Name of the Examination : M. Tech. Energy Science and Technology First Year
First Semester - 2024
(1st Semester)
Subject : Energy Conversion Methods II
Use separate answer script for each Part
PART I (60 Marks)

Time: Three hours   **Marks : 100**

Answer **any three** questions.

(Use separate Answer Script for each Part)

1. Describe the working principle of a down-draft biomass gasifier. Give the probable chemical equations in the different stages of the gasification process. Also give the average composition of biomass gasifier gas.   20

2. What is biomethanation process ? What are the major steps involved in biomethanation of solid organic waste ? Give the chemical equations involved in different steps of the biomethanation process. List the different process parameters which affect the rate of biogas production in a biogas digester.   20

3. What is biodiesel? How does biodiesel is produced from vegetable oils? Give the chemical equation for the transesterification process. Compare the different properties of biodiesel with petro-diesel.   20

4. Design a 5m³ biogas digester fed with vegetable market waste, based on the following data. Assume standard data, if required.
   Data given:
   i)   Average total solid content of vegetable market waste : 18% (weight percent)
   ii)   Biogas production per kg of the waste : 0.06m³/kg
   iii)   HRT : 30 days

   Calculate the working volume and the total volume of the digester.   20

5. Design a biogas digester which can operate an engine coupled with an electrical generator, assuming 20% of the generated electrical output is required to heat and stir the digester. The electrical power to be supplied to the users will be 5 kW for 4 hours per day. Calculate the working volume of the digester based on the following data. Assume standard data, if required.
   Data given:
   i)   Waste fed to the digester : Biodegradable portion of municipal solid waste (MSW)
   ii)   Biogas production per kg of the waste : 0.05 m³ / kg
   iii)   Average total solid content of the waste : 20% (weight percent)
   iv)   HRT : 28 days   v) Average calorific value of biogas : 4700 kCal / m³
   v)   Biogas engine efficiency : 25%   vi) Generator efficiency : 90%.   20

MASTER OF TECHNOLOGY IN ENERGY SCIENCE & TECHNOLOGY

EXAMINATION - 2024

(First Year, First Semester)

ENERGY CONVERSION METHODS II

Time: Three hours (Part I+II) Full Marks: 100

Use separate answer script for each Part

Part – II (40 Marks)

Answer *any two* from the following questions.

1. (a) A PV system using 50 W, 12 V panels with 6-V, 125 Ah batteries is needed to power a home in Kolkata, West Bengal, with a daily of load 1700 Wh. System voltage is 24 V. There is an average 5 daylight hours in winter. Estimate the number of panels and storage values for the systems. Average solar radiation in winter at Kolkata is 3.8 kWh/m²/day.

   [Battery backup is require for 3 days, battery depth of discharge is 70% and efficiency is 75%] 15

   (b) What are the key advantages and disadvantages of harnessing geothermal energy as a sustainable power source?

   5

2. (a) Describe details of construction of Nickel Cadmium (NiCd) Batteries? What safety precautions should be taken when using nickel cadmium batteries in industries?

   5+5

   (b) What is the STC and NOCT conditions for solar cells? What is the effect of temperature on the open-circuit voltage of solar cell? explain.

   2+3

   (c) Draw and explain the equivalent circuit of solar cells?

   5

3. Answer any **four** of the following question 5×4=20
   (a) Solid-oxide fuel cell (SOFC).
   (b) Hot Dry Rock (HDR) / Enhanced Geothermal System (EGS).
   (c) Dye-sensitized solar cell (DSSC).
   (d) Describe in details the working principle of MPPT.
   (e) What is doping for solar cell and miss-match losses in solar PV system?