

Code No: R05410305

R05**Set No. 2**

IV B.Tech I Semester Examinations, November 2010
REFRIGERATION AND AIR CONDITIONING
Mechanical Engineering

Time: 3 hours**Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

1. A simple evaporative air refrigeration system is used for an aeroplane to take 20 tonnes of refrigeration load. The ambient air conditions are 20°C and 0.9 bar. The ambient air is rammed isentropically to a pressure of 1 bar. The air leaving the main compressor at pressure 3.5 bar is first cooled in the heat exchanger having effectiveness of 0.6 and then in the evaporator where its temperature is reduced by 50°C . The air from the evaporator is passed through the cooling turbine and then it is supplied to the cabin which is to be maintained at a temperature of 25°C and at a pressure of 1.05 bar. If the internal efficiency of the compressor is 80% and that of cooling turbine is 75%. Determine
- (i) Mass of air bled off the main compressor,
 - (ii) Power required for the refrigerating system and
 - (iii) C O P of the refrigerating system. [16]
2. (a) What is the function of the following components in an absorption system:
- i. Absorber
 - ii. Rectifier
 - iii. Analyser
 - iv. Heat exchangers.
- (b) Draw a neat diagram of lithium bromide water absorption system and explain its working. [8+8]
3. (a) Explain the various types of axial flow fans.
- (b) What are the advantages and disadvantages of the backward blade fan over forward blade fan? [8+8]
4. A vapour compression refrigerator uses methyl chloride (R-40) and operates between pressure limits of 177.4 kPa and 967.5 kPa. At entry to the compressor, the methyl chloride is dry saturated and after compression has a temperature of 102°C . The compressor has a bore and stroke of 75mm and runs at 8 rev/s with a volumetric efficiency of

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80%. The temperature of the liquid refrigerant as it leaves the condenser is 35°C and its specific heat capacity is $1.624 \text{ kJ/kg} \cdot \text{K}$. The specific heat capacity of the superheated vapour may be assumed to be constant. Determine:

- refrigerator C O P
- mass flow rate of refrigerant and
- cooling water required by the condenser if its temperature rise is limited to 12°C . Specific heat capacity of water = $4.187 \text{ kJ/kg} \cdot \text{K}$.

The relevant properties of methyl chloride are as follows: [16]

Sat.temp. $^{\circ}\text{C}$	Pressure kPa	Specific Volume m^3/kg		Specific enthalpy kJ/kg		Specific entropy kJ/kg.K	
		Liquid	Vapour	Liquid	Vapour	Liquid	Vapour
-10	177.4	0.00102	0.233	45.38	460.76	0.183	1.762
45	967.5	0.00115	0.046	132.98	483.6	0.485	1.587

- Explain the working of bare tube coil evaporators.
 - Discuss the physical and thermodynamic properties of the following refrigerants and how the leaks are detected in each case.
R - 11, R - 12, R - 22, R - 717 and R - 13. [8+8]
- An auditorium of 400 seating capacity is air-conditioned for summer season when the following data is known:
 Out of door conditions: 42°C and 48% R.H., required comfort conditions: 21°C and 54% R.H., the quantity of conditioned air supplied at the entrance condition: $0.27 \text{ m}^3/\text{min}/\text{person}$, 62% of the conditioned air is recirculated and mixed with the fresh atmospheric air, the dew point temperature of the cooling coil is 9°C . The required condition is achieved first by cooling and dehumidifying and then by heating. Find the following:

 - The condition of air after mixing
 - The capacity of the cooling coil in tons of refrigeration and its by-pass factor
 - Condition of air before entering into heating coil
 - The quantity of steam required per hour in the heating coil if the steam is supplied at 100°C saturated. Assume only latent heat of steam is used for heating. [16]
- Explain the various components of Steam Jet Refrigeration system and clearly discuss the function of each component.
 - List out the fields of applications of Vortex tube. [10+6]
- Explain how does the body attempt to compensate for a warm environment approaching body temperature?

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- (b) Draw and explain the comfort chart and zone of comfort for year-round air-conditioning. [6+10]

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Answer any FIVE Questions
All Questions carry equal marks

1. (a) Explain the various components of Steam Jet Refrigeration system and clearly discuss the function of each component.
(b) List out the fields of applications of Vortex tube. [10+6]
2. A simple evaporative air refrigeration system is used for an aeroplane to take 20 tonnes of refrigeration load. The ambient air conditions are 20°C and 0.9 bar. The ambient air is rammed isentropically to a pressure of 1 bar. The air leaving the main compressor at pressure 3.5 bar is first cooled in the heat exchanger having effectiveness of 0.6 and then in the evaporator where its temperature is reduced by 50°C . The air from the evaporator is passed through the cooling turbine and then it is supplied to the cabin which is to be maintained at a temperature of 25°C and at a pressure of 1.05 bar. If the internal efficiency of the compressor is 80% and that of cooling turbine is 75%. Determine
 - (i) Mass of air bled off the main compressor,
 - (ii) Power required for the refrigerating system and
 - (iii) C O P of the refrigerating system. [16]
3. (a) What is the function of the following components in an absorption system:
 - i. Absorber
 - ii. Rectifier
 - iii. Analyser
 - iv. Heat exchangers.

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(b) Draw a neat diagram of lithium bromide water absorption system and explain its working. [8+8]

4. An auditorium of 400 seating capacity is air-conditioned for summer season when the following data is known:

Out of door conditions: 42°C and 48% R.H., required comfort conditions: 21°C and 54% R.H., the quantity of conditioned air supplied at the entrance condition: $0.27\text{ m}^3/\text{min}/\text{person}$, 62% of the conditioned air is recirculated and mixed with the fresh atmospheric air, the dew point temperature of the cooling coil is 9°C . The required condition is achieved first by cooling and dehumidifying and then by heating. Find the following:

- The condition of air after mixing
- The capacity of the cooling coil in tons of refrigeration and its by-pass factor
- Condition of air before entering into heating coil
- The quantity of steam required per hour in the heating coil if the steam is supplied at 100°C saturated. Assume only latent heat of steam is used for heating. [16]

5. A vapour compression refrigerator uses methyl chloride (R-40) and operates between pressure limits of 177.4 kPa and 967.5 kPa. At entry to the compressor, the methyl chloride is dry saturated and after compression has a temperature of 102°C . The compressor has a bore and stroke of 75mm and runs at 8 rev/s with a volumetric efficiency of 80%. The temperature of the liquid refrigerant as it leaves the condenser is 35°C and its specific heat capacity is $1.624\text{ kJ/kg}\cdot\text{K}$. The specific heat capacity of the superheated vapour may be assumed to be constant. Determine:

- refrigerator C O P
- mass flow rate of refrigerant and
- cooling water required by the condenser if its temperature rise is limited to 12°C . Specific heat capacity of water = $4.187\text{ kJ/kg}\cdot\text{K}$.

The relevant properties of methyl chloride are as follows: [16]

Sat.temp. $^{\circ}\text{C}$	Pressure kPa	Specific Volume m^3/kg		Specific enthalpy kJ/kg		Specific entropy kJ/kg.K	
		Liquid	Vapour	Liquid	Vapour	Liquid	Vapour
-10	177.4	0.00102	0.233	45.38	460.76	0.183	1.762
45	967.5	0.00115	0.046	132.98	483.6	0.485	1.587

- Explain how does the body attempt to compensate for a warm environment approaching body temperature?
 - Draw and explain the comfort chart and zone of comfort for year-round air-conditioning. [6+10]
- Explain the various types of axial flow fans.
 - What are the advantages and disadvantages of the backward blade fan over forward blade fan? [8+8]
- Explain the working of bare tube coil evaporators.

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- (b) Discuss the physical and thermodynamic properties of the following refrigerants and how the leaks are detected in each case.

R - 11, R - 12, R - 22, R - 717 and R - 13.

[8+8]

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Answer any FIVE Questions
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- Explain the various components of Steam Jet Refrigeration system and clearly discuss the function of each component.
 - List out the fields of applications of Vortex tube. [10+6]
- A vapour compression refrigerator uses methyl chloride (R-40) and operates between pressure limits of 177.4 kPa and 967.5 kPa. At entry to the compressor, the methyl chloride is dry saturated and after compression has a temperature of 102°C. The compressor has a bore and stroke of 75mm and runs at 8 rev/s with a volumetric efficiency of 80%. The temperature of the liquid refrigerant as it leaves the condenser is 35°C and its specific heat capacity is 1.624 kJ/kg. K. The specific heat capacity of the superheated vapour may be assumed to be constant. Determine:

 - refrigerator C O P
 - mass flow rate of refrigerant and
 - cooling water required by the condenser if its temperature rise is limited to 12°C. Specific heat capacity of water = 4.187 kJ/kg.K.

The relevant properties of methyl chloride are as follows: [16]

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- Explain how does the body attempt to compensate for a warm environment approaching body temperature?
 - Draw and explain the comfort chart and zone of comfort for year-round air-conditioning. [6+10]
- What is the function of the following components in an absorption system:

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- i. Absorber
 - ii. Rectifier
 - iii. Analyser
 - iv. Heat exchangers.
- (b) Draw a neat diagram of lithium bromide water absorption system and explain its working. [8+8]
5. (a) Explain the various types of axial flow fans.
- (b) What are the advantages and disadvantages of the backward blade fan over forward blade fan? [8+8]
6. An auditorium of 400 seating capacity is air-conditioned for summer season when the following data is known:
 Out of door conditions: 42°C and 48% R.H., required comfort conditions: 21°C and 54% R.H., the quantity of conditioned air supplied at the entrance condition: $0.27\text{ m}^3/\text{min}/\text{person}$, 62% of the conditioned air is recirculated and mixed with the fresh atmospheric air, the dew point temperature of the cooling coil is 9°C . The required condition is achieved first by cooling and dehumidifying and then by heating. Find the following:
 - (a) The condition of air after mixing
 - (b) The capacity of the cooling coil in tons of refrigeration and its by-pass factor
 - (c) Condition of air before entering into heating coil
 - (d) The quantity of steam required per hour in the heating coil if the steam is supplied at 100°C saturated. Assume only latent heat of steam is used for heating. [16]
7. A simple evaporative air refrigeration system is used for an aeroplane to take 20 tonnes of refrigeration load. The ambient air conditions are 20°C and 0.9 bar. The ambient air is rammed isentropically to a pressure of 1 bar. The air leaving the main compressor at pressure 3.5 bar is first cooled in the heat exchanger having effectiveness of 0.6 and then in the evaporator where its temperature is reduced by 50°C . The air from the evaporator is passed through the cooling turbine and then it is supplied to the cabin which is to be maintained at a temperature of 25°C and at a pressure of 1.05 bar. If the internal efficiency of the compressor is 80% and that of cooling turbine is 75%. Determine
 - (i) Mass of air bled off the main compressor,
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8. (a) Explain the working of bare tube coil evaporators.

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- (b) Discuss the physical and thermodynamic properties of the following refrigerants and how the leaks are detected in each case.

R - 11, R - 12, R - 22, R - 717 and R - 13.

[8+8]

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1. A simple evaporative air refrigeration system is used for an aeroplane to take 20 tonnes of refrigeration load. The ambient air conditions are 20°C and 0.9 bar. The ambient air is rammed isentropically to a pressure of 1 bar. The air leaving the main compressor at pressure 3.5 bar is first cooled in the heat exchanger having effectiveness of 0.6 and then in the evaporator where its temperature is reduced by 50°C . The air from the evaporator is passed through the cooling turbine and then it is supplied to the cabin which is to be maintained at a temperature of 25°C and at a pressure of 1.05 bar. If the internal efficiency of the compressor is 80% and that of cooling turbine is 75%.

Determine

- (i) Mass of air bled off the main compressor,
- (ii) Power required for the refrigerating system and
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[16]

2. (a) Explain the working of bare tube coil evaporators.
 (b) Discuss the physical and thermodynamic properties of the following refrigerants and how the leaks are detected in each case.
 R - 11, R - 12, R - 22, R - 717 and R - 13. [8+8]
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4. (a) What is the function of the following components in an absorption system:
- i. Absorber
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 - iii. Analyser
 - iv. Heat exchangers.
- (b) Draw a neat diagram of lithium bromide water absorption system and explain its working. [8+8]

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5. (a) Explain how does the body attempt to compensate for a warm environment approaching body temperature?
 (b) Draw and explain the comfort chart and zone of comfort for year-round air-conditioning. [6+10]
6. (a) Explain the various components of Steam Jet Refrigeration system and clearly discuss the function of each component.
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7. An auditorium of 400 seating capacity is air-conditioned for summer season when the following data is known:
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