Ref. No. : Ex/EE/5/ME/T/114/2024(S)

BACHELOR OF ENGINEERING (ELECTRICAL ENGINEERING) FIRST YEAR FIRST SEMESTER SUPPLEMENTARY EXAM – 2024

PRIME MOVERS FOR ELECTRICAL SYSTEMS **Time : 3 hours** **Full Marks : 100**

Instructions : Answer any five (5) questions. Assume any missing data with justification.

1. Explain the types of wind turbines with detailed sketches. Explain the Lanchester-Betz limit and derive the expression for the maximum efficiency of a wind turbine. **(20)**

2. (a) Explain with detailed sketches the operating principles of a four-stroke petrol engine. Derive the expression of the efficiency of such an engine.

(b) An ideal petrol engine operates between two temperature limits-300 K and 1700 K. It operates with a compression ratio of 6. The ambient air pressure is 1 atm. Assuming the specific heats of constant pressure and volumes remain constant over its operating temperature range, calculate the pressure and temperature at each point in the cycle and the thermal efficiency of the engine. **(8+12)**

3. Explain with detailed sketches the operating principles of a four-stroke diesel engine. Derive the expression of the efficiency of such an engine. **(20)**

4. (a) What is a gas turbine? Find the expression of its efficiency.

(b) An ideal gas turbine draws the intake air at 1 atm. and 300 K. The air is then compressed to 6 atm., which is then used to combust a hydrocarbon fuel in the combustion chamber. A large air-fuel ratio is maintained to complete the combustion, which raises the maximum cycle temperature to 1200 K. The hot flue gas drives the gas turbine shaft to generate a net power output. If the combustion processes produce as much as 100 MW of input energy, determine the thermal efficiency of the cycle, power output, and work ratio. Note: $(c_v)_{air}=0.718\,kJ/kg.K$, $(c_p)_{air}=1.005\,kJ/kg.K$, $R=0.287\,kJ/kg.K$ **(8+12)**

5. (a) Explain with a net sketch of the typical setup of a hydraulic power plant.

(b) Derive the expression of hydraulic efficiency of a Pelton turbine and find its maximum efficiency condition. **(8+12)**

6. (a) What are the differences between CI and SI engines.

(b) A gas turbine operates between two temperature limits of 300 K and 1100 K. Determine its (i) maximum pressure ratio and (ii) efficiency. **(5+15)**