

INTRODUCTION TO SOLAR AND WIND TECHNOLOGY (CHEN 4222)

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) The SI unit of Stefan-Boltzmann constant in the Stefan-Boltzmann radiation heat transfer law _____.
 - (a) $\text{Wm}^{-1}\text{K}^{-4}$
 - (b) Wm^{-2}K^4
 - (c) Wm^{-1}K^4
 - (d) $\text{Wm}^{-2}\text{K}^{-4}$
- (ii) Identify the type of light not obtainable in Earth's surface as it is entirely absorbed by Ozone layer
 - (a) Visible light
 - (b) Radio waves and infrared
 - (c) X-ray and Gamma ray
 - (d) Ultraviolet C
- (iii) Solar energy in percentage out of total installed renewable energy capacity in India _____.
 - (a) 7%
 - (b) 15%
 - (c) 30%
 - (d) 60%
- (iv) Aperture area of a solar collector is roughly equal to _____.
 - (a) coolant area
 - (b) absorber area
 - (c) generator area
 - (d) system area
- (v) A typical output of a solar cell is _____.
 - (a) 0.13V
 - (b) 0.26V
 - (c) 0.39V
 - (d) 0.5V
- (vi) The tip speed ratio is ratio of
 - (a) Power developed to rotor torque
 - (b) Power coefficient to torque coefficient
 - (c) Torque coefficient to power coefficient
 - (d) Square of power coefficient to square of torque coefficient
- (vii) With the introduction of carbon percentage in blade material construction the weight increase is proportion to the _____, where 'L' is the length of the blade.
 - (a) $L^{3.52}$
 - (b) $L^{2.53}$
 - (c) $L^{2.35}$
 - (d) $L^{3.25}$

- (viii) For wind turbine bearing with maximum contamination of the lubricant the contamination factor is close to _____.
 (a) 1 (b) 1.5
 (c) 2 (d) 0
- (ix) Slip in induction generator will be _____.
 (a) 1 (b) 0
 (c) in between 0 and (d) negative
- (x) Which of the following element is used to make solar cell?
 (a) Silver (b) Gold
 (c) Platinum (d) Silicon

Fill in the blanks with the correct word

- (xi) A black surface has emissivity equal to _____.
- (xii) The _____ is the total quantity of solar energy per unit of time at the averaged Earth–sun distance, reached by a unit of area of a surface perpendicular to the sun’s rays (the normal sun direction) outside the atmosphere of earth.
- (xiii) A solar cell has a lifespan of _____ year.
- (xiv) Mathematical expression for circulation is given by _____.
- (xv) Carbon in the wind turbine blade material reduces its _____ possibility.

Group - B

2. (a) State and explain the following laws relating thermal radiation and temperature of a radiating body: Plank’s distribution law; Stefan Boltzman law and Wien’s displacement law. [[CO1](Understand/LOCQ)]
- (b) Determine net radiation heat exchange per square meter area for two infinite parallel plates held at temperature of 850 K and 450 K respectively. Take the emissivity 0.6 for hot plate and 0.3 for the cold plate. [[CO1](Apply/IOCQ)]
6 + 6 = 12
3. (a) A flat plate solar collector facing due south is placed with an 15° angle of inclination on a horizontal surface. The collector is located at a latitude 15°N. Assuming a ground reflectivity of 0.25 determine the tilt factors for beam radiation, diffuse radiation and reflected radiation on 15th May, 2025 at 11 am solar time. [[CO1](Evaluate/HOCQ)]
- (b) Discuss the method of predicting monthly average daily total solar radiation flux on an inclined surface at any given location on earth if monthly average daily extra-terrestrial radiation on a horizontal surface of the location is provided to you. [[CO1](Analyse/IOCQ)]
6 + 6 = 12

Group - C

4. (a) Discuss what are the factors that affects the solar cell performance and how to improve solar cell performance. [[CO2](Remember/LOCQ)]
(b) A single solar cell on illumination by insolation of about 800 W/m^2 produces a voltage of 0.5 V and a current up to 2.0 A. The efficiency of the solar cell is 12%. Calculate the area of the solar cell. [[CO4](Apply/IOCQ)]
6 + 6 = 12
5. (a) Write a short notes on the operation of a Pyranometer. [[CO2](Understand/LOCQ)]
(b) Discuss the construction details of solar cell with schematic diagram. What is leakage current of solar cell. [[CO4](Remember/LOCQ)]
6 + (4 + 2) = 12

Group - D

6. (a) What are the regimes can be identified around an airflow at different wind velocity? Elaborate on the regimes. [[CO3](Remember/LOCQ)]
(b) With a proper vector diagram show that the resultant velocity with which the wind turbine blade rotates is $\Omega r + \frac{\omega}{2}r$, where Ω is the blade velocity, ω is the wind (wake) velocity adhered to the surface of the blade and r is the radius of the rotor. [[CO3](Analyse/HOCQ)]
(3 + 6) + 3 = 12
7. (a) Discuss the working principle of a cup anemometer with a diagram. [[CO4](Remember/LOCQ)]
(b) Derive the expression for maximum power produced by a wind turbine using axial momentum theory. [[CO4](Apply/HOCQ)]
5 + 7 = 12

Group - E

8. (a) A wind turbine operates 24 h for 365 days and delivers energy 3,942,000 kWh. The power rating is 1,500 kW. Calculate the capacity factor for the turbine. [[CO4](Apply/IOCQ)]
(b) Show different components of wind electric generator with a neat sketch. [[CO4](Remember/LOCQ)]
(c) Classify different types of wind tower. [[CO4](Remember/LOCQ)]
3 + 7 + 2 = 12
9. (a) Distinguish between synchronous and asynchronous generators. [[CO4](Understand/LOCQ)]
(b) Distinguish between fixed and variable speed wind turbines. Discuss the different components of a wind turbine. [[CO4](Analyse/IOCQ)]
4 + (4 + 4) = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	53.12	30.21	16.67