

**071306T4EEN**

**ELECTRICAL ENGINEERING (POWER OPTION)**

**LEVEL 6 ENG/OS/PO/CR/06/6**

**INSTALL SOLAR**

**SYSTEM July/August**

**2024**



**Time: 3 Hours**

**TVET CURRICULUM DEVELOPMENT, ASSESSMENT AND CERTIFICATION**

**COUNCIL (TVET CDACC)**

**3 HOURS**

**answers**

**SECTION A: (40 Marks)**

**1. I-V Curve for a Shaded PV Module:**

- The I-V curve will show a reduced short-circuit current due to the shaded cell. The curve will flatten out earlier than expected, indicating the effect of the bypass diodes. The curve will have a knee where the voltage drops significantly after the shaded cell.

**2. Applications of Solar Energy:**

- Solar water heating.
- Solar electricity generation (PV systems).
- Solar cooking.
- Solar-powered ventilation systems.

**3. I-V Curve Parameters from Figure 2:**

- **Short Circuit Current ( $I_{sc}$ ):** The current at zero voltage (the maximum current).

- **Voltage at Maximum Power ( $V_{mp}$ ):** The voltage at which the product of current and voltage is maximized.
  - **Maximum Power ( $P_{max}$ ):** The product of  $V_{mp}$  and  $I_{sc}$ .
4. **Safety Measures for Installing Grid-Tied Solar PV Systems:**
    - Use of personal protective equipment (PPE).
    - Ensuring proper grounding of the system.
  5. **Tests Conducted on a Grid-Tied Solar PV System:**
    - Voltage and current measurements at the output.
    - Insulation resistance testing.
    - Functionality tests of the inverter.
  6. **Final Circuits in a Grid-Tied Solar PV System:**
    - AC output circuit.
    - DC input circuit from the solar panels.
    - Battery charging circuit (if applicable).
  7. **Advantages of Polycrystalline Solar Modules:**
    - Lower manufacturing cost compared to monocrystalline.
    - Good performance in high temperatures.
    - Less waste during production.
  8. **Factors to Consider When Choosing a Mounting Site:**
    - Sunlight exposure (avoid shading).
    - Orientation and tilt angle.
    - Structural integrity of the mounting surface.
    - Accessibility for maintenance.
  9. **Components of a Site Safety Plan:**
    - Hazard identification and risk assessment.
    - Emergency response plan.
    - Training and certification requirements.
    - Personal protective equipment (PPE) requirements.
    - Site access control measures.
  10. **Composition of Electrolyte in Lead Acid Batteries:**
    - A mixture of sulfuric acid ( $H_2SO_4$ ) and distilled water.

**11. Manufacturing of Amorphous Silicon Solar Cells:**

- Amorphous silicon solar cells are made by depositing a thin layer of silicon on a substrate using a chemical vapor deposition (CVD) process.

**12. Dangers Associated with Lead Disposal:**

- Soil contamination leading to toxic exposure.
- Water pollution affecting local ecosystems.

**SECTION B: (60 Marks)**

**13. a) Wiring Diagram of a Simple Single-Phase AC Grid-Tied Solar PV System:**

- (You will need to create a diagram showing solar panels, inverter, grid connection, and load.)

**b) Components of the System:**

- Solar panels.
- Inverter.
- Charge controller (if applicable).
- AC disconnect switch.
- DC disconnect switch.
- Circuit breakers.
- Metering equipment.
- Mounting structure.
- Wiring and connectors.
- Grounding equipment.

**14. a) Start-Up Procedures During Grid-Tied Solar PV Installation:**

- Ensure all components are properly installed and connected.
- Check for any visible damage to components.
- Verify electrical connections and tighten as necessary.
- Power on the inverter and check for proper operation.
- Monitor system performance and ensure it is grid-tied correctly.

**b) Benefits of Licensing a Solar PV Installer:**

- Assurance of quality workmanship.
- Compliance with local regulations and codes.
- Enhanced credibility with clients.
- Access to ongoing training and resources.

15. a) i. **Potential Issues Without a Charge Controller:**

- Overcharging of batteries.
- Deep discharge leading to battery damage.
- Reduced lifespan of the batteries.
- System inefficiency.

ii. **Effect of Temperature on Solar PV Output:**

- Higher temperatures generally reduce the output voltage of solar PV modules.

b) **Procedure to Verify Current and Voltage:**

- Use a multimeter to measure voltage across the solar panels and inverter outputs.
- Measure current using a clamp meter on the output circuits.
- Compare measurements with expected values from specifications.

c) **Difference Between String and Array:**

- **String:** A series of solar panels connected in series.
- **Array:** A collection of one or more strings of solar panels.

16. a) **Balance of System (BOS) Components:**

- Inverters.
- Charge controllers.
- Mounting hardware.
- Wiring and connectors.
- Safety equipment (e.g., fuses, breakers).

b) **Single Line Diagram for a Grid Tie Hybrid System:**

- (You will need to draw a diagram including solar PV, wind power, inverter, grid connection, and load.)

c) **Commissioning Procedures:** (This part seems incomplete; please provide more context or specific details you need for this section.)