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B. E. (Seventh Semester) Examination, April-May 2016

(New Scheme)

(Mech. Engg. Branch)

REFRIGERATION & AIR-CONDITIONING

Time Allowed : Three hours

Maximum Marks : 80

Minimum Pass Marks : 28

Note : *Attempt question only of 16 marks from each unit. Use of Refrigeration Chart, Table and Steam Table are allowed.*

Unit-I

1. (a) What is the unit of Refrigeration? 2

(b) Explain Vapour Compression Refrigeration System with suitable diagram. 7

(c) A refrigeration machine using R-12 as refrigerant operates between the pressure 2.5 bar & 9 bar. The compression is isentropic & there is no undercoding in the condenser.

The vapour is in dry saturated condition at the beginning of the compression. Estimate the theoretical coefficient of performance. If the actual coefficient of performance is 0·65 of theoretical value, calculate the net cooling produced per hour. The refrigerant flow is 5 kg per minute. Take Cp for superheated vapour at 9 bar as 0.64 kJ/kgK.

Properties of Refrigerant are : 7

Pressure, bar	Saturation Temperature °C	Enthalpy kJ/kg		Entropy of Saturated vapour (kJ/kg)
		Liquid	Vapour	
9·0	36	70·55	201·8	0·6836
2·5	–7	29·62	184·5	0·7001

(d) What are the different possible combination of multiple evaporator and compressor system? Explain any three and draw the schematic diagrams and P–h diagram. 7

Unit-II

2. (a) What is dense air refrigeration system? 2

(b) Explain Boot-strap air cooling system with suitable diagram. Also draw schematic T–S diagram of the system. 7

(c) The following data refer to a boot strap air cycle evaporative refrigeration system used for an aeroplane to take 20 tonnes of refrigeration load :

Ambient air temperature = 15°C

Ambient air pressure = 0·8 bar

Mach number of the flight = 1·2

Ram efficiency = 90%

Pressure of air bled off the main compressor = 4 bar

Pressure of air in the secondary compressor = 5 bar

Isentropic efficiency of the main compressor = 90%

Isentropic efficiency of the secondary compressor = 80%

Isentropic efficiency of the coding turbine = 80%

Temperature of air leaving the first heat exchanger = 170°C

Temperature of air leaving the second heat exchanger = 155°C

Temperature of air leaving the evaporator = 100°C

Cabin temperature = 25°C

Cabin pressure = 1 bar

Find : 7

(i) Mass of air required to take the cabin load;

(ii) Power required for the refrigeration system; and

(iii) C.O.P. of the system (Cp for air 1 kJ/kgK and $\gamma = 1{\cdot}4$).

(d) A dense air machine operates on reversed Brayton cycle and is required for a capacity of 10 TR. The cooler pressure is 4·2 bar and the refrigerator pressure is 1·4 bar. The air is cooled at a temperature of 50°C and the temperature of air at inlet to compressor is –20°C. Determine for the ideal cycle : 7

(i) C.O.P.;

(ii) Mass of air circulated per minute;

(iii) Theoretical piston displacement of compressor;

(iv) Theoretical piston displacement of expander; and

(v) Net power per tonne of refrigeration.

Show the cycle on p–V & T–s planes.

(where $\gamma = 1.4$; Cp = 1 kJ/kgK, R for air = 287 J/kgK)

Unit-III

3. (a) Give the chemical formula and names of the refrigerants R–22 and R–114. 2

(b) Explain Lithium Bromide Absorption Refrigeration System with suitable diagram. 7

(c) In an absorption type Refrigerator, the heat in supplied to NH_3 generator by condensing steam at 2 bar and 90% dry. The temperature in the refrigerator is to be maintained at –5°C. Find the maximum C.O.P. possible.

If the refrigeration load is 20 tonnes and actual C.O.P. is 70% of the maximum C.O.P., find the mass of steam required per hour. Take temperature of the atmospher 30°C. 7

(d) Write the function and types of condenser. Explain them briefly with neat sketches. 7

Unit-IV

4. (a) What is Psychrometry? 2

(b) What is effective temperature? Explain comfort with comfort chart. 7

(c) The reading from a sling psychrometer are as follows :

Dry bulb temperature = 30°C; Wet bulb temperature = 20°C and Barometer reading = 740 mm of Hg.

Using steam tables, Determine : 7

(i) Dew point temperature;

(ii) Relative humidity;

(iii) Specific humidity;

(iv) Degree of saturation;

(v) Vapour density;

(vi) Enthalpy of mixture per kg of dry air

(Take : R of air = 287 J/kgK; 1 mm of Hg = 133·3 N/m^2)

(d) Air at 10°C dry bulb temperature and 90% relative humidity is to be heated and humidifield to 35°C dry bulb temperature and 22·5°C wet bulb temperature. The air is pre-heated sensibly 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%. The air is again reheated sensibly to obtain the final desired condition. Find : 7

(i) The temperature to which the air should be preheated;

(ii) The total heating required;

(iii) The make up water required in the air washer; and

(iv) The humidifying efficiency of the air washer.

Unit-V

5. (a) What do you understand by the term cooling load? 2

(b) (i) Explain the following : 7

(x) Summer air conditioning system.

(y) Winter air conditioning system.

(ii) Explain RSHF and GSHF in detail. Also how they are shown in psychrometric chart? 7

(c) The following data relates to the office air conditioning plant having maximum seating capacity of 25 occupants :

Outside design conditions = 34°C DBT, 28°C WBT

Inside design conditions = 24°C DBT, 50% RH

Solar heat gain = 9120 W

Latent heat gain per occupant = 105 W

Sensible heat gain per occupant = 90W

Lightening load = 2300 W

Sensible heat load from other sources = 11630 W

Infiltration load = 14 m^3/min.

Assume 40% fresh air and 60% of recirculated air passing through the evaporator coil and the by-pass factors of 0·15.

Find :

(i) The dew point temperature;

(ii) Capacity of the plant

Draw the schematic diagram of the system and show the system on skeleton psychrometry chart and insert the temperature and enthalpy values at sailent points. 14