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)   If incident photon energy is less than the band gap energy, then the semiconductor
         (a) absorbs photon
         (b) appears transparent to the photons
         (c) absorbs very small percent of incident photons
         (d) none of the above.

   (ii) The absorption coefficient in the semiconductor is a strong function of
         (a) photon energy   (b) band gap energy
         (c) both (a) & (b)   (d) none of the above.

   (iii) 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.

   (iv) In tandem solar cells, the output current is limited by
         (a) smallest current generated in individual junctions
         (b) voltages produced by individual cells
         (c) both (a) & (b)
         (d) none of the above.

   (v)   In MQW solar cell
         (a) short circuit current increases
         (b) efficiency increases
         (c) open circuit voltage is same as in p-n junction
         (d) all three of the above

   (vi) Perovskite materials are used in
         (a) tandem solar cell   (b) dye sensitised solar cell
         (c) crystalline silicon solar cell   (d) none of them.

   (vii) Thickness of Thin Film coated by PVD technique is
         (a) 1-10µm   (b) 10-25 µm
         (c) 50-100 µm   (d) 0.10-0.50 µm.

   (viii) Maximum efficiency is obtained in
         (a) flat plate collector   (b) evacuated tube collector
         (c) live focussing collector   (d) paraboloid dish collector.

   (ix) The extraterrestrial radiation flux varies by ___ % over a year
         (a) ±1.1   (b) ±2.2   (c) ±3.3   (d) ±4.4.

   (x)   Solar radiation flux is usually measured with the help of a:
         (a) anemometer   (b) pyranometer
         (c) sunshine recorder   (d) all of the above.

Group – B

2. (a) Distinguish between advantages and disadvantages of APCVD, LPCVD and PECVD.

   (b) Distinguish between hot wall and cold wall reactors used in CVD. What are the process variables in CVD?

   6 + 6 = 12

3. (a) State and explain Epitaxy. Write its various uses. Describe its classification scheme.

   (b) State the working principles of a simple evaporation system. What is step coverage problem?

   6 + (4 + 2) = 12

Group – C

4. (a) Solar cell having an active area of (5cm x 5cm) is irradiated with light having an irradiance of $200 W/m^2$. If the cell has $\eta_c = 15\%$, $V_{oc} = IV$ and $I_{oc} = 100mA$, determine the maximum power that can be drawn from this cell under the given condition. Hence, estimate the fill factor.

   (b) Derive all the necessary expressions for the calculations in 4(a).

   6 + 6 = 12

5. (a) Explain the operation of an illuminated p-n junction in the various quadrants of its current – voltage characteristics.

   (b) Why is the tandem solar cell advantageous over the single junction solar cell.

                                                                    9 + 3 = 12

Group – D

6. (a) What are the advantages of HIT solar cells compared to the crystalline silicon solar cell? Discuss the principle of operation of HIT solar cell.

   (b) Illustrate how the solar cells with hot charge carriers increase the conversion efficiency almost to the maximum extent possible theoretically.

                                                              (6 + 2) + 4 = 12

7. (a) Discuss the principle of operation of quantum well solar cells with intermediate band.

   (b) Discuss the effects of doped amorphous silicon layer, intrinsic amorphous silicon layer, interface defects and passivated surfaces on the HIT solar cell performance.

                                                                    6 + 6 = 12

Group – E

8. (a) Explain why the solid state Dye-Sensitised solar cell is superior than the normal DSSC.

   (b) What is dark current? Explain the phenomenon in connection with Crystalline solar cell. What are the various applications of SiO_2 in low power device?

                                                                    6 + 6 = 12

9. (a) Mention the names of two photoresists. Write their merits and demerits. What is an inorganic photoresist? Mention various kinds of radiations to which photoresists are sensitive.

   (b) How much silicon will be consumed to grow 1 micrometer SiO_2 in a thermal oxidation process. Given: densities of Si and SiO_2 are 2.33 and 2.27 gm/cc respectively. Atomic weight of Si is 28 and molecular weight of SiO_2 is 60.

                                                                    6 + 6 = 12