Name: **Enrolment No:**	

UPES

End Semester Examination, May 2025

Course: Refrigeration and Cold Chain **Semester: IV**

Program: B.Tech Food Technology **Time : 03 hrs.**

Course Code: MECH2038 **Max. Marks: 100**

Instructions: Assume suitable values for parameters/variables if they are not given in any question. Use the psychometric chart given at the end.

SECTION A

(5Q × 4M= 20 Marks)

S. No.		Marks	CO
Q 1	What are the key differences between chilling and freezing as methods of food preservation?	**4**	**CO1**
Q 2	Define a total loss refrigeration system. Provide examples of refrigerants used in these systems, their applications, and the types of food best preserved this way.	**4**	**CO2**
Q 3	(a) Discuss various types of heat loads experienced in a cold storage facility. (b) Differentiate between primary and secondary refrigerants.	**4**	**CO2**
Q 4	Explain the Bypass Factor (BPF) and Apparatus Dew Point (ADP) temperature.	**4**	**CO2**
Q 5	250 kg/h of air saturated at 2°C is mixed with 50 kg/h of air at 35°C and 80% RH. Determine the final state of the air.	**4**	**CO2**
SECTION B **(4Q × 10M = 40 Marks)**			
Q 6	An ammonia ice plant operates with a condensing temperature of 40°C and an evaporating temperature of -10°C. The plant aims to produce 10 metric tons of ice per 24 hours, starting from water at 20°C and freezing it to ice at -5°C. If the actual coefficient of performance (C.O.P.) of the plant is 65% of the theoretical C.O.P. of a reversed Carnot cycle operating between the same temperature limits, calculate: **(a)** The refrigeration effect required in kJ/day. **(b)** The power input to the compressor in kW. **(Given:** Specific heat of water = 4.187 kJ/kg·K, Latent heat of fusion of ice at 0°C = 333.5 kJ/kg, Specific heat of ice = 2.093 kJ/kg·K)	**10**	**CO3**

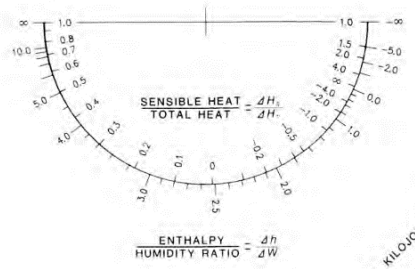
Q 7	On a particular day, the weather forecast states that the dry bulb temperature is 37^{o}C, the relative humidity is 50%, and the barometric pressure is 101.325 kPa. Find the humidity ratio, dew point temperature and enthalpy of moist air on this day. Will the moisture in the above air condense when it comes in contact with a cold surface whose surface temperature is 24^{o}C? Use the following information as per requirement. Saturation vapor pressure (p_s) @ 37^{o}C = 6.2795 kPa, @ 24^{o}C = 2.336 kPa **OR** The air-handling unit of an air-conditioning plant delivers a combined total of 6000 cmm of dry air. This consists of 25 per cent fresh air at 35°C DBT and 25°C WBT and 75 per cent recirculated air at 28°C DBT and 55 per cent RH. The air exits the cooling coil at a saturated state with a temperature of 15°C. Determine the total cooling load and room heat gain. Illustrate the process on the psychrometric chart.	**10**	**CO3**
Q 8	(a) Explain summer air conditioning for (i) hot and humid and (ii) hot and dry weather conditions. (b) Explain cooling with an adiabatic humidification process. (c) How will you achieve 24°C and 50% RH from 40°C and 50% RH? Discuss and illustrate the process on the psychrometric chart.	**10**	**CO3**
Q 9	Discuss the advantages and constraints associated with Controlled and Modified Atmosphere (CA/MA) storage systems, focusing on their application in preserving various agricultural commodities.	**10**	**CO4**
SECTION-C (2Q × 20M = 40 Marks)			
Q 10	**(a)** Discuss the following terms with respect to cold storage (i) Classification (ii) Insulation, (iii) Control of temperature and humidity, (iv) Vapor barrier, (v) Stacking and handling of materials **(b)** A cold storage facility is tasked with storing 100 tons of agricultural produce. The produce is to be stored at a desired temperature of 5°C, and the outside ambient temperature is expected to be 25°C. The relative humidity inside the storage is to be maintained at 80%. The thermal conductivity of the storage walls is 0.05 W/m°C, and the surface area of the walls is 500 m². The heat gain due to product respiration is estimated to be 0.02 kW per ton of produce. Calculate the total heat load on the cold storage facility and determine the refrigeration capacity (in tons) required to maintain the desired temperature. **OR** In a 100% outdoor summer air conditioning system, the room's sensible heat load is 320 kW, and the room's latent heat load is 80 kW. The desired indoor	**20**	**CO5**

	conditions are 23°C and 45% RH, while the outdoor design conditions are 32°C and 35% RH. The air is supplied to the room at a dry bulb temperature of 13°C. Determine (a) The necessary mass flow rate of air. (b) The moisture content of the supplied air. (c) Sensible and latent heat loads on the coil. (d) The required cooling capacity of the coil, Coil Sensible Heat Factor, and coil Apparatus Dew Point if the coil bypass factor is 0.2. The barometric pressure is 1 atm.		
Q 11	A large truck is to transport 40,000 kg of apples precooled to 3^{o}C under average ambient conditions of 25^{o}C and 90% relative humidity. The structure of the walls of the truck is such that the rate of heat transmission is UA = 70 W/^{o}C temperature difference between the ambient and the apples. From experience, ambient air is estimated to enter the cargo space of the truck through the cracks at a rate of 6 L/s, and the average heat of respiration of the apples at 3^{o}C is 0.015 W/kg for this particular load. Determine the refrigeration load of this truck and the amount of ice needed to meet the entire refrigeration need of the truck for a 20-hour trip. **Properties**: ***The humidity ratio of air is 0.0180 kg water vapor/kg dry air at 25^{o}C and 90% relative humidity, and 0.0047 at 3^{o}C and 100% relative humidity. The latent heat of vaporization of water at 3^{o}C is 2494 kJ/kg. The density of air at the ambient temperature of 25^{o}C and 1 atm is 1.184 kg/m^{3}, and its specific heat is C_p = 1.007 kJ/kg ^{o}C. The latent heat of ice is 335 kJ/kg***	**20**	**CO5**

ASHRAE PSYCHROMETRIC CHART NO. 1

NORMAL TEMPERATURE SEA LEVEL

BAROMETRIC PRESSURE 101.325 kPa.



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