SOLAR PHOTOVOLTAIC SYSTEM DESIGN
(REEN 5244)

Time Allotted : 3 hrs   **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and
<u>any 5 (five)</u> from Group B to E, taking <u>at least one</u> from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

    (i)   Photocurrent in a tandem multijunction solar cell is
           (a) larger
           (b) equal
           (c) slightly larger
           (d) smaller than that obtained in a solar cell with single junction.

    (ii)   The most common material used in making solar cell is
           (a) Zink   (b) Silicon   (c) Gold   (d) Germanium.

    (iii) Absorption coefficient of a bulk semiconductor is
           (a) a tuneable property   (b) a material property
           (c) thickness dependent property   (d) both (b) & (c).

    (iv)   Bye pass diodes are connected to the PV panel to overcome the
           (a) shading Effect   (b) to increase the Short ckt current
           (c) to increase the open ckt voltage (d) none of these.

    (v)   Maximum efficiency from solar cell can be obtained at
           (a) UV range   (b) infrared range
           (c) visible spectrum range   (d) in dark.

    (vi)   The earth's axis of polar axis is always inclined at an angle of
           (a) 45.5°   (b) 23.5°   (c) 62.75°   (d) 18.3°.

    (vii) The slope of the V-I curve of a solar cell is 66.1°. Calculate the value of resistance. Assume the relationship between voltage and current is a straight line.
           (a) 3.5 Ω   (b) 2.2 Ω   (c) 2.5 Ω   (d) 2.9 Ω

    (viii) Why mounting of solar panels are made of aluminium
           (a) good strength to weight ratio   (b) good current conductor ratio
           (c) good heat conduction ratio   (d) none of these.

(ix) Anti reflection coating (ARC) used in solar cell
(a) to minimize the reflection   (b) to increase the reflection
(c) to minimize the absorption   (d) to maximize the absorption.

(x) Interactive PV system operates
(a) stand alone   (b) parallel with the grid
(c) both (a) & (b)   (d) none of these.

Group- B

2. (a) Evaluate the hour angle at sunrise and sunset on June 21 and December 21 for a surface inclined at an angle of 10^0 and facing due south ($\gamma=0°$). The surface is located in Kolkata (22° 34' N, 88° 21' E).   [(CO4)(Evaluate/HOCQ)]
   (b) Estimate the diffuse component in monthly and hourly basis?
        [(CO4)(Evaluate/HOCQ)]
   6 + 6 = 12

3. (a) Distinguish the principle of operation of solar cell and photodetector. Explain the significance of Fill factor.   [(CO4)(Analyse/IOCQ)]
   (b) Explain the operation of Plasmon solar cells.
        [(CO3)(Understand/LOCQ)][(CO2)(Understand/LOCQ)]
   (4 + 2) + 6 = 12

Group - C

4. (a) Draw the equivalent schematic circuit diagram and explain the output current equation.   [(CO4)(Remember/LOCQ)]
   (b) Explain the 'Reliability of Solar Inverter' in respect of Photovoltaic System.
        [(CO2)(Understand/LOCQ)]
   6 + 6 = 12

5. (a) Explain the necessity of 'Bypass Diodes' and 'Blocking Diodes' in PV Plant.
        [(CO4)(Understand/LOCQ)]
   (b) Outline the string and array in respect of photovoltaic system?
        [(CO2)(Analyze/IOCQ)]
   Illustrate that the performance of solar cell dependent on shading effect.
        [(CO2)(Understand/LOCQ)]
   (2 + 2) + (4 + 4) = 12

Group - D

6. (a) A solar PV panel consists of each cell which has an output capability of 0.3A at 0.5V. Assume that an array of such cells with 75 parallel strings and each string with 200 cells in series is to be building up. Evaluate the array output voltage, array current and array output power.   [(CO4)(Evaluate/HOCQ)]

(b)   Critically discuss the function of 'Deep Cycle Battery' in a PV plant.

[(CO4)(Evaluate/HOCQ)]

6 + 6 = 12

7.   (a)   Illustrate the Maximum Power Point Tracking (MPPT) of a Photovoltaic Plant. Elucidate your idea about the relation of MPPT with solar irradiance and temperature.   [(CO1)(Remember/LOCQ)]
(b)   Distinguished the single phase and three phase DC to AC converter.

[(CO4)(Analyse/IOCQ)]

(4 + 3) + 5 = 12

Group - E

8.   (a)   Differentiate the function of Standalone PV plant and Grid tied PV plant. Draw the block diagram of these two type PV plant.   [(CO4)(Analyse/IOCQ)]
(b)   Explain the function of Solar pump in a remote area.

[(CO3)(Understand/LOCQ)]

(5 + 3) + 4 = 12

9.   (a)   Designing of a Photovoltaic System establishes the importance of 'Maximum Power Point Tracking' towards the charge controller — Explain.

[(CO3)(Create/HOCQ)]

(b)   Outline with necessary block diagram the Grid tied Photovoltaic system.

[(CO5)(Analyze/IOCQ)]

6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	38.54	30.21	31.25

Course Outcome (CO):

After the completion of the course students will be able to
1. To demonstrate knowledge of different solar cells modules and uses.
2. To describe working of the solar cell modules.
3. To explain the selection of batteries for different solar systems.
4. To apply engineering materials in renewable Energy/ power generation.
5. To design grid connected and standalone solar systems.

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question