CBCS SCHEME

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18ME42

Fourth Semester B.E. Degree Examination, Dec.2023/Jan.2024
Applied Thermodynamics

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. With a neat P-V and T-S diagrams for a diesel cycle, derive an expression for air-standard efficiency in terms of compression ratio and cut-off ratio. **(10 Marks)**

b. The compression ratio of a diesel cycle is 14 and cut off ratio is 2.2. At the beginning of the cycle, air is at 0.98 bar and 100°C. Find : (i) Temperature and pressure at salient points (ii) Air standard efficiency (iii) Mean effective pressure. Represent with neat sketches of P-V and T-S. **(10 Marks)**

OR

2 a. Explain with neat diagram combustion in CI engine. **(10 Marks)**

b. A six cylinder four stroke IC engine is designed to develop 60 KW power at an average pressure of 7 bar. The bore and stroke of the engine is 70 mm and 100 mm respectively. If the engine speed is 3700 rpm, find the average misfires/min and actual power developed. **(10 Marks)**

Module-2

3 a. With neat P-V and T-S diagrams, explain the processer of Brayton cycle and derive an expression for efficiency of ideal gas turbine. **(10 Marks)**

b. Air enters compressor of an open cycle constant pressure gas turbine at a pressure of 1 bar and temperature of 20°C. The pressure of air after compression is 4 bar. The isentropic efficiencies of the compressor and turbine are 80% and 85% respectively. The air fuel ratio used is 90:1. The air flow rate is 3 kg/s. Find : (i) Power developed (ii) Thermal efficiency of the cycle. **(10 Marks)**

OR

4 a. Analyze Ram pressure ratio with respect to Mach number of a Ram jet engine for sea level conditions. **(10 Marks)**

b. A jet propulsion unit with turbo jet engine propelling with a forward speed of 1100 km/h produces 14 kN of thrust and uses 2400 kg of air per minute. Find:
(i) The relative exit jet velocity (ii) The thrust power
(iii) The propulsive power (iv) The propulsive efficiency **(10 Marks)**

Module-3

5 a. With a schematic diagram and T-S diagram, briefly explain the working of regenerative vapor cycle with open feed water heaters. Derive the thermal efficiency expression for the same. **(10 Marks)**

b. A reheat cycle operating between 30 bar and 0.04 bar pressure. The temperature of steam supplied from boiler is 450°C. The first stage of expansion taken place till the steam is dry saturated and then reheated to 450°C and then expanded in second stage. Determine:
i) Reheat pressure ii) Quality of exhaust steam
iii) Ideal cycle efficiency iv) Steam rate **(10 Marks)**

OR

6 a. With neat diagram, explain the effects of pressure and temperature on Rankine cycle performance. **(12 Marks)**

b. In a boiler house steam from a steam generator enters a turbine at 20 bar and expands to condenser pressure of 0.2 bar. Determine the Rankine cycle efficiency neglecting pump work.

(i) When steam is 85% dry at turbine inlet.
(ii) When steam is saturated at turbine inlet.
(iii) When steam is superheated at turbine inlet by 37.6°C **(08 Marks)**

Module-4

7 a. Analyse vapour compression refrigeration cycle for, (i) Heat rejected (ii) COP (iii) Compressor displacement (iv) Power consumption per TR **(10 Marks)**

b. An air refrigeration plant is to be designed according to following specifications:
Pressure at compressor inlet = 101 kPa
Pressure of air at compressor exit = 404 kPa
Temperature of air at compressor inlet = –6°C
Temperature of air at turbine inlet = 27°C
Isentropic efficiency of compressor = 85%
Isentropic efficiency of turbine = 85%
Determine:
(i) COP of the cycle
(ii) Power required to produce 1 ton of refrigeration
(iii) Air circulation rate per ton of refrigeration. **(10 Marks)**

OR

8 a. Explain the following with definition:
(i) Specific humidity
(ii) Degree of saturation
(iii) Dalton's law of partial pressures **(10 Marks)**

b. Atmospheric air at 40°C and 40% RH is to be cooled to a state of saturated air at 10°C by dehumidification. The mass flow rate of air entering the dehumidifier in 0.8 kg/s. Neglecting the pressure drop, determine: (i) Mass of water removed (ii) Quantity of heat removed. **(10 Marks)**

Module-5

9 a. Obtain an expression for work done by a reciprocating compressor with and without clearance volume. **(10 Marks)**

b. Find the power required to compress and deliver 2 kg of air per minute from 1 bar and 20°C to a delivery pressure of 7 bar when the compression is carried out in:
(i) Single stage compressor
(ii) Two stage compressor
The compression of air follows the law $PV^{1.4} = C$. Neglect clearance and assume ideal conditions for intercooler. Take R = 0.287 kJ/kg.K. **(10 Marks)**

OR

10 a. Why turbine nozzles are made divergent after the throat? **(10 Marks)**

b. Steam at a pressure of 6.85 bar and 0.9 dry expands through a nozzle having a throat area of 4.65 cm^2. The back pressure is 1.03 bar. Determine:
(i) Mass of steam flowing per minute
(ii) The diameter of month of the nozzle for maximum discharge
(iii) The final velocity of the steam **(10 Marks)**

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