2024

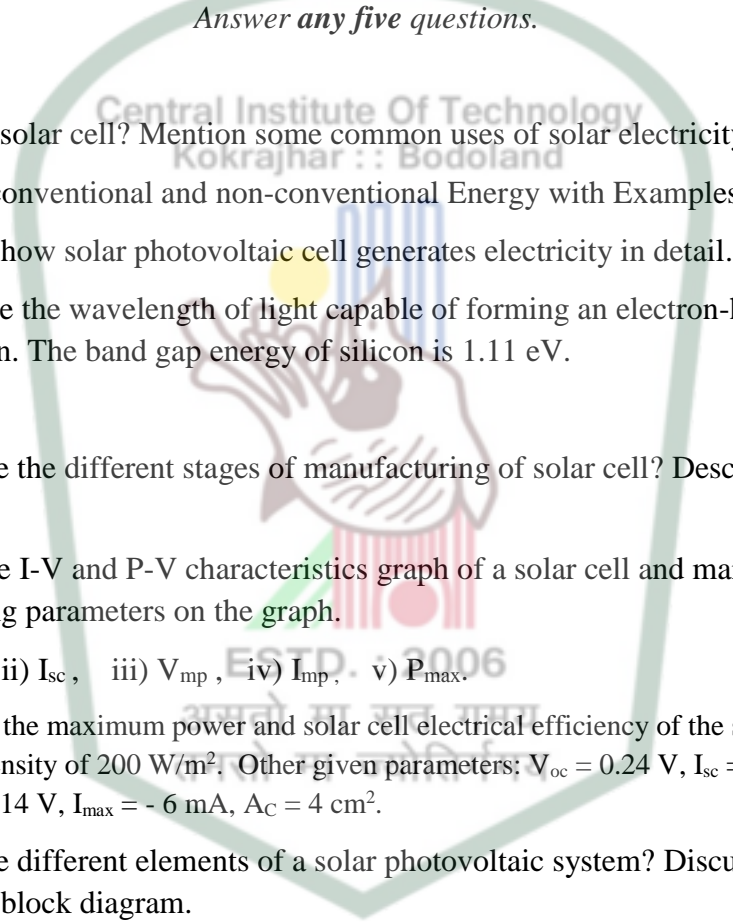## SOLAR CELL TECHNOLOGY

Full Marks : 100

Time : Three hours

The figures in the margin indicate full marks for the questions.

*Answer **any five** questions.*

1. a) What is solar cell? Mention some common uses of solar electricity. 5

    b) Define conventional and non-conventional Energy with Examples. 5

    c) Explain how solar photovoltaic cell generates electricity in detail. 8

    d) Calculate the wavelength of light capable of forming an electron-hole pair in silicon. The band gap energy of silicon is 1.11 eV. 2

2. a) What are the different stages of manufacturing of solar cell? Describe briefly. 5

    b) Draw the I-V and P-V characteristics graph of a solar cell and mark the following parameters on the graph. 5

    i) V_{oc} , ii) I_{sc} , iii) V_{mp} , iv) I_{mp} , v) P_{max}.

    c) Evaluate the maximum power and solar cell electrical efficiency of the solar cell at an intensity of 200 W/m². Other given parameters: $V_{oc} = 0.24$ V, $I_{sc} = -9$ mA, $V_{max} = 0.14$ V, $I_{max} = -6$ mA, $A_C = 4$ cm². 5

    d) What are different elements of a solar photovoltaic system? Discuss with a suitable block diagram. 5

3. a) Discuss the effects of irradiance and temperature on solar cell. 5

    b) Design a PV plant for 40 kW Demand. What will be the size of the PV plant to meet this demand? How many PV panels are required? How will these PV panels be connected? Use 205 Wp PV modules. Specifications of each panel are: 205 Wp, 7.3 A, 28 V. 10

    c) Describe the working principle of standalone SPV system with only AC/DC load, electronics control circuit and battery. 5

4. a) Draw and describe briefly the basic energy band diagram of a semiconductor.   5

    b) Calculate number of c-Si solar cell with open-circuit voltage of about 0.5 V with 0.08 V drops at more than 25 °C operating temperature for 15 V open-circuit voltage of PV module.   5

    c) A monochromatic red laser beam emitting 1 mW at a wavelength of 638 nm is incident on a silicon solar cell. Find the following: i. The number of photons per second incident on the cell; ii. The maximum possible efficiency of conversion of this laser beam to electricity   5+5

5. a) Total load requirement of a house is given in the following table. Design a PV system with the required battery backup (2 days) .   10

Table: Load profile of a house

Type of appliance	Number	Wattage (W)	Usage (hours/day)
CFL	2	11	5
CFL	1	9	3
Tube	1	55	5
TV	1	100	5
Fan	2	50	8

    b) Write the definition of photolysis and photo-catalysis.   5

    c) Describe Photo-catalytic reactions with suitable examples.   5

6. a) Write the applications of solar photo-catalytic detoxification using different types of solar reactors.   10

    b) Three reactors—a flat-plate, a parabolic trough concentrator, and a shallow solar pond were tested for effectiveness in treating a water stream contaminated with 4CP. Using 0.1% TiO_2 solution, all three gave a reaction rate constant ko of 0.0172 min^{-1} for an incident UV radiation of 31 W/m^2.   5+5

        i) Determine the reaction rate for a 0.1% TiO_2 solution of the contaminated water passing through each reactor experiencing a steady UV insolation of 43 W/m^2.

ii) Determine the depth of a rectangular shallow pond reactor to give (A) the reaction rate found in part (i) and (B) double the reaction rate found in part (i).

Use the following reference values:

$(A/V)_0 = 19.7$ m^{-1} for shallow pond reactor

$a = 1.0$ for concentrating reactor.

7. b) Write short notes (any four) 5×4

i) Solar cell materials

ii) Maximum power point tracking

iii) Hybrid type solar PV system

iv) Grid-connected solar PV system

v) P-N junction and its characteristics

vi) Testing and rating parameters of solar cell