INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

MECHANICAL ENGINEERING

TUTORIAL QUESTION BANK

Course Name	:	**REFRIGERATION AND AIR CONDITIONING**
Course Code	:	**A60334**
Class	:	III B. Tech II Semester
Branch	:	Mechanical Engineering
Year	:	2017 – 2018
Course Coordinator	:	Dr.CH V K N S N Moorthy, Professor, Department of Mechanical Engineering.
Team of Instructors	:	Dr. CH V K N S N Moorthy, Professor. Mr. A. Somaiah, Assistant Professor.

COURSE OVERVIEW:

Refrigeration and air conditioning continues to grow in importance in every segment of our day-to-day living. The course covers various conventional refrigeration systems like air, vapour compression, vapour absorption and steam jet refrigeration systems, also describes some unconventional refrigeration systems; thermoelectric refrigeration, Hilsch tube, etc.. The course introduces the psychometry, various air conditioning systems and heat pump circuits.

S. No	Question	Blooms Taxonomy Level	Course Outcome
	UNIT – I		
	PART - A (SHORT ANSWER QUESTIONS)		
1	Define Unit of refrigeration.	Remember	3
2	Define Coefficient of performance.	Understand	3
3	What is the effect of sub cooling of liquid on the COP?	Remember	3
4	What is the effect of super heating of vapor on the COP?	Understand	3
5	Define Wet compression	Remember	3
6	What is the effect of increase of suction pressure on COP?	Remember	3
7	Define Dry compression	Remember	3
8	What is the effect of decrease of delivery pressure on COP?	Understand	3
9	What is a heat pump?	Remember	3
10	A refrigerator operates between the temperatures of -23^{O}C and 27 ^{O}C. Determine the minimum power required per ToR to operate the refrigerator.	Understand	3
11	Draw the p-h diagram for sub cooling with dry compression.	Remember	3
12	Discuss the governing law of refrigeration.	Understand	3
13	Draw the T-S diagram for sub cooling with dry compression.	Remember	3
14	Define sub cooling.	Understand	3
15	What is superheat horn?	Remember	3
16	Give some applications of refrigerator.	Understand	3
17	Define refrigeration.	Remember	3
18	What are the disadvantages of wet compression?	Understand	3
19	Draw the p-h diagram for sub cooling with wet compression.	Remember	3
20	Classify the refrigerants and state physical properties.	Understand	3

<table>
<tr><th>S. No</th><th>Question</th><th>Blooms Taxonomy Level</th><th>Course Outcome</th></tr>
<tr><td colspan="4">PART - B (LONG ANSWER QUESTIONS)</td></tr>
<tr><td>1</td><td>Describe the mechanism of a simple vapour compression refrigeration system.</td><td>Understand</td><td>3</td></tr>
<tr><td>2</td><td>What are the important types of vapour compression cycles? Explain with the help of P-h diagram.</td><td>Remember</td><td>3</td></tr>
<tr><td>3</td><td>The capacity of a refrigerator is 200 TR when working between -6^{0}C and 25^0 C. determine the mass of ice produced per day from water at 25^{0}C. Also find the power required to drive the unit. Assume that the cycle operates on reversed Carnot cycle and latent heat of ice is 335 KJ/Kg.J</td><td>Understand</td><td>3</td></tr>
<tr><td>4</td><td>An ammonia refrigerator produces 30 tonnes of ice from and at 0^{0}C in 24 hours. The temperature range of the compressor is 25^{0}C to -15^{0}C. The vapour is dry saturated at the end of compression and an expression and an expansion value is used. Assume a coefficient of performance to be 60% of the theoretical value. Calculate the power required to drive the compressor. Latent heat of ice = 335 kJ/kg. Properties of ammonia are;
<table>
<tr><td rowspan="2">Temperature ^{0}C</td><td colspan="2">Enthalpy kJ/kg</td><td colspan="2">Entropy kJ/kg</td></tr>
<tr><td>Liquid</td><td>Vapour</td><td>Liquid</td><td>Vapour</td></tr>
<tr><td>25</td><td>298.9</td><td>1465.84</td><td>1.1242</td><td>5.0391</td></tr>
<tr><td>-15</td><td>112.34</td><td>1426.54</td><td>0.4572</td><td>5.5490</td></tr>
</table></td><td>Remember</td><td>3</td></tr>
<tr><td>5</td><td>Explain how you would detect whether a refrigerant is under charged or over charged.</td><td>Understand</td><td>3</td></tr>
<tr><td>6.</td><td>A R12 refrigerating machine works on a vapor compression cycle. The temperature of refrigerant in the evaporator is -20^{0}C. The vapor is dry saturated when it enters the compressor and leaves it in a superheated condition. The condenser temperature is 30^{0}C. Assuming Cp for R12 in the superheated condition as 1.884 KJ/Kg K, determine: i) Condition of vapor at the entrance to the condenser, ii) Condition of vapor at the entrance to the evaporator and iii) COP_{th} of the machine. Properties of R12
<table>
<tr><th>Temp^{0}C</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>-20</td><td>17.82</td><td>178.73</td><td>0.0731</td><td>0.7087</td></tr>
<tr><td>30</td><td>64.59</td><td>199.62</td><td>0.2400</td><td>0.6843</td></tr>
</table></td><td>Remember</td><td>3</td></tr>
<tr><td>7</td><td>What is the effect of sub-cooling on COP? Explain.</td><td>Understand</td><td>3</td></tr>
<tr><td>8</td><td>A refrigeration system works on ammonia between pressure limits, 2.36 bar and 15.54 bar. If the refrigerant is sub cooled by 10k before throttling, determine the improvement in COP over simple vapor compression cycle.</td><td>Understand</td><td>3</td></tr>
<tr><td>9</td><td>An ammonia ice plant operates between condenser temperature of 35^{0}C and an evaporator temperature of -15^{0}C. It produces 5 tonnes of ice per day from water at 25^{0}C to ice at -5^{0}C. The ammonia enters as dry saturated vapor and leaves the condenser as saturated liquid.
Determine:
a) The capacity of the refrigerating plant
b) Mass flow of the refrigerant
c) Discharge temperature of ammonia from the compressor d) Power of the compressor motor if the isentropic efficiency of the compressor is 85% and mechanical efficiency of the compressor is 90% e) Relative efficiency. The latent heat of formation of ice is 335 kj/kg and specific heat of ice is 2.1 kj/kg-k.</td><td>Remember</td><td>3</td></tr>
<tr><td>10</td><td>Distinguish between dry and wet compression. What are the advantages of one over the other?</td><td>Understand</td><td>3</td></tr>
<tr><td>12</td><td>A refrigerator using CO_2 as refrigerant works between the temperatures 17.5^{0}C and -17.5^{0}C. The CO_2 leaves the compressor at 30^{0}C. The gas is completely condensed but there is no under cooling. Calculate theoretical COP.</td><td>Remember</td><td>3</td></tr>
<tr><td>13</td><td>Explain how you would detect whether a refrigerant is under charged or over charged.</td><td>Understand</td><td>3</td></tr>
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<tr><th>S. No</th><th>Question</th><th>Blooms Taxonomy Level</th><th>Course Outcome</th></tr>
<tr><td>14</td><td>An ammonia refrigerator works between - 6.7^{0}C and 26^{0}C. The vapour leaves the compressor in dry and saturated condition. Assuming there is no under cooling; calculate the theoretical COP of the system.</td><td>Remember</td><td>3</td></tr>
<tr><td>15</td><td>An ammonia refrigerator works between -6.7^{0}C and 26.7^{0}C, the vapor being dry at the end of isentropic compression. There is no under cooling of liquid ammonia and the liquid is expanded through a throttle valve after leaving the condenser. Sketch the cycle on the T-S and P-h diagram and calculate the refrigeration effect per Kg of ammonia and the theoretical COP of the unit with the help of properties given below.
<table>
<tr><td>Temp^{0}C</td><td>h_f, KJ/Kg</td><td>h_g, KJ/Kg</td><td>S_f, KJ/Kg K</td><td>S_g, KJ/Kg K</td></tr>
<tr><td>-6.7</td><td>152.18</td><td>1437.03</td><td>0.6016</td><td>5.4308</td></tr>
<tr><td>26.7</td><td>307.18</td><td>1467.03</td><td>1.1515</td><td>5.0203</td></tr>
</table></td><td>Understand</td><td>3</td></tr>
<tr><td>16</td><td>Explain the effect of sub cooling of liquid and superheat of vapor on the system performance.</td><td>Understand</td><td>3</td></tr>
<tr><td>17</td><td>An ammonia refrigerating machine fitted with an expansion valve works between the temperature limits of -10^{0}C and 30^{0}C. The vapor is 95% dry at the end of isentropic compression and the fluid leaving the condenser is at 30^{0}C. Assuming actual COP as 60% of the theoretical, calculate the Kgs of ice produced per KW hour at 0^{0}C from water at 10^{0}C. Latent heat of ice is 335 KJ/Kg. ammonia has the following properties
<table>
<tr><td>Temp^{0}C</td><td>h_f, KJ/Kg</td><td>h_{fg}, KJ/Kg</td><td>S_f,KJ/Kg K</td><td>S_g, KJ/Kg K</td></tr>
<tr><td>30</td><td>323.08</td><td>1145.80</td><td>1.2037</td><td>4.9842</td></tr>
<tr><td>-10</td><td>135.37</td><td>1297.68</td><td>0.5443</td><td>5.4770</td></tr>
</table></td><td>Understand</td><td>3</td></tr>
<tr><td>18</td><td>Five hundred kgs of fruits are supplied to a cold storage at 20^{0}C. The cold storage is maintained at -5^{0}C and the fruits get cooled to the storage temperature in 10 hours. The latent heat of freezing is 105 kj/kg and specific heat of fruit is 1.256 kj/kg k. Find the refrigeration capacity of the plant.</td><td>Understand</td><td>3</td></tr>
<tr><td>19</td><td>A machine working on a Carnot cycle operates between 305 K and 260 K. Determine the COP when it is operated as i) a refrigerator ii) a heat pump and a iii) a heat engine</td><td>Understand</td><td>3</td></tr>
<tr><td>20</td><td>Derive an expression for COP of Carnot refrigerator and plot T-S and P-V diagrams of the cycle.</td><td>Understand</td><td>3</td></tr>
<tr><td colspan="4">PART - C (ANALYTICAL QUESTIONS)</td></tr>
<tr><td>1</td><td>A Carnot refrigeration cycle absorbs heat at 270K and rejects it at 300K.
i. Calculate the COP of this refrigeration cycle.
ii. If the cycle is absorbing 1130 KJ/min. At 270 K, how many KJ of work is required per second?
iii. If the Carnot heat pump operates between the same temperatures as the above refrigeration cycle, what is the COP?
iv. How many kj/min will the heat pump deliver at 300K if it absorbs 1130 KJ/min at 270K.</td><td>Understand</td><td>3</td></tr>
<tr><td>2</td><td>1.5kw per tonne of refrigeration is required to maintain the temperature of -40^{0}C in the refrigerator. If the refrigeration cycle works on carnot cycle, determine the following:
i. COP of the cycle
ii. temperature of the sink
iii. heat rejected to the sink per tonne of refrigeration
iv. heat supplied and EPR if the cycle is used as a heat pump.</td><td>Understand</td><td>3</td></tr>
</table>

<table>
<tr><th>S. No</th><th>Question</th><th>Blooms Taxonomy Level</th><th>Course Outcome</th></tr>
<tr><td>3</td><td>A vapour compression refrigerator works between the pressure limits of 60 bar and 25 bar. The working fluid is just dry at the end of compression and there is no under cooling of the liquid before the expansion valve. Determine: 1. COP of the the cycle and 2. Capacity of the refrigerator if the fluid flow is at the rate fo 5 Kg/min.
<table>
<tr><th rowspan="2">Pressure, bar</th><th rowspan="2">Sat.Temp.,K</th><th colspan="2">Enthalpy, Kj/Kg</th><th colspan="2">Entropy, Kj/Kg</th></tr>
<tr><th>Liquid</th><th>vapor</th><th>Liquid</th><th>vapor</th></tr>
<tr><td>60</td><td>295</td><td>151.96</td><td>293.29</td><td>0.554</td><td>1.0332</td></tr>
<tr><td>25</td><td>261</td><td>56.32</td><td>322.58</td><td>0.226</td><td>1.2464</td></tr>
</table></td><td>Understand</td><td>3</td></tr>
<tr><td>4</td><td>Establish with a neat p-h and T-S diagrams, how an actual cycle differs from a theoretical vapour compression cycle.</td><td>Understand</td><td>3</td></tr>
<tr><td>5</td><td>Sketch the T-S and p-h diagrams for the vapour compression cycles when the vapour after compression is:
i. Dry saturated
ii. Wet
iii. Super heated and
iv. Wet before compression</td><td>Understand</td><td>3</td></tr>
<tr><td colspan="4">UNIT – II</td></tr>
<tr><td colspan="4">PART - A (SHORT ANSWER QUESTIONS)</td></tr>
<tr><td>1</td><td>What is the function of accumulator in a flooded type evaporator refrigerator?</td><td>Remember</td><td>4</td></tr>
<tr><td>2</td><td>What is the name of bank of tubes at the back of domestic refrigerator?</td><td>Understand</td><td>4</td></tr>
<tr><td>3</td><td>What type of the compressor is used in domestic refrigerator?</td><td>Remember</td><td>4</td></tr>
<tr><td>4</td><td>What type of expansion devise is used in domestic refrigerator?</td><td>Understand</td><td>4</td></tr>
<tr><td>5</td><td>Which component of the vapor compression refrigeration system produces the refrigeration effect.</td><td>Remember</td><td>4</td></tr>
<tr><td>6</td><td>For small installations of refrigeration systems (up to 35kW) which type of condenser is used?</td><td>Understand</td><td>4</td></tr>
<tr><td>7</td><td>During which component of the VCR system, the enthalpy of the refrigerant remains constant?</td><td>Remember</td><td>4</td></tr>
<tr><td>8</td><td>A capillary tube is used in a small refrigerator to serve the purpose of which component of the refrigerating system?</td><td>Understand</td><td>4</td></tr>
<tr><td>9</td><td>Why a throttle valve is used in refrigerating system in place of expander?</td><td>Remember</td><td>4</td></tr>
<tr><td>10</td><td>Write the correct sequential order of the different components in VCR system starting from the Compressor.</td><td>Understand</td><td>4</td></tr>
<tr><td>11</td><td>What do you mean by hermetically sealed compressor?</td><td>Remember</td><td>4</td></tr>
<tr><td>12</td><td>Give the classification of expansion devices.</td><td>Understand</td><td>4</td></tr>
<tr><td>13</td><td>What do you mean by open type compressor?</td><td>Remember</td><td>4</td></tr>
<tr><td>14</td><td>Give the classification of compressors.</td><td>Understand</td><td>4</td></tr>
<tr><td>15</td><td>What do you mean by bare tube coil evaporator?</td><td>Remember</td><td>4</td></tr>
<tr><td>16</td><td>What do you mean by semi-hermetically sealed compressor?</td><td>Understand</td><td>4</td></tr>
<tr><td>17</td><td>Give the classification of evaporators.</td><td>Remember</td><td>4</td></tr>
<tr><td>18</td><td>What do you mean by undercharging?</td><td>Understand</td><td>4</td></tr>
<tr><td>19</td><td>Give the classification of condensers.</td><td>Remember</td><td>4</td></tr>
<tr><td>20</td><td>What do you mean by overcharged?</td><td>Understand</td><td>4</td></tr>
<tr><td colspan="4">PART - B (LONG ANSWER QUESTIONS)</td></tr>
<tr><td>1</td><td>Classify the compressors and explain the working, advantages and disadvantages of reciprocating compressors with neat sketch.</td><td>Understand</td><td>4</td></tr>
<tr><td>2</td><td>Classify the compressors and explain the working, advantages and disadvantages of centrifugal compressors with neat sketch.</td><td>Understand</td><td>4</td></tr>
<tr><td>3</td><td>Classify the compressors and explain the working, advantages and</td><td>Understand</td><td>4</td></tr>
</table>

S. No	Question	Blooms Taxonomy Level	Course Outcome
	disadvantages of rotary compressors with neat sketch.		
4	Classify the compressors and explain the working, advantages and disadvantages of screw compressors with neat sketch.	Understand	4
5	Describe the hermetically and semi hermetically sealed compressors, also give their merits and demerits.	Remember	4
6	Describe the working principle of shell and tube type evaporator with neat sketch.	Understand	4
7	Describe the working principle of shell and coil type evaporator with neat sketch.	Understand	4
8	a) What problems do lubricating oil causes in the evaporator? b) With a neat diagram, explain the function of flooded type evaporator.	Remember	4
9	Explain the working of a dry expansion type evaporator with a neat sketch.	Understand	4
10	Describe the working principle of bare tube coil, finned tube coil and plate type evaporators with neat sketches.	Understand	4
11	Explain the working of natural convection and forced convection type evaporator, also discuss their merits and demerits.	Understand	4
12	How do you identify the frosting, non-frosting and defrosting evaporators, explain.	Remember	4
13	Explain the working of an automatic expansion valve with the help of a neat sketch.	Understand	4
14	With the help of a schematic diagram, explain the functioning of thermostatic expansion valve.	Understand	4
15	Describe the working principle of low side float valve, with a neat sketch.	Remember	4
16	Describe the working principle of high side float valve, with a neat sketch.	Understand	4
17	With the help of a neat diagram, explain the working of fixed opening type expansion valve.	Understand	4
18	With the help of a schematic diagram, explain the Working of air cooled condensers.	Understand	4
19	With the help of a schematic diagram, explain the Working of water cooled condensers.	Understand	4
20	With the help of a schematic diagram, explain the Working of evaporative condenser.	Remember	4
	PART - C (ANALYTICAL QUESTIONS)		
1	How do you select the compressor for particular application and give some refrigerants and compressor pairs.	Remember	4
2	How do you select the condenser for particular application and the differences between air cooled, water cooled and evaporative condensers?	Remember	4
3	What are the differences between fixed opening type and varying opening type of expansion devices, also give some refrigerants and suitable materials pairs.	Remember	4
4	How the length and diameter of the evaporator coils will affect the system performance, discuss?	Understand	4
5	Give the advantages and disadvantages of hermetically sealed, semi hermetically sealed and open type compressors.	Understand	4
	UNIT – III		
	PART - A (SHORT ANSWER QUESTIONS)		
1	Why the boiling point difference of absorbent-refrigerant should be high.	Remember	1
2	What is the effect of latent heat of absorbent on performance of the absorption systems?	Understand	1
3	What is the refrigerant in Li-Br and water absorption system?	Remember	1
4	What is the refrigerant in Ammonia and water absorption system?	Understand	1
5	What is the function of rectifier in Ammonia absorption system?	Remember	1
6	What are the desirable requirements of a Refrigerant - Absorption pair?	Understand	1
7	Name air refrigeration cycle and What are the processes of Air refrigeration cycle?	Remember	1
8	If in an air refrigeration plant, the temperatures of air entering and leaving	Understand	1

S. No	Question	Blooms Taxonomy Level	Course Outcome
	the expander are 300K and 200K respectively, determine the COP of the plant assuming isentropic compression and expansion.		
9	Which parts replace the function of compressor in absorption system?	Remember	1
10	What are the three fluids used in Electrolux refrigeration?	Understand	1
11	Define absorbent and adsorbent.	Remember	1
12	What do you mean by the product of COP of refrigerator and heat engine?	Understand	1
13	What is the other name of an Electrolux refrigerator?	Remember	1
14	Who invented the Electrolux refrigerator principle?	Understand	1
15	What is the role of hydrogen in Electrolux refrigerator?	Remember	1
16	What is the absorbent in lithium bromide absorption system?	Understand	1
17	What is the refrigerant in lithium bromide absorption system?	Remember	1
18	What are the disadvantages of absorption refrigeration over compression system?	Understand	1
19	What is the difference between 2-shell and 4-shell Li-Br absorption system?	Understand	1
20	What is the function of absorber in the vapor absorption system?	Remember	1
21	What is the absorbent in Li-Br and water absorption system?	Understand	1
22	What is the absorbent in Ammonia and water absorption system?	Understand	1
23	What is the function of analyzer in Ammonia absorption system?	Remember	1
24	Write the expression for COP of aqua ammonia vapor absorption system	Understand	1
1	Name air refrigeration cycle and What are the processes of Air refrigeration cycle?	Remember	1
2	If in an air refrigeration plant, the temperatures of air entering and leaving the expander are 300K and 200K respectively, determine the COP of the plant assuming isentropic compression and expansion.	Understand	1
3	Which component in steam jet refrigeration system replaces the compressor of VCR system?	Remember	1
4	List the major disadvantages of steam jet refrigeration system	Understand	1
5	Define absorbent and adsorbent.	Remember	1
6	State the principle of steam jet refrigeration system	Understand	1
7	What is the nature of velocity of steam at the exit of nozzle in steam jet refrigeration system?	Remember	1
8	Where the expansion of motive steam takes place in a steam jet refrigeration system?	Understand	1
9	What is the other name of an Electrolux refrigerator?	Remember	1
10	What is the formula for the COP of an air refrigeration cycle?	Understand	1
11	What is the principle of dense air system?	Remember	1
12	What is the principle of open air system?	Understand	1
13	Define entrainment and state whether the process of entrainment is reversible or irreversible?	Remember	1
14	What is the function of flash chamber in steam jet refrigeration system?	Understand	1
15	Draw actual and theoritical Bell coleman cycle.	Understand	1
16	State the expression for C.O.P of Bell coleman cycle.	Remember	1
17	List the advantages of air refrigeration.	Understand	1
18	Draw the diagram of steam ejector.	Remember	1
19	List the disadvantages of air refrigeration.	Understand	1
20	State the function of a steam ejector.	Remember	1
21	Define nozzle efficiency.	Understand	1
22	Write the expression for diffuser efficiency.	Remember	1
23	Compare air refrigeration with V.C.R.S	Understand	1
24	Compare air refrigeration with steam jet refrigeration system.	Understand	1
	PART - B (LONG ANSWER QUESTIONS)		
1	Explain the working of a simple vapor absorption refrigeration system with a neat sketch.	Understand	1

S. No	Question	Blooms Taxonomy Level	Course Outcome
2	What are the different refrigerant - absorbent working pairs and what is the effect of evaporator temperature on performance of absorption systems.	Understand Remember	1
3	Discuss the advantages of vapor absorption refrigeration system over vapor compression refrigeration system.	Understand,	1
4	Describe with a neat sketch the working of lithium Bromide (two shell) water absorption system.	Understand,	1
5	Describe with a neat sketch the working of lithium Bromide (Four shell) water absorption system.	Remember	1
6	Explain the working of a practical Ammonia-water vapour absorption refrigeration system with neat sketch.	Understand	1
7	Explain with neat sketch Domestic Electrolux Refrigerator, with the functions of hydrogen, ammonia and water in the three fluid refrigeration system.	Remember	1
8	Explain the function of liquid-vapour heat exchanger between the generator and absorber and how it can improve the performance of the vapour absorption system.	Understand	1
9	Derive an expression for the COP of vapor absorption refrigeration system.	Understand	1
10	Calculate the COP of vapour absorption refrigeration system has the generator temperature of 80^0C, condenser temperature of 25^0C and an evaporator temperature of -10^0C.	Remember	1
11	In an absorption refrigeration system heating, cooling and refrigeration takes place at the temperature of 150^0C, 30^0C and -20^0C. Find the theoretical COP of the system; if the heating temperature is increased to 200^0C and refrigeration temperature is decreased to -40^0C. Calculate the percentage of change in theoretical COP.	Understand	1
12	Derive an expression for the C.O.P of a Bell-Coleman cycle refrigeration system.	Understand	1
13	A refrigerator is working between the temperatures – 30^0C and 35^0C. What is the maximum possible COP of the refrigerator? If the actual COP is 75% of maximum, determine the refrigerating effect per KW of power input.	Understand	1
14	Show that the coefficient of performance of an air cycle system is only a function of pressure ratio.	Understand	1
15	An air refrigeration system operates with a cooler pressure 10 bar and refrigerator pressure 2 bar. The temperature of the air leaving the cooler is 25^0C and the air leaving the room is 3^0C. The compressor displacement is 30 cubic meter/min. Find i. Tons of refrigeration. ii. Power per ton. iii. Expander displacement in cum/min.	Understand	1
16	A Bell - Coleman cycle works between 1 and 6 bar pressure limits. The compression and expansion indices are 1.25 and 1.3 respectively. Obtain COP and tonnage of the unit for an airflow rate of 0.5 kg/s. Neglect clearance volume and take temperature at the beginning of compression and expansion to be 7^0C and 37^0C, respectively.	Remember	1
17	Refrigerator working on Bell-Coleman cycle operates between pressure limits of 1.05 bar and 8.5 bar. Air is drawn from the cold chamber at 10^0C, compressed and then is cooled to 30^0C, before entering the expansion cylinder. The expansion and compression follow the law, $PV^{1.3}$ = constant. Determine the theoretical cop of the system.	Understand	1
18	In a Steam jet refrigeration system dry saturated steam at 7 bar abs. pressure is supplied. The flash chamber temperature is 5^0C, the condenser temperature is 40^0C, make up water is supplied at 20^0C. Assuming that quality of motive steam and flash vapour at the beginning of compression as	Remember	1

S. No	Question	Blooms Taxonomy Level	Course Outcome
	93% dry and efficiency of the nozzle, efficiency of entertainment and the efficiency of the thermo-compressor as 90%, 65% and 91% respectively. Determine: (a) Weight of steam required per hour per ton of refrigeration. (b) The volume of vapour removed from the flash chamber per hour per ton of refrigeration.		
19	Explain the principle and working of steam jet refrigeration system and the function of steam ejector with a neat sketch.	Understand	1
20	Draw the temperature-entropy and enthalpy-entropy diagram of a steam jet refrigeration system and write the expressions for the following efficiencies; i. Nozzle ii. Entrainment and iii. Compression	Remember	1
	PART - C (ANALYTICAL QUESTIONS)		
1	Explain the function of ammonia, water and hydrogen in Electrolux refrigerator?	Understand	1
2	Describe the working of steam jet refrigeration system with a neat sketch.	Remember	1
3	Derive the expression for COP of aqua ammonia vapour absorption system with a neat sketch of simple VAS.	Understand	1
4	A vapour compression cycle with ammonia as the refrigerant works between the limits of saturated suction temperature of -20^0C and saturated condensing temperature 30^0C. It is a simple saturated cycle and compression is isentropic; determine the work of compression per kg of ammonia. Compare the same, if ammonia vapour leaving the evaporator at -20^0C is absorbed by water so that the mass concentration in the solution reaches about 40%, and its solution is pumped to the condenser pressure. The specific volume of the solution may be assumed as $0.001161 m^3/kg$	Understand	1
5	Sketch the steam jet refrigeration on T-s diagram and analyze the nozzle efficiency, entrainment efficiency, compression efficiency and mass of motive steam required.	Understand	1
	UNIT – IV		
	PART - A (SHORT ANSWER QUESTIONS)		
1	Define Air-conditioning.	Remember	2
2	What is wet bulb temperature?	Understand	2
3	Define degree of saturation	Remember	2
4	Sketch the process of heating and humidification on psychometric chart.	Understand	2
5	Define Relative humidity	Remember	2
6	What is Apparatus Dew Point?	Understand	2
7	Give the expression for Sensible Hea Factor.	Remember	2
8	Define Dew Point Temperature.	Understand	2
9	Sketch the process of cooling and humidification on psychometric chart.	Remember	2
10	Define Dalton's Law.	Understand	2
11	Sketch the process of sensible heating on psychometric chart.	Remember	2
12	Define and plot cooling and dehumidification process on psychometric chart	Understand	2
13	Draw the process of humidification on psychometric chart.	Remember	2
14	Define and write the formula for BPF.	Understand	2
15	Sketch the process of sensible cooling on psychometric chart.	Remember	2
16	Draw the process of cooling and dehumidification on psychometric chart.	Understand	2
17	Write any two major requirements of human comfort	Remember	2
18	Sketch the process of heating and dehumidification on psychometric chart.	Understand	2
19	List any two requirements of industrial air conditioning	Remember	2
20	Sketch the process of dehumidification on psychometric chart.	Understand	2
	PART - B (LONG ANSWER QUESTIONS)		
1	Ten grams of moisture per kg of dry air is removed from atmospheric air	Understand	2

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	when it is passed through an air conditioning system and its temperature becomes 20^0C. The atmospheric conditions are 40^0C DBT and 60% RH. Calculate the following for the conditioned air. i. Relative humidity, ii. Wet-bulb temperature, iii. Dew point temperature, iv. Enthalpy change for the air. Assume standard atmospheric pressure.		
2	(a) When is dehumidification of air necessary and how it is achieved? (b) Represent the following process in a skeleton psychometric chart. i. Sensible cooling ii. Cooling and humidification iii. Adiabatic mixing of air streams.	Understand	2
3	Explain the following with neat sketch i. Partial pressure of water vapour ii. Dew Point Temperature iii. Relative Humidity and Degree of saturation.	Remember	2
4	a) Write a short note on the bypass factor of the cooling coils. b) The sensible heat factor of an air-conditioned room is 0.67. The condition of the air leaving the air-conditioned room is 27^0C DBT and 52% RH. The maximum permissible temperature difference between the inlet air and outlet air is 11^0C. If the quantity of air flow at the inlet of the room is 180m^3/min, then determine the sensible and latent heat load of air conditioned room.	Understand,	2
5	An air conditioned hall of 1100 m^3 volume is maintained at 22^0C DBT and 52% RH. When outdoor air conditions are 45^0C DBT and 26^0C WBT, the hall sensible heat load is 23kw. The fresh air is 22% of the total air supplied. The ADP of the cooling coil is 10^0C and its bypass factor is 0.12. Calculate a) The condition and flow rate of supply air b) The latent heat gain of the room c) The cooling capacity of the coil.	Understand	2
6	The following data refer to an air conditioning system for industrial process for hot and wet summer conditions: outdoor conditions = 33^0C DBT and 78% RH, required conditions = 20^0C DBT and 73% RH, amount of out-door air supplied = 220 m^3/min, coil dew point temperature = 12^0C. If the required condition is achieved by first cooling and dehumidifying and then by heating, determine; (a) The capacity of the cooling coil and its by-pass factor. (b) The capacity of the heating coil and surface temperature of the heating coil if the by-pass factor is 0.18.	Understand	2
7	Derive the expression for the specific humidity and relative humidity.	Remember	2
8	List out different sources that contribute to the sensible heat load of the room to be air conditioned and Explain the procedure to construct the RSHF line on a psychrometric chart.	Understand	2
9	An air conditioned auditorium is to be maintained at 27^0C DBT and 60% RH. The ambient condition is 40^0C DBT and 30^0C WBT. The total sensible heat load is 100000 KJ/h and total latent heat load is 40000 KJ/h. 60% of the return air is recirculated and mixed with 40% of make-up air after the cooling coil. The condition of air leaving the cooling coil is at 18^0C. Determine: (i) Room Sensible Heat Factor (ii) The condition of air entering the auditorium; (iii) The amount of make-up air; Show the process on psychrometric chart.	Understand	2
10	Define the "human comfort", and explain the factors which affect the human comfort.	Understand	2
11	The air in a room is to be maintained at 19^0C and 54 % R.H. by air supplied at a temperature of 14^0C. The design out-door conditions are as follows: Sensible heat gain: 20000 kJ/hr, Latent heat gain: 4000 kJ/hr, Out-door conditions: 30^0C DBT and 42% R.H. The ratio of recirculated air to fresh air is fixed at 2.8: 1 by weight .The plant consists of direct expansion cooling coil and after-heater and a constant speed fan. Calculate: (a) The quantity of air supplied per minute in cubic meters	Remember	2

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	(b) The load on refrigerating plant in tons of refrigeration assuming the bypass factor of the cooling coil 0.15 (c) The load on after - heater in kW.		
12	Why ventilation is required? Explain why different ventilation standards for different purposes are recommended.	Understand	2
13	An air conditioned plant is to be designed for a small office for winter conditions: Outdoor conditions are 10^0C DBT and 8^0C WBT, required indoor conditions are 20^0C DBT and 60% RH, amount of air circulation is 0.3 m^3/min./person, seating capacity of the office is 50 persons. The required condition is achieved first by heating and then by adiabatic humidifying, determine; i. Heating capacity of the coil in KW and the surface temperature; if the by-pass factor of the coil is 0.32; and ii. Capacity of the humidifier.	Understand	2
14	The atmospheric air at 180C DBT and 70% RH is supplied to the heating chamber at the rate of 120m^3/min. The leaving air has a temperature of 24^0C without change in its moisture contents. Determine the heat added to the air per minute and final RH of the air.	Understand	2
15	What are the important considerations in the design of an air conditioning system?	Understand	2
16	Give the classification of the effects of heat on human body? Explain briefly.	Understand	2
17	Briefly explain the thermodynamics of human body.	Understand	2
18	800 m^3/min. of recirculated air at 22^0C DBT and 10^0C DPT is to be mixed with 300 m^3/min. of fresh air at 30^0C DBT and 50% RH. Determine the enthalpy, specific volume, humidity ratio and DPT of the mixture.	Understand	2
19	The amount of air supplied to air conditioned hall is 300 m^3/min. The atmospheric conditions are 35^0C DBT and 55% RH. The required conditions are 20^0C DBT and 60% RH, determine, the sensible heat and latent heat removed from the air per minute. Also, find SHF for the system.	Understand	2
20	120 m^3 of air per minute at 35^0C DBT and 50% R.H is cooled to 20^0C DBT by passing through a cooling coil Determine the following: i. R.H of out coming air and its WBT ii. Capacity of the cooling coil in tons of refrigeration iii. Amount of water vapor removed per hr. iv. ADP.	Understand	2
	PART - C (ANALYTICAL QUESTIONS)		
1	The outdoor summer design condition for a bank for 100 persons at a place is T_{db} = 310K and T_{wb}=300K. The required inside conditions are T_{db} = 295K and φ = 60%. The room sensible heat 400,000kJ/h. The room latent heat 2,00,000kJ/h. Ventilation requirement per person 0.0047m^3/h. The by-pass factor is 0.15. Evaluate (a) grand total heat (b) ESHF (c) apparatus dew-point (d) volume flow rate of dehumidified air.	Understand	2
2	Explain about Sensible Heat Factor and with neat sketch on psychometric chart explain the process of determination of SHF for a process.	Understand	2
3	Define Grand Sensible Heat Factor and Room Sensible Heat Factor and with neat sketch on psychometric chart explain the process of determination of GSHF and RSHF for a process.	Understand	2
4	Define ESHF and with neat sketch on psychometric chart explain the process of determination of ESHF for a process.	Remember	2
5	Explain in detail with neat sketch on psychometric chart the difference between Dew Point Temperature and Apparatus Due Point.	Understand	2
	UNIT – V		
	PART - A (SHORT ANSWER QUESTIONS)		
1	State the function of grills in Air conditioning system.	Remember	5
2	Differentiate between grill and register used in air conditioning system.	Understand	5
3	What is the difference between fan and blower in air conditioning system?	Remember	5
4	State the function of a humidifier.	Understand	5

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5	What is the function of a dehumidifier.	Remember	5
6	State the disadvantages of axial flow fans?	Understand	5
7	How dehumidification process is achieved by reducing the air temperature?	Remember	5
8	What is the name of the process of drawing water in the form of fine mist for humidification process?	Understand	5
9	What are the sources of heat for heat pumps?	Remember	5
10	Define the term 'Throw'?	Understand	5
11	Why do we use deodorants in Air conditioning?	Remember	5
12	What are the common units used for the pressure developed by fans? Write the reason for expressing the pressure in those units.	Understand	5
13	State principle of working of centrifugal fans?	Remember	5
14	What is the significance of classifying the fans into Class I, II and III?	Understand	5
15	State the principle of working of axial fans?	Remember	5
16	What is the disadvantage of humidification process by injecting steam?	Understand	5
17	How can the life of HEPA filters be improved?	Remember	5
18	What is the difference between screen filters and fine filters?	Understand	5
19	Define HEPA filters?	Remember	5
20	What is meant by AHU? Give one example	Understand	5
	PART - B (LONG ANSWER QUESTIONS)		
1	What are the sources of heat in nature which can be used for heat pumps? Discuss about the performance of Heat pump when used with the different sources of heat. State the advantages and disadvantages in each case.	Remember	5
2	Describe the working of the heat pump by drawing the circuit for Water to air design.	Understand	5
3	Describe any two methods of humidification of air by atomizing the water into air, with simple line sketches.	Understand,	5
4	Briefly explain different methods used to remove the odours from the air?	Understand	5
5	Which type of air cleaner would be selected for removing very small dirt particles and smoke from the air? Explain its working principle.	Remember	5
6	Explain the principle of various dehumidification methods.	Understand	5
7	Explain the process of desalination of sea water by using a heat pump with neat diagram.	Remember	5
8	Explain the following heat pump circuits with a neat sketch Fixed refrigerant circuit design.	Understand	5
9	Explain the following heat pump circuits with a neat sketch Water –to- water design.	Remember	5
10	Explain the working principle of forward curved and back ward curved fans with neat sketches.	Understand	5
11	Describe the working of the heat pump by drawing the circuit for Air to water design.	Remember	5
12	Describe the use of heat pump for heating and cooling cycle with a neat sketch.	Understand	5
13	What are the advantages and disadvantages of spray type dehumidifier over coil type dehumidifier?	Remember	5
14	Explain the advantages and disadvantages of viscous filters over dry filters.	Understand	5
15	With the help of a neat diagram, explain the functioning of dry and wet filters.	Remember	5
16	With the help of a diagram, explain the Air washer humidifier and state the advantages of this type.	Understand	5
17	Explain the working principle of radial blade and propeller fans with neat sketches.	Remember	5
18	Explain the working principle of Tube-axial and vane axial fans with neat sketches.	Understand	5

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19	Explain briefly pre filters and fine filters with neat sketches.	Remember	5
20	Explain briefly Absolute filters and Electronic filters with neat sketches.	Understand	5
	PART - C (ANALYTICAL QUESTIONS)		
1	The power required for heating a room with reverse cycle refrigeration is less than what is required for heating with electrical strip heaters. Explain how.	Understand	5
2	The first row of a cooling coil in the air entry side may not sweat. Why?	Remember	5
3	Explain the important role of air filters in air conditioning.	Remember	5
4	Three way diverting valves are generally used, instead of two-way solenoid valves, in chilled water coils. Why?	Understand	5
5	Why is balancing valve used in chilled water systems?	Remember	5

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