SunEnergyEdu — Student Laboratory Experiment

An Exploration of Solar Energy and Power Conversion

Overview

This laboratory introduces students to the SunEnergyEdu platform—a mobile, dual-axis solar tracking system integrated with power electronics, sensing, and a graphical user interface (GUI). Students will install the software environment, wire and test the hardware, measure solar panel characteristics under varying conditions, and analyze the effect of tracking on power generation and battery charging.

Task 1 — Software Setup

Objective: Install and run the software required to interface with the SunEnergyEdu controller.

1. Install the following tools on your PC:
    a. Arduino IDE
    b. PyCharm (or any Python-supported IDE)
2. Open and verify the front-end GUI and back-end control software.
3. Connect the PC to the controller and ensure that GUI displays live data and commands actuate the motors or sensors.

Task 2 — Hardware Wiring

Objective: Assemble and verify the electrical connections for the power and signal circuits.

- Equipment:
- SunEnergy solar module
- NIBB (Non-Inverted Buck-Boost) DC–DC converter
- Breadboard, jumper wires, banana cables
- Measurement equipment

Steps:

1. Wire the power circuit using banana cables.
2. Connect the signal and sensor lines on the breadboard using jumper wires.
3. Inspect connections and verify measurements on the GUI.

Task 3 — Solar Panel I–V and P–V Characteristics

Objective: Measure power generated by the solar panel at various operating voltages.

Steps:

1. Connect PC to controller and open GUI.
2. Adjust the NIBB converter to test voltages: 10V, 12V, 14V, 16V, 18V, 20V, 22V, 24V.
3. Record voltage, current, and power.
4. Create I–V and P–V plots.
5. Identify the maximum power point (MPP).

Task 4 — Effect of Rotation and Tilt

Objective: Quantify how orientation affects power generation.

Steps:

1. Enable dual-axis tracker.
2. Log data with Plot button.
3. Adjust tilt/rotation manually (+10, -10, +20, -20, etc.).
4. Record power levels.
5. Compare with tracker's optimum settings.

Sun Position Data Table Example:

Time | Rotation | Tilt

07:00 | 20 | 80

08:00 | 30 | 70

...

18:00 | 150 | 70

19:00 | 160 | 80

Task 5 — Battery Charging Time

Objective: Estimate battery charging duration and determine battery capacity.

Steps:

1. Enable dual-axis tracker.
2. Record initial SOC.
3. Wait 15 minutes.
4. Record final SOC and average current.
5. Estimate charging time from 10% to 90% and battery capacity (Ah).

Deliverables

Students must submit a report including:

- Data tables
- I–V and P–V plots
- Angle vs. power graphs
- Comparison of tracking methods
- Battery charging estimation
- Discussion of accuracy and implications