Ref. No.: Ex/PG/EST/T/127A/2024

M. TECH.ENERGY SCIENCE AND TECHNOLOGY
FIRST YEAR SECOND SEMESTER EXAMINATION – 2024

Subject: ADVANCED ENERGY MANAGEMENT

Time: Three Hours Full Marks : 100

Use Separate Answer Script for each Part

PART I (60 Marks)

Answer **any three** questions.

1. Calculate the unit cost of electricity generation from a coal fired thermal power plant, if the capital cost of a coal-fired thermal power plant is Rs. 5.0 crore per MW and the cost of coal and oil are Rs. 2.00 per kg and Rs. 40 per litre respectively. Assume a 9% yearly interest rate on the capital investment. 650 gm coal and 4ml oil are required to generate one unit of electricity in a thermal power plant. Assume standard data if required. 20

2. a) From energy conservation point of view a four-stroke I.C. engine is more superior than a two-stroke I.C. engine. Yet two-stroke engines are widely used, especially in the developing countries. What are the reasons behind this ? 4

   b) Describe with neat sketches the four-stroke operating cycle and the two-stroke operating cycle of the I.C. engines. 16

3. a) Define specific energy consumption in passenger vehicle and in goods vehicle. Write a short note on energy conservation techniques in road transport. 10

   b) Assume that 70% of all freight is currently carried by small trucks (less than 8 ton capacity) and that 30% is carried by large trucks (greater than 8 ton capacity).

   Restructure the truck dispatching system so that substantial reduction in energy consumption can be achieved.

   Data given:

   i) Average specific energy consumption for the small trucks (less than 8 ton capacity) is 5.2 MJ /ton /km.

   ii) Average specific energy consumption for the large trucks (greater than 8 ton capacity) is 2.7 MJ /ton /km.

   iii) A total freight of 1000 ton is transported per day to a distance of 100 km. 10

4. a) A plant is using 4 ton/day of coal to generate steam. The calorific value of coal is 4000 kCal/ kg. The cost of coal is Rs. 2500 /ton. The plant substitutes coal with rice husk, as a boiler fuel, which has a calorific value of 3000 kCal/kg and cost Rs. 1500 /ton. Calculate the annual cost savings (if any) at 300 days of operation, assuming that the boiler efficiency (η) decreases from 78% on coal to 72% on rice husk. 14

b) A furnace of 12 ton/hour output consumes 900 kg/hour of fuel oil. Calculate the furnace efficiency by assuming specific heat of stock material as 0.15 kCal/kg ^{0}C , stock material heated from 90^{0}C to 1250^{0}C and GCV of fuel oil as 10,000 kCal/kg . 6

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M.TECH ENERGY SCIENCE AND TECHNOLOGY FIRST YEAR SECOND SEMESTER EXAM - 2024

ADVANCED ENERGY MANAGEMENT

Time: 3 Hours **Full Marks: 100**

Part II (40 Marks)

(Each question carries **20 marks**)
(*Answer any **two** questions*)

1. a. With the help of a labeled schematic diagram, describe the functioning of a refrigeration system.

   b. Show the T-S and P-V plot for Ideal Reversed Brayton Cycle. Mention the processes involved.

   c. Analyzing each process separately, derive the equation for coefficient of performance for Ideal Reversed Brayton Cycle.

2. a. With the help of T-S plot, show how the Ideal Reversed Brayton Cycle changes when internal irreversibility is considered in expander and compressor.

   b. Derive the equations for coefficient of performance of Actual Reversed Brayton Cycle and isentropic efficiencies of compressor and turbine.

   c. In an aircraft refrigeration system, air enters the compressor at 0.1 MPa, and it is compressed to 0.3 MPa with an isentropic efficiency of 72%. Temperature of air at inlet of the compressor is 10°C. It is then cooled to 20°C at constant pressure. The air is then expanded to 0.1 MPA in an expander with an isentropic efficiency of 78%. The lower temperature air absorb a cooling load of 3TR. Assuming air to behave as an ideal gas, find coefficient of performance, net power input in kW and mass flow rate.

3. What is microgrid? Explain the operation of micro grid architecture and what are the major challenges of it. Write about the differences between fuel cells and biomass gasifiers.

4.a. Write construction and working principle of electric vehicle (EV).

   b. Explain the operation of pumped storage power plant.