Code No: 136DQ **R16**

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

B. Tech III Year II Semester Examinations, July - 2023

REFRIGERATION AND AIR CONDITIONING

(Mechanical Engineering)

Time: 3 Hours **Max. Marks: 75**

Note: i) Question paper consists of Part A, Part B.
ii) Part A is compulsory, which carries 25 marks. In Part A, Answer all questions.
iii) In Part B, Answer any one question from each unit. Each question carries 10 marks and may have a, b as sub questions.

PART – A

(25 Marks)

1.a) Explain how the COP of a refrigeration system related to its energy efficiency? [2]
b) Explain the concept of dense air refrigeration and discuss its advantages over open air refrigeration. [3]
c) What are the main disadvantages or limitations of vapor compression systems? [2]
d) What are the common measures to be considered to improve the actual cycle performance of vapor compression refrigeration systems? [3]
e) What are the environmental impacts of refrigerants on global warming and ozone depletion? [2]
f) List out various expansion devices used in refrigeration systems. Which device is used in domestic refrigeration system and why? [3]
g) Which components in VARS replace compressor in VCRS? Discuss. [2]
h) What materials are commonly used in thermoelectric refrigeration devices? [3]
i) In an air conditioning process 5 kJ/min heat is extracted from room. If the sensible heat factor is 0.7. Then find the latent heat load. [2]
j) Write the applications of heat pump. [3]

PART – B

(50 Marks)

2. Dense air refrigeration machine operating on reverse Brayton or Bell coleman or Joule cycle operates between 3.4 and 17 bar. The temperature of air after the cooler is 15^0C and after the refrigeration is 6^0C, if the refrigeration capacity is 6 tonnes, determine
a) Temperature after compression and expansion.
b) Air circulated per min.
c) Work of compressor and expander.
d) COP. [10]

OR

3. In an air craft refrigeration air enters the compressor at 0.2 MPa. 4^0C and is compressed to 0.5 MPa with an isentropic efficiency of 82%. The air is then cooled to 55^0C at constant pressure and is then expanded in a turbine to 0.1 MPa with an isentropic efficiency of 88%, the lower temperature air absorbs the cooling load of 5TR at a constant pressure before returning to the compressor, Assuming air to be an ideal gas. Find
a) COP
b) Net power input. [5+5]

4. A vapour compression refrigeration machine, with Freon-12 as refrigerant, has a capacity of 20 tons of refrigeration operating between -28^{0}C and 26^{0}C. The refrigerant is sub-cooled to 4^{0}C before entering the expansion valve and the vapour is superheated by 5^{0}C before leaving the evaporator. The machine has a six-cylinder single-acting compressor with stroke equal to 1.25 times the bore. It has a clearance of 3% of the stroke volume. Determine:
a) Theoretical power required.
b) COP.
c) Volumetric efficiency.
d) Bore and stroke of cylinder.
The speed of the compressor is 1000 r.p.m. [10]

Sat. temp (^{0}c)	Sat. pressure (kgf/cm^2)	v_g (m^3/kg)	h_f (kcal/kg)	h_g(kcal/kg)	s_f (kcal/kg-k)	s_g (kcal/kg-k)
-28	1.1149	0.1492	93.98	133.77	0.977	1.139
26	6.8175	0.027	106.01	139.7	1.0207	1.1334

OR

5. Draw the vapour compression refrigeration cycle on T-s diagram when the refrigerant is dry and saturated at the end of compression and find the expression for the COP in terms of
a) Temperature and entropies,
b) Enthalpies. [6+4]

6. Explain the following in brief with neat sketches:
a) Automatic expansion valve
b) Water cooled condenser
c) Shell and coil type evaporator. [10]

OR

7.a) Explain the working of hermetically sealed compressor and explain its advantages and limitations.
b) Explain the working of following types of evaporators with neat sketches:
(i) Flooded evaporator, (ii) Natural convection evaporator. [5+5]

8. For a vapor absorption refrigeration. Explain the properties required for choosing:
a) Ideal refrigerant,
b) Ideal absorbent,
c) Ideal refrigerant-absorbent combination. [3+3+4]

OR

9. A steam ejector water vapor refrigeration system is supplied with motive dry saturated steam at 7 bar. It expands through a nozzle down to flash chamber pressure meant to chill water at 4^{0}C. Taking nozzle efficiency = 0.95; entrainment efficiency = 0.75; and compression efficiency = 0.80, obtain
a) Amount of water to be evaporated and motive steam per tonne of cooling tonnage of the plant for 2 kg/s of evaporation of water.
b) COP.
Assume the condensing temperature to be 35^{0}C and make-up water temperature as 28^{0}C. [6+4]

10. A summer air conditioning system for a small office building is to be designed. The design is to be based on the following information:
Outside design condition: DBT-35^{0}C, WBT-28^{0}C
Inside design condition: DBT-26^{0}C, 50% RH
Room sensible heat gain: 45 kW
Room latent heat gain: 9 kW
Ventilation air: 0.95 m^3/s
A four row direct expansion refrigerant 134A coil with bypass factor of 0.2 is to be used. Analyze the problem on a psychometric chart and determine the following:
a) The room Apparatus Dew Point (ADP)
b) The temperature of the air leaving the coil
c) The total quality of air required (m^3/s). [10]

OR

11.a) Define various psychrometric properties.
b) How do you calculate sensible and latent heat loads? Explain. [5+5]