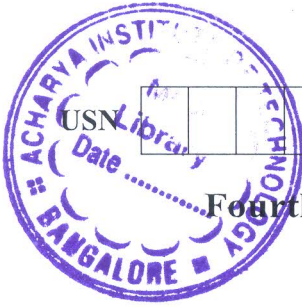


# CBCS SCHEME

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:
- (i) Cut-off ratio
  - (ii) The heat supplied per kg of air
  - (iii) The cycle efficiency
  - (iv) 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 m<sup>3</sup>/s. The compressor pressure ratio is 10. The turbine inlet temperature is 1500 K. Determine:
- (i) The thermal efficiency
  - (ii) 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.
- (i) Assuming ideal process, find per kg of steam the net work and the cycle efficiency.
  - (ii) 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:
- (i) The cycle efficiency
  - (ii) The quality of exhaust steam from the turbine
  - (iii) 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  $0.30$  m<sup>3</sup>/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)