RAC

Unit 1

Previous year Questions

1.What is the basic difference between open and closed Air refrigeration cycles? Describe a Bell-coleman or Reversed Joule air refrigeration cycle with the help of a neat labelled sketch and also explain the basic difference between this cycle and a reversed carnot air refrigeration cycle.

2. A simple aircraft refrigeration system has to undertake a load of 20TR. The ambient pressure and temperatures are 0.9bar and 22C respectively. The pressure of air is increased to 1 bar due to isentropic ramming action. The air is further compressed in a compressor upto 3.5 bar and then cooled in a heat exchanger up to 72C. Finally the air is passed through a cooling turbine and then supplied to the cabin at a pressure of 1.03bar. The air leaves the cabin at 25C. Calculate the power required and C.O.P of the system. Take Cp =1.005 kJ/kg-k and gamma =1.4.

[Ans:Power =154.8KW, COP=0.5]

3.An air refrigeration system following Bell-coleman cycle is operating between pressure limits of 1.04bar and 8 bar respectively. Air is drawn from the cold chamber at 9C and after compression it is cooled to 28C, before entering the expansion cylinder. If expansion and compression process follow the law $PV^{1.28}$ =constant, determine the theoretical COP of the above refrigeration system. Take gamma=1.4 and Cp=1.005KJ/kg-k for Air.

[Ans:COP=1.82]

4.Describe the operation of a Bootstrap air-cycle system for aircraft applications with the help of its block diagram and a temperature-entropy diagram.

5.In the air cooling system of a jet aircraft, air is bled from the engine compressor at 3 bar , and is cooled in a heat exchanger to 105C. It is expanded to 0.69bar in an air turbine, the isentropic efficiency of the process being 85%. The air is then delivered to the cockpit and leaves the aircraft at 27C. Calculate the temperature at which the air enters the cockpit and the mass flow of air required for a refrigerating effect of 4kw. If the air turbine is used to help to drive the auxiliaries , calculate it contribution in power.

[Ans:The air enters cockpit=5.16C, mass =0.124KJ/sec, Power =13.7kw]

6.A carnot refrigerator has working temperatures of -30C and 35C. If it operates with R-12 as a working fluid , Calculate:

i.isentropic compression work ii.refrigeration effect iii. Heat rejected per unit mass of the refrigerant iv. Cop of the cycle

If an actual refrigerator has a cop which is 75% of that of the ideal carnot cycle, calculate the power consumption and heat rejected to the surroundings per ton of refrigeration.

[Ans: compressor work=35.5KJ/kg, Refrigeration effect=103.9KJ/kg,Heat rejected =4.733kw, COP=2.8]

7.30tons of Fish are required to be stored in a cold storage plant at a temperature of -10C. The temperature of the fish when supplied is 30C. The specific heat of the fish above freezing point is 2.94kJ/kgC and below freezing point is 1.25KJ/kgC. The freezing point of the fish is -3C and its latent heat is 233KJ/kg. If the cooling is achieved in 10hours, Calculate the capacity of the refrigerating plant and the carnot cycle COP between this temperature range.

[Ans:capacity =80.65 tonnes, COP=6.11]

8.In a simple aircraft refrigeration system, air is compressed from a temperature of 27C and total pressure of 1.2 bar to a pressure of a 6 bar. The total load of the passengers of the aircraft is 30kw. The exit pressure of the cooling turbine is equal to the cabin pressure of 1 atm. The compressor and turbine efficiencies are 80% and 75% respectively. The rise in the temperature of the cool air in the cabin is 60C. Assuming Cp air =1.005kJ/kgK, determine:

i.Refrigeration capacity ii. The mass of air-flow required iii. The power required for refrigeration iv.COP of the system

[Ans: Refrigeration capacity=10.86Tons ii. The mass of air-flow required=2268.65kg/hr iii. The power required for refrigeration=134.3KW iv.COP of the system=0.283]

9.Enlist various types of air-refrigeration systems being employed for aircraft refrigeration, and briefly describe any one of them with the help of a neat labeled sketch.

10. i. Enumerate various methods of refrigeration.

ii. Explain in brief, the concept of actual power for refrigeration in aircraft refrigeration system. What do you understand by Dry Air Rated Temperature(DART)?

Unit 2

1.The following data refer to a single stage vapour compression system. Refrigerant used (ozone friendly) R=134a ; condensing temperature =350c; Evaporator temperature =-100C; compressor RPM =2800; Clearance Volume/swept volume=0.03; swept volume =269.4 $x10^{-6}$ m^3 ; Expansion index=1.12; compression efficiency =0.8; condensate subcooling =50c. Find: 1.capacity of the

system in TR 2. Power required 3.COP 4.Heat rejection to condenser .The properties of R-134a are given below:

Sat Temp. C	Pressure, bar	Specific volume of vapour,m3/kg	Specific enthalpy, kJ/kg		Specific entropy, kJ/kgk	
			Liquid	Vapour	Liquid	Vapour
-10	2.014	0.0994	186.7	392.4	0.9512	1.733
35	8.87	0.0231	249.1	417.6	1.1680	1.715

Assume isentropic compression and suction vapour as dry saturated. The specific heat of vapour refrigerant may be taken as 1.1KJ/kgk and for liquid refrigerant as 1.458kJ/kgk.

[Ans:Tonnage =4.497, Power =3.572kw, COP =4.89]

2. A. a.Show that for subcooling from condenser temperature of 40c and 30C , the enthalpy of subcooled liquid may be approximated by the enthalpy of saturated liquid at 30C fro R22 and NH3.

B. Discuss the applications of flash chamber with the help of P-h chart and schematic diagrams.

3.Explain the working of cascade refrigeration system with the help of neat sketch. Is it different from multistage system. Discuss?

4.A vapour compression refrigeration system of 5 ton capacity operates at 40C condenser and -16C evaporator temperatures. The vapour is superheated by 5C at at the entry to the compressor. Determine COP and power requirement. Use the following properties of the refrigerant(do not use other property tables as refrigerant is not known to you)

At tsat =40c (Psat =1.0166MPa): hf=256.41kJ/kg, hg=419.43kJ/kg, Sg=1.711kJ/kg and

For superheated vapour Cp=1.145kJ/kgk

At tsat =-16C(Psat =0.15728 MPa): hg=389.02kJ/kg, Sg=1.7379kJ/kgK and for superheated vapour Cp=0.831KJ/kgK.

[Ans: COP =3, Power required =5.83KW]

5.A. With the help of schematic diagram of vapour compression refrigeration system, discuss the purpose of using “filter”, “Drier”, the “Receiver” in the system.

B.with the help of P-h or T-s plots, explain how actual vapour compression cycle deviate from ideal cycle.

6.The condenser and evaporator temperatures of a 20T capacity, simple saturated vapour compression refrigeration system, are 40C and -20C respectively. The refrigerant used in the

system is R22. Draw the cycle on P-H diagram(assuming isentropic compression) and calculate i. The mass of refrigerant to be circulated. Ii. Power required in the compressor and iii. The COP of the cycle. " If the system employes 5C subcooling of refrigerant liquid and a superheating of 10C of refrigerant vapour, what will bt the new COP of cycle" ? whether it will increase or decrease.

[Ans:i. mass =33.86kg/min, ii. Power =23kw iii.COP=3.041, New COP=2.75, so new COP will be reduced]

7.what is the significance of multistage vapour compression system and what are its advantages over simple vapour compression system? Also explain the purpose; of flash gas removal and flash intercooler in multistage compression system.

8.In a 15 Ton ammonia refrigeration plant, the condensing temperature is 25C and evaporating temperature is -10C. The refrigerant is subcooled by 5C before reaching the inlet of the throttle valve. The vapour leaving the evaporator is dry saturated. Find the COP and mass flow rate of the refrigerant.

Use the following table for properties of Ammonia.

Ts ,C	Enthalpy, Kcal/kg		Entropy,Kcal/kg		Specific heat, Kcal/kg	
	Liquid	Vapour	Liquid	Vapour	Liquid	Vapour
25	128.1	406.8	1.097	2.0324	1.1	.67
-10	89.6	398.7	0.9593	2.1362	0.98	0.59

[Ans:mass =5.26kg/sec, COP=6.64]

9.A 100TR system using R-12 is to operate on a two stage vapour compression refrigeration system with a flash chamber. The refrigerant is evaporating at -40(0.641 bar), flash chamber works on an intermediate temperature of 0C(7.45bar). Low pressure compressor and expansion valve operate between 0.641bar and 3.08bar, and the high pressure compressor and expansion valves operate between 3.08 bar and 7.45 bar. Saturated vapour enters both the compressor and saturated liquid enters each expansion valves. Determine:i.The flow rate of refrigerant handled by each compressor.

ii. The power requirement of compressors.

iii. COP of the system.

May use the properties given below for R-12:

Superheated properties for R-12:

Pressure, bar	Ts ,C	Properties	20C Superheat	40C Superheat
3.08	0	S(KJ/kg)	0.7423	0.7853
		H(KJ/kg)	200.5	213.5

7.45	30	S(KJ/kg)	0.7321	0.7751
		H(KJ/kg)	214.3	228.6

Saturated properties for R-12:

Pressure, bar	Sat. Temp, C	Hf, kJ/kg	Hg, kJ/kg	Sf,KJ/kgk	Sg,KJ/kgk
0.641	-40	0	169.6	0	0.7274
2.19	-10	26.9	183.2	0.1080	0.7020
3.08	0	36.1	187.5	0.1420	0.6966
7.45	30	64.6	199.6	0.2399	9.6854
9.6	40	74.6	203.2	0.2718	0.6825

[Ans: mass =0.09kg,Wc =71.5kJ/kg, COP =1.34]

10.In a simple vapour compression refrigeration system using R-12 as refrigerant, the evaporator and condenser temperatures are -10C and 35C respectively. If the capacity of the system is 15tons, and the compression is isentropic, calculate the following with the help of P-h chart for R-12: i. Mass of refrigerant to be circulated. Ii. Power required in the compressor iii. Total heat rejected in the condenser, and iv. COP of the cycle.

Also calculate the carnot cop and show the percentage difference between the two. Draw the cycle on p-h chart for R-12.

[Ans: m=0.15133kg/sec , ii. Power -13.76kw iii. Qc=72.08kw iv.COP =5.23]

UNIT 3

Previous year Questions (Important Questions)

1.A.Explain the merits and demerits of absorption system compared to the mechanical vapour compression system. [2012-13]

B. In the absorption system, which components replace the compressor of the compression system? [2012-13]

2. Define primary refrigerant and discuss desirable properties of primary refrigerants. Give the refrigerant number for the following: CHCLF2, C2H6, CO2, CH2F-CF3. [2011-12]

3. Explain the working of practical Aqua Ammonia Vapour Absorption Refrigeration system. How do we ensure pure ammonia at the entry to the condenser: Discuss the significance and working of aqua heat exchanger . [2011-12]

4.A. Explain the method of obtaining an isotherm (in two phase region) of enthalpy-concentration(h-c) diagram for a mixture. [2011-12]

B. How do we get temperature-concentration(T-C) diagram for a mixture (binary)? [2011-12]

5. Two Aqua Ammonia mixture streams at saturated liquid state and pressure of 20bar each are mixed adiabatically. Stream A has a mass flow rate of 9kg/s and a concentration of 0.8, where as stream B has a mass flow rate of 9 kg/s and a concentration of 0.2. Determine the temperature, concentration and specific enthalpy of mixture stream after adiabatic mixing. Also find the concentration of ammonia in liquid and vapour phases after adiabatic mixing. [2011-12]

[Ans: temperature =90C, enthalpy =2100kJ/kg, Concentration =0.5]

6.With the help of neat sketch, explain in brief, the working principle of a **continuous vapour absorption refrigeration system**, obtaining an expression for maximum COP of the cycle. Also determine the COP of a vapour absorption system having a generator temperature of 100C, evaporator temperature of -15C and absorber/condenser temperature of 40C. [2009-10]

[**continuous vapour absorption refrigeration system=Lithium bromide v.A.S , COP=0.75**]

7. what is the basic function of refrigerants in a refrigeration cycle and how they are classified? Write some desirable properties of refrigerants. What is the basic difference between primary and secondary refrigerants? [2009-10]

8.Give classification and nomenclature of refrigerants in detail. Discuss the effects of CFC refrigerants on Ozone layer briefly. [2007-08]

9.A. Explain the method of obtaining an isotherm (in two phase region) on enthalpy-concentration diagram for a mixture.

B. Compare aqua ammonia vapour absorption refrigeration system with Li-Br water absorption refrigeration system. [2007-08]

10.A. Explain in brief the concept of Aidabatic mixing of two streams, as related to vapour absorption refrigeration system. Also discuss the significance of Temperature –Concentration diagram.

B. Enumerate the classification of Refrigerants. What are the desirable properties of refrigerants? Name some common refrigerants generally used in refrigeration systems. What do you understand by CFC free refrigerants?

UNIT 4

Attempt All Questions

Q1.Attempt any two

A. Enumerate any 3 methods of refrigeration?
B. Definition refrigeration? Give difference between heat engine, refrigerator and heat pump with diagram and formulas?
C. Discuss about reversed carnot cycle with reference to cycle, processes and COP?

Q2. Attempt any one

A. A cold storage plant is required to store 20tonnes of fish. The fish is supplied at a temp. of 30C. The specific heat of fish above freezing point 2.93, below freezing point is 1.26 KJ/kgk. The fish is stored in cold storage which is maintained at -8C. The freezing point of fish is -4C. The latent heat of fish is 235kJ/kg. If the plant requires 75kw to drive it, find
   i. The capacity of plant ii. Time taken to achieve cooling.
   Assume actual COP of the plant as 0.3 of the carnot COP.
B. 30tons of Fish are required to be stored in a cold storage plant at a temperature of -10C. The temperature of the fish when supplied is 30C. The specific heat of the fish above freezing point is 2.94kJ/kgC and below freezing point is 1.25KJ/kgC. The freezing point of the fish is -3C and its latent heat is 233KJ/kg. If the cooling is achieved in 10hours, Calculate the capacity of the refrigerating plant and the carnot cycle COP between this temperature range.

Q3. Attempt any one

A. Discuss reversed Brayton cycle with its diagram, cycle, COP derivation by considering adiabatic and isentropic process.
B. Discuss Boot strap evaporative cooling system with diagram, T-S cycle,processes and formulas involved in it.

Q4. Attempt any one

A. A carnot refrigerator has working temperatures of -30C and 35C. If it operates with R-12 as a working fluid , Calculate:i.isentropic compression work ii.refrigeration effect iii. Heat rejected per unit mass of the refrigerant iv. Cop of the cycle
   If an actual refrigerator has a cop which is 75% of that of the ideal carnot cycle, calculate the power consumption and heat rejected to the surroundings per ton of refrigeration.

   B.A dense air refrigeration cycle operates between pressures of 4 bar and 16 bar. The air temperature after heat rejection to surrounding is 37C and air temperature at exit of refrigerator is 7C. The isentropic efficiencies of turbine and compressor are 0.85 and 0.8 respectively. Determine the compressor and turbine work per TR; COP; and power per TR. Take gamma =1.4 and Cp=1.005kJ/kgk

Q5. Attempt any one

A. In the air cooling system of a jet aircraft, air is bled from the engine compressor at 3 bar , and is cooled in a heat exchanger to 105C. It is expanded to 0.69bar in an air turbine, the isentropic efficiency of the process being 85%. The air is then delivered to the cockpit and leaves the aircraft at 27C. Calculate the temperature at which the air enters the cockpit and the mass flow of air required for a refrigerating effect of 4kw. If the air turbine is used to help to drive the auxiliaries , calculate it contribution in power.

B. A Boot-Strap cooling system of 10TR capacity is used in an aeroplane. The ambient air temperature and pressure are 20C and 0.85 bar respectively. The pressure of air increases from 0.85 bar to 1 bar due to ramming action of air. The pressure of air discharged from the main compressor is 3 bar. The discharge pressure of air from the auxiliary compressor is 4 bar. The isentropic efficiency of each of the compressor is 80%, while that of turbine is 85%. 50% of the enthalpy of air discharged from the main compressor is removed in the first heat exchanger and 30% of the enthalpy of air discharged from the auxiliary compressor is removed in the second heat exchanger using rammed air. Assuming ramming action to be isentropic, the required cabin pressure of 0.9 bar and temperature of the air leaving the cabin not more than 20C, Find 1. The power required to operate the system; and 2. The cop of the system. Draw the T-s diagram of the system. Take gamma =1.4 and Cp=1KJ/kg K.

UNIT 5

Previous year Questions (Important Questions)

1. Explain about the applications of Air Conditioning systems in industry? [2012 -13]
2. What is Food Preservation?
3. Discuss some common methods used for food preservation. [2011-12]

4 Describe the work in Ice Plant. What would be the nature of ice if it is formed quickly.

[2011-12]

5. What is the difference between the industrial and comfort air conditioning requirements? [2011-12]

B.List various types of compressors used in refrigeration units? Discuss the advantages of hermetically sealed compressor [2011-12]

4. A. Explain the working of thermostatic expansion valve with the neat sketch. [2011-12]

B. Explain frictional losses and dynamic losses in flow through duct. Give and expression for friction pressure drop in ducts. [2011-12]

5. with the help of example, explain the following methods of duct design.

I. Equal friction method.

ii. static regain method [2010-11]

6.Discuss various types of cooling towers in brief. What is range and approach of a cooling tower? [2010-11]

7.What is the basic difference between a 'Coil Equipment', and a 'spray equipment', as used in air conditioning system? Explain the working of an ' Air washer' with the help of a neat labeled sketch, explaining how can you calculate its humidifying efficiency? [2009-10]

8. Discuss in brief, the transmission and distribution of air through ducts and fans, explaining the different factors which lead to pressure drop in ducts. [2009-10]

9.what is the function of cold storages and what is their importance in today's life? 2000Tons of potatoes are available at a temperature of 30C . It has to be preserved in a cold storage at a temperature of 2C. How much refrigeration is necessary? If this refrigeration is to be obtained in 3 days, what should be the capacity (tonnage) of the plant?

[Ans: Net refrigeration required =245.7TR] [2009-10]

10 A water cooler is required to be installed in an industrial organization to supply drinking water at 10C to 600 workers for 8 hours duty time. Water is available at 30C. The heat transfer through insulation is 5% of the total heat load. The drinking water requirement for this heavy duty cooler is 1.1 litres per hour. Determine the capacity(tonnage) of water cooler and the total water consumption per day. Take Cp for water is 4.1868kj/kgk.

[Ans: capacity =4.62TR, water consumption=5280litres/day] [2009-10]