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Roll No.

337732(37)

B. E. (Seventh Semester) Examination,

Nov.-Dec. 2021

(New Scheme)

(Mech. Engg. Branch)

REFRIGERATION & AIR CONDITIONING

Time Allowed : Three hours

Maximum Marks : 80

Minimum Pass Marks : 28

Note : Attempt questions only of 16 marks from each unit. Use of Refrigeration chart, Table, Psychometric chart and steam table are allowed.

Unit-I

1. (a) Define a ton of refrigeration.

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(b) Write the effect of various performance parameter

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in vapour compression refrigeration system with suitable diagram. 7

- (c) The following data refers to a 30 TR ice plant using ammonia as refrigerant :

The temperature of water entering and leaving the condenser are 20°C and 27°C and temperature of brine in the evaporator is -15°C.

Before entering the expansion valve ammonia is cooled to 20°C and the ammonia enters the compressor dry saturated.

Calculate for one tonne of refrigeration the power expended, the amount of cooling water in the condenser and the coefficient of performance of the plant.

Use the properties given in the table below : 7

Saturation Temperature °C	Enthalpy, kJ/kg		Entropy, kJ/kgK		Specific heat kJ/kgK	
	liquid	Vapour	Liquid	Vapour	Liquid	Vapour
-15	112.34	1426.54	0.4572	5.5490	4.396	2.303
25	289.90	1465.84	1.1242	5.0391	4.606	2.805

- (d) A cold storage is to be maintained at -10°C while

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the surroundings are at 40°C. The heat leakage from the surroundings into the cold storage is estimated to be 30 kW. The actual COP of the refrigeration plant is two-third of an ideal plant working between the same temperatures. Find the following :

- Power required to drive the plant.
- In same temperature limit what is the value of $(COP)_{ideal}$ for Heat pump case.
- For same temperature limit what is the efficiency (η_{ideal}) value for heat engine incase cycle operates in cyclic heat engine. 7

Unit-II

- What is the limitation of carnot cycle with gas. 2
 - Explain, with a neat sketch, the working principle of boot strap air evaporative type air refrigeration system. Draw T-S diagram for the system. 7
 - An aircraft moving with speed of 2000 km/h uses simple air refrigeration cycle for air-conditioning. The ambient pressure and temperature are 0.35 bar and -10°C respectively. The pressure ratio of compressor

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is 4.5. The heat exchanger effectiveness is 0.95. the isentropic efficiency of compressor & expanders are 0.8 each. The cabin pressure and temperature are 1.06 bar and 25°C. Determine temperature & pressure at all points of the cycle. Also find the volume flow rate through compressor inlet & expander outlet for 100 TR.

Take C_p , C_v & R value for standard air.

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(d) A dense closed cycle refrigeration system working between 2 bar & 4 bar extracts 126 MJ of heat per hour. The air enters the compressor at 5°C and into expander at 20°C, Assuming the unit runs at 300 r.p.m. find out :

- (i) Power required to run the unit.
- (ii) Bore of compressor
- (iii) Refrigeration capacity in tonnes of ice at 0°C per day.

Take the following

The compressor and expander are double acting and stroke of compressor and expander is 300 mm. The mechanical efficiency of compressor is

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80%. The mechanical efficiency of expander is 85%. Assume the expansion & compression are isentropic.

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Unit-III

3. (a) What is secondary refrigerant? 2
- (b) Explain the working principle, advantages and disadvantage of electrolux refrigerator. 7
- (c) Explain working principle of actual vapour absorption refrigeration system. 7
- (d) Write type and working principle of expansion device. 7

Unit-IV

4. (a) What is Human Comfort? 2
- (b) Explain following psychrometric processes with the help of chart. 14
 - (i) Sensible heating
 - (ii) Sensible cooling
 - (iii) Humidification

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- (iv) Dehumidification
 - (v) Heating & Humidification
 - (vi) Cooling & Dehumidification
 - (vii) Cooling with adiabatic Humidification
- (c) Air at 10°C DBT and 90% relative Humidity is to be heated and humidified to 35°C DBT and 22.5°C WBT. The air is preheated sensible before passing to the air washer in which water is recirculated. The relative humidity of the air coming out of the air washer is 90%. This air is again reheated sensibly to obtain the final desired condition. Find :
- (i) The temperature to which the air should be preheated.
 - (ii) Plot the process in psychrometric chart
 - (iii) Heat required for preheating of air
 - (iv) Heat required for reheating of air
 - (v) Total Heat required through process
 - (vi) Make up water required in the air washer
 - (vii) Humidifying efficiency of the air washer

5. (a) What do you understand by the term cooling load? 2
- (b) A hall is to be maintained at 24°C DBT and 60% relative humidity under the followings :
- Outdoor conditions = 38°C DBT & 28°C WBT
 Sensible Heat load in the room = 46.4 kW
 Latent heat load in the room = 11.6 kW
 Total infiltration air = $1200\text{ m}^3/\text{h}$
 Apparatus dew point temperature = 10°C
 Quantity of recirculated air from the hall = 60%
 if the quantity of recirculated air is mixed with the conditioned air after the cooling coil, find the following :
- (i) The flow diagram for the given air conditioning system.
 - (ii) The condition of air leaving the conditioner coil and before mixing with the recirculated air.
 - (iii) The condition of air before entering the hall.
 - (iv) The mass of air entering the cooler.
 - (v) The mass of total air passing through the hall;
 - (vi) The By-pass factor of the cooling coil, and

(vii) The refrigeration load on the cooling coil in tonnes of refrigeration. 14

(c) Explain central air conditioning system with suitable diagrams. 14