

**MATERIALS FOR ENERGY CONVERSION SYSTEMS
(REEN 5104)**

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) The nonlinear optical properties of carbon nanotubes depend strongly on the
 - (a) diameter of the tube
 - (b) polarization of incident radiation
 - (c) symmetry of the tube
 - (d) both (a) & (c).
 - (ii) The absorption coefficient increases rapidly for

(a) $\lambda < 1.24/E_g$	(b) $\lambda = 1.24/E_g$
(c) $\lambda > 1.24/E_g$	(d) None of the above.
 - (iii) Shading effect can be reduced by
 - (a) choosing optimum metal thickness
 - (b) choosing optimum height - to -width ratio.
 - (c) reducing carrier lifetime
 - (d) both.
 - (iv) Influence of intrinsic amorphous Si layer provides
 - (a) poor surface passivation
 - (b) good surface passivation
 - (c) extremely poor surface passivation
 - (d) extremely good surface passivation.
 - (v) Staebler - Wronski effect depends on the
 - (a) thickness of the i-layer
 - (b) doping concentration of i-layer
 - (c) magnitude of electric field
 - (d) wavelength of incident light.

- (vi) The most commonly used etchants for silicon are
 - (a) mixture of HNO₃ & HF in DI water
 - (b) mixture of HNO₃ & HF in H₂SO₄
 - (c) mixture of CaCO₃ & HNO₃ in DI water
 - (d) none of these.
- (vii) Standard Clean room temperature is

(a) 22 +/- 5 ^o C	(b) 32 ^o C +/- 2 ^o C
(c) 50 +/- 2 ^o C	(d) 20 ^o C +/- 5 ^o C.
- (viii) Full form of CVD
 - (a) Cubic Volume Density
 - (b) Chemical Vapour Deposition
 - (c) Coating Volume Deposition
 - (d) None of these.
- (ix) The typical office building air contains-----numbers of particles (0.5 micron) per cubic feet

(a) 5 lac to 10 lac	(b) 10 billions
(c) 10000	(d) 50000.
- (x) Homoepitaxy means

(a) growth of silicon in silicon	(b) growth of silicon in air
(c) reduction of silicon layer	(d) none of these.

Group - B

2. (a) Identify the contaminants that affect
 - (i) Minority Carrier life time
 - (ii) Oxide leakage
 - (iii) function breakdown and bipolar gain.
- (b) Why is Photolithography preferred to be done in a "Class-10" clean room and in yellow light?

(3 + 3 + 3) + 3 = 12
3. (a) Write the application of PECVD and Epitaxial growth in solar cell fabrication. Discuss- "solid-state materials are the alternatives of dye sensitized solar cells".
- (b) What is dark current? Discuss.

(2 + 2 + 5) + 3 = 12

Group - C

- 4 (a) Distinguish the principle of operation of solar cell and photodetector. Explain the significance of Fill factor.
- (b) The absorption coefficients of Si for wavelength $\lambda=1.0\mu\text{m}$ and $\lambda=0.5\mu\text{m}$ are 10^2 cm^{-1} and 10^4 cm^{-1} respectively. Calculate the thickness of a semiconductor that absorbs 90% of the incident photon energy.
- (6 + 3) + 3 = 12**

- 5 (a) Describe the tandem and parallel configurations of multi-junction solar cells. Discuss the pros and cons to be addressed for optimal coverage of solar spectrum and good performance of tandem solar cell.
- (b) Why is the tandem solar cell advantageous over the single junction solar cell?
- (4+6) + 2 = 12**

Group - D

6. (a) Draw the flow diagram for the production of amorphous – Si solar cells / module.
- (b) Briefly discuss the features of the components of the above module.
- 6 + 6 = 12**
7. (a) Explain Chiral vector and chiral angle. Why are carbon nanotube based solar cells more advantageous than Dye-sensitized solar cells?
- (b) Discuss few optimization strategies of carbon nanotube based solar cell design.
- (4 + 4) + 4 = 12**

Group - E

8. (a) Discuss about the flexible and organic solar cells.
- (b) What is Perovskite material? Write the advantages of using Perovskite material in solar cells.
- (3 + 3) + (2 + 4) = 12**
9. (a) Explain the principle of operation of DSSC solar cell.
- (b) What is Dark current? Why is TiO_2 mostly used in Dyesensitized solar cells?
- 6 + (2 + 4) = 12**