Code No: RT32037A | R13 | SET - 1

III B. Tech II Semester Regular Examinations, April - 2016

REFRIGERATION AND AIR CONDITIONING

(Mechanical Engineering)

Time: 3 hours | Maximum Marks: 70

Note: 1. Question Paper consists of two parts (**Part-A** and **Part-B)**
2. Answering the question in **Part-A** is compulsory
3. Answer any **THREE** Questions from **Part-B**

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PART –A

1. a) Explain the term ``Tonne of refrigeration ``. [4M]
   b) Why in practice a throttle valve is used in vapour compression refrigerator rather than an expansion cylinder to reduce pressure between the condenser and the evaporator? [4M]
   c) `` A completely odourless refrigerant is not desirable``, discuss the statement. [3M]
   d) Discuss the function of absorber in vapour absorption refrigeration system. [3M]
   e) What is the difference between wet bulb temperature and thermodynamic wet bulb temperature? [4M]
   f) Explain the features required for the proper selection of a fan for a given application? [4M]

PART –B

2. a) Draw the schematic of a boot-strap cycle of air refrigeration system, and show the cycle on T-s diagram. [6M]
   b) In a boot-strap refrigeration system for an aircraft the ambient conditions are 0.225 bar and -50^{0}C. Cooling load estimate is 20 ton refrigeration (20 TR). The speed of the plane is 1000 km/hr. Ram efficiency is 0.9. the pressure ratio for the main compressor is 3.5 and this bled off air is further compressed in secondary compressor run by cooling air turbine on a single shaft such that output from turbine is equal to input to the compressor. The internal efficiency of main compressor as well as secondary compressor is 0.9, and that of cooling turbine is 0.8. The air from secondary compressor is cooled by ram air to 50^{0}C. The cooling air turbine running the secondary compressor has its exit pressure of 1 bar. Determine (i) Delivery pressure from the secondary compressor, (ii) Mass flow rate bled for cooling the cabin, (iii) COP of the system. [10M]

3. a) Discuss the effect of sub-cooling on COP. Would you desire large sub-cooling and why? [6M]
   b) A refrigerating plant using CO_2 as refrigerant works between 25^{0}C and -5^{0}C. The dryness fraction of CO_2 is 0.6 at the entry of the compressor. Find the ice formed per day if the ice is formed at 0^{0}C and from the water at 10^{0}C. Quantity of CO_2 circulated=10 kg/min. Take relative efficiency=0.6. Take C_p (water) = 4.2 kJ/kg, latent heat of ice=335kJ/kg. [10M]

Temperature ^{0}C	Liquid heat (kJ/kg)	Latent heat (kJ/kg)	Entropy of liquid (kJ/kg K)
25	81.25	121.6	0.2513
-5	-7.53	245.8	-0.0419

4. a) Describe the working of an evaporative condenser. [7M]
   b) Explain the working of following types of evaporators with neat sketches: (i) Shell and tube evaporator, (ii) Forced convection evaporator, (iii) Shell and coil evaporator. [9M]

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5. a) Draw a neat diagram of lithium bromide water absorption system and explain its working in major field of applications of this system. [8M]

   b) Derive an expression for the COP of an ideal vapour absorption system in terms of temperature T_G at which heat is supplied to the generator, the temperature T_E at Which heat is absorbed in the evaporator and the temperature T_C at which heat is discharged from the condenser and absorber. [8M]

6. a) Explain the difference between comfort air-conditioning and industrial air-conditioning. [8M]

   b) Define the term `` effective temperature `` and explain its importance in air-conditioning system. Describe the factors which affect effective temperature. [8M]

7. a) Describe a centrifugal fan with the help of a neat sketch? [8M]

   b) Explain in detail about heat pump circuits? [8M]

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REFRIGERATION AND AIR CONDITIONING

(Mechanical Engineering)

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2. Answering the question in **Part-A** is compulsory
3. Answer any **THREE** Questions from **Part-B**

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PART –A

1. a) Discuss the advantages of the dense air refrigerating system over an open air refrigeration system. [3M]
   b) Under what circumstances the superheating of vapour before coming to compressor is more objectionable? Give the ways to prevent it. [4M]
   c) Discuss why refrigerants are so selected that evaporator pressures and condenser pressure are greater than atmospheric pressure. [4M]
   d) Discuss the advantages of vapour absorption refrigeration system over vapour compression refrigeration system. [4M]
   e) Prove that the partial pressure of water vapour in the atmospheric air remains constant as long as the specific humidity remains constant. [4M]
   f) What is the function of a fan in an air conditioning system? [3M]

PART –B

2. a) Draw the schematic of a boot-strap evaporative cycle of air refrigeration system, and show the cycle on T-s diagram. [6M]

   b) A regenerative air refrigeration system for an air plane has to take 30 ton of load, while the ambient conditions are 0.80 bar and 7^0C. The ramming action leads to a pressure rise from 0.8 bar to 1.2 bar at constant entropy. The air is bled off the main compressor at 4.8 bar. The ram air heat exchanger is 60% effective. The air from the heat exchanger passes on to cooling turbine. Some portion of the air after expanding in the cooling turbine passes on to the regenerative heat exchanger reducing the temperature of the main compressed air to 50^0C. The cooling air from turbine gets heated to 100^0C before discharging. The isentropic efficiencies of the compressor and the turbine are 90% and 80% respectively. The cabin is pressurized to 1 bar and maintained at 25^0C. Determine (i) The ratio of the air extracted from cooling turbine for regenerative cooling of the ram air, (ii) Power required for maintaining the cabin at required condition. Assume the cooling turbine power developed to be used for ram air exhaust fan. [10M]

3. a) How does the increase in condenser temperature affect COP? Also explain the influence of evaporator temperature on COP. Which of the two temperatures have more influence on COP? [6M]
   b) A refrigerating plant of 28 kW capacity has its evaporation temperature -8^0C and condenser temperature of 30^0C. The refrigerant, R-12 is sub-cooled 5^0C before entering the expansion valve and the vapour is superheated 6^0C before leaving the evaporator coil. The compression of the refrigerant in the compressor is isentropic. If there is a suction pressure drop of 0.2 bar through the valves; and discharge pressure drop through the valve of 0.1 bar, determine the C.O.P. of the plant, theoretical piston displacement, m³/min and the heat removed in the condenser. Solve the problem with the help of P-h chart. Give also a diagrammatic sketch of this cycle on the T-s chart. [10M]

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4. a) Discuss the natural and forced convection types of air-cooled condensers. [8M]
   b) Discuss the operation of a capillary tube in a refrigeration system. [8M]

5. a) Draw a neat diagram of three-fluid system of refrigeration (Electrolux refrigeration system) and explain its working. [8M]
   b) List out the merits and demerits of thermo-electric refrigeration system over other refrigeration system. What are the fields of its applications? [8M]

6. a) Define room sensible heat factor. How room sensible heat factor line is drawn on the psychrometric chart? [8M]
   b) Explain in brief as to how the human body reacts to changes in temperature of environment. Also explain the effect of activities on the heat load calculation for comfort application. [8M]

7. a) Explain the various types of axial flow fans. [8M]
   b) Explain the case of heat pump for heating and cooling cycle with neat diagram. [8M]

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Code No: RT32037A | R13 | SET - 3

III B. Tech II Semester Regular Examinations, April - 2016

REFRIGERATION AND AIR CONDITIONING

(Mechanical Engineering)

Time: 3 hours | Maximum Marks: 70

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2. Answering the question in **Part-A** is compulsory
3. Answer any **THREE** Questions from **Part-B**

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PART –A

1. a) `` The COP of an air refrigeration cycle is very low, but still a refrigeration system is most common in the Air craft ``, discuss the statement. [3M]
   b) Mention the advantages of vapour compression refrigeration system over air refrigeration system. [3M]
   c) What are essential properties of a good refrigerant? [3M]
   d) Define and write the expression for nozzle efficiency in steam jet refrigeration system. [3M]
   e) Define the term `bypass` factor used for cooling or heating coil and find the expression for that. [5M]
   f) Make the arrangement of heat pump when it is used for year round air conditioning. [5M]

PART –B

2. a) Explain the difference between simple air craft refrigeration and boot-strap air refrigeration system. [6M]

   b) An air refrigerator working on Bell-Coleman cycle takes air into the compressor at 1 bar and 268 K. It is compressed in a compressor to 5 bar and cooled to 298 K at the same pressure. It is further expanded in the expander to 1 bar and discharged to take the cooling load. The isentropic efficiencies of the compressor and expander are 85% and 90% respectively. Determine : (i) Refrigeration capacity of the system if the air circulated is 40 kg/ min; (ii) Power required for the compressor; and (iii) C.O.P of the system. [10M]

3. a) Draw the vapour compression refrigeration cycle on T-s diagram when the refrigerant is dry and saturated at the end of compression and find an expression for the C.O.P in terms of (i) Temperature and entropies; (ii)Enthalpy. [8M]

   b) A vapour compression refrigerator uses R-12 as refrigerant and the liquid evaporates in the evaporator at -15^0C. The temperature of this refrigerant at the delivery from the compressor is 15^0C when the vapour is condensed at 10^0C. Find the coefficient of performance if the liquid is cooled by 5^0C before expansion by throttling. Take specific heat at constant pressure for the superheated vapour as 0.64kJ/kg K and that for liquid as 0.94 kJ/kg K. the other properties of refrigerant are as follows: [8M]

Temperature in ^{0}C	Enthalpy in kJ/kg		Specific entropy in kJ/kg K	
	liquid	vapour	liquid	vapour
-15	22.3	180.88	0.0904	0.7051
10	45.4	191.76	0.1750	0.6921

4. a) Write short notes on (i) Ozone layer depletion; (ii) Global warming. [8M]
   b) Explain the working principle of thermostatic expansion valve with the help of a neat diagram. [8M]

5. a) Derive an expression for finding out the mass of motive steam required per kg of water vapour produced. [8M]
   b) Explain the working principle of vortex tube and explain that the energy exchange phenomenon in vortex tube is not a violation of second law of thermodynamics. [8M]

6. a) Explain the procedure to draw a grand sensible heat factor line on a psychrometric chart. What do you understand by effective room sensible heat factor? [8M]
   b) Why ventilation is required? Explain why different ventilation standards for different purposes are recommended? [8M]

7. a) Give the classification of fans and explain the working principles on which they work. [8M]
   b) Suggest the different constructional features used in heat pump to improve the overall EPR. [8M]

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Code No: RT32037A | R13 | SET - 4

III B. Tech II Semester Regular Examinations, April - 2016

REFRIGERATION AND AIR CONDITIONING

(Mechanical Engineering)

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2. Answering the question in **Part-A** is compulsory
3. Answer any **THREE** Questions from **Part-B**

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PART –A

1. a) What is the need of air conditioning of air-crafts at high altitudes where ambient temperatures are very low. [4M]
   b) Distinguish between dry and wet compression. What are the advantages at one over the other? [3M]
   c) What are the desirable properties of an ideal refrigerant? [3M]
   d) Define and write the expression for entrainment efficiency in steam jet refrigeration system. [4M]
   e) With the help of psychrometric chart explain the following process and give the important characteristic features of adiabatic cooling and humidification process. [4M]
   f) Give the classification of fans. [4M]

PART –B

2. a) Explain refrigeration system using Brayton cycle and show the state points on Temperature-Entropy diagram considering the irreversibilities. [8M]
   b) A dense air refrigeration machine operating on Bell-Coleman cycle operates between 3.4 bar and 17 bar. The temperature of air after the cooler is 15^0C and after the refrigerator is 6^0C. For a refrigeration capacity of 6 tonnes, find: (i) Temperature after compression and expansion, (ii) Air circulation required in the cycle per minute, (iii) Work of compressor and expander, (iv) Theoretical C.O.P and (v) Rate of water circulation required in the cooler in kg/min, if the rise in temperature is limited to 30^0C. [8M]

3. a) How does an actual vapour compression cycle differ from that of a theoretical cycle? [6M]
   b) A vapour compression refrigeration machine, with Freon-12 as refrigerant, has a capacity of 12 tonne of refrigeration operating between -28^0C and 26^0C. The refrigerant is sub-cooled by 4^0C before entering the expansion valve and the vapour is superheated by 5^0C before leaving the evaporator. The machine has a six-cylinder single-acting compressor with stroke equal to 1.25 times the bore. It has a clearance of 3% of the stroke volume. Determine (i) Theoretical power required, (ii) C.O.P, (iii) Volumetric efficiency, (iv) Bore and stroke of cylinder. The speed of compressor is 1000 r.p.m. the following properties of Freon-12 may be used: [10M]

Sat. temperature ^{0}C	Pressure bar	Sp.Volume of vapour, m^3/kg	Enthalpy,kJ/kg		Entropy,kJ/kg K	
			liquid	vapour	liquid	vapour
-28	1.093	0.1475	10.64	175.11	0.0444	0.7153
26	6.697	0.0262	60.67	198.11	0.2271	0.6865

Specific heat of liquid refrigerant=0.963 kJ/kg K and specific heat of superheated vapour=0.615 kJ/kg K.

4. a) Write short notes on the types of refrigeration compressors. [8M]
   b) Explain the working of following types of evaporators with neat sketches: [8M]
   (i) Flooded evaporator, (ii) Natural convection evaporator.

5. a) Explain with the help of a neat sketch, the working of a steam jet refrigeration system. [8M]
   b) Explain the working principle of thermo-electric refrigeration system. Compare the working of different components of thermo-electric refrigeration system with the working of different components of vapour compression system. [8M]

6. a) Explain the concept of effective sensible heat factor for room to be air conditioned. How is it useful to find the ADP for fixed room design condition? [8M]
   b) Define the `` human comfort `` and explain the factors which affect human comfort. [8M]

7. a) Explain the use of HEAT PUMP for heating and cooling cycle with neat diagram. [8M]
   b) Explain in detail different components of fans? [8M]

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