Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION, DECEMBER 2018

Course Code: ME405

Course Name: REFRIGERATION AND AIR CONDITIONING

Max. Marks: 100 Duration: 3 Hours

Use of Refrigeration tables, Charts and Psychrometric chart is permitted.

PART A

Answer any three full questions, each carries 10 marks. Marks

1 a) A simplesaturated heat pump working with refrigerant 134a for space heating operates between temperature limits of 15°C and 50°C. The heat required to be pumped is 100MJ/hr. Calculate 1. Theoretical piston displacement of compressor 2. Theoretical power requirement 3. COP (7)

b) With the help of necessary sketches prove that $COP_{Heat\ Pump} = COP_{Refrigerator} + 1$ (3)

2 a) An aircraft moving with speed of 1000 km/hr uses simple gas refrigeration system of 100TR capacity for air-conditioning. The ambient pressure and temperature are 0.35 bar and -10°C respectively. The pressure ratio of the compressor is 4.5. The heat exchanger effectiveness is 0.95. The isentropic efficiencies of compressor and expander are 0.8 each. The cabin pressure and temperature are 1.06 bar and 25°C. Determine i) temperatures and pressures at all points of the cycle and calculate (ii) COP,(iii) Power required (7)

b) Describe working of a simple air conditioning system used for aircrafts (3)

3 a) Differentiate between wet and dry compression (3)

b) A Freon 12 vapour compression system operating at a condenser temperature of 40°C and evaporator temperature 0°C develops 15TR. Determine 1. Theoretical piston displacement 2. Heat rejected in system 3. Carnot COP and actual COP of cycle. (7)

4 a) An aircraft refrigeration system has to handle a cabin load of 25 tonnes. The atmospheric temperature is 16°C. The atmospheric air is compressed to a pressure of 0.96 bar and temperature of 29°C due to ram action. The air is then further compressed in a compressor to 4.8bar, cooled in a heat exchanger to 66°C expanded in a turbine to 1 bar pressure and supplied to cabin. The air leaves the cabin at a temperature of 26°C. The isentropic efficiencies of both compressors and turbine are 0.9. Calculate 1. Mass of air circulated per minute 2. COP. Take for air C_p =1.005kJ/kg K and Υ=1.4. (7)

b) Derive COP of a Carnot refrigerator and point out the limitations of reversed Carnot cycle and establish the significance of cycle. (3)

PART B

Answer any three full questions, each carries 10 marks.

5 Explain a three stage cascade refrigeration system with figure. Show the system on p-h diagram. (10)

6		Explain with the help of flow diagram and on p-h & T-S diagram multi compression refrigeration system with flash cooler and single evaporator.	(10)
7		Explain with a neat diagram working of a domestic refrigerator	(10)
8		With neat labeled sketch explain the working of flooded evaporator. State its application.	(10)

PART C

Answer any four full questions, each carries 10 marks.

9	a)	Derive *Borda-Carnot equation*.	(4)
	b)	Air at standard atmospheric pressure and temperature of 20^{o}C flowing with a velocity of 12 m/s enters a sudden enlargement where the duct area doubles. What is the increase in static pressure of the air as it passes through the enlargement?	(6)
10	a)	Air at 10^{o}C and 70% RH and 30^{o}C and 80% RH are mixed in equal proportions by weight in an adiabatic chamber and is left for sufficient time to reach equilibrium. Find properties of mixed air	(6)
	b)	Define (i) ADP, (ii) CSHF, (iii) DPT and (iv) Humidity ratio	(4)
11		Sensible and latent loads on a space are 50 kW and 10 kW respectively. Cold and dehumidified air at 10^{o}C DBT and 90% RH is used to maintain the space condition at 24^{o}C DBT. Find (i) RSHF (ii) space relative humidity and (iii) mass flow rate of supply air?	(10)
12		Space cooling load is estimated as Q_S = 50 kW and Q_L = 5 kW. The space and out door conditions are 24^{o}C DBT and 50% RH and 35^{o}C DBT and 40% RH. Given m_o: m_{rc}=0.25, ADP=8^{o}C Find (i) Bypass factor of cooling coil (ii) supply and out door air quantities, (iii) CSHF and (iv) cooling coil load (***m_o= mass of outside air, m_{rc}= mass of re circulated air***)	(10)
13	a)	What are the major assignments of the control system in an air conditioning plant?	(3)
	b)	Draw the elements of a basic control system for an air conditioning plant in a flow diagram	(3)
	c)	Name at least ten major control components in an air conditioning system	(4)
14		A 60^{o}, 30×30 cm branch take off leaves a 30×50 cm trunk duct. The size of the down stream section is also 30×50cm. The upstream flow rate is 1.5 m^3/s and the branch flow rate is 0.5 m^3/s. The upstream pressure is 500 Pa and the air temperature is 15^{o}C. (i) What is the pressure following the straight through section, and (ii) What is the pressure in the branch line?	(10)

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Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION(S), MAY 2019

Course Code: ME405

Course Name: REFRIGERATION AND AIR CONDITIONING

Max. Marks: 100 Duration: 3 Hours

Use of Refrigeration tables, Charts and Psychrometric chart is permitted.

PART A

Answer any three full questions, each carries 10 marks. Marks

1 a) Define COP and Tonnes of refrigeration. (4)

b) In a Bell-Coleman refrigerator air is drawn into the cylinder of the compressor from cold chamber at a pressure of 1.03 bar and temperature 12^{o}C. After isentropic compression to 5.5bar the air is cooled at constant pressure to a temperature of 22^{o}C.The polytropic expansion $pV^{1.25}$= constant follows and air expanded to 1.03 bar is passed to cold chamber. Determine (1) Work done/kg of air flow (2) Refrigerating effect/kg of air flow (3) COP (6)

2 a) With the help of neat sketches explain working of vortex tube refrigeration system (4)

b) A freezer of 20 TR capacity has evaporator and condenser temperature of -30^{o}C and 25^{o}C respectively. The refrigerant R-12 is sub-cooled by 4 ^{o}C before entering the expansion valve and is superheated by 5^{o}C before entering the evaporator. If a six cylinder single acting compressor with stroke equal to bore running at 1000 rpm. is used. Determine 1. COP 2. Theoretical piston displacement per minute 3. Theoretical bore and stroke (6)

3 a) With the help of neat sketches explain the working of a simple vapour compression refrigeration system. (4)

b) A food storage locker with R12 refrigerant requires a refrigeration of 2400kJ/min. capacity has an evaporator temperature of 263K and a condenser temperature of 303K.The refrigerant is sub cooled by 6^{o}C before entering the expansion valve and vapour is superheated by 7^{o}C before leaving the evaporator coil. The refrigeration compressor is a two cylinder single acting with stroke equal to 1.25 times the bore and operates at 1000rpm. Calculate 1. Mass of refrigerant circulated/min. 2. Heat removed by condenser/min 3.Theoretcal bore and stroke. (6)

4 a) Derive an expression for COP of an Reversed Brayton cycle air refrigeration system (4)

b) A regenerative air cooling system is used for an airplane to take 20 TR. The ambient air at a pressure of 0.8 bar and temperature 10°C is rammed isentropically till pressure rises to 1.2 bar. The air bled off the main compressor at 4.5 bar is cooled by the ram air in the heat exchanger whose effectiveness is 60%. The air from the heat exchanger is further cooled to 60°C in the regenerative heat exchanger. The cabin is to be maintained at a temperature of 25°C and pressure of 1 bar. If the isentropic efficiencies of compressor and turbine are 90% and 80% respectively, Find (1) Mass of air bled from cooling turbine to be used for regenerative cooling (2) Power required and (3) COP. (6)

PART B

Answer any three full questions, each carries 10 marks.

5 A two stage vapour compression machine with a flash inter cooler is to produce 30 TR while working between -35°C and 45°C. The pressure in the flash cooler is the geometric mean of the upper and lower limits. The suction gas to the low pressure compressor is super heated by 5°C and the condenser liquid is sub cooled by 5°C. The working substance is R-12. Determine (i) COP (ii) power (iii) Fluid flow through LP and HP compressor (10)

6 Explain working of a refrigeration system with multiple evaporators of different capacity with figure. (10)

7 a) Explain with a neat diagram working of a domestic refrigerator (6)

b) Compare deep freezing and cold storage (4)

8 Explain any one type of commonly used cooling tower with a diagram (10)

PART C

Answer any four full questions, each carries 10 marks.

9 a) Air at 25°C, 70% RH and 1 bar is compressed to 2 bar and cooled back to 25°C. Find water condensation per kg of air (6)

b) Define the terms: (a) DPT, (b) RH (c) WBT (d) SHF and show them on a psychrometric chart (4)

10 a) With the help of a neat diagram, explain the working of a winter air conditioning system (6)

b) Derive Bernoulli's equation from energy equation through second law considerations. (4)

11	a)	Explain in detail about "Equal Friction Method "in duct design	(5)
	b)	Differentiate between Packaged and Central air conditioning systems	(5)
12	a)	Moist air exists at 24^{o}C DBT and 18^{o}C WBT. Find the properties of air at 101.325 kPa using equations. Also find the properties at 80 kPa.	(6)
	b)	Ambient air at 40^{o}C DBT and 30% RH is cooled in an air washer of 85% efficiency. Find the properties of humid air?	(4)
13		2.5 kg of air is cooled and dehumidified from 30^{o}C DBT, 40% RH to 15^{o}C DBT & 80% RH in a cooling and dehumidifying coil. Find (i) ADP, (ii) Bypass Factor and (iii) Heat Transfer. If bypass factor is halved keeping the ADP same find (iv) exit air condition and (v) Heat Transfer.	(10)
14		With the help of a neat diagram explain year round refrigeration system	(10)

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Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION(R&S), DECEMBER 2019

Course Code: ME405

Course Name: REFRIGERATION AND AIR CONDITIONING

Max. Marks: 100 Duration: 3 Hours

Use of Refrigeration and Air Conditioning data book is permitted

PART A

Answer any three full questions, each carries 10 marks. Marks

1 a) What you mean by natural refrigeration and artificial refrigeration? Give two examples each. (5)

b) With the support of schematic flow diagram and T-S diagram, explain the working of simple bootstrap aircraft refrigeration system (5)

2 a) A refrigeration system produces ice at the rate of 30 kg/ hour at -2 ^{o}C from water at 25 ^{o}C. Determine the refrigeration effect and tonnage of the system. Also, find the COP, if the power input is 1.1 kW. (5)

b) A refrigeration system working on Bell-Coleman cycle operates with a pressure ratio of 8 and lower pressure of 1 bar. The cold chamber exit temperature is 9.1^{o}C and expander inlet temperature is 29^{o}C. If the expansion and compression follow polytropic process with n = 1.35, determine the COP. (5)

3 a) What is the principle of adiabatic demagnetization refrigeration? Describe its working using a schematic diagram. (5)

b) In an ammonia vapour compression refrigeration system, the pressure in the evaporator is 2.1 bar and the ammonia at the evaporator entry is 0.19 dry and at the exit is 0.86 dry. During compression, the work input per kg of refrigerant is 150 kJ. Calculate the COP and theoretical piston displacement of the compressor, if the mass flow rate of refrigerant is 4.5 kg/min. (5)

4 a) With the support of p-h diagram, explain the influence of superheating of suction vapour and sub-cooling of condenser outlet on the COP of vapour compression refrigeration system. (5)

b) Determine the theoretical COP of a vapour compression refrigerator with carbon dioxide as refrigerant, working between temperature limits of 25^{o}C and -5^{o}C. The dryness fraction of carbon dioxide at the compressor suction is 0.6. (5)

PART B

Answer any three full questions, each carries 10 marks.

5 a) With the support of a schematic and p-h diagram, explain the working of a two stage vapour compression system with flash gas removal and inter-cooling. (5)

b) Explain the desirable properties of refrigerants for vapour compression refrigeration systems. (5)

6 a) Explain with the help of schematic and p-h diagrams, the working of a two stage evaporator vapour compression refrigeration system with single compressor. (5)

b) With the support of a schematic diagram, explain the principle of working of Electrolux refrigeration. (5)

7 a) State any five applications of refrigeration. With the support of a neat sketch, explain any one of the stated applications. (5)

b) With a neat sketch explain any one type of water cooled condensers used in vapour compression refrigeration systems. (5)

8 a) With a neat sketch, explain the working of a flooded evaporator. (5)

b) Describe the principle and working of thermostatic expansion valve. (5)

PART C

Answer any four full questions, each carries 10 marks.

9 a) Define the terms (i) dry bulb temperature, (ii) absolute humidity (iii) wet bulb temperature (iv) dew point temperature and (v) relative humidity (5)

b) Determine the dew point temperature, absolute humidity, specific enthalpy and specific volume of moist atmospheric air at mean sea level, if the dry bulb and wet bulb temperatures are 28^{o}C and 21^{o}C, respectively. Show these properties using a representative psychrometric chart. (5)

10 a) 100 m^3/min of air at 20% relative humidity and 5^{o}C is to be conditioned to 50% relative humidity and 30^{o}C. Determine the load on the air conditioning unit. Also, determine the amount of water to be added or removed from the air during the process. (5)

b) What you mean by effective temperature in air conditioning? Describe a comfort chart. (5)

11 In an air conditioning plant, the air handling unit supplies 4500 m^3/min of dry air which include 20% (by weight) fresh air at 40^{o}C DBT and 27^{o}C WBT. The re-circulated air is at 25^{o}C and 50% relative humidity. The air leaves the cooling (10)

coil at 13^{o}C in saturates state. Calculate the total air conditioning load and room heat gain.

12 a) Draw the schematic diagram of window air conditioner; describe its working. (5)

b) With a schematic diagram, explain the construction and working of an year round air conditioning system (5)

13 a) Compare and contrast between the split system and packaged system in room air conditioning. (5)

b) Explain any one method of duct design and its applicability (5)

14 a) What are the special considerations to be made when designing an air conditioning system for hospitals. Give schematic illustrations to support your points. (5)

b) Explain any one type of humidifiers used in air conditioning systems with illustrations. (5)

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Reg No.:_____ **00000ME405121903** Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Seventh semester B.Tech examinations (S), September 2020

Course Code: ME405

Course Name: REFRIGERATION AND AIR CONDITIONING

Max. Marks: 100 Duration: 3 Hours

Use of chart and tables are permitted

PART A

Answer any three full questions, each carries 10 marks. Marks

1 a) Prove that COP Heat Pump= COP Refrigerator + 1. Use necessary sketches to justify your answer. (5)

b) What are the limitations of reversed Carnot cycle? What is the significance of Carnot cycle? (5)

2 With the help of the schematic, T-s and P-h diagrams describe the working of a simple vapour compression refrigeration system. Also write down the expressions to find out the Capacity, Compressor work and COP of the system. (10)

3 The cooling load of a new Boeing aeroplane is 10 Tonnes. A boot strap cooling system is proposed. The temperature and pressure conditions of the atmospheric air are 20°C and 0.9 bar. The cabin pressure is 1.02 bar and temperature of air leaving the cabin should be greater than 25°C. The pressure of air will be increased from 0.9 bar to 1.1 bar due to ramming and this process is considered isentropic. The pressures of air leaving the main and auxiliary compressor will be 3 bar and 4 bar respectively. Isentropic efficiency of compressors and turbine to be used are 0.85 and 0.8 respectively. It is considered that 50% of the total heat of air leaving the main compressor is removed in the first heat exchanger and 30% of the total heat of air leaving the auxiliary compressor is removed in the second heat exchanger. Calculate 1) the power required to take heat load of the cabin and 2) the COP of the system. (10)

4 A vapour-compression refrigeration system use Refrigerant 134a as the working fluid. The R134a flow rate is 6 kg/min. The refrigerant enters the compressor at -10^0C and 1.4 bar. The isentropic compressor efficiency is 70%. The refrigerant leaves the condenser at 24^0C and 7 bar. There are no (10)

appreciable pressure drops as the refrigerant flows through the condenser and evaporator. Ignoring heat transfer between the compressor and its surroundings and the pressure drops in condensor and evaporator, determine (a) the COP and (b) the refrigerating capacity in TR.

PART B

Answer any three full questions, each carries 10 marks.

5 What are the desirable properties of refrigerants? Write a short note on eco-friendly refrigerants. (10)

6 a) Describe the working of a water cooler based on simple vapour compression refrigeration cycle using a schematic diagram. (5)

b) What is called 'charging of refrigerant'? Point out minimum two ways to perform it? Mention minimum two methods for the leak detection of refrigerants. (5)

7 How a two stage multi pressure system with flash intercooling is different from the system with flash gas removal alone. Show the differences using the schematic and P-h diagrams. (10)

8 What are the different types of Evaporators used in refrigeration system? Describe with a neat sketch minimum two types of evaporators commonly used. (10)

PART C

Answer any four full questions, each carries 10 marks.

9 Define the psychrometric terms: i) DBT ii) WBT iii) DPT iv) Specific humidity v) Relative Humidity. Describe and show the following processes on a representative psychrometric chart: a) Sensible cooling and humidification and b) Heating and dehumidification and c) sorbent dehumidification. (10)

10 a) With the help of schematic diagram describe the working of winter air conditioning system. (5)

b) What is the function of thermostat in a refrigeration system? How does it work? Describe the working of any one type of humidistat widely used in refrigeration practices. (5)

11 Air at 32 ^{0}C DBT and 70% RH is cooled and dehumidified to the following conditions: 1) 20 ^{0}C and 70% RH, 2) 22 ^{0}C and 50% RH and 3) 24 ^{0}C and 30% RH. If the air flow rate of air is 600 litres/sec, find out the heat absorbed in kW and moisture removed in g/s for the three conditions. (10)

12	a)	With the help of schematic diagram describe the working of year round air conditioning system	(5)
	b)	Differentiate between all air and air water system	(5)
13		A summer AC is operating using 100% ventilation are without any recirculation. The outside air is at 35 ^{0}C DBT and 45% RH. The conditioned room is maintained at 25 ^{0}C DBT and 45% RH. The flow rate of air is 0.95 m^3/s and The SHR of the room is 0.72. The air leaving the cooling coil is 90% saturated and rest 10% is bypassed. Determine 1) the apparatus dew point and the temperature of the air leaving the coil, 2) How much cooling in kW is the unit doing? and 3) How much moisture in kg/kg of dry air is condensed out of the incoming air per hour?	(10)
14		Describe the important factors to be considered while designing an air conditioning system for 1) cinema theatres and 2) hospitals with schematic representations	(10)

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