# University of Mumbai

## Examination Summer 2022

**Program:** Mechanical Engineering     **Curriculum Scheme:** REV- 2019 'C' Scheme

**Examination:** TE     **Semester:** VI

**Course Code:** MEC603     **Course Name:** HVAC&R

**Time:** 2 hour 30 Minutes     **Max. Marks:** 80

DATE: 24/5/2022     QP CODE: 93503

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1T01436 - T.E.(Mechanical) Engineering)(SEM-VI)(Choice Base Credit Grading System )(R-2020-21) ('C' Scheme) / 89423 - Heating, Ventilation, Air Conditioning and Refrigeration

N. B. :
1. All questions are **compulsory.**
2. Assume suitable data if required and state it clearly.
3. Use of Steam Table, Psychrometric chart, P-H Chart is permitted.

| Q1. | Choose the correct option for following questions. All the Questions are compulsory and carry equal marks |
|---|---|
| 1. | If a heat pump cycle operates between the condenser temperature of +27°C and evaporator temperature of -23°C, then the Carnot COP will be |
| Option A: | 0.2 |
| Option B: | 1.2 |
| Option C: | 5.1 |
| Option D: | 6 |
| | |
| 2. | For summer air conditioner which of the following psychrometric process is applicable |
| Option A: | Cooling & Dehumidification |
| Option B: | Only Cooling |
| Option C: | Cooling & Humidification |
| Option D: | Only dehumidification |
| | |
| 3. | In case of sensible cooling of air, the coil efficiency is given by |
| Option A: | BPF-1 |
| Option B: | 1-BPF |
| Option C: | 1+ BPF |
| Option D: | 1/BPF |
| | |
| 4. | In load estimation, RSH = 39 and RLH = 13 then what will be value of RSHF |
| Option A: | 0.36 |
| Option B: | 0.29 |
| Option C: | 0.47 |
| Option D: | 0.75 |
| | |
| 5. | Heat is absorbed by the refrigerant, during vapour compression refrigeration cycle in |
| Option A: | Compressor |
| Option B: | Condenser |

| | |
|---|---|
| Option C: | Evaporator |
| Option D: | Throttling valve |
| | |
| 6. | The boiling point of ammonia is |
| Option A: | -100°C |
| Option B: | -50°C |
| Option C: | +33.3°C |
| Option D: | -33.3°C |
| | |
| 7. | Atmospheric air with DBT of 28°c and WBT of 17°c is cooled to 15°c without changing its moisture content. Find original relative humidity, Final relative humidity and Final wet bulb temperature |
| Option A: | 34% ,73% , 12°c repectively |
| Option B: | 64% ,33% , 12°c repectively |
| Option C: | 74% ,23% , 12°c repectively |
| Option D: | 94% ,13% , 12°c repectively |
| | |
| 8. | Equal friction method of designing air conditioning ducts |
| Option A: | Is ideal when the system is balanced |
| Option B: | Is ideal when the system is not balanced |
| Option C: | Is ideal only for return ducts |
| Option D: | Is ideal for none of the above |
| | |
| 9. | When the moisture is added in to air at constant dry bulb temperature the process is known as |
| Option A: | Dehumidification |
| Option B: | Humidification |
| Option C: | Sensible cooling |
| Option D: | Sensible heating |
| | |
| 10. | In HVACR industry refrigerant Air is designated as |
| Option A: | R-717 |
| Option B: | R-744 |
| Option C: | R-764 |
| Option D: | R-729 |

| Q2 | Solve any Four out of Six Questions                   5 marks each |
|---|---|
| A | Define i) Relative humidity ii) Ton of Refrigeration iii) Degree of Saturation, iv) Dew point temperature v) Coefficient of performance |
| B | What is the effective temperature? Which are the factors governing effective temperature? |
| C | What are the properties of good refrigerant? Compare the primary and secondary refrigerant with few examples. |
| D | Explain the various methods of duct design |
| E | Explain with suitable sketch working of Simple vapor absorption refrigeration system. |
| F | Explain the effect of changing evaporator pressure & condenser pressure on COP of VCR cycle with P-H Diagram. |

| Q3 | Solve any Two Questions out of Three              10 marks each |
|---|---|
| A | The cockpit of a jet plane is to be cooled by a simple air refrigeration system. The data available is as follows.<br>Cockpit cooling load =20 TR<br>Speed of the plane = 1000km/hrs<br>Ambient air temperature = -15°C<br>Ram efficiency = 90%<br>Pressure ratio in the main compressor =3<br>Pressure drop in the heat exchanger =0.1 bar<br>Isentropic efficiencies of main compressor and turbine = 80%<br>Temperature of air entering the cooling Turbine = 30°C<br>Pressure of the air leaving the cooling turbine = 1.06 bar<br>Pressure in the cockpit = 1 bar<br>If the cockpit is to be maintained at 25°C find<br>   1) Stagnation temperature and pressure of air entering the main compressor<br>   2) Mass flow rate of air to cockpit<br>   3) Power required to drive the refrigerating system<br>   4) C.O.P of the system |
| B | Explain summer and winter air-conditioning processes with the help of psychrometric chart. |
| C | A Simple $NH_3$ vapour compression system has compressor with piston displacement of 3 $m^3$/min, a condenser pressure of 12 bar and evaporator pressure of 2,5 bar. The liquid is sub-cooled to 20°Cby soldering the liquid line to suction line. The temperature of vapour leaving the cooling water is 6000KJ/hr and volumetric efficiency of compressor is 0.8. Use PH Chart. Find:<br>   1) Capacity of the system<br>   2) Indicated power<br>   3) COP of the system<br>   4) Draw P-H and T-S Diagram |

| Q4. | |
|---|---|
| A | Solve any Two Questions out of Three        5 marks each |
| i. | Write a note on ICE plant |
| ii. | Dry bulb temperature =30°c<br>Wet bulb temperature = 20°c<br>Barometer reading = 740 mm of Hg<br>Using steam table. Determine<br>   1. Partial pressure of water vapour<br>   2. Relative humidity<br>   3. Dew point temperature<br>   4. Specific humidity<br>      Vapour density |
| iii. | Explain the use of heat pump for heating and cooling cycle with neat diagram. |
| B | Solve any One Question out of Two        10 marks each |
| i. | The following data refers to the office of air conditioning plant having maximum seating capacity of 30 occupants.<br>Outside design conditions: 36° CDBT and 27° CWBT<br>Inside design conditions: 22° CDBT and 55% RH<br>Solar heat gain: 8500 W<br>Latent heat gain per occupant : 100 W |

|     |                                                                                                                                                                                                                                                                                                                                       |
| --- | --- |
|     | Sensible heat gain per occupant : 83W <br> Lightening load: 2500 W <br> Sensible heat load from other sources : 12000 W <br> Infiltration load: 15 m3/min <br>     1) Assuming 40% fresh air and 60 % of recirculated air passing through the evaporator coil and the by-pass factor of 0.12, Find dew point temperature of the coil and capacity of the plant. |
| ii. | An air conditioning plant is required to supply 60 m³ of air per minute at a Dry bulb temperature of 21 deg C and 55% Relative humidity. The outside air is at dry bulb temperature of 28 deg C and 60% relative humidity. Determine the mass of water drained and capacity of the cooling coil. Assume the air conditioning plant first to dehumidify and then to cool the air |