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

SECTION A (5 × 4 marks)

S. No.		Marks	CO
Q 1	A refrigerating machine working on reversed Carnot cycle consumes 5.5 kW for producing refrigerating effect of 940 kJ/min for maintaining a region at -38 deg. C. Determine (i) COP of refrigerating machine (ii) Higher temperature of cycle.	**4**	**CO 2**
Q 2	How can moisture be removed from a refrigeration system?	**4**	**CO 1**
Q 3	The pressure and temperature of air in a room are 1.0132 bar and 30 deg. C respectively. If the relative humidity is found to be 40%, estimate: (i) The partial pressure of water vapour (ii) The specific volume of each component.	**4**	**CO 4**
Q 4	State the properties and uses of the following refrigerants: (i) Ammonia (ii) R11 (Trichloro monofluoro methane)	**4**	**CO 3**
Q 5	Describe briefly about the following processes: (i) Sensible heating (ii) Cooling and dehumidification.	**4**	**CO 4**

SECTION B (4 × 10 marks)

Q 6	(a) In a refrigerator working on Bell-Coleman cycle, the air is drawn into the cylinder of the compressor from the cold chamber at a pressure of 1.03 bar and temperature 12 deg. C. After isentropic compression to 5.5 bar, the air is cooled at constant pressure to a temperature of 22 deg. C. The polytropic expansion $pv^{1.25}$ = constant then follows and the air expanded to 1.03 bar is passed to cold chamber. Determine: (i) Work done per kg of airflow (ii) Refrigerating effect per kg of airflow (iii) COP (iv) Refrigerating capacity of	**10**	**CO 2**

<table>
<tr><td></td><td>the plant in tonnes for a mass flow rate of 90 kg/h. For air take $\gamma = 1.4$, $C_p = 1.003$ kJ/kg K.
(or)
(b) A refrigerator works between -7 deg. C and 27 deg. C. The vapour is dry at the end of adiabatic compression. There is no under-cooling and evaporation is by throttle valve. Determine: (i) The co-efficient of performance (ii) Power of the compressor to remove 180 kJ/min. The properties of the refrigerant are as under:
<table>
<tr><th rowspan="2">Temp. (deg. C)</th><th colspan="2">Enthalpy (kJ/kg)</th><th rowspan="2">Entropy of liquid (kJ/kg K)</th><th rowspan="2">Entropy of vapor (kJ/kg K)</th></tr>
<tr><th>Liquid</th><th>Vapor</th></tr>
<tr><td>-7</td><td>-30</td><td>1298</td><td>-0.108</td><td>4.75</td></tr>
<tr><td>27</td><td>115</td><td>1173</td><td>427</td><td>4.33</td></tr>
</table></td><td></td><td></td></tr>
<tr><td>Q 7</td><td>A small-size cooling tower is designed to cool 5.5 litres of water per second, the inlet temperature of which is 44 deg. C. The motor-driven fan induces 9 cubic m/s of air through the tower and the power absorbed is 4.75 kW. The air entering the tower is at 18 deg. C, and has a relative humidity of 60%. The air leaving the tower can be assumed to be saturated and its temperature is 26 deg. C. Calculate: (i) The amount of cooling water (make-up) required per second (ii) The final temperature of the water. Assume that the pressure remains constant throughout the tower at 1.013 bar.</td><td>10</td><td>CO 5</td></tr>
<tr><td>Q 8</td><td>The pressure and temperature of air in a room are 1.0132 bar and 30 deg. C respectively. If the relative humidity is found to be 40%, estimate: (i) The partial pressure of water vapour (ii) The specific volume of each component; (iii) The specific humidity.</td><td>10</td><td>CO4</td></tr>
<tr><td>Q 9</td><td>What is a condenser? How are condensers classified? Explain briefly about aircooled condenser with the help of neat diagram and state its merits and demerits too?</td><td>10</td><td>CO 1</td></tr>
<tr><td colspan="4">SECTION-C (2 × 20 marks)</td></tr>
<tr><td>Q 10</td><td>(a) Define a ‘Unitary system’. Discuss briefly about the following (i) Attic fans (ii) Remote units (iii) Self-contained units
(b) Design an air conditioning system for an industrial process for the following hot and wet summer conditions:
Outdoor conditions: 32 deg. C DBT and 65% R.H.
Required air inlet conditions: 25 deg. C DBT and 60% R.H.
Amount of free air circulated: 250 cubic. m/min</td><td>20</td><td>CO 5</td></tr>
</table>

<table>
<tr>
<td></td>
<td>Coil dew temperature: 13 deg. C
The required condition is achieved by first cooling and dehumidifying and then by heating. Calculate the following: (i) The cooling capacity of the cooling coil and its by-pass factor (ii) Heating capacity of the heating coil in kW and surface temperature of the heating coil if the by-pass factor is 0.3 (iii) The mass of water vapour removed per hour.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q 11</td>
<td>(a) How are evaporators classified? Explain briefly about Flooded type evaporator with the help of a neat diagram?

(b) A Freon-12 vapour compression refrigeration system has a condensing temperature of 50 deg. C and evaporating temperature of 0 deg. C. The refrigeration capacity is 7 tonnes. The liquid leaving the condenser is saturated liquid and compression is isentropic. Determine (i) The refrigerant flow rate (ii) The power required to run the compressor (iii) The heat rejected in the plant (iv) COP of the system. Take enthalpy at the end of isentropic compression = 210 kJ/kg. The properties of F-12 are detailed in table below.

<table>
<tr><th>Temp deg. C</th><th>Pressure bar</th><th>h_f kJ/kg</th><th>h_g kJ/kg</th><th>s_f kJ/kg K</th><th>s_g kJ/kg K</th></tr>
<tr><td>50</td><td>12.199</td><td>84.868</td><td>206.298</td><td>0.3034</td><td>0.6792</td></tr>
<tr><td>0</td><td>3.086</td><td>36.022</td><td>187.397</td><td>0.1418</td><td>0.6960</td></tr>
</table>

(or)

(a) Explain briefly about automatic expansion valve and thermostatic expansion valve? What are the advantages of using an expansion valve instead of an expander in a vapour compression refrigeration cycle?

(b) An ice-making machine operates on ideal vapour compression refrigeration cycle using refrigerant R-12. The refrigerant enters the compressor as dry saturated vapour at -15 deg. C and leaves the condenser as saturated liquid at 30 deg. C. Water enters the machine at 15 deg. C and leaves as ice at -5 deg. C. For an ice production rate of 2400 kg in a day, determine the power required to run the unit. Find also the COP of the machine. Use refrigerant table only to solve the problem. Take the latent heat of fusion for ice as 335 kJ/kg.</td>
<td>20</td>
<td>CO 2</td>
</tr>
</table>