

CBCS SCHEME

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17ME43

Fourth Semester B.E. Degree Examination, June/July 2023 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 steam table and thermodynamic data handbook is permitted.*

Module-1

- 1 a. What is an air standard efficiency? Derive an expression for air standard efficiency of an Otto cycle. (07 Marks)
- b. In an air standard diesel cycle, the compression ratio is 16, and at the beginning of isentropic compression, the temperature is 15°C and the pressure is 0.1 MPa. Heat is added until the temperature at the end of the constant pressure process is 1480°C. Calculate:
- Cut-off ratio
 - The heat supplied per kg of air
 - The cycle efficiency
 - M.E.P.
- (13 Marks)

OR

- 2 a. With the help of line diagram and T-S diagram, explain inter cooling and reheating in gas turbine cycle. (10 Marks)
- b. Air enters the compressor of an ideal air standard Brayton cycle at 100 kPa, 300 K with a volumetric flow rate of 6 m³/s. The compressor pressure ratio is 10. The turbine inlet temperature is 1500 K. Determine:
- The thermal efficiency
 - The power output.
- (10 Marks)

Module-2

- 3 a. Discuss with help of T-S diagram the effect of boiler pressure condenser pressure on the performance of a Rankine cycle with P-V and T-S diagram. (08 Marks)
- b. Steam at 20 bar, 360°C is expanded in a steam turbine to 0.08 bar. It then enters a condenser, where it is condensed to saturated liquid water. The pump feeds back the water into the boiler.
- Assuming ideal process, find per kg of steam the net work and the cycle efficiency.
 - If the turbine and the pump have each 80% efficiency, find the percentage reduction in the net work and cycle efficiency.
- (12 Marks)

OR

- 4 a. With the help of schematic diagram and T-S diagram, explain reheat Rankine cycle and derive an expression for its thermal efficiency. (08 Marks)
- b. A 40 MW steam power plant working on Rankine cycle operates between boiler pressure of 4 MPa and condenser pressure of 10 kPa. The steam leaves the boiler and enters the steam turbine at 400°C, the isentropic efficiency of the steam turbine is 85%. Determine:
- The cycle efficiency
 - The quality of exhaust steam from the turbine
 - The steam flow rate in kg per hour, consider pump work.
- (12 Marks)

Module-3

- 5 a. Explain the following terms with reference to a combustion process:
- Stoichiometric air
 - Enthalpy of formation
 - Enthalpy of combustion
 - Combustion efficiency
- (08 Marks)
- b. The product of combustion of an unknown hydrocarbon C_xH_y have the following composition as measured by an Orsat apparatus $CO_2 = 8\%$, $O_2 = 8.8\%$, $CO = 0.9\%$, $N_2 = 82.3\%$. Determine:
- Composition of the fuel
 - Air/fuel ratio
 - Percentage of excess air used
- (12 Marks)

OR

- 6 a. Explain the phenomenon of knocking in SI engine. What are the different factors which influence the knocking? (10 Marks)
- b. The following particulars refers to a 2-stroke diesel engine:
- Bore = 10 cm, Stroke = 15 cm, Piston speed = 300 m/min, torque developed = 58 Nm, mechanical efficiency = 80%, indicated thermal efficiency = 40%, calorific value of fuel = 44 MJ/kg. Determine:
- Indicated power
 - Indicated mean effective pressure
 - Fuel consumption per kWh on brake power output.
- (10 Marks)

Module-4

- 7 a. With neat sketch, explain the working of a vapour absorption refrigeration system. (08 Marks)
- b. A vapour compression refrigerator of 10 tonnes capacity using Freon-12 as the refrigerant has an evaporator temperature of $-10^\circ C$ and a condenser temperature of $30^\circ C$. Assuming simple saturation cycle, determine: (i) Mass flow rate of refrigerant in kg/min (ii) Power input (iii) COP. Take $C_{pV} = 0.72$ kJ/kgK. (12 Marks)

OR

- 8 a. Define the following:
- Dry bulb temperature
 - Dew point temperature
 - Relative humidity
 - Degree of saturation
- (08 Marks)
- b. It is required to design an air conditioning plant for a office room with the following conditions: outdoor conditions $14^\circ C$ DBT and $10^\circ C$ WBT; required conditions $20^\circ C$ DBT and 60% R.H.; amount of air circulation 0.30 m³/min/person. Seating capacity of office 60. The required condition is achieved first by heating and then by adiabatic humidifying. Determine the following:
- Heating capacity of the coil in KW and the surface temperature required if the bypass factor of coil is 0.4.
 - The capacity of the humidifier.
- (12 Marks)

Module-5

- 9 a. Define the following with respect to compressor:
- (i) Isothermal efficiency
 - (ii) Adiabatic efficiency
 - (iii) Mechanical efficiency
 - (iv) Volumetric efficiency
- (08 Marks)
- b. A single acting reciprocating compressor with cylinder of 15 cm diameter and 18 cm stroke has a clearance volume of 4% of swept volume. It takes in air at 1 bar 25°C and delivers at 8 bar while running at 1200 rpm. The actual power input is 18 KW. Estimate:
- (i) The power required to drive the unit
 - (ii) The isothermal efficiency
 - (iii) The mechanical efficiency when the mass flow rate is 4 kg/min.
- (12 Marks)

OR

- 10 a. Discuss the different shapes of nozzle. (04 Marks)
- b. Discuss the following:
- (i) Effect of friction in nozzle flow
 - (ii) Supersaturated flow through nozzle
- (06 Marks)
- c. What is critical pressure ratio? Derive an expression for pressure ratio which gives maximum discharge through the nozzle. (10 Marks)
