

JK LAKSHMIPAT UNIVERSITY JAIPUR
INSTITUTE OF ENGINEERING AND TECHNOLOGY
B.Tech., Theory Exam-III Examination, December, 2025
Energy Resources, Economics, and Environment

Roll No.

Course Code : ME1221

Time: 2 Hours

Max. Marks: 30

Instructions to students:

Do not write anything other than your roll number on question paper.

Assume suitable data wherever required and mention it clearly.

Writing appropriate units, nomenclature, and drawing neat sketches/schematics/ flow chart wherever, required are an integral part of the answer.

- Q.1 India consumes 900 million tonnes of oil equivalent of primary energy annually, with coal (45%), oil (25%), natural gas (10%), and renewables (20%). Construct a Sankey diagram showing the energy flow and estimate how much of total energy is lost if the conversion efficiency is 60%. **05** CO1, CO2
- Q.2 Using the Kaya Identity framework, evaluate which factor poses the greatest challenge for India to improve over the next decade. Support your answer with reasoned arguments based on India's developmental priorities, technological constraints, energy mix, and socio-economic realities. **05** CO1, CO2
- Q. 3 In early 2022, the Russia-Ukraine conflict triggered major disruptions in global energy markets. Crude oil prices briefly crossed USD 120/barrel, LNG spot prices surged to record highs, and several European countries scrambled to secure non-Russian energy supplies. These shifts intensified global competition for oil and gas, altered trade routes, and influenced long-term energy contracts. India, which imports over 85% of its crude oil and over 50% of its natural gas, faced rising energy bills, supply uncertainties, and pressure to rethink its fuel mix. At the same time, India increased discounted crude imports from Russia, raising both economic advantages and geopolitical risks. Based on the scenario, analyze how the Russia-Ukraine war reshaped global oil and gas markets. Consider price volatility, trade realignments, and supply shortages. **06** CO2
- Q. 4 In parts of western Rajasthan, Khejri trees are being cut due to land development, agricultural pressures, and the growing demand for land to set up large solar power plants. Identify the environmental externalities associated with this deforestation. Who bears these external costs, and why are they not reflected in market decisions? Suggest one **06** CO4

regulatory measure and one incentive-based measure that could help protect the Khejri species.

- Q. 5 A small rural hospital requires an uninterrupted power supply for critical equipment, with a peak load of 12 kW and an average load of 7 kW. The administration is considering two backup power options: a diesel generator system and a solar PV system with battery storage. The diesel generator is rated at 12 kW, costs ₹4 lakh, and has a life of 10 years. Diesel costs ₹94 per litre, with a net calorific value of 43 MJ/kg, density of 0.82 kg/litre, and carbon content of 85%. The generator operates at 32% efficiency, and its O&M cost is ₹0.5 per kWh. The solar PV + battery system has a PV capacity of 22 kW. The PV modules cost ₹10 lakh with a life of 25 years. The battery bank, providing one day of autonomy at the average load, costs ₹7 lakh and lasts 7 years. The balance-of-system components (inverters, charge controllers, wiring) cost ₹3.5 lakh, with a life of 20 years. The system's O&M cost is ₹0.25 per kWh. 08
CO₂, CO₃
- a) Determine the simple payback period for the additional investment required for the PV-battery system over the diesel generator. Using a discount rate of 20%, calculate the levelized cost of electricity (₹/kWh) for both systems.
- b) Estimate the annual CO₂ emissions from the diesel generator, assuming 1 kg of carbon produces 3.67 kg of CO₂.