Name: **Enrolment No:**	UPES UNIVERSITY WITH A PURPOSE

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, December 2019

Course: Refrigeration and Air Conditioning — **Semester: VII**
Program: B.TECH Mech. /Mech Splz. — **Time 03 hrs.**
Course Code: MHEG 484 — **Max. Marks: 100**

Instructions:
1. **Attempt all the questions in order.**
2. **Assume any other missing data.**
3. **Draw the T-s and P-v diagram wherever needed.**

Use of Refrigeration charts (Ammonia, R12, R11, R22 etc.), Steam Table, and Psychrometeric chart is allowed in the examination hall.

SECTION A

S. No.		Marks	CO
Q 1	A refrigerating system operates on the reversed Carnot cycle. The higher temperature of the refrigerant in the system is 35 deg. C and the lower temperature is -15 deg. C. The capacity is to be 12 tonnes. Neglect all losses. Determine: (i) Coefficient of performance (ii) Heat rejected from the system per hour.	**4**	**CO 2**
Q 2	State the effects and causes of moisture in refrigeration systems.	**4**	**CO 1**
Q 3	The atmospheric conditions are 20 deg. C and specific humidity of 0.0095 kg/kg of dry air. Calculate the following: (i) Partial pressure of vapour (ii) Relative humidity.	**4**	**CO 4**
Q 4	How are refrigerants designated? Enumerate the ideal properties of an ideal refrigerant.	**4**	**CO 3**
Q 5	Describe briefly about the following processes: (i) Heating and humidification (ii) Heating and dehumidification.	**4**	**CO 4**

SECTION B

Q 6	(a) Determine the theoretical COP for CO_2 machine working between temperature range of 25 deg. C and -5 deg. C. The dryness fraction of CO_2 gas during the suction stroke is 0.6. How many tonnes of ice would a machine working between the same limits and having a relative co-efficient of performance of 45% make in 24 hours? The water for the ice is supplied at 15 deg. C and the compressor takes 8.2 kg of CO_2 per minute. Latent heat of ice may be taken as 335 kJ/kg. The following properties are given:	**10**	**CO 2**

Temp.	Heat (kJ/kg)	Latent heat	Entropy (kJ/kg K)

		Deg. C	Liquid	Vapour	(kJ/kg)	Liquid	Vapour	
		25	81.17	202.5	121.34	0.251	0.644	
		-5	-7.53	236.8	245.2	- 0.042	0.841	
	(or) (b) A Bell-Coleman refrigerator operates between pressure limits of 1 bar and 8 bar. Air is drawn from the cold chamber at 9 deg. C, compressed and then it is cooled to 29 deg. C before entering the expansion cylinder. Expansion and compression follow the law $pv^{1.35}$ = constant. Calculate the theoretical COP of the system. For air take $\gamma = 1.4$, $C_p = 1.005$ kJ/kg K.							
Q 7	An air-water vapour mixture enters an air-conditioning unit at a pressure of 1 bar, 38 deg. C DBT, and a relative humidity of 75%. The mass of dry air entering is 1 kg/s. The air-vapour mixture leaves the air conditioning unit at 1 bar, 18 deg. C, 85% relative humidity. The moisture condensed leaves at 18 deg. C. Determine the heat transfer rate for the process.							**10**	**CO 5**
Q 8	The atmospheric conditions are 32 deg. C and specific humidity of 13.4 g/kg of air. Determine: (i) Partial pressure of vapour (ii) Relative humidity (iii) Dew point temperature. Atmospheric pressure = 758 mm Hg.							**10**	**CO 4**
Q 9	What are the functions of a compressor in a refrigeration system? Explain briefly about reciprocating compressor and centrifugal compressor with the help of neat diagram?							**10**	**CO 1**
	SECTION-C								
Q 10	(a) Explain about the following unitary central systems: (i) Induction units (ii) All-air high velocity systems (b) Design an air conditioning plant for a small office room for the following winter conditions: Outdoor conditions: 14 deg. C DBT and 10 deg. C WBT Required conditions: 20deg. C DBT and 60% R.H Amount of air circulation: 0.30 cubic. m/min/person Seating capacity of the office: 60 The required condition is achieved first by heating and then by adiabatic humidification. Determine the following: (i) Heating capacity of the coil in kW and the surface temperature required if the by-pass factor of coil is 0.4. (ii) The capacity of the humidifier. Solve the problem by using psychrometric chart.							**20**	**CO 5**
Q 11	(a) What is the function of a cooling tower? How does a natural draft tower differ from a mechanical draft tower?								

(b) A food storage locker requires a refrigeration system of 2400 kJ/min capacity at an evaporator temperature of 263 K and a condenser temperature of 303 K. The refrigerant used is Freon-12 and sub-cooled by 6 deg. C before entering the expansion valve and vapour is superheated by 7 deg. C before leaving the evaporator coil. The compressor of refrigerant is reversible adiabatic. The refrigeration compressor is two cylinder single acting with stroke equal to 1.25 times the bore and operates at 1000 r.p.m. Determine (using thermodynamic tables of properties for Freon-12): (i) Refrigerating effect per kg. (ii) Mass of refrigerant to be circulated per minute. (iii) Theoretical piston displacement per minute. (iv)Theoretical power required to run the compressor in kW (v) Heat removed through the condenser per minute (vi) Theoretical bore and stroke of compressor. Take: Liquid specific heat = 1.235 kJ/kg K, vapour specific heat = 0.733 kJ/kg K.

20 **CO 2**

Properties of Freon-12:

Sat. Temp. K	Absolute pressure	Specific vol. of vapour (m^3/kg)	Enthalpy (kJ/kg)		Entropy (kJ/kg K)	
			Liquid	Vapour	Liquid	Vapour
263	2.19	0.0767	26.9	183.2	0.1080	0.7020
303	7.45	0.0235	64.6	199.6	0.2399	0.6854

(or)

(c) Write a short note on air cooled and water cooled condenser with the help of neat diagrams?

(d) The evaporator and condenser temperatures of 20 tonnes capacity freezer are 28 deg. C and 23 deg. C respectively. The refrigerant -22 is subcooled by 3 deg. C before it enters the expansion valve and is superheated to 8 deg. C before leaving the evaporator. The compression is isentropic. A six cylinder single acting compressor with stroke equal to bore running at 250 rpm is used. Determine: (i) Refrigerating effect/kg. (ii) Mass of the refrigerant to be circulated per minute. (iii) Theoretical piston displacement per minute. (iv) Theoretical power. (v) C.O.P. (vi) Heat removed through condenser.