Total No. of Questions : 10] **SEAT No. :**

P1954 **[Total No. of Pages : 6**

[5059]-531

B.E. (Mechanical)

REFRIGERATION & AIR CONDITIONING

(2012 Pattern)

Time : 2½ Hours] ***[Max. Marks : 70***

Instructions to the candidates:-

1) ***Neat diagrams must be drawn wherever necessary.***
2) ***Figures to the right indicate full marks.***
3) ***Use of refrigeration tables, friction chart, psychrometric chart, electronic pocket calculator and steam tables is allowed.***
4) ***Assume suitable data, if necessary.***

Q1) a) Dense air refrigeration plant working on Belt Coleman cycle produces 6 tonn of ice at 0°C per day. Lowest pressure is 1 bar and suction temperature is 20°C. Pressure ration is 6 and adiabatic index of compression and expansion is γ =1.4. Temperature of air leaving condenser is 40°C. **[8]**

Find :

i) COP

ii) Mass flow rate of air - refrigerant

iii) Piston displacement

iv) If bore dia = stroke length and double acting compressor has speed 300 rpm.

Find dimensions of bore. Given = Cp_{water} = 4.187 kJ/kgK

Latent heat of fusion of ice = 335 kJ/kg

Water inlet temperature 15°C.

Draw P-V, T-S diagram.

b) Write short note = Air conditioning required in Hospital. **[2]**

P.T.O.

OR

Q2) a) Explain with neat block diagram working of domestic refrigerator. State important parameters. **[3]**

b) Reversible carnot heat engine absorbs heat at temperature T_{2E} and rejects heat to sink at temperature T_1. The power developed by engine is used to drive reversible carnot refrigerator which absorbs heat from reservoir at temperature T_{2R} and rejects heat at T_1. If T_{2E}= 600 K and T_{2R}= 300 K, Find **[7]**

i) T_1, such that heat supplied to heat engine is equal to heat absorbed by refrigerator.

ii) Find T_1, such that efficiency of Engine is equal to COP of refrigerator. Draw Block Diagram.

Q3) a) Ice factory produces 20 tonnes of ice per day from and at 0°C. The evaporator temperature is –8°C and condenser temperature of 30°C. Refrigerant R-12 is subcooled by 5°C before throttling. Suction vapors are superheated by 2 degree. If the single acting twin cylinder compressor has speed 1000 rpm, L:D ratio 1.5 **[8]**

Find

i) COP

ii) Condenser capacity including subcooling

iii) Stroke length, if volumetric efficiency of compressor = 0.945

Latent heat of fusion of ice = 335 kJ / kg.

* Use of Refrigerant chart - R - 12 is allowed. Draw p-h diagram with parameters.

b) List the desirable properties of refrigerant **[2]**

i) Thermo physical

ii) Chemical in one line - (minimum two each)

OR

Q4) a) Give important conditions of Monbeal protocol and Kyoto protocol. **[3]**

b) Refrigeration plant work on CO_2 refrigerant with compressor displacement 0.25 m^3/min. Evaporator and condenser temperatures are –15°C and 25°C respectively. Degree of subcooling 10°. If the isentropic compression is wet with volumetric efficiency 85% such that specific enthaly at the beginning of compression is 295.5 kJ / kg, **[7]**

Find

i) COP

ii) Capacity in TR

iii) Power required. Draw p-h, T-S diagram with parameters mentioned. Specific heat of CO_2 liq = 2.4 kJ/kgK. Use following table properties.

temp. °C	P bar	V_f	V_g	h_f	h_g	s_f	s_g
		m^3/kg		kJ/kg		kJ/kgK	
–15	22.88	0.00101	0.0166	49.62	322.86	0.1976	1.2567
15	50.92	0.00130	0.0063	127.75	308.08	0.4697	1.0959
25	64.32	0.00147	0.0042	164.17	283.63	0.5903	0.9912

Q5) a) Air is supplied to Room at - DBT = 22°C and RH = 55%. Hot air is passed through water spray section where water is sprayed at 10°C. Supply air has saturation temperature of 3°C is supplied over heater before water spray. **[6]**

Find

i) mass of water sprayed per m^3 of air

ii) temperature of air after heating. Show process on psychrometric chart. Use of psychrometric chart is allowed.

b) Describe thermodynamics of human body temperature control. **[5]**

c) Elaborate in detail factors contributing cooling load. **[5]**

OR

Q6) a) DBT of air 32°C and WBT is 20°C, is passed through cooling coil at 5°C saturation temperature. The heat extracted by coil is 14 kW; and air flow rate is 42.5 m^3/min. Using psy - chart find **[5]**

i) DBT and WBT of air leaving coil.

ii) By pass factor of cooling coil.

Show process on chart schematic.

b) Define : **[6]**

i) RSHF

ii) GSHF

iii) ESHF

with representation on schematic psychrometric chart. (All processes to be shown on single figure only). Explain their physical significance.

c) If the total barometric pressure is 97 kPa and DBT = 36°C and DPT=15°C, from fundamentals find properties of moist air. **[5]**

Q7) a) For cold storage plant, vegetable storage capacity is 450 tonnes. Inside design condition 19°C DBT, 60% RH. Outdoor conditions - 36°C DBT, 28°C WBT Infiltration - 180 m^3/hr., Fresh air supply - 4500m^3/hr. Number of operators working = 20. **[12]**

Heat gain through glass = 5.5 kW

Sensible heat gain through wall, ceiling = 10.8kW

Water content in vegetables = 74%

Loss of water content per hour = 0.01%

Heat from equipments etc = 3.1kW

System consist of cooling & dehumidifying and then re-heating (if required) such that air entry temperature should not exceed 16°C.

Determine

i) amount of air recirculated, if it is mixed with fresh air before entering the cooling coil.

ii) Capacity of heating coil. Use psychrometric chart. Show processes on schematic.

b) How the infiltration load are Estimated. Explain with example. **[5]**

OR

Q8) a) Explain the concept 'comfort'; the factors affecting the human comfort and use of comfort chart. **[6]**

b) For airconditioned space, **[8]**

RSH = 200 kW, RLH = 30 kW.

Supply air is 8 times the fresh air required.

Indoor conditions = 44°C DBT, 30% RH

Outdoor conditions = 26°C DBT 50% RH

By pass factor of coil = 0.15

Find

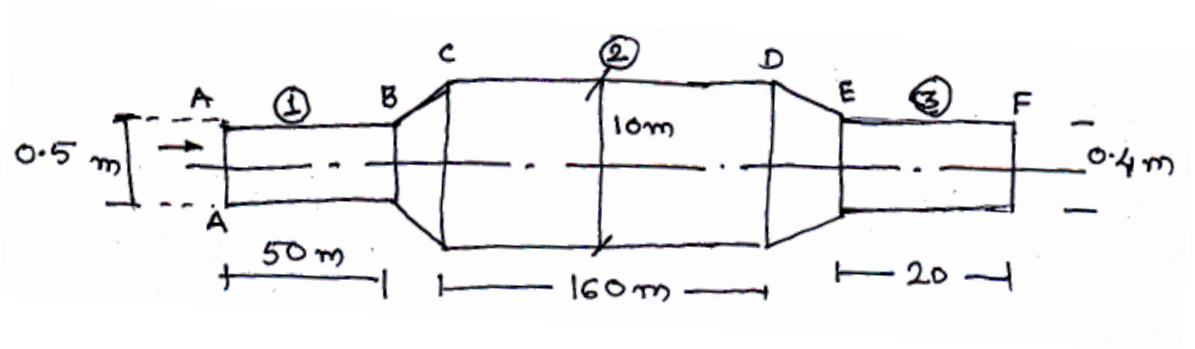
i) Temperature & sp. humidity at inlet to coil.

ii) If temperature of air leaving coil is 16°C find specific humidity at outlet.

iii) Supply air rate.

c) What are the advantages and limitations of capillary tube compared to other expansion devices. **[3]**

Q9) a)



For the above duct system inlet velocity of air at A-A is 540 m/min. Loss in $(B-C)=\frac{1}{2}\times$ velocity pressure in (A-B), Loss in $(D\text{-}E)\frac{1}{5}\times$Velocity pressure in (E-F) using friction loss equation $P_f=\frac{0.263\,C^{1.85}}{D^{1.27}}$, where

P_f = friction loss in mm of water per 100 m length of duct.

C = duct velocity (m/s)

D = duct diameter (m)

Calculate static pressure at 'A' **[8]**

b) Explain static regain method. its advantages and applicability, limitations. **[6]**

c) List the different types of fans used in air conditioning system. State applications. **[3]**

OR

Q10) a) Describe with sketch, physical working of humidity sensor and smoke sensors. **[6]**

b) What are different materials used for ducts. State their advantages and disadvantages applications. **[6]**

c) List minor losses and the methods of estimation of minor losses. **[5]**