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Name of the Program: B.Sc. Engg. (EE)
Semester: 6th Sem.

Date: 17th February, 2023
Time: 10:00 am – 11:30 am

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Mid-Semester Examination
Course Number: EEE 4631
Course Title: Renewable Energy System

Summer Semester : 2021 - 2022
Full Marks: 75
Time : 90 minutes

There are **4 (four)** questions. Questions 1 and 2 are **compulsory**. Answer **any one** between questions 3 and 4. The symbols have their usual meanings. Marks of each question and corresponding CO and PO are written in the brackets. Assume any reasonable value for missing data (if any).

1.a) Assume a photovoltaic module is installed on March 1 in Tucson (latitude 32.1°) and optimized at solar noon. Find the change in the tilt angle if the time is changed to 3 PM (solar time). Figuratively justify your answer. **(15) (CO2) (PO2)**

b) Consider a *p–n* junction diode at 20°C with a reverse saturation current of 10^{-9} A. Find the voltage drop across the diode when it is carrying the following: **(10) (CO2) (PO2)**

i. no current (open-circuit voltage)
ii. 1 A
iii. 10 A

Given, charge of an electron is 1.602×10^{-19} C and Boltzmann's constant is 1.381×10^{-23} J/K.

2.a) Find the altitude angle and azimuth angle for the sun at 1 PM solar time at IUT, Bangladesh (latitude 23.71°) on the winter solstice. Graphically represent the azimuth angle. **(15) (CO2) (PO2)**

b) Consider a 100-cm^2 photovoltaic cell with reverse saturation current $I_0 = 10^{-12}$ A/cm^2. In full sun, it produces a short-circuit current of 40 mA/cm^2 at 25°C. Find the open-circuit voltage at full sun and again for 50% sunlight. Plot the results. **(10) (CO2) (PO2)**

3.a) Compare the 47° latitude, clear-sky insolation on a collector at solar noon on the summer solstice for a two-axis tracking mount versus a single-axis polar mount. Ignore ground reflectance. **(15) (CO2) (PO2)**

b) Show the modifications needed for finding the effective tilt angle for: **(06) (CO1) (PO1)**

i. One-axis polar mount
ii. Two-axis tracking

c) Explain the significance of Equation of time. **(04) (CO1) (PO1)**

4.a) Explain the following with proper diagrams: **(10) (CO1) (PO1)**

- **i.** Azimuth angle
- **ii.** Altitude angle
- **iii.** Solar declination
- **iv.** Hour angle

b) Find the direct beam solar radiation normal to the sun's rays at solar noon on a clear day at IUT (latitude 23.71°) on May 21. Also find the beam insolation at that time on a collector that faces 20° toward the southeast if it is tipped up at a 52° angle. **(15) (CO2) (PO2)**

Supplementary information:

$$d = 1.5\times10^{8}\left\{1+0.017\sin\left[\frac{360(n-93)}{365}\right]\right\}\ km$$

$$I_0 = SC.\left[1+0.034\cos\left(\frac{360n}{365}\right)\right]\ W/m^2$$

$$A = 1160+75\sin\left[\frac{360}{365}(n-275)\right]\ W/m^2$$

$$k = 0.174+0.035\sin\left[\frac{350}{365}(n-100)\right]$$

$$C = 0.095+0.04\sin\left[\frac{360}{365}(n-100)\right]$$