**Solar Electric Technician Training**

**Module 3: Measurement of electrical and solar parameter**

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| **Objectives:** By the end of this session, learners will be able to:   * Measure resistance. * Measure voltage. * Measure current. * Measure power. * Connect circuits in series and parallel. * Test diodes. * Perform continuity test. * Measure earth resistance. * Determine solar radiation with online data. * Identify, differentiate, and comprehend single phase and 3-phase systems. | **Instructor:** *[Name]* |
| **Session duration:**   * 8 hours (Theory) * 16 hours (Practical) |

| **Trainers' activities** | **Learners’ activities** | **Teaching aids** | **Time** |
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| Session kick-off: Start the session by briefly explaining session agenda and objectives.  Ask questions:   * What kind of bulb we use for circuits? * How much current is flowing in the circuit? | * Listen to the session objectives and agenda. * Note it down if required. * Voluntarily answer the questions. |  | 10’ |
| Give **illustrated talk on Ohm’s law by explaining**   * Fundamental principle and relationship between voltage, current, resistance and power. | * Participate in the discussion. | * Presentation slides of Module 3 in media folder. |
| Give illustrated talk on **tools and equipment:**   * Define & explain multi-meter and clamp-meter including its functions and setting parameters. | * Participate in the discussion. * Complete assigned assignment (E1) | * Assignment (E1) | 30’ |
| **Demonstrate parameter settings of tools and equipment:**  Explain do’s and don’ts. | * Participants to perform tasks as per instructions provided. |

| **Trainer’s activities** | **Learners’ activities** | **Teaching aids** | **Time** |
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| **Measurement of resistance** | | | **110’** |
| Give **illustrated talk** on resistance:   * Explain fundamental concept and unit of resistance. | * Participate in the discussion. | * Presentation slides of Module 3 in media folder. | 10’ |
| **Demonstrate** measurement of resistance.   * Procedures. * Sample measurement using multimeter. | * Observe and discuss measurement. * Complete assignment. | * Multimeter * Resistor with different values * Resistor colour code chart * Load (lightbulb) * Assignment (E2) | 40’ |
| **Assign** assignment to measure resistance. | * Participants perform the given task. | 60’ |
| **Measurement of voltage** | | | **140’** |
| Give **illustrated talk** on voltage:   * Explain fundamental concept, units, AC and DC voltage. * Single and three phase voltage. | * Participate in the discussion. | * Presentation slides of Module 3 in media folder. | 60’ |
| **Demonstrate** measurement of voltage.   * Measure voltage using multimeter for DC source (PV module, batteries). * Measure voltage using multimeter for AC source (NEA line). | * Participants in the observation and discussion. | * Multimeter * Load (AC or DC) * Assignment (E3) | 20’ |
| **Assign** assignment to measure voltage. | * Participants to perform the measurement task. | 60’ |
| **Measurement of current** | | | **140’** |
| Give **illustrated talk** on current:   * Explain fundamental concept and units. * AC and DC current. * Single and three phase current. | * Participate in the discussion. | * Presentation slides of Module 3 in media folder. | 60’ |
| **Demonstrate** measurement of current:  Using multimeter/clamp meter. | * Participants to observe and discuss measurement. | Multimeter, Clamp meter, Load (AC or DC), Assignment (E4) | 20’ |
| **Assign** assignment to perform a measurement of current. | * Participants perform the given task. | 60’ |
| **Measurement of power** | | | **140’** |
| Give **illustrated talk** on power:   * Fundamental concept * Unit of power * AC and DC power * Single and three phase power | * Participate in the discussion. | * Presentation slides of Module 3 in media folder. | 60’ |
| **Demonstrate** on measurement of power.   * Load circuit diagram * Measure power using multimeter. | * Participants to observe and take part in discussion. | * Multimeter * Clamp meter * Load (AC or DC) * Assignment (E5) | 20’ |
| **Assign** assignment to measure power. | * Participants perform the given task. | 60’ |
| **Connect circuits in series and parallel** | | | **180’** |
| **Series connection** | | | |
| Ask questions   * What happens to a string of Christmas lights if one bulb goes out? * **Series circuit lights**: In a series circuit, If one bulb in a string of Christmas lights (such as older or cheaper) fails, the entire string will go out because the circuit is broken or interrupted. | * Participate in the discussion. | * Presentation slides of Module 3 in media folder. | 30’ |
| **Demonstrate**   * A sample series circuit diagram. * Explain what happens to the current in a series circuit when more bulbs are added?   Ask questions   * What happens if one component fails in a series circuit? * How is the voltage divided in a series circuit? * What happens to the current in a series circuit? * Can you add more components to a series circuit? | * Participants to observe and discuss the demonstration. | * Wire, switches, power supply, load, other necessary materials to conduct practical. * Sample circuit connection. | 20’ |
| **Assign** assignment to perform series circuit connection. | * Participants to complete the assigned task of creating series circuit connection. | * Assignment (E6) | 40’ |
| **Parallel connection** | | | |
| Ask question   * In a series circuit, when one bulb goes out, the entire string of Christmas lights will go out because the circuit is broken. How does this differ in a parallel circuit? | * Participate in the discussion. | * Presentation slides of Module 3 in media folder. | 30’ |
| **Demonstrate**   * Show a sample parallel circuit diagram. * Explain what happens to the current in a parallel circuit if more bulbs are added?   Ask question   * What happens if one component fails in a parallel circuit? * How does the voltage get divided in a parallel circuit? * What happens to the current in a parallel circuit? * Can you add more components to a parallel circuit? | * Participants to the observe and participate in discussion. | * Wire, switches, power supply, load, other necessary materials to conduct practical. * Sample circuit connection. | 20’ |
| **Assign** assignment to perform parallel connection. | * Participants perform the given task. | * Assignment (E7) | 40’ |
| **Test diodes** | | | **120’** |
| Give **illustrated talk** on:   * What is diode? * Function of diode. * Importance of diode. * Why it is important to test diodes of the circuit? | * Participate in the discussion. | * Presentation slides of Module 3 in media folder. | 20’ |
| **Demonstrate** the sample testing of diode. | * Observe the demonstration and participate in discussion. | * Diodes, wires, other necessary tools and materials | 40’ |
| **Assign** assignment to perform parallel connection. | * Participants perform the given task. | * Assignment (E7) | 60’ |
| **Perform continuity test** | | | **120’** |
| Ask question:   * Why is continuity test conducted? * How the test performed? | * Participate in the discussion. | * Presentation slides of Module 3 in media folder or meta cards. | 15’ |
| Give **illustrated talk on:**   * Brief steps to perform the continuity test. | * Participants in the discussion. |  | 15’ |
| **Demonstrate** a sample continuity test. | * Observe the demonstration and participate in discussion. |  | 30’ |
| **Assign** assignment to perform continuity test. | Participants perform the given task. | * Assignment (E8) | 60’ |
| **Measure earth resistance** | | | **150’** |
| Give **illustrated talk** on measurement of earth resistance by covering:   * What is earth resistance? * How is it measured? * What are the necessary tools required to measure it? * Brief steps to measure earth resistance**.** * Safety measures to apply. | * Participate in the discussion. | * Presentation slides of Module 3 in media folder. | 30’ |
| **Demonstrate** a sample measurement of earth resistance. | * Observe the demonstration and participate in discussion. |  | 30’ |
| **Assign** assignment to perform earth resistance measurement. | * Participants perform the given task. | * Assignment (E9) | 90’ |

| **Trainer’s activities** | **Learners’ activities** | **Teaching aids** | **Time** | |
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| **Determine solar radiation with online data** | | | **120’** | |
| Explain the concept of solar radiation and its significance in solar PV systems. | * Listen to the explanation and take notes. | * Whiteboard, markers, projector | 20' | |
| **Retrieving solar radiation data by**:  Introducing various online platforms and tools for accessing solar radiation data. | * Explore the recommended online tools and familiarize themselves with the interfaces. | * Computer with internet access, projector. | 15' | |
| **Demonstrate:**  How to access and retrieve solar radiation data from a selected online platform (e.g., PVGIS, NASA POWER, or Metronome). | * Follow the trainer to access solar radiation data for specific locations. | * Computer with internet access, projector. | 20' | |
| Guide learners through a practical exercise on how to input location details (e.g., Kathmandu, Pokhara, Biratnagar) and retrieve data.  How to record key metrics (average daily solar radiation, peak sunlight hours). | * Access the online tools, retrieve data for specified locations, and record the findings. * Retrieve and download solar radiation data for specified locations. * Record the findings | * Computer with internet access, projector. * Assignment (E10) | 25' |
| Explain how to Interpret the retrieved solar radiation data and its implications for solar PV system design. | * Analyse the data and discuss how it affects system sizing and performance. | * Computer with internet access, projector. | 20' |
| Demonstrate how the retrieved data can be applied to the design of a solar PV system. | * Use the data to make informed decisions about the sizing and placement of PV modules | * Computer with internet access, projector. | 20' | |
| Facilitate a discussion on the importance of accurate solar radiation data and answer questions. | * Participate in discussion, ask questions and clarify any doubts. | * Whiteboard and markers. | 20 | |
| **Identify, differentiate, and comprehend single and three-phase systems** | | | **180’** | |
| Explain the fundamental concepts of single-phase and three-phase systems. | * Listen to the explanation and take notes. | * Whiteboard, markers, circuit diagrams | 20' | |
| Show actual single-phase and three-phase setups for visual identification of system. | * Observe and identify key components of single and three-phase systems. | * Single-phase and three-phase setups, circuit boards | 20' | |
| Demonstrate wiring connections for both systems and assign participants an assignment related to this | * Observe load distribution and attempt to balance loads across phases. | * Wires, connectors, circuit boards, multi meters (E11) | 40' | |
| Explain the importance of load balancing in three-phase systems with the help of the assignment/exercise. | * Observe load distribution and attempt to balance loads across phases. | * Observe load distribution and attempt to balance loads across phases (E12) | 30' | |
| Guide learners to differentiate between the systems based on practical setups. | * Compare the efficiency and power output of both systems. | * Compare the efficiency and power output of both systems. | 30' | |
| Introduce common issues in both systems and demonstrate troubleshooting. | * Identify and troubleshoot problems in both single and three-phase systems. | * Identify and troubleshoot problems in both single and three-phase systems. | 30' | |
| Recap key points and address any questions. | * Participate in discussion and ask questions. | * Whiteboard, markers | 10' | |
| **Total time** | | | **1440’** | |