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B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

September / October 2023 Supplementary Examinations

Programme: B.E.
Branch: ES – Cluster Elective
Course Code: 19EE6CE1WS
Course: Wind and Solar Energy systems

Semester: VI
Duration: 3 hrs.
Max Marks: 100

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

UNIT - I

1 a) Represent with the help of a diagram green energy flow and brown energy flow in the environment. Compare them — **10**

   b) How do you match supply and demand with renewable energy options? Explain highlighting the advantages of connecting a renewable energy system to a grid network? — **10**

UNIT - II

2 a) Draw a diagram to represent the Solar Azimuth angle. Give its equation with usual notations. What is the test for solar azimuth angle for its magnitude greater or less than 90°? What is the sign convention? — **07**

   b) What is the need for measuring solar radiation? With the help of a neat diagram, explain the working of an Angstrom compensated type Pyrheliometer? — **07**

   c) In a place having a latitude of 33.7°, on 21st of May, clear sky beam radiation is found to be 902 W/m^2 at noon (solar). Find the angle of incidence and corresponding beam insolation on a collector surface facing 20° towards south east if the collector tilt angle is 52°. — **06**

OR

3 a) Draw a diagram to represent the angle of declination and define it? Give its formula? What is the meaning of declination angle equal to zero Explain? — **07**

   b) What is the difference between a pyranometer and a pyrheliometer? What are the different types of sensors used in these meters? Explain — **07**

   c) In a place having a latitude of 33.7°, on 21st of May, clear sky beam radiation is found to be 902 W/m^2 at noon (solar). Find the angle of incidence and corresponding beam insolation on a collector surface facing 20° towards south east if the collector tilt angle is 33.7°. — **06**

UNIT - III

4 a) Give the structure of a multifunction solar cell and Explain its working. What are the advantages of a multifunction solar cell over a single junction cell? — **08**

b)   **06**
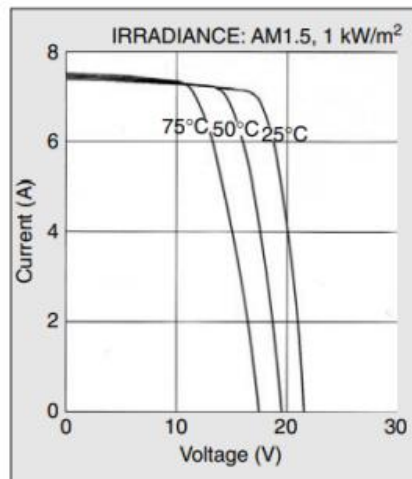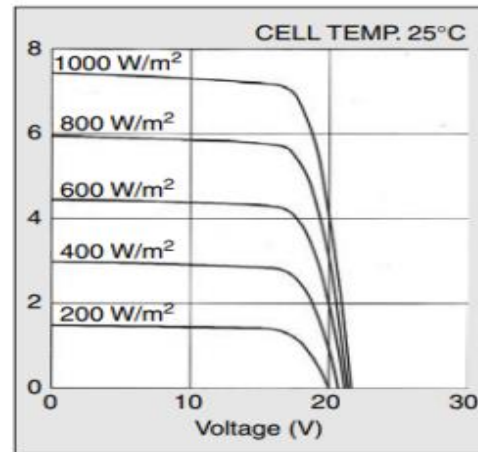

Figure 4b.1   Figure 4b.2

Identify the characteristics shown in figures 4b.1 and 4b.2. Explain each one of them highlighting the impact of parameter variation indicated.

c)   **06**
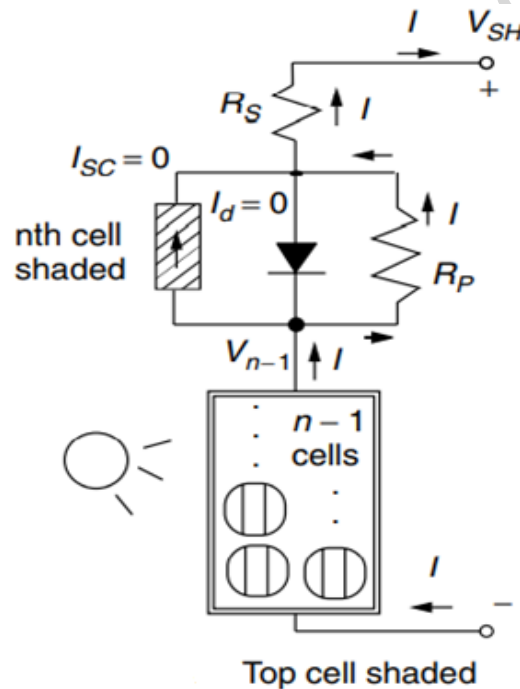

Top cell shaded

Figure 4c

In a PV module having n cells, as shown in Figure 4c, the top cell is shaded. Obtain an expression for the drop in the voltage caused by the shaded cell.

UNIT - IV

5   a)   Draw a simplified block diagram of a utility grid connected PV system? Describe its operation and list the desirable features of the system. State its advantages and disadvantages.   **10**

b)   Design a PV array - DC peak power rating and area required in square meters; for a residential building to provide 3600 kWh per year of AC electricity that the home uses. The annual insolation with the fixed orientation PV array is 5.7 kWh / m^2 - day. Take collector efficiency of 12.5%. Assume a derating factor of 25% for DC to AC conversion. Use peak sun approach.   **10**

If 116 Wp PV modules are available for use in the above residential building, find the number of PV modules required.

OR

6 a) Draw a simplified block diagram of a standalone PV system including a backup AC generator. Explain its operation. Discuss about the obligations on the users of standalone PV systems. **10**

b) Draw Thevenin's Equivalent circuit of a battery. A 100 A-h, 12 V battery with a rest voltage of 12.5 V (at its current SOC) is charged at C/5 rate, during which the applied voltage is 13.2 V. Using a simple Thevenin's equivalent circuit, estimate the internal resistance of the battery. What fraction of the input power is lost in the internal resistance of the battery? **10**

If the charging is done at C/20 rate what is the input voltage required with the same internal resistance and what fraction of the input power is lost in the internal resistance?

UNIT - V

7 a) Describe the construction and working of a horizontal axis, three blade wind turbine with the help of a neat diagram. What is the function of yaw control, pitch control and Tethering control **10**

b) A three bladed wind turbine, 40 m rotor diameter produces 600 kW at a wind speed of 14m/s. Taking air density as 1.225 kg/m^3. Calculate **10**
   i) Tip speed of the rotor
   ii) If the tip speed ratio (TSR) is 4 at what rpm does the rotor turn?
   iii) If the generator needs to turn at 1800 rpm, with rotor speed as obtained in the above step
   iv) What gear ratio is required.
   v) What is the overall efficiency of the wind turbine from wind to electricity

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