UKA TARSADIA UNIVERSITY

B.Tech (Mechanical) (Semester 8)
030050801(2014-15)
Refrigeration and Air Conditioning System

Date :20/11/2021 **Time :**1:30PM- 4:30PM
Max. Marks:60

Instructions :

1. Attempt all questions.
2. Write each section in a separate answer book.
3. Make suitable assumptions wherever necessary.
4. Draw diagrams/figures whenever necessary.
5. Figures to the right indicate full marks allocated to that question.
6. Follow usual meaning of notations/abbreviations.

SECTION - 1

Q 1 A) Answer the following in brief (Any 3) **[6]**

I) Sketch the block diagram of a heat pump.

II) What is meant by the term refrigerating effect?

III) State the equation for the COP of a heat pump and refrigerator.

IV) Draw the T-S diagram of the bootstrap air cooling system.

Q 1 B) Answer the following (Any 1) **[4]**

I) Write a short note on simple air cooling system for aircraft.

II) An aircraft air conditioning needs refrigeration capacity of 10 TR. At the altitude of aircraft, the atmospheric pressure and temperature are 0.9 bar and 10 ^{o}C respectively. The pressure of air after the ramming effect in a diffuser increases to 1.013 bar. The temperature of the air is reduced by 50 ^{o}C in the heat exchanger. The pressure in the cabin is 1.01 bar and the temperature of air leaving the cabin is 25 ^{o}C. The pressure of the compressed air is 3.5 bar. Assume that all the expansions and compressions are isentropic. Determine the power required to take the load of cooling in the cabin and COP of the system.

Q 2 A) Answer the following in brief. (Any 2) **[4]**

I) What is the significance of Hydrogen used in Electrolux refrigeration system?

II) What are the advantages of compound compression with intercooler system over single stage compression?

III) Compare the thermal compression of VARS with mechanical compression of VCRS.

Q 2 B) Answer the following in detail. (Any 2) **[8]**

I) Derive the expression of COP for simple VCRS.

II) A simple refrigerant 134a (tetra-fluro-ethane) heat pump for space heating, operates between temperature limits of 15 ^{0}C and 50 ^{0}C. The heat required to be pumped is 100 MJ/h. Determine: (i) The dryness fraction of refrigerant entering the evaporator; (ii) The theoretical power of the compressor. Assuming the specific heat of vapour as 0.996 kJ/kg K. The specific volume of refrigerant 134a saturated vapour at 15^{0}C is 0.04185 m^{3}/kg. The other relevant properties of R-134a are given below:

Saturation Temperature (^{0}C)	Pressure (bar)	Specific Enthalpy (kJ/kg)		Specific Entropy (kJ/kg K)	
		Liquid	Vapour	Liquid	Vapour
15	4.887	220.26	413.6	1.0729	1.7439
50	13.18	271.97	430.4	1.2410	1.7312

III) An ammonia refrigerator works between - 6.7 ^{0}C and 26.7^{0}C, the vapour 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 coefficient of performance of the unit with the help of the properties given below :

Temperature (^{0}C)	Enthalpy (kJ/kg)		Entropy (kJ/kg K)	
	Liquid	Vapour	Liquid	Vapour
-6.7	152.18	1437.03	0.6016	5.4308
26.7	307.18 1	1467.03	1.1515	5.0203

Q 3 Answer the following (Any 2) **[8]**

I) Explain the contant pressure expansion valve with neat sketch.

II) Classify the condenser used in refrigeration systems. Derive the 'heat rejection factor' for condenser.

III) State and explain any four different characteristics of a good refrigerant.

SECTION - 2

Q 4 A) Answer the following (any two) **[4]**

I) What are the different parts of an air conditioning unit?

II) What do you mean by 'specific speed' of a centrifugal fan?

III) Write applications of industrial air conditioning system.

Q 4 B) Answer the following (any two) **[6]**

I) Explain construction and working of summer air conditioning system with neat sketch.

II) Explain ice plant with neat sketch.

III) Draw neat sketch of the followings
(a) year-round air conditioning system
(b) winter air conditioning system

Q 5 A) Answer the following in brief. (Any 2) **[4]**

I) Describe the various heating loads taken into account while determining the capacity of a refrigerating machine.

II) Enlist the types of grilles and diffusers.

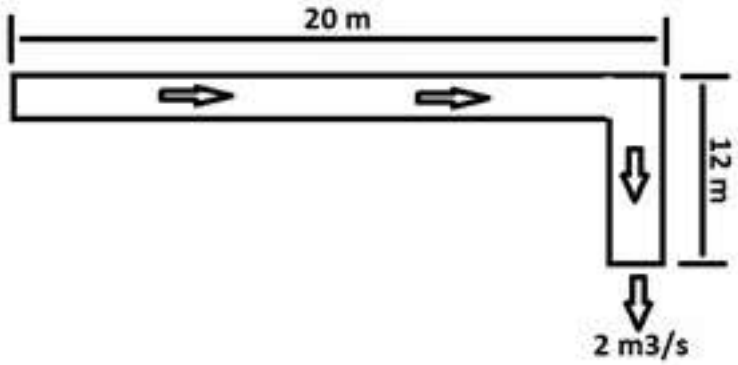
III) Why rectangular shape duct is preferred over circular duct?

Q 5 B) Answer the following in detail. (Any 2) **[8]**

I) An air conditioning system is to be designed for a restaurant with the following data:
Outside condition= 40 ^{O}C DBT, 28 ^{O}C WBT
Inside condition=25 ^{O}C DBT, 50 % RH
Solar heat gain through walls, roof, and floor=5.87 kW
Solar heat gain through glass =5.52 kW
Occupants = 25
Sensible heat gain per person= 58 W
Latent heat gain per person= 58 W
Internal lighting load= 15 lamps of 100 W, 10 tube lights of 80 W
Sensible heat gain from the other sources= 11630 W
Infiltration air = 15 m^3/min
ADP= 10.8 ^{O}C
If 25 % fresh air and 75 % recirculated air is mixed and passed through the conditioner coil, find BPF and RSHF.

II) A retail shop located in a city at 30^{o} N latitude has the following loads:
RSH = 58.15 kW
RLH = 14.51 kW
Outside condition = 40 ^{o}C DBT, 27 ^{o}C WBT
Inside conditions= 25 ^{o}C DBT, 50 % RH
Ventilation air = 70 m^3/min
Assuming 63 % fresh air and 37 % recirculated air passing through the evaporator coil. ADP = 11 ^{o}C. Determine BPF and ERSHF.

III) Find FTP for given duct layout with the help of velocity reduction method. Consider Cv exit = 0.98, Cv elbow = 0.88, Cv branch = 0.92, Delta_P = (0.022243 $Q^{1.852}$.L)/ $D^{4.973}$. Assume standard air density and velocity 4.5 m/s for all



ducts.

Q 6 Answer the following (Any 2) **[8]**

I) Explain heating and humidification for winter air conditioning system with the help of psychrometric chart.

II) Derive the relationship between humidity ratio and pressure of water vapor W = 0.622 x $p_v/(p_b-p_v)$

III) Explain the adiabatic mixing of two air streams with the help of neat sketch.