Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Seventh Semester B.Tech Degree (S, FE) Examination January 2023 (2015 Scheme)

Course Code: ME405

Course Name: REFRIGERATION AND AIR CONDITIONING

Max. Marks: 100 Duration: 3 Hours

(Use of Refrigerant Property tables, charts and Psychrometry charts is permitted)

PART A

Answer any three full questions, each carries 10 marks. Marks

1 a) Draw schematic and T-S diagram for a reduced ambient aircraft refrigeration system. Why it is preferred for high speed applications? (5)

b) In an aircraft refrigeration unit, air is bled from the jet compressor at 3.5 bar and 270°C and is passed through an air cooled heat exchanger. The chilled air leaves the heat exchanger at 3.5 bar and 75°C and is expanded through a turbine to 0.76 bar. The isentropic efficiency of the turbine is 85%. The air is then delivered to the aircraft cabin and leaves the cabin at 16°C. Calculate the refrigerating effect, per unit mass flow rate of air. (5)

2 a) Explain the effect of subcooling on the COP in a vapour compression refrigeration cycle, with the help of a p-h diagram. (3)

b) An R-22 vapour compression refrigeration system has a liquid-vapour regenerative heat exchanger. The heat exchanger warms the saturated vapour from evaporator at -10°C to 5°C with the liquid coming out of the condenser at 30°C. If the compressor is capable of pumping 12L/s at the suction, find the refrigerating capacity and the COP. (7)

3 A vapour compression plant using R134a as the refrigerant operates between evaporator pressure of 2 bar and a condenser saturation pressure of 8 bar. The vapour entering the compressor and the liquid leaving the condenser are saturated. The compressor is a double acting reciprocating type, with bore of 250 mm and stroke of 300 mm, running at a speed of 200 rev/min with a volumetric efficiency of 85%. Calculate (a) mass flow rate of refrigerant (b) refrigeration capacity (c) required power input. (10)

4 In a Bootstrap aircraft refrigeration system with 5 TR capacity, air after ramming is at temperature 30°C and the pressure ratio for the jet compressor is 3.2. Temperature to be maintained inside the cabin is 20°C. The temperatures at the entry point of the secondary heat exchanger, at the exit of the secondary heat exchanger and at the exit of the turbine are are 403 K, 360 K and 250 K, respecively. The work developed by the turbine is sufficient to run the secondary compressor. Find the following: (a) Effectiveness of the secondary heat exchanger (b) work done by the primary compressor. (c) C.O.P of the system. (10)

PART B

Answer any three full questions, each carries 10 marks.

5 a) Explain the working principle of an evaporative condenser with a simple sketch. (5)

b) What is a hermetically sealed compressor? Why it is preferred in a domestic refrigerator? (5)

6 a) Why the freezer compartment is kept at the top in a domestic refrigerator? (5)

b) How does a D-X type evaporator differ from a flooded type? (5)

7 a) Explain the working of an electrolux refrigeration system with a schematic diagram. (5)

b) What are the properties of refrigerants pertinent to safety and environmental protection? (5)

8 In an ammonia vapour compression system, the evaporator has a cooling load of 250 kW and works between evaporator temperature of -25°C and condensing temperature of 35°C. A two stage compression with intercooling and flash gas removal is used, with intermediate pressure being the geometric mean of evaporator and condenser pressures. The vapour at the suction of the second stage compressor is saturated. Calculate the following: (a) power required in two stage compression (b) power required, if only single stage compression was used. (10)

PART C

Answer any four full questions, each carries 10 marks.

9 a) Define the following terms: a) specific humidity b) dew point temperature c) degree of saturation d) relative humidity (4)

b) In an air-conditioning unit, 3.5 m^3/s of air at 27^0C dry bulb temperature, 50 percent relative humidity and at standard atmospheric pressure enters the unit. The leaving condition of the air is 13°C dry bulb temperature and 90 percent (6)

relative humidity. Calculate (a) refrigerating capacity in kW (b) the rate of water removal from air.

10 a) Give a description on the common methods followed in design of ducts for air handling systems. (6)

b) What are the considerations to be accounted for, while selecting the location for air outlets in a centralized air conditioning system? (4)

11 a) Define the following terms and show them on a psychrometric chart. (a) RSHF line (b) GSHF line (c) coil ADP (d) bypass factor. (4)

b) In an air-conditioning system, 150 m^3/min of return air at 27 °C DBT and 50 % RH is mixed with 15 m^3/min of outside air at 40°C DBT and 40% RH. The mixed air stream flows over a cooling coil and leaves at 12°C and 85% RH. Determine the cooling capacity of the air- conditioning unit in tonnes of refrigeration. (6)

12 a) What are the different dynamic losses to be considered in ducts of air handling system? (5)

b) Which kind of air conditioning system is most appropriate for a large cinema hall, in the ongoing covid-19 pandemic crisis? Justify your answer with a suitable explanation. (5)

13 a) Explain various psychrometric processes possible in an air washer, with illustrations using a psychrometric chart. (5)

b) You are asked to select a split airconditioner with right capacity for a bed room in a house in coastal Kerala. What are different factors you will consider while estimating the cooling load, based on the knowledge you have gained from this course? (5)

14 With a schematic diagram, explain a centralized air conditioning system and its various components. (10)

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