

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) An engine working on the Otto cycle is supplied with air at 0.3 MPa at 45°C. The compression ratio is 9.5 and the heat supplied is 3150 kJ/Kg. Calculate the maximum pressure and temperature of the cycle and the cycle efficiency.
(b) Write a detailed note on the Otto cycle, its working procedure, and a sample pressure-volume diagrammatic illustration. (12+8)
2. (a) Explain with a detailed sketch of the types of wind turbines. What are the power parameters of a wind turbine?
(b) What is Lanchester-Betz Limit? Prove that the maximum power coefficient of a wind turbine is 59.26%. (8+12)
3. (a) A gas turbine power plant operating on an ideal Brayton cycle has a pressure ratio of $r_k=9$. The gas temperature is 295 K at the inlet of the compressor and 1550 K at the turbine inlet. Determine the gas temperature at the compressor and turbine exits and the thermal efficiency of such a cycle.
(b) Write a detailed note on the Brayton cycle and its working procedure, and obtain an expression of its efficiency. (12+8)
4. (a) Derive an expression of the efficiency of a Diesel cycle. Write all pertinent assumptions.
(b) Write a detailed note on the Diesel cycle, its working procedure, and a sample pressure-volume diagrammatic illustration. (12+8)
5. (a) Sketch with details on the general layout of a hydroelectric power plant using a Pelton wheel. Obtain an expression for the hydraulic efficiency of the Pelton wheel.
(b) A Pelton wheel has a mean bucket speed of 14 m/s and is supplied with water at 700 liters per second flow rate under a head of 47 m. If the bucket deflects the jet through an angle of 145°, find the power developed by the turbine and its hydraulic efficiency. Assume the velocity coefficient as 0.99 and neglect friction in the bucket. If the mechanical efficiency of the turbine is 75%, determine its overall efficiency. (10+10)
6. Write short notes on: (a) The Rankine cycle. (b) The Spark-ignition engine operation cycle. (c) TDC and BDC with a sketch. (d) The Polytropic process. (5+5+5+5)