School of Engineering

B.TECH Mechanical Engineering
Mid Term Examination - Nov 2023

Duration : 90 Minutes
Max Marks : 50

Sem III - G3UB302T - Engineering Thermodynamics

General Instructions
Answer to the specific question asked
Draw neat, labelled diagrams wherever necessary
Approved data hand books are allowed subject to verification by the Invigilator

1) Explain the state of equilibrium. Also discuss thermal, chemical, and mechanical equilibrium with suitable examples. — K2 (2)

2) State the Zeroth law of thermodynamics and explain its importance in establishing thermal equilibrium. — K1 (3)

3) Write short notes on the following:1. Equality of temperature 2. Law of perfect gases 3. Process and cycle 4. Point Function, Path Function — K2 (4)

4) . Explain the Second Law of Thermodynamics. Prove that the violation of Kelvin-Plank statement leads to the violation of Clausius statement. — K2 (6)

5) Derive the work done for the following processes: 1. Isochoric process 2. Isobaric process 3. Isothermal process 4. Adiabatic process 5. Polytrophic process — K3 (6)

6) A reversible heat engine operates between two reservoirs at temperatures of 600°C and 40°C. The engine drives a reversible refrigerator which operates between reservoirs at temperatures of 40°C and -20°C. The heat transfer to the engine is 2 MJ and the net work output of the combined engine and refrigerator plant is 360 kJ. Find the heat transfer to the refrigerant and the net heat transfer to the reservoir at 40°C. Also, find these values if the efficiencies of the heat engine and C.O.P. of the refrigerator are each 40% of the maximum possible values. — K3 (9)

7) In a gas turbine unit, the gases flow through the turbine is 15 kg/s and the power developed by the turbine is 12000 kW. The enthalpies of gases at the inlet and outlet are 1260 kJ/kg and 400 kJ/kg respectively, and the velocity of gases at the inlet and outlet are 50 m/s and 110 m/s respectively. Examine: (i) The rate at which heat is rejected to the turbine, and (ii) The area of the inlet pipe given that the specific volume of the gases at the inlet is0.45 m3/kg — K4 (8)

8) An automobile having a mass of 2,000 kg deflects its suspension springs 0.02 m under static conditions. Analyze the natural frequency of the automobile in the vertical direction by assuming damping to be negligible.

K4 (12)

OR

A spherical balloon of 2 m diameter is filled with a gas at 200 kPa and 300 K. The gas inside the balloon is heated. Finally, the pressure reaches 1 MPa. During the process of heating, assume that the pressure is proportional to the diameter of the balloon. Simplify the work done by the gas inside the balloon.

K4 (12)