CBCS SCHEME

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18MR45

Fourth Semester B.E. Degree Examination, Jan./Feb. 2023
Marine Heat Engine and Air Conditioning

Time: 3 hrs. Max. Marks: 100

Note: **1.** ***Answer any FIVE full questions, choosing ONE full question from each module.***
2. ***Use of thermodynamic data handbook is permitted.***

Module-1

1 a. Derive an expression of work done for single stage compressor when the compression process is polytropic ($PV^n = C$). **(10 Marks)**

b. In a 2-stage air compressor, the work output is found to be 350 kJ/kg of sir. It is used to compress 1 kg of free air from 1 bar pressure and 32°C initial temperature. The value of n = 3 and R = 0.287 kJ/kgK. Find the intermediate pressure, temperature and heat rejected in the intercooler. **(10 Marks)**

OR

2 a. Derive an expression for volumetric efficiency of compressor in terms of clearance ratio and pressure ratio. **(06 Marks)**

b. Show that the condition for minimum work done in a two-stage reciprocating compressor with perfect intercooling is $P_3 = \sqrt{P_1 P_4}$ where P_3 is intermediate pressure, P_1 and P_2 are suction and discharge pressure respectively. **(08 Marks)**

c. A single stage reciprocating air compressor takes 1 m^3 of air per minute at 1.013 bar and 15°C and delivers the same at 7 bar. If the law of compression is $PV^{1.35} = C$ and the clearance is negligible. Compute the indicated power. **(06 Marks)**

Module-2

3 a. With the help of flow diagram, explain the working of simple vapour compression refrigeration system. Also represent the processes on T-S and H-S diagram. **(10 Marks)**

b. A simple vapour compression plant produces 5 tonnes of refrigeration. The enthalpies of the working fluid at inlet to the compressor, at exit of compressor and at exit from the condenser are 183.19 kJ/kg, 209.41 kJ/kg and 74.59 kJ/kg respectively. Estimate:
(i) The refrigerant flow rate
(ii) COP of the plant
(iii) Power required to drive the compressor
(iv) The rate of heat rejection in the condenser **(10 Marks)**

OR

4 a. What are the different types of refrigerants used in onboard ship refrigeration system? **(06 Marks)**

b. What are the desirable properties of refrigerants? Explain its characteristics. **(06 Marks)**

c. 1.5 KW per tonne of refrigeration is required to maintain a temperature of –40°C in the refrigerator. If the refrigerator works on Carnot cycle, determine the following:
(i) COP of the cycle
(ii) Temperature of the sink
(iii) Heat rejected to the sink per tonne of refrigeration. **(08 Marks)**

Module-3

5 a. Briefly explain the construction and working of marine refrigeration system with a neat labelled sketch. **(10 Marks)**

b. Explain with neat sketch of L.P cut out and HP cut out in refrigeration plant. **(10 Marks)**

OR

6 a. Explain indication, causes and action required for following cases:
(i) Under charging of refrigeration system
(ii) Over charging of refrigeration system **(12 Marks)**

b. With neat sketch, explain thermostatic expansion value and mention its functions. **(08 Marks)**

Module-4

7 a. Define the following :
(i) Dry bulb temperature (ii) Wet bulb temperature (iii) Specific humidity
(iv) Relative humidity (v) Degree of saturation (vi) Enthalpy of moist air **(06 Marks)**

b. Obtain an expression for specific humidity and degree of saturation. **(06 Marks)**

c. A room measure 5m × 5m × 3m. It contains atmospheric air at 100 kPa, DBT = 30°C and relative humidity = 30%. Find the mass of dry and the mass of associated water vapour in the room. Solve the problem without use of psychrometric chart and using the properties of water from steam tables. **(08 Marks)**

OR

8 a. With a neat schematic diagram, explain winter air conditioning system. **(10 Marks)**

b. With neat sketch, explain the air handling unit of air conditioning system. **(10 Marks)**

Module-5

9 a. Derive an expression of NTU effectiveness for parallel flow heat exchanger. **(10 Marks)**

b. A counter flow heat exchanger is employed to cool 0.55 kg/s of oil from 115°C to 40°C by the use of water. The inlet and outlet temperature of cooling water are 15°C and 75°C respectively. The overall heat transfer coefficient is expected to be 1450 Watt per meter square degree celcius. Using NTU method, calculate the following:
(i) Mass flow rate of water
(ii) The effectiveness of heat exchanger
(iii) The surface area required **(10 Marks)**

OR

10 a. Explain the following:
(i) Effectiveness and NTU of heat exchanger
(ii) Shell and tube type heat exchanger
(iii) Duct insulation
(iv) Air distribution **(12 Marks)**

b. Water to water heat exchanger of a counter flow arrangement has heating surface area of 2 m^2. Mass flow rates of hot and cold fluids are 2000 kg/hr and 1500 kg/hr respectively. Temperature of hot and cold fluids at inlet are 85°C and 25°C respectively. Determine the amount of heat transferred from hot and cold water and their temperature at the exit if the overall heat transfer coefficient U = 1400 W/m^2K. **(08 Marks)**

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