

CBCS SCHEME

USN

--	--	--	--	--	--	--	--	--	--

15ME43

Fourth Semester B.E. Degree Examination, June/July 2023

Applied Thermodynamics

Time: 3 hrs.

Max. Marks: 80

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

Module-1

- 1 a. Derive the expression for Air standard efficiency for Diesel cycle. (08 Marks)
b. An engine of 250mm bore and 375mm stroke works on Otto – cycle. The clearance volume is 0.00263m^3 . The initial pressure and temperature are 1 bar and 50°C . if the maximum pressure is limited to 25bar. Find the following : i) Air standard efficiency of the cycle
ii) The mean effective pressure for the cycle. Assume Ideal conditions. (08 Marks)

OR

- 2 a. With neat sketch, explain the working principle of Ramjet and Turbo Jet Engine. (08 Marks)
b. In an open cycle gas turbine plant air enters the compressor at 1 bar and 27°C . The pressure after compression is 4 bars. The isentropic efficiency of the turbine and compressor are 85% and 80% respectively. Air fuel ratio is 80%. Calorific value of the fuel is 42,000 kJ/kg. Mass flow rate of air is 2.5 kg/s. Determine the power output from the plant and cycle efficiency. Assume $C_p = 1.0 \text{ kJ/kg } ^\circ\text{K}$, $\gamma = 1.4$ for air and gases. (08 Marks)

Module-2

- 3 a. With PV and TS diagram, explain the performance on Rankine cycle
i) Effect of condenser pressure ii) Effect of boiler pressure. (08 Marks)
b. In a Rankine cycle, the maximum pressure of steam supplied is 6 bar. The dryness fraction is 0.9. The exhaust pressure is 0.7 bars. Find the theoretical work done and Rankine efficiency. (08 Marks)

OR

- 4 a. With block diagram, explain the working principle of Reheat Rankine cycle and derive the efficiency of the cycle. (08 Marks)
b. An ideal Rankine cycle with reheat is designated to operate according to the following specifications. Pressure of steam at HPT inlet is 20MPa, Temperature of steam at HPT is 550°C , Temperature at end of reheat is 550°C , Pressure of steam at the turbine exhaust is 15KPa, Quality of steam at turbine exhaust is 90%. Determine i) Pressure of steam in reheater ii) Ratio of pump work to turbine work iii) Ratio of heat rejection to heat addition iv) Cycle thermal efficiency. (08 Marks)

Module-3

- 5 a. Define the following with reference to Combustion process : i) Air – Fuel ratio
ii) Enthalpy of formation iii) Adiabatic flame temperature iv) Combustion efficiency. (08 Marks)
b. Methane (CH_4) is burnt with atmospheric air. The analysis of products is given as follows :
 $\text{CO}_2 = 10\%$, $\text{O}_2 = 2.37\%$, $\text{CO} = 0.53\%$, $\text{N}_2 = 87.1\%$.
i) Write the combustion equation ii) Calculate the air fuel ratio
iii) Percentage theoretical air. (08 Marks)

OR

- 6 a. Explain the following to find FP : i) Willan's Line method and ii) Morse test. (08 Marks)
 b. The following particulars refer to a 2 – Stroke engine , Bore = 20cm , Stroke = 30cm , Speed = 350 rpm , Indicated mean effective pressure = 275 kN/m² , Net brake load = 610N , Dia. of brake drum = 1m , Oil consumption = 4.25 kg/hr , Calorific value of fuel = 44000kJ/kg. Determine i) IP ii) BP iii) η_{mech} iv) Indicated thermal efficiency. (08 Marks)

Module-4

- 7 a. With neat sketch, explain the working principle of vapour absorption refrigeration system and derive the expression for C.O.P of the system. (08 Marks)
 b. In an air – standard refrigeration cycle, air enters the compressor at 1 bar and 10°C and leaves at 5.1 bar. Air enters the expander at 30°C. Find COP for the cycle. Calculate the rate at which air must enter the compressor to produce a refrigerating effect of 1 ton refrigeration. (08 Marks)

OR

- 8 a. Define the following : i) Dry bulb temperature ii) Wet bulb temperature
 iii) Dew point temperature iv) Specific humidity. (08 Marks)
 b. A room measures 5m × 5m × 3m. It contains atmosphere air at 100 KPa , DBT = 20°C and RH = 30%. Find the mass of dry air and the mass of water vapour in the room. (08 Marks)

Module-5

- 9 a. Derive the expression for minimum work done in a 2 – stage compressor with perfect inter cooling. (08 Marks)
 b. A single stage reciprocating compressor takes 1m³ of air per minute at 1.013 bar and 15°C and delivers it at 7 bar. Assuming that the law of compression is $PV^{1.35} = C$ and clearance is negligible. Calculate the indicated power. (08 Marks)

OR

- 10 a. Derive an expression for velocity of steam leaving from nozzle in terms of pressure ratio and expansion index. (08 Marks)
 b. Steam expands from 17 bar and 284°C to 0.7 bar in a Convergent – Divergent nozzle. Assuming that expansion is frictionless and the steam discharge is 0.25 kg/s. Calculate the diameter of the nozzle.
 i) At a point where the pressure is 9.5 bar.
 ii) At exit using H – S chart. (08 Marks)
