Ref. No. : Ex/EE/5/ME/T/114/2023

B.E. ELECTRICAL ENGINEERING FIRST YEAR FIRST SEMESTER – 2023

Subject : PRIME MOVERS FOR ELECTRICAL SYSTEMS **Time : 3 Hrs.** **Full Marks : 100**

Instructions : Answer any FIVE questions. Write all pertinent assumptions. Assume any missing data.

1. (a) Describe the detailed operating process of an Otto cycle with a diagrammatic pressure-volume representation.

   (b) An engine working on the Otto cycle is supplied with air at 0.2 MPa at 35^0C. The compression ratio is 7.5. The heat supplied is 2100 kJ/Kg. Calculate the maximum pressure and temperature of the cycle and the cycle efficiency. (8+12)

2. (a) Describe the detailed operating process of a Diesel cycle with a diagrammatic pressure-volume representation.

   (b) Derive the efficiency of a Diesel cycle. (5+15)

3. (a) Describe the Rankine cycle and derive an expression of its efficiency.

   (b) Consider a steam power plant operating on the simple ideal Rankine cycle. The steam enters the turbine at 3 Mpa and 350^0C and is condensed in the condenser at a pressure of 75 kPa. Determine the efficiency of this cycle. At 75 kPa, h_1=384.39 kJ/kg, v_1=0.001037 m^3/kg. At 3 MPa, h_3=3115.3 kJ/kg, s_3=6.7428 kJ/kg.K. Also from steamtables, the staurated properties at state point 4 as s_{f4}=1.213 kJ/kg.K, s_{fg4}=6.2434 kJ/kg.K, h_{f4}=384.39 kJ/kg, and h_{fg4}=2278.6 kJ/kg. (8+12)

4. (a) Describe the primary operating cycle of a gas turbine engine and derive its efficiency.

   (b) A stationary power plant operating on an ideal Brayton cycle has a pressure ratio of r_p=9. The gas temperature is 300 K at the compressor inlet and 1500 K at the turbine inlet. Determine i) the gas temperature at the exits of the compressor and the turbine and ii) the thermal efficiency. (10+10)

5. (a) Derive the hydraulic efficiency of the Pelton wheel and obtain the expression for its maximum efficiency.

   (b) A Pelton wheel has a mean bucket speed of 12 m/s and is supplied with water at a rate of 750 liters per second under a head of 45 m. If the bucket deflects the jet through an angle of 150^0, find the power developed by the turbine and its hydraulic efficiency. Take the coefficient of velocity as 0.98. Neglect friction in the bucket. Also, determine the overall efficiency of the turbine if its mechanical efficiency is 70%. (10+10)

6. Write short notes on (i) Lanchester-Betz Limit; (ii) Wind turbines; (iii) Enthalpy; (iv) Spark-ignition and compression ignition engines. (5+5+5+5)