Exam Date & Time: 12-Jan-2024 (09:30 AM - 12:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

THIRD SEMESTER B.TECH END SEMESTER MAKEUP EXAMINATIONS, JAN 2024

THERMAL ENGINEERING [MIE 2125]

Marks: 50 **Duration: 180 mins.**

A

Answer all the questions.

Instructions to Candidates: Answer ALL questions Missing data may be suitably assumed

1) With examples explain Open, Closed and Isolated system. (3)

A)

B) Sketch the P-V diagram for Isobaric, Isothermal and Adiabatic processes. (3)

C) In a steady flow apparatus 135kJ of work is done by each kg of fluid. The specific volume, pressure and velocity at the inlet are: $0.37m^3$ /kg, 600kPa and 16m/s. The inlet is 32 m above the floor and the discharge pipe is at floor level. The discharge conditions are: 0.62 m3 /kg, 100kPa and 270m/s. The total heat loss between the inlet and discharge is 9 kJ/kg of fluid. For the flow through this apparatus does the specific internal energy increases or decreases and by how much? (4)

2) Give the thermodynamic representation of 1) Heat Engine, 2) Refrigerator, 3) Heat Pump. (3)

A)

B) With P-V diagram, describe the various processes involved in a Carnot cycle. (3)

C) A 50-kg copper block initially at 80°C is dropped into an insulated tank that contains 120 L of water at 25°C. Determine the final equilibrium temperature and the total entropy change for this process. (The density and specific heat of water at 25°C are ρ = 997 kg/m^3 and cp = 4.18 kJ/kg. °C. The specific heat of copper at 27°C is c = 0.386 kJ/kg. °C). (4)

3) With a help of neat sketch, explain the different parts and working principle of simple Rankine cycle. Also, draw the T-S diagram for Rankine cycle. (3)

A)

B) Identify the advantages of re-heat and regeneration on simple Rankine cycle. Draw the T-S diagram for reheat cycle and regeneration cycle. (3)

C) A steam power plant operates on the ideal reheat Rankine cycle. Steam enters the high-pressure turbine at 8 MPa and 500°C and leaves at 3 MPa. Steam is then reheated at constant pressure to 500°C before it expands to 20 kPa in the low-pressure turbine. (4)

Determine the turbine work output, in kJ/kg, and the thermal efficiency of the cycle. Also, show the cycle on a *T-s* diagram with respect to saturation lines.

4) A) With a help of neat sketch, explain the different parts and working principle of Brayton cycle. Also, draw the T-S diagram for Brayton cycle. (4)

B) A refrigerator uses refrigerant-134a as the working fluid and operates on an ideal vapor compression refrigeration cycle between 0.14 and 0.8 MPa. If the mass flow rate of the refrigerant is 0.05 kg/s, determine (a) the rate of heat removal from the refrigerated space and the power input to the compressor, (b) the rate of heat rejection to the environment, and (c) the COP of the refrigerator. (3)

C) Sketch the T-S diagram for each of the following factors effecting vapor compression refrigeration system. (3)

a) Sub-cooling the refrigerant

b) Decreasing the evaporator pressure

c) Super-heating the vapor at compressor inlet

5) A) A four-stroke gas engine has a cylinder diameter of 25 cm and stroke 45 cm. The effective diameter of the brake is 1.6 m. The observations made in a test of the engine were as follows: Duration of test = 40 min, Total number of revolutions = 8080, Total number of explosions = 3230, Net load on the brake = 90 kg, Mean effective pressure = 5.8 bar, Volume of fuel consumed at STP = 7.15 m^3, Pressure of gas indicated in meter = 136 mm water of gauge, Atmospheric temperature = 17 ◦C, Calorific value of gas = 19 MJ/m^3 at NTP, Rise in temperature of jacket cooling water = 45 ◦C, Cooling water supplied = 180 kg. Calculate the following, 1) IP, 2) BP, and 3) Indicated thermal efficiency. (3)

B) For the Q. No. 5A, draw a heat balance sheet in kJ/min. (3)

C) In the Otto cycle, all the heat transfer q_H occurs at constant volume. It is more realistic to assume that part of q_H occurs after the piston has started its downward motion in the expansion stroke. Therefore, consider a cycle identical to the Otto cycle, except that the first two-thirds of the total q_H occurs at constant volume and the last one-third occurs at constant pressure. Assume that the total q_H is 2100 kJ/kg, that the state at the beginning of the compression process is 90 kPa, 20◦C, and that the compression ratio is 9. Calculate the maximum pressure and temperature and the thermal efficiency of this cycle. Compare the results with those of a conventional Otto cycle having the same given variables. (4)

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