SCHOOL OF ELECTRICAL ENGINEERING AND COMPUTER SCIENCES

___EE215 ELECTRONIC DEVICES AND CIRCUITS___

PROJECT REPORT

Battery Charger with Overcharge Protection Circuit

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Battery Overcharge Protection Circuit:

1. Introduction:

With the widespread use of rechargeable batteries in portable electronics, ensuring safe and efficient charging has become essential. Overcharging a battery can result in overheating, reduced lifespan, or even hazardous failure. This project presents a **Battery Overcharge Protection Circuit** designed to automatically stop charging once the battery reaches a safe voltage limit. The circuit is simple, cost-effective, and built using widely available components, making it ideal for small-scale battery-powered projects and educational purposes.

2. Problem Statement:

Many basic battery chargers continue supplying current even after the battery is fully charged. This leads to overcharging, which can damage the battery's internal chemistry and pose safety hazards such as swelling or fire. While commercial protection circuits exist, they are often expensive or unnecessarily complex for small projects. Hence, a **simple, affordable, and effective** solution is needed to safely disconnect the battery once it is fully charged.

3. Objectives:

- Design and simulate a basic overcharge protection circuit.
- Automatically disconnect the charger when the battery voltage exceeds a safe threshold (e.g., ~8.3V for simulation and 7.8 for hardware).
- Use a **transistor-relay** combination as a voltage-controlled switch.
- Include **LED indication** to show charging and cut-off status.
- Implement and simulate the design in **Proteus** for verification.

4. Methodology:

The project consists of a **DC power supply**, a **voltage sensing circuit**, a **relay-controlled switching mechanism**, and an **LED indicator**. The approach is divided into the following components:

A. AC to DC Conversion:

- A **step-down transformer (TR1)** converts 220V AC to ~12V AC.
- A **diode bridge rectifier (D6–D9)** converts AC to pulsating DC.

- A **filter capacitor (C1)** smooths the DC output.
- A **7809 voltage regulator (U1)** provides a stable 9V DC output to power the circuit.

B. Voltage Sensing and Switching Control:

- A **voltage divider** (R2 and R4) monitors battery voltage and applies a scaled version to the **base of the transistor (Q1 - BC547)**.
- When the battery voltage is **below threshold**, Q1 remains **OFF**, and the **normally closed relay contact (RL1)** allows current to flow for charging.
- When the battery voltage **exceeds threshold**, the base-emitter voltage turns Q1 **ON**, which energizes the **relay coil** and opens the circuit—**disconnecting the battery from the charger**.

C. LED Indicator:

- A **green LED (D4)**, with a current-limiting resistor (R3), lights up when the relay is active, signaling that charging has stopped.

D. Protection Diode:

- A **flyback diode (D3)** across the relay coil protects the transistor from voltage spikes due to inductive kickback when the relay turns off.

5. Resources:

Hardware Components:

- Step-down Transformer (TR1)
- Diodes: 1N4007 × 5 (D3–D9)
- Voltage Regulator: 7809 (U1)
- NPN Transistor: BC54 (Q1)
- Relay: 5V SPDT (RL1)
- Capacitor: 100 µF (C1)
- Resistors: R1–R4 (1kΩ and 10kΩ)
- LED: Green (D4)
- DC Voltage Source (simulating battery in Proteus)

Software:

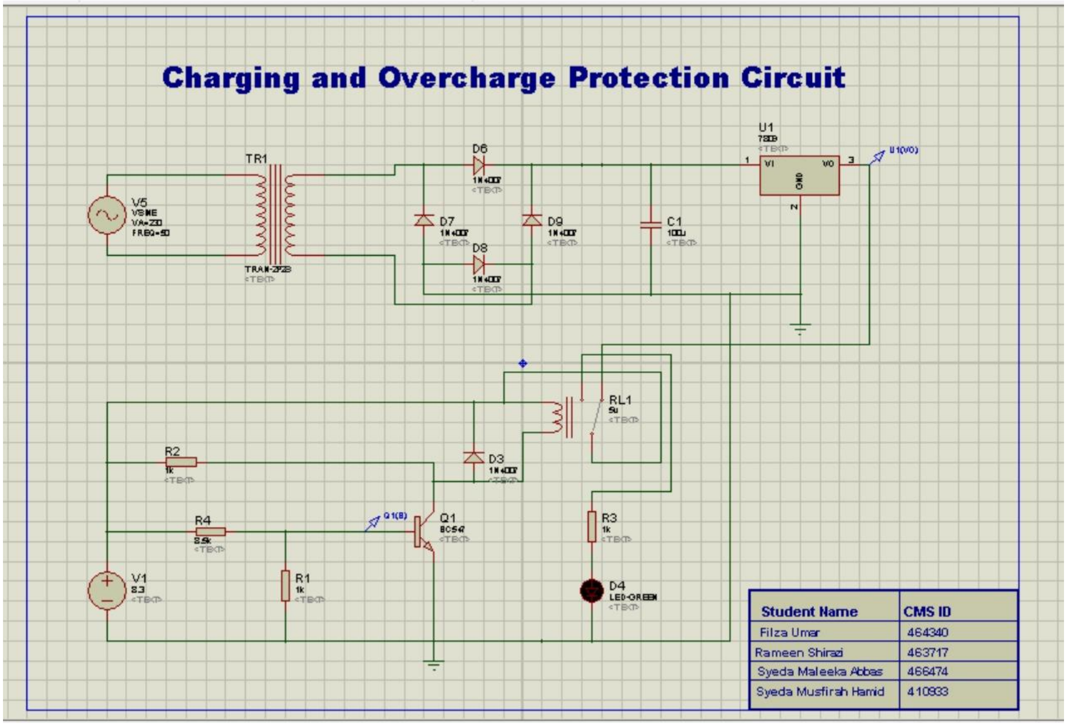
- Proteus Design Suite (for circuit design and simulation):

6. Results:

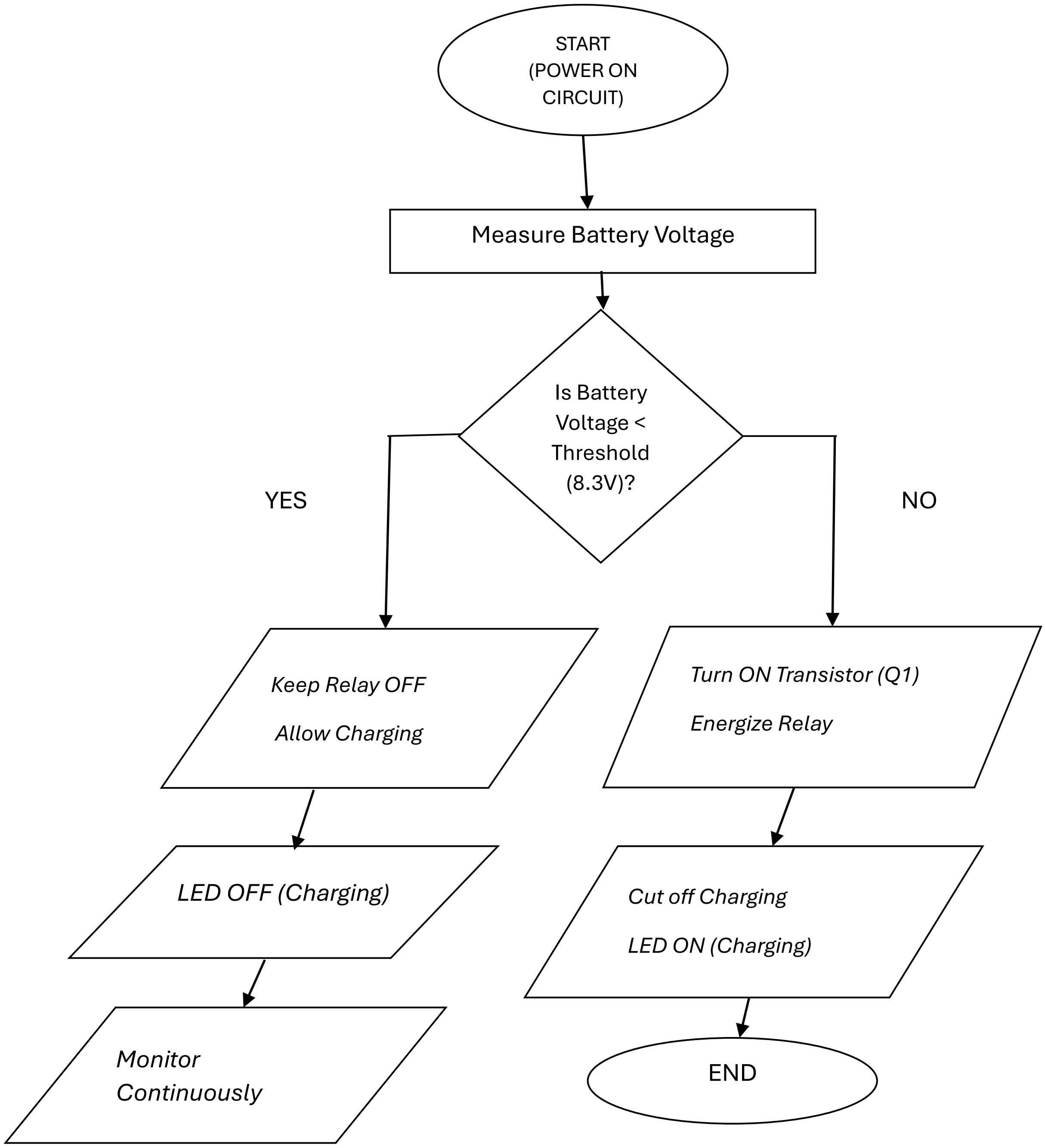
➢ **Simulation Behaviour (in Proteus):**

- When the battery voltage is **below 8.3V**, the relay remains in its default state (closed), allowing current to charge the battery.
- When the voltage **exceeds 8.3V**, the transistor turns **ON**, energizing the relay and **opening** the circuit, thereby stopping the charging.
- The **Red LED** turns **ON** to indicate the battery is fully charged and the charger has been disconnected.

This behaviour confirms the **correct operation** of the overcharge protection mechanism.



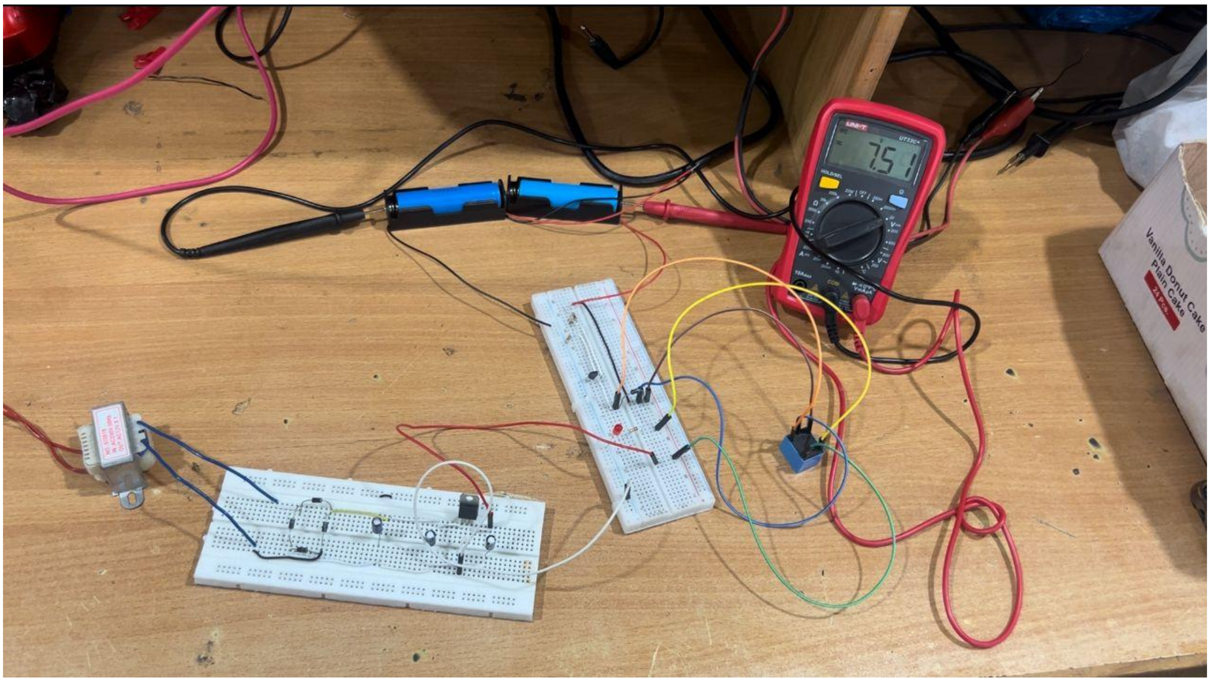
➢ **Flow chart:**


START
(POWER ON
CIRCUIT)
Measure Battery Voltage
Is Battery
Voltage <
Threshold
(8.3V)?
YES
NO
Keep Relay OFF
Allow Charging
Turn ON Transistor (Q1)
Energize Relay
LED OFF (Charging)
Cut off Charging
LED ON (Charging)
Monitor
Continuously
END

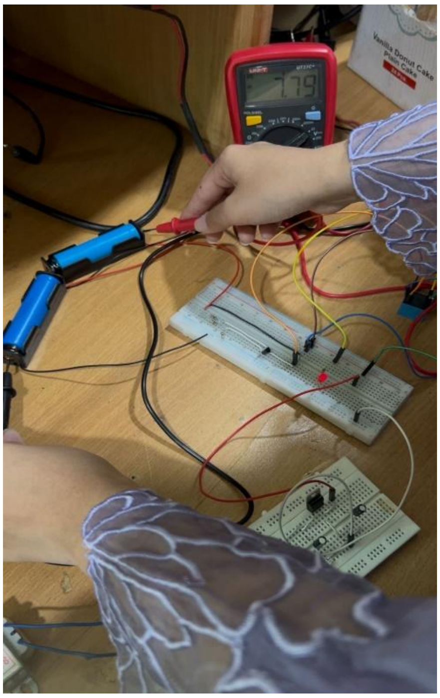
- **Hardware:**
  Due to difference of resistors used in the simulation and the hardware, in the hardware we used 1k and 10k ohm resistors making the threshold voltage to be 7.8V(7.79V to be exact). Hence the behaviour of the hardware is described as:
  - When the battery voltage is **below 7.8V**, the relay remains in its default state (closed), allowing current to charge the battery.
  - When the voltage **exceeds 7.8V**, the transistor turns **ON**, energizing the relay and **opening** the circuit, thereby stopping the charging.
  - The **red LED** turns **ON** to indicate the battery is fully charged and the charger has been disconnected.

This behaviour confirms the **correct operation** of the overcharge protection mechanism.

(Before charging-LED OFF)



(After charging-LED ON)



7. Conclusion:

This project successfully demonstrates a **low-cost, reliable battery overcharge protection circuit** using basic electronic components. The circuit efficiently detects when a battery reaches its maximum voltage and automatically disconnects the charger, protecting the battery from overcharging. The use of a transistor-relay system avoids the need for microcontrollers or advanced ICs, making it an ideal solution for student projects and DIY applications. Proteus simulations validate the circuit's effectiveness under various operating conditions.

8. References:

- **LM7809 Voltage Regulator Datasheet**
  https://pdf.datasheet.live/7cb7272b/fairchildsemi.com/LM7809.pdf

- **BC54 Transistor Datasheet**
  https://www.nexperia.com/product/BC54-10PA-Q

- **1N4007 Diode Datasheet**
  https://www.vishay.com/docs/88503/1n4001.pdf

- **Proteus Design Suite Documentation**
  https://www.labcenter.com/projectnotes/

- **Relay Protection Circuits – All About Circuits**
  https://www.allaboutcircuits.com/textbook/digital/chpt-5/protective-relays/

- **Basic Electronics Tutorials**
  https://www.electronics-tutorials.ws/