B. Tech.
(SEM. VI) EVEN SEMESTER THEORY EXAMINATION, 2016-17
REFRIGERATION AND AIR CONDITIONING

Time : 3 Hours Max. Marks : 100

Section-A

1. Attempt **all** parts of the following : (2 × 10 = 20)

a. **What do you mean by refrigeration effect and unit of refrigeration ?**

Ans. Refer Q. 1.3, Page SQ–1D, 2 Marks Questions, Unit-1.

b. **Describe boot strap cycle of air refrigeration system.**

Ans. Refer Q. 1.14, Page SQ–4D, 2 Marks Questions, Unit-1.

c. **Differentiate open and closed air refrigeration system.**

Ans. Refer Q. 1.9, Page SQ–3D, 2 Marks Questions, Unit-1.

d. **Explain dry air rated temperature (DART).**

Ans. Refer Q. 1.15, Page SQ–4D, 2 Marks Questions, Unit-1.

e. **How does an actual vapour compression cycle differ from that of a theoretical cycle ?**

Ans. Refer Q. 2.3, Page SQ–5D, 2 Marks Questions, Unit-2.

f. **Discuss the operation of a capillary tube in refrigeration system.**

Ans. Refer Q. 5.9, Page SQ–17D, 2 Marks Questions, Unit-5.

g. **Explain psychrometric process.**

Ans. Refer Q. 4.10, Page SQ–13D, 2 Marks Questions, Unit-4.

h. **Explain the modified comfort chart with neat sketches.**

Ans. Refer Q. 4.14, Page SQ–14D, 2 Marks Questions, Unit-4.

i. **Write the expression for calculating the heat gain through the ducts.**

Ans. Refer Q. 5.15, Page SQ–18D, 2 Marks Questions, Unit-5.

j. **What are the different factors considered in load estimation sheet for comfort application ?**

Ans. Refer Q. 4.13, Page SQ–13D, 2 Marks Questions, , Unit-4.

Section-B

2. Attempt any **five** of the following questions : (10 × 5 = 50)

a. In an open cycle air refrigeration machine, air is drawn from a cold chamber at – 2 °C and 1 bar and compressed to 11 bar. It is then cooled at this pressure to the cooler temperature of 20 °C and then expanded in expansion cylinder and returned to the cold room. The compression and expansion are isentropic and follows the law $pv^{1.4}$ = constant. Sketch the *p-v* and *T-s* diagrams of the cycle and for a refrigeration of 15 tonnes. Determine : 1. theoretical COP, 2. rate of circulation of the air in kg/min, and 3. piston displacement per minute in the compressor and expander.

Ans. Refer Q. 1.17, Page 1–20D, Unit-1.

b. In a vapour compression refrigeration system using *R*-12, the evaporator pressure is 1.4 bar and the condenser pressure is 8 bar. The refrigerant leaves the condenser sub-cooled to 30 °C. The vapour leaving the evaporator is dry and saturated. The compression process is isentropic. The amount of heat rejected in the condenser is 13.42 MJ/min. Determine :

1. **Refrigerating effect in kJ/kg,**
2. **Refrigerating load in TR, and**
3. **COP.**

Ans. Refer Q. 2.8, Page 2–13D, Unit-2.

c. In a 100 TR aqua ammonia absorption plant, saturated liquid ammonia at 30 °C leaves the condenser and enters the expansion valve. The evaporator pressure is 1.9 bar and the vapour temperature at evaporator exit is – 10 °C. The mass concentrations of ammonia in the weak and strong solutions are 0.25 and 0.325 respectively. Determine the mass flow rates in kg/min of the strong and weak solutions.

Ans. Refer Q. 3.13, Page 3–17D, Unit-3.

d. Atmospheric air at dry bulb temperature of 16 °C and 25 % relative humidity passes through a furnace and then through a humidifier, in such a way that the final dry bulb temperature is 30 °C and 50 % relative humidity. Find the heat and moisture added to the air. Also determine the sensible heat factor of the process.

Ans. Refer Q. 4.12, Page 4–24D, Unit-4.

e. An air conditioning plant is required to supply 60 m^3 of air per minute at a DBT of 21 °C and 55 % RH. The outside air is at DBT of 28 °C and 60 % RH. Determine the mass of water drained and capacity of the cooling coil. Assume the air condition plant first to dehumidify and then to cool the air.

Ans. Refer Q. 4.11, Page 4–23D, Unit-4.

f. Draw a neat labelled sketch of a practical vapour absorption refrigeration cycle and explain its working in brief.

Ans. Refer Q. 3.9, Page 3–11D, Unit-3.

g. Define the terms :

i. Dew point temperature **ii. Specific humidity**

iii. Relative humidity **iv. Degree of saturation**

Ans. Refer Q. 4.3, Page 4–4D, Unit-4.

h. Attempt the following :

i. What are the desirable properties of an ideal refrigerant ?

Ans. Refer Q. 3.20, Page 3–24D, Unit-3.

ii. Discuss in detail, the secondary refrigerants.

Ans. Refer Q. 3.23, Page 3–25D, Unit-3.

Section-C

Attempt any two of the following questions : (15 × 2 = 30)

3. What is multistage vapour compression refrigeration system ? Compare it with cascade refrigeration system. Explain advantages and disadvantages over simple vapour compression system.

Ans. Refer Q. 2.22, Page 2–33D, Unit-2.

4. A Bell-Coleman refrigerator operates between pressure limits of 1.1 bar and 5 bar. The temperatures at the suction to the compressor and inlet to the expander are 27 °C and 37 °C, respectively. Isentropic efficiencies of the compressor and expander are 0.80 and 0.82, respectively. Determine the power input to the compressor, if the refrigerator produces cooling at the rate of 50 TR.

Ans. Refer Q. 1.14, Page 1--16D, Unit-1.

5. Answer the following :

i. Discuss the effect of variation of condenser and evaporator pressures and sub-cooling of condensate on COP of a vapour compression refrigeration system.

Ans. Refer Q. 2.12, Page 2–19D, Unit-2.

ii. Discuss the applications of flash chamber with the help of *p-h* chart and schematic diagrams.

Ans. Refer Q. 2.17, Page 2–24D, Unit-2.

B. Tech.
(SEM. VI) EVEN SEMESTER THEORY EXAMINATION, 2017-18
REFRIGERATION AND AIR CONDITIONING

Time : 3 Hours **Max. Marks : 100**

1. Attempt **all** sections. If require any missing data ; then choose suitably.
2. Use of steam tables, refrigerant's property tables and charts, psychrometric charts, and enthalpy-concentration diagram is allowed.

Section-A

1. Attempt **all** question in brief : (2 × 10 = 20)

a. Define refrigeration.

Ans. Refer Q. 1.1, Page SQ–1D, 2 Marks Questions, Unit-1.

b. Differentiate between refrigerator and heat pump.

Ans. Refer Q. 1.4, Page SQ–1D, 2 Marks Questions, Unit-1.

c. Give advantages of vapour compression refrigeration system.

Ans. Refer Q. 2.2, Page SQ–5D, 2 Marks Questions, Unit-2.

d. List the advantages of cascade system over single stage vapour compression refrigeration system.

Ans. Refer Q. 2.17, Page SQ–7D, 2 Marks Questions, Unit-2.

e. Draw the schematic diagram of simple vapour absorption refrigeration system.

Ans. Refer Q. 3.1, Page SQ–8D, 2 Marks Questions, Unit-3.

f. What is an azeotrope ?

Ans. Refer Q. 3.16, Page SQ–10D, 2 Marks Questions, Unit-3.

g. Give chemical name of *R* - 112.

Ans. Refer Q. 3.17, Page SQ–10D, 2 Marks Questions, Unit-3.

h. Define BPF and SHF.

Ans. Refer Q. 4.16, Page SQ–14D, 2 Marks Questions, Unit-4.

i. **What is duct ? Why is it used ?**

Ans. Refer Q. 5.13, Page SQ–18D, 2 Marks Questions, Unit-5.

j. **Define dew point temperature.**

Ans. Refer Q. 4.8, Page SQ–13D, 2 Marks Questions, Unit-4.

Section-B

2. Attempt any three part of the following : $(10 \times 3 = 30)$

a. **In a refrigerator working on Bell-Coleman cycle, air is drawn into the cylinder of the compressor from the cold chamber at 1 bar and – 30C. After reversible adiabatic compression to 5 bar, the air is cooled at constant pressure to a temperature of 170C. After subsequent polytropic expansion ($pv^{1.23} = C$) to 1 bar in the expansion cylinder, the air is passed to the cold chamber. Sketch the *p-v* and *T-s* diagram of the cycle and determine for unit mass flow of the air :**

i. **Refrigeration effect,**
ii. **Work expanded, and**
iii. **COP.**

Ans. Refer Q. 1.13, Page 1–15D, Unit-1.

b. **The following data refer to a two stage compression ammonia refrigerating system with water intercooler. Condenser pressure = 14 bar, evaporator pressure = 2 bar, intercooler pressure = 5 bar, load on the evaporator = 10 TR. If the temperature of de-superheated vapour and sub-cooled liquid refrigerant are limited to 300C, find : (a) the power required to drive the system and (b) COP of the system. Use *p-h* chart.**

Ans. Refer Q. 2.20, Page 2–29D, Unit-2.

c. **Draw and explain practical vapour absorption refrigeration system.**

Ans. Refer Q. 3.9, Page 3–11D, Unit-3.

d. **The atmospheric air at 300C DBT and 75 % RH enters a cooling coil at the rate of 200 m^3/min. The coil dew point temperature is 140C and BPF of the coil is 0.1. Determine the (i) Temperature of the air leaving the cooling coil, (ii) The capacity of the cooling coil in TR and kW, (iii) The amount of water vapours removed per min and (iv) Sensible heat factor for the process.**

Ans. Refer Q. 4.14, Page 4–27D, Unit-4.

e. **What are different types of expansion devices generally used in refrigeration system ? Describe thermostatic expansion valve with neat sketch.**

Ans. Refer Q. 5.10, Page 5–15D, Unit-4.

Section-C

3. Attempt any one part of the following : (10 × 1 = 10)

a. **In an aircraft refrigeration unit of a cooling load of 12 TR, the atmospheric temperature and pressure are 120C and 0.9 bar respectively. This pressure increases to 1.01 bar due to ramming effect. The air is bled from the engine compressor at 3.5 bar and passed through the air cooled heat exchanger where its temperature is reduced by 500C, the air is then expanded in the cooling turbine, delivered to the aircraft cabin and subsequently leaves the aircraft at 200C. The pressure in the cabin is 1.03 bar. Calculate the power required to undertake the cooling load and COP of the system.**

Ans. Refer Q. 1.21, Page 1–27D, Unit-1.

b. **A 15 ton aircraft refrigeration plant operates on boot strap cooling system. The conditions of ambient air are 170C and 0.95 bar. Due to isentropic ramming action, the pressure of air is increased to 1.2 bar. The pressure of air discharge from main compressor and auxiliary compressor are 3.2 bar and 4.2 bar respectively. 15 % of the enthalpy of air discharged from main compressor is removed in the first heat exchanger and 35 % of the enthalpy of the air discharge from the auxiliary compressor is removed in the second heat exchanger using rammed air. Subsequently, the air is expanded in the turbine with 85 % isentropic efficiency and discharge into the cabin at 1.013 bar pressure. The air is finally exited to the atmosphere at a temperature which is not to exceed 250C. Assuming the isentropic efficiency of both the compressors 80 %, determine (a) power required to take the cabin load (b) COP of the system.**

Ans. Refer Q. 1.25, Page 1–32D, Unit-1.

4. Attempt any one part of the following : (10 × 1 = 10)

a. **A vapour compression refrigerator uses *R*-40 and operates between temperature limits of – 10 and 450C. At entry to the compressor, the refrigerant is dry saturated and after compression it acquires a temperature of 600C. Using properties from the table, find the COP of the refrigerator.**

Ans. Refer Q. 2.7, Page 2–11D, Unit-2.

b. The following data refer to a two stage compression ammonia refrigerating system with water intercooler. Condenser pressure = 14 bar, evaporator pressure = 2 bar, intercooler pressure = 5 bar, load on the evaporator = 10 TR. If the temperature of de-superheated vapour and sub-cooled liquid refrigerant are limited to 300C, find :

i. the power required to drive the system

ii. COP of the system. Use *p-h* chart.

Ans. Refer Q. 2.20, Page 2–29D, Unit-2.

5. Attempt any one part of the following : (10 × 1 = 10)

a. Explain advantages of vapour absorption refrigeration system.

A geothermal well at 1300C supplies heat at the rate of 100500 kJ/hr to a vapour absorption system. The environment is at 300C and the refrigerated space is maintained at – 220C. Determine the maximum possible heat removed from the refrigerated space.

With the help of psychrometric chart, explain following processes :

i. Cooling and adiabatic humidification process.

ii. Adiabatic mixing of two air streams.

Ans.

A. Advantages of Vapour Absorption System and Numerical : Refer Q. 3.12, Page 3–16D, Unit-3.

B. Psychrometric Processes : Refer Q. 4.6, Page 4–11D, Unit-4.

b. Describe electrolux refrigeration system with the help of neat sketches.

Ans. Refer Q. 3.16, Page 3–20D, Unit-3.

6. Attempt any one part of the following : (10 × 1 = 10)

a. In an air conditioning system, the inside conditions are DBT 250C, RH 50 % and outside conditions are DBT 400C and WBT 270C. The room sensible heat factor is 0.8, 50 % of the room air is rejected to atmosphere and an equal quantity of fresh air is added before air enters the air conditioning apparatus. If the fresh air added is 100 m^3/min, determine :

i. Room sensible and room latent heat load

ii. Sensible and latent heat load due to fresh air

iii. Apparatus dew point temperature

iv. Humidity ratio and DBT of air entering air conditioning apparatus.

Assume BPF as 0 and density of air 1.2 kg/m^3 at a total pressure of 1.01325 bar.

Ans. Refer Q. 4.26, Page 4–43D, Unit-4.

b. With the help of psychrometric chart, explain following processes :

i. Sensible heating and sensible cooling processes

ii. Cooling and dehumidification process

How are refrigerants classified ? What are the desirable properties of refrigerants ? Name some common refrigerants generally used in refrigeration system.

Ans.

A. **Psychrometric Processes :** Refer Q. 4.6, Page 4–11D, Unit-4.

B. **Refrigerants Classification, Properties of Refrigerants and some Common Refrigerants :** Refer Q. 3.22, Page 3–25D, Unit-3.

7. Attempt any **one** part of the following : **(10 × 1 = 10)**

a. Describe a cold storage in brief. What factors are considered in design of a cold storage ?

Ans. Refer Q. 5.13, Page 5–21D, Unit-5.

b. A rectangular duct section of 500 × 350 mm^2 size carries 75 m^3/min of air having density of 1.15 kg/m^3. Determine the equivalent diameter of a circular duct if (a) the quantity of air carried in both the cases is same; (b) the velocity of the air in both the cases is same. If f = 0.01 for sheet metal, find the pressure loss per 100 m length duct.

Ans. Refer Q. 5.20, Page 5–31D, Unit-5.