

Time Allotted : 3 hrs

Full Marks : 70

*Figures out of the right margin indicate full marks.*

*Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one 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) A solar cell is basically  
(a) a voltage source, controlled by flux of radiation  
(b) a current source, controlled by flux of radiation  
(c) an uncontrolled current source  
(d) an uncontrolled voltage source.
- (ii) A fuel cell is basically  
(a) an electro-mechanical energy conversion device  
(b) an electro-static energy conversion device  
(c) a thermo-electric energy conversion device  
(d) an electro-chemical energy conversion device.
- (iii) The most widely used material for solar cell is  
(a) gallium arsenic (b) cadmium (c) silicon (d) steel.
- (iv) Maximum wind energy available is proportional to  
(a) square of radius of the rotor (b) cube of wind velocity  
(c) air density (d) all above.
- (v) Limitation of solar energy is that  
(a) direction of rays does not change (b) energy storage is essential  
(c) energy density is high (d) cost is low.
- (vi) The standard value of solar constant is  
(a) 1150 W/m<sup>2</sup> (b) 1367 W/m<sup>2</sup>  
(c) 2100 W/m<sup>2</sup> (d) 1825 W/m<sup>2</sup>.

- (vii) The earth's orbit around the sun is  
(a) round (b) elliptical (c) semi circular (d) not yet derived .
- (viii) Photovoltaic energy is the conversion of sunlight into  
(a) electricity (b) chemical energy  
(c) biogas (d) geothermal energy.
- (ix) Perovskite materials are used in  
(a) tandem solar cell (b) dye sensitised solar cell  
(c) crystalline silicon solar cell (d) none of them.
- (x) The nonlinear optical properties of carbon nano-tubes depend strongly on the  
(a) diameter of the tube (b) polarization of incident radiation  
(c) symmetry of the tube (d) both (a) & (c).

**Group - B**

2. (a) How the energy resources are classified based on long term availability. Define renewable energy resources.  
(b) What are the salient features of non-conventional energy sources?  
(c) What is geothermal energy? State the advantages and disadvantages of geothermal energy.
- (2 + 1) + 4 + (1 + 4) = 12**
3. (a) Explain how wind energy can be extracted in wind turbines.  
(b) Describe the principle of operation of fuel cell.  
(c) Mention the problems with large hydropower stations. Mention the advantages of MHPs.
- 4 + 4 + (2 + 2) = 12**

**Group - C**

4. (a) Mention the components of solar radiation. State the different methods of utilization of solar energy. Briefly describe the sun structure and identify the layer that radiates energy into the solar system.  
(b) For a city located at 80.50 longitudes, calculate the solar time on March 15, 2017 at 10.30 am Indian Standard Time.
- (2 + 3 + 3) + 4 = 12**

5. (a) With a neat diagram, describe declination angle. Calculate the declination angle ( $\delta$ ) for March 31 in a leap year. Also estimate the day light hours at Kolkata (latitude  $22^{\circ}30'$  N) on the same day.

(b) Describe the structure of a flat plate solar collector. What is a solar concentrator?

$$(2 + 2 + 2) + 6 = 12$$

#### Group - D

6. (a) Explain the principle of PV energy conversion.

(b) The band gap energy of GaAs is 1.43 eV. Calculate the optimum wavelength of light for PV generation in a GaAs cell.

(c) Describe single crystal silicon solar cell with its constructional details.

$$4 + 2 + 6 = 12$$

7. (a) Explain in details the working principle of solar cells with equivalent circuit and I-V curve.

(b) Find out the parameters like (i) short circuit current ( $I_{sc}$ ), (ii) solar cell temperature ( $T_c$ ), (iii) open circuit voltage, (iv) fill factor and (v) maximum power ( $P_{max}$ ) of a module formed by 33 solar cells connected in series under the operating conditions  $G=700 \text{ W/m}^2$  and  $T_a=34^{\circ}\text{C}$ . The manufacturer's value under standard conditions are  $I_{sc}=3\text{A}$ ,  $V_{oc}=21\text{V}$ ,  $P_{max}=46\text{W}$  and  $\text{NOCT}=45^{\circ}\text{C}$ .

$$6 + 6 = 12$$

#### Group - E

8. (a) Name various physical vapour deposition techniques. Why is vacuum necessary during physical vapour deposition of metals? Distinguish between hot wall and cold wall reactors used in CVD.

(b) Explain in brief, the principle of operation of HIT solar cell.

$$(2 + 3 + 3) + 4 = 12$$

9. Write short notes on (any three)

(i) Biodiesel

(ii) Flat plate collector

(iii) Materials for solar cell.

(iv) Tidal energy.

$$(3 \times 4) = 12$$