[10]**

(b) Define the coefficient of performance of a Heat pump in words? Can it be greater than unity? Define refrigerating effect. Explain how one Ton of refrigeration is calculated? **[5+5]**

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Q: 2(a) Describe the following on Vapour compression refrigeration cycle. **[5+5]**

(i) Effect of condenser pressure, (ii) Effect of sub-cooling.

(b) An ideal vapour compression system uses R-12 as the refrigerant. The system uses an evaporator temperature of 0°C and a condenser temperature of 40°C.The capacity of the system is 7 TR. Considering simple saturated vapor compression cycle, determine

i) The mass flow rate of refrigerant

ii) Power required to run the compressor

iii) Heat rejected in the condenser

iv) COP of the system.

Use the properties of R-12 from the table given below:

Temp.(0°C)	Pressure (bar)	h_f(kJ/kg)	h_g(KJ/kg)	s_f(kJ/kg-k)	s_g(kJ/kg-k)
0	3.087	36.05	187.53	0.142	0.696
40	9.609	74.59	203.2	0.727	0.686

Take C_p for superheated vapour as 0.6 kJ/kg.K. **[10]**

Q: 3(a) Air enters the compressor of an reversed Brayton refrigeration cycle at 140 kPa, 270 K, with a volumetric flow rate of 1 m^3/s, and is compressed to 420 kPa. The temperature at the turbine inlet is 320 K. Determine (a) The net power input, in kW (b) The refrigerating capacity, in kW. (c) The coefficient of performance. **[12]**

(b) Derive the COP of a refrigeration system using Bell-Coleman cycle and show the state points on T-S diagram. **[8]**

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Q: 4(a) Explain with the help of neat sketches, vapour absorption cycle for refrigeration. How is it different from vapour compression refrigeration system? **[7+3]**

(b) Dry saturated steam at 4 bar is used in the generator of vapour absorption system. The evaporator is maintained at -5°C. Circulating cooling water rejects heat at 30°C in the condenser. Determine $(COP)_{max}$ for the system. Also, if the steam leaves the generator as saturated liquid, determine the consumption of steam per hour for 15TR refrigeration plant. Assume relative COP as 0.4. **[10]**

Q: 5(a) Define i) Relative humidity, ii) Specific humidity, iii) Dew point temperature iv) Degree of saturation of Moist air. Derive the relation between the relative humidity (φ) and degree of saturation (μ). **[5+5]**

(b) Moist air exists at 35°C DBT and 28°C WBT and at 1.01325 bar pressure. Using the psychrometric chart find the following .(i) Specific humidity, (ii) relative humidity, (iii) dew point temperature, (iv) specific volume and (v) specific enthalpy for this air. And hence also calculate the degree of saturation or percentage humidity for the air from the parameters already determined. **[10]**

Q: 6(a) Sketch a psychrometric chart and indicate the lines of constant wet bulb temperature, constant specific volume and constant relative humidity. Derive the equation to calculate the specific humidity (humidity ratio) of moist air. **[5+5]**

(b) Atmospheric air at 30°C dry bulb temperature and 75% relative humidity enters a cooling coil at the rate of 200m³/min. Coil dew point temperature is 14°C and the By-pass factor of the coil is 0.1.Determine (i) Temperature of air leaving cooling coil,(ii) capacity of cooling coil in kW,(iii) amount of water vapour removed per minute, (iv) sensible heat factor for the process. **[10]**

Q: 7(a) Describe the followings:

i) Cooling and Dehumidification, ii) By-pass factor of heating and cooling coils, iii) heating and dehumidification, iv) cooling and humidification. **[10]**

(b) What do you understand by primary and secondary refrigerants? Explain in brief.Why is the reversed Carnot cycle executed within a saturation curve and not a realistic model for refrigeration cycles? **[10]**