

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 processor 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)

1 of 2

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and/or equations written eg, 42+8 = 50, will be treated as malpractice.

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.
- When steam is 85% dry at turbine inlet.
 - When steam is saturated at turbine inlet.
 - 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:
- COP of the cycle
 - Power required to produce 1 ton of refrigeration
 - 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 is 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 $R = 0.287 \text{ kJ/kg.K}$. (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 mouth of the nozzle for maximum discharge
(iii) The final velocity of the steam (10 Marks)
