Register No.: ..... Name: .....

SAINTGITS COLLEGE OF ENGINEERING (AUTONOMOUS)

(AFFILIATED TO APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY, THIRUVANANTHAPURAM)

FIRST SEMESTER M.TECH DEGREE EXAMINATION (R), DECEMBER 2023

POWER SYSTEMS

(2021 Scheme)

Course Code: 21PS104-A

Course Name: Green Energy Systems

Max. Marks: 60 **Duration: 3 Hours**

PART A

(Answer all questions. Each question carries 3 marks)

1. With a neat sketch, describe the components of solar radiation.
2. Define i) Open circuit voltage, ii) Short circuit current, and iii) Fill factor of the solar cell.
3. With the help of the wind turbine power curve, explain the terms cut-in speed, rated output, wind speed and cut-out speed.
4. Outline the advantages and limitations of hybrid PV-wind power generation.
5. Explain any one method for the forecasting of ocean thermal energy.
6. Discuss the biomass gasification process.
7. Explain the principle of thermionic energy conversion.
8. State any three applications of fuel cells.

PART B

(Answer one full question from each module, each question carries 6 marks)

MODULE I

9. A flat plate collector, facing due south, having two glass covers is located at Ahmadabad (23.03° N, 72.58° E), with the following data: -
   Standard longitude for IST: 82.5° E
   Date: December 22
   Solar time: 11 h 27.5 min
   Collector tilt angle: Latitude+15°
   Determine the angle of incidence of beam radiation on the collector surface. (6)

OR

10. From fundamentals, derive the expression for the instantaneous collector efficiency of a liquid flat plate collector. (6)

MODULE II

11. Elucidate how a solar cell can be a represented using a two-diode (6)

model. Justify your answer with the help of relevant equations and equivalent circuit.

OR

12. Design a solar photovoltaic system wherein the load consists of a CFL, TV, fan, refrigerator and computer. The system should allow the use of loads in the non-sunshine hours. The operating hours and the power rating of these loads are as follows:
CFL (2 Nos.), 9 W, 5 h/day
Fan (1 No.), 60 W, 8 h/day
TV (1 No.), 150 W, 2 h/day
Fridge (1 No.), 150 W, 8h/day
Computer (1 No.), 250 W, 3 h/day
Consider that PV module of 75 W_p is available with voltage and current at maximum power point of 15 V and 5 A, respectively. Assume the efficiencies of inverter, battery, and charge controller circuit as 93%, 85%, and 90% respectively. Assume the depth of discharge of 12 V, 100 Ah batteries as 70%. (6)

MODULE III

13. Derive the expression for power that can be extracted by a wind turbine rotor using the one-dimensional momentum theory. (6)

OR

14. Describe the wind turbine topologies based on rotor axis orientation and rotor power control. (6)

MODULE IV

15. With the help of a neat block diagram, describe the components of a wind-PV hybrid system. (6)

OR

16. Justify the need for storage systems in wind-PV hybrid systems. (6)

MODULE V

17. Describe the closed cycle OTEC plant with the help of a neat figure. How is it different from an open cycle OTEC plant? (6)

OR

18. Elucidate the KVIC and Janata models for biomass energy conversion. (6)

MODULE VI

19. How can geothermal resources be classified? Describe the hydrothermal resource with the aid of a simplified structural representation. (6)

OR

20. Describe mini hydropower systems with the help of a schematic diagram. (6)

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