APPLICATION OF GREEN ENERGY
(ECEN 4249)

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) Albedo is the
(a) Fraction of global radiation (b) Solar Constant
(c) Extra terrestrial irradiance (d) None of these

(ii) The following is the indirect method of solar energy utilization
(a) Wind energy (b) Wave energy
(c) Bio-mass energy (d) All of above.

(iii) Anti-reflective coatings are applied to the surface of solar cell
(a) to increase the temperature (b) to increase the efficiency
(c) to minimize the absorptance (d) none of these.

(iv) Dye-sensitized solar cells are made of _____ organic dye.
(a) Ruthium melallo (b) Aniline
(c) Safranine (d) Induline

(v) The zenith angle is the angle made by the sun's ray with the _____ to a _____ surface.
(a) normal, horizontal (b) tangent, horizontal
(c) normal, vertical (d) none of the above

(vi) The radiation intensity on the surface of the sun is approximately
(a) 6.33×10^7 W/m^2 (b) 13.53×10^5 W/m^2
(c) 7.53×10^5 W/m^2 (d) 8.5×10^5 W/m^2

(vii) Most efficient solar cells are
(a) Dyesensitized solar cell (b) Amorphous silicon solar cell
(c) Mono-crystalline solar cell (d) Polycrystalline solar cell.

(viii) Output of wind turbine depends on air velocity
(a) cubically (b) proportionally
(c) exponentially (d) to the power of four.

(ix) Perovskite materials are used to fabricate the solar cell because
(a) abundant in nature (b) more band gap
(c) conductivity is more (d) all are correct.

(x) Which of the following is not renewable energy source?
(a) Hydropower (b) Tidal power
(c) Geothermal power (d) Fuel cell.

Fill in the blanks with the correct word

(xi) The negative side of the solar cells usually faces the _____.

(xii) Open circuit voltage of solar cell reduces by _____ for every one degree rise in temperature.

(xiii) A solar cell converts light energy into _____.

(xiv) Series and parallel combination of the solar cell is known as _____.

(xv) Full form of FF in the solar field is _____.

Group - B

2. (a) Define renewable energy resources. *[(CO1)(Remember/LOCQ)]*
(b) Explain the reasons, why wind mills are more popular as alternative energy sources? Derive the relationship between the power delivered and the wind speed? *[(CO2)(Understand/LOCQ)]*
(c) If a 6m diameter wind rotor is rotating at 20 rpm, and the wind speed is 4m/s, evaluate the tip speed ratio of the rotor. *[(CO2)(Evaluate/HOCQ)]*

2 + (4 + 3) + 3 = 12

3. (a) What is Fuel cell? Discuss the difference between a fuel cell and a battery? *[(CO1)(Understand/LOCQ)]*
(b) Discuss the classification of different green energy sources. *[(CO2)(Remember/LOCQ)]*
(c) The effective head of water in a Pelton wheel is 40m from foreby to the turbinerunner. Calculate the velocity of water in the jet and the associated energy per second. *[(CO2)(Evaluate/HOCQ)]*

4 + 4 + 4 = 12

Group - C

4. (a) What is Global Radiation? How you can estimate the Global radiation? *[(CO3)(Remember/LOCQ)]*
(b) What does it mean the “air mass ratio”? Compare beam radiation and total solar radiation in connection of solar energy source. *[(CO3)(Understand/LOCQ)]*
(c) For a city located at 80.50 longitudes, Calculate the solar time on March 15, 2017 at 10.30 am Indian standard time. *[(CO3)(Evaluate/HOCQ)]*

4 + 4 + 4 = 12

5. (a) Calculate the declination angle, hour angle and zenith angle of the sun at Lucknow (26.75N) at 9.30 am on February 16, 2016. *[(CO3)(Evaluate/HOCQ)]*

(b) Explain the principle of operation of flat plate type collectors. *[(CO3)(Analyze/IOCQ)]*

(c) Define the following terms: solar constant, collector efficiency. *[(CO3)(Remember/LOCQ)]*

5 + 4 + 3 = 12

Group - D

6. (a) Describe the key semiconductor materials commonly used in the fabrication of solar cells. Discuss their essential properties that make them suitable for solar energy conversion applications. *[(CO4)(Remember/LOCQ)]*

(b) Explain the band structure of semiconductor materials and its relevance to solar cell operation. *[(CO4)(Apply/HOCQ)]*

(c) Explain how doping affects the electrical properties and performance of solar cell devices. *[(CO4)(Apply/HOCQ)]*

(2 + 4) + 3 + 3 = 12

7. (a) Analyze the mechanisms of charge carrier generation, separation, and collection in solar cells. *[(CO4)(Analyse/IOCQ)]*

(b) Describe the structure and properties of carbon nanotubes (CNTs) and their potential applications in solar cells. Discuss the advantages and challenges associated with incorporating CNTs into photovoltaic devices. *[(CO4)(Remember/LOCQ)]*

5 + (3 + 4) = 12

Group - E

8. (a) Discuss the key design considerations and material combinations used in the construction of Tandem Solar Cells. Provide examples of successful Tandem Solar Cell technologies and their applications. *[(CO6)(Apply/IOCQ)]*

(b) Elaborate on the operating mechanisms and unique features of Heterojunction with Intrinsic Thin-layer (HIT) Solar Cells. *[(CO6)(Remember/LOCQ)]*

7 + 5 = 12

9. (a) Discuss the fundamental principles and applications of key fabrication techniques employed in solar cell manufacturing: Sputtering, Physical Vapor Deposition (PVD), Chemical Vapor Deposition (CVD), and Plasma-Enhanced Chemical Vapor Deposition (PECVD). *[(CO6)(Analyze/LOCQ)]*

(b) Illustrate the principles and operation of Dye-Sensitized Solar Cells (DSSCs). *[(CO6)(Remember/LOCQ)]*

8 + 4 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	60.4	16.7	22.9

Course Outcome (CO):

After the completion of the course students will be able to

1. Apply the previous knowledge gathered from the course on Environmental Studies.
2. Analyze and categorize the different environment friendly Green energy.
3. Evaluate and calculate the solar radiation and designing of solar thermal collectors.
4. Analyze and design of different type of solar cells and array.
5. Categorize the different type of PV Plant.
6. Understand and identify the different fabrication techniques pertaining to solar cell fabrication.

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