

**MATERIAL FOR RENEWABLE ENERGY APPLICATION  
(REEN 5141)**

**Time Allotted : 2½ hrs**

**Full Marks : 60**

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

*Candidates are required to answer Group A and  
any 4 (four) from Group B to E, taking one from each group.*

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

**Group – A**

1. Answer any twelve:

**12 × 1 = 12**

*Choose the correct alternative for the following*

- (i) A 1D nanomaterial has  
(a) two dimensions in the nanoscale (b) one dimensions in the nanoscale  
(c) zero dimensions in the nanoscale (d) none of these.
- (ii) Film deposition in Chemical Vapor Deposition is enabled through  
(a) precursors (b) inert gases carrying precursors  
(c) a catalyst (d) none of these.
- (iii) Wind turbine blades generate wakes that in turn create aerodynamic load  
\_\_\_\_\_.  
(a) distributions (b) fluctuations  
(c) reduction (d) both (a) and (c).
- (iv) To enable a plasma enhanced process in a CVD chamber will require  
(a) a light source (b) a heat source  
(c) a positively charged plate (d) a corona discharge
- (v) Well defined yield point can be seen in  
(a) brittle materials (b) ductile materials  
(c) plastic materials (d) both (a) and (b)
- (vi) For imaging, the scanning electron microscopy uses  
(a) a UV light beam (b) X rays  
(c) electron beam (d) none of these
- (vii) In solar cells, silicon nitride is used as  
(a) an insulator (b) as support for solar cell layers  
(c) as an antireflector (d) None of these
- (viii) An example of III-V compound based solar cell is  
(a) GaAs based cells (b) CuInSe<sub>2</sub> based cells  
(c) CdTe based cells (d) none of these.

- (ix) The process of screen printing is used  
 (a) to fabricate metal contacts on the solar cell  
 (b) to deposit a layer of anti reflective coating  
 (c) to deposit the emitter layer  
 (d) none of these
- (x) Atomic force microscopic evaluates the  
 (a) bulk structure of a sample (b) the surface structure of the sample  
 (c) the composition of the sample (d) none of these.

*Fill in the blanks with the correct word*

- (xi) Rotation induces \_\_\_\_\_ force on wind turbine blades.
- (xii) Amorphous silicon is not the preferred material in photovoltaics because \_\_\_\_\_
- (xiii) The process of sputtering differs from evaporation in the following two ways  
 i. \_\_\_\_\_  
 ii. \_\_\_\_\_
- (xiv) The difference in polycrystalline and monocrystalline silicon is \_\_\_\_\_.
- (xv) Proof stress is generally applicable for \_\_\_\_\_ materials.

### **Group - B**

2. (a) Describe the process of mechanical exfoliation to create graphene starting with the raw material. *[[CO1](Understand/IOCQ)]*
- (b) Can the process of ball milling be used to generate nanomaterial alloys? If so how? *[[CO1](Analyze/IOCQ)]*
- (c) The sputtering process is very similar to pulsed laser deposition process. Explain where they are similar. *[[CO1](Apply/IOCQ)]*  
**4 + 4 + 4 = 12**
3. (a) Describe one application of pulsed laser deposition being used in solar cell fabrication. *[[CO1](Analyze/IOCQ)]*
- (b) State the primary difference between pulsed laser deposition (PLD) and sputtering. When would you use PLD over sputtering? *[[CO1](Analyze/IOCQ)]*
- (c) Describe the method of formation of silica gel with the sol gel process. State all precursors and reactions involved. *(CO1)(Apply/IOCQ)]*  
**2 + 4 + 6 = 12**

### **Group - C**

4. (a) Why is passivation c-Si solar cells done with silicon nitride layers? *[[CO3](Apply/IOCQ)]*
- (b) What are semiconductor heterojunctions? Explain the difference between Type I and Type II semiconductor heterojunctions. *[[CO3](Understand/LOCQ)]*

- (c) With a diagram, depict the structure of GaAs solar cell grown on n-type doped GaAs wafer. [[CO3](Understand/LOCQ)]  
**4 + 4 + 4 = 12**
5. (a) With a schematic labelling all parts, describe the structure of thin film solar cells. [[CO3](DEscribe/LOCQ)]  
 (b) With schematic labelling all parts, describe the p-i-n concept in amorphous silicon solar cells. [[CO3](Describe/HOCQ)]  
**6 + 6 = 12**

### Group - D

6. (a) Briefly describe the importance of nacelle in wind turbine. [[CO4](Remember/LOCQ)]  
 (b) Suggest the mitigation strategies for corrosion of wind turbine. [[CO4](Evaluate/HOCQ)]  
**6 + 6 = 12**
7. (a) Briefly describe (i) yield strength, (ii) ultimate strength from stress-strain diagram for ductile materials. [[CO1](Remember/LOCQ)]  
 (b) Write brief notes on:  
 (i) Poisson's ratio, (ii) Fatigue. [[CO1](Remember/LOCQ)]  
**(3 + 3) + (3 + 3) = 12**

### Group - E

8. (a) State Bragg's Law explaining all terms in it through a sketch of the incident electromagnetic waves. [[CO2](Remember/LOCQ)]  
 (b) State the primary components of the X-ray diffractometer and explain their usage. [[CO2](Describe/LOCQ)]  
 (c) State two types of sample characterizations done with X-ray diffraction. [[CO2](Describe/LOCQ)]  
**4 + 6 + 2 = 12**
9. (a) What sample information is provided in characterization done with UV-Vis spectrometer? [[CO2](Analyse/IOCQ)]  
 (b) Explain the working principle of the UV-Vis spectrometer with a schematic. [[CO2](Apply/IOCQ)]  
 (c) State two shortcomings of a UV-VIS spectrometer. (CO2)(Remember/LOCQ)]  
**3 + 6 + 3 = 12**

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	49	38.5	12.5

**Course Outcomes (CO):**

Upon completion of the course, students will be able to:

1. Familiarize with the properties of different materials- metals and nonmetals.
2. Understand the manufacturing process of nano-material and its characterizations techniques.
3. Design photovoltaic material and its electronic properties for the solar energy application.
4. Understand the role of selection for the wind turbine material and it required properties.

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