Arduino Multimeter Report

(Voltmeter, Ohmmeter, Ammeter, Capacitance meter)

الرقم الجامعي	الاسم
23010995	يوسف عزت رمضان احمد النمر
23010986	يوسف حمدي يس حسن عبدالمجيد
23010637	عمرو محمود موسى عبدالعال
23010573	عبدالله محمد اسماعيل الرويني

Electronics and Communication EEP 112 Electrical and Electronic Measurements

1. Introduction

This report presents a DIY Arduino-based multimeter capable of measuring current, voltage, resistance, and capacitance. It is intended for educational purposes, helping students and hobbyists understand basic electronics through hands-on practice.

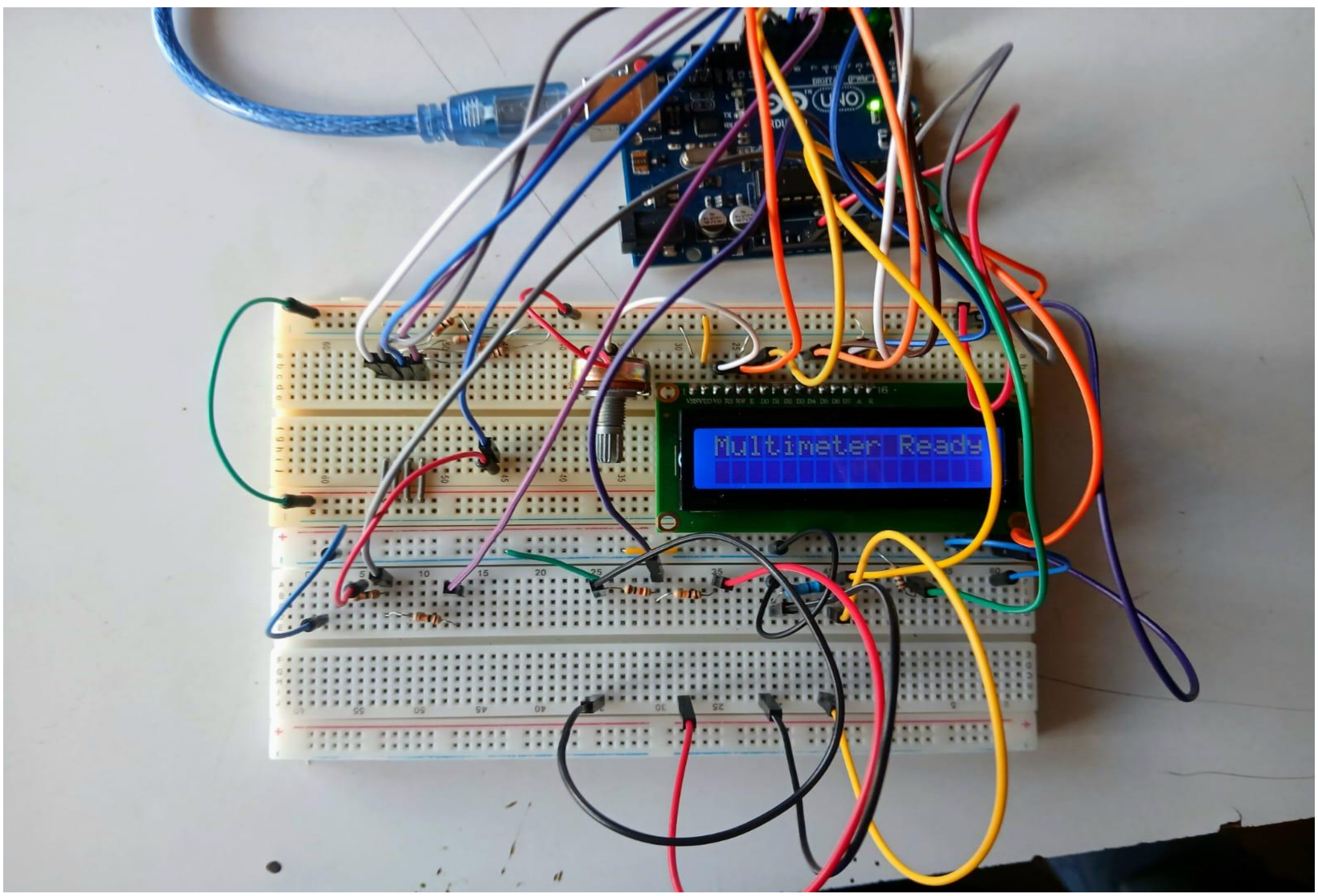
2. Project Overview

The Arduino Multimeter project aims to build a cost-effective, portable digital multimeter using an Arduino Uno and a 16x2 LCD screen. The device measures four electrical parameters:

- **Voltage**
- **Current**
- **Resistance**
- **Capacitance**

It uses a set of DIP switches to select the measurement mode and displays the result on the LCD. The project is ideal for educational purposes, electronics labs, or as a DIY tool for hobbyists.

By integrating analog reading, digital control, and fundamental circuit laws (Ohm's law, voltage dividers, and capacitor charging curves), this multimeter simulates key functionalities of a commercial multimeter with reasonable accuracy.



3. Hardware Used

- Arduino UNO
- 16x2 LCD Display
- Resistors (Known 950 Ohm, 10k Ohm for capacitor timing)
- Shunt Resistor (0.5 Ohm)
- DIP Switches (4-way)
- Breadboard and Jumper Wires
- USB Cable and Computer
- Capacitors for testing (varied)

4. Circuit Description

Each DIP switch corresponds to one mode:
- Switch 1 (Pin 9): Current
- Switch 2 (Pin 10): Voltage
- Switch 3 (Pin 11): Resistance
- Switch 4 (Pin 12): Capacitance

The respective analog pins read signals from external components, and the LCD displays the result.

5. Working Principle

1. Voltage Measurement

Principle:
The Arduino cannot measure voltages higher than 5V directly. To handle higher voltages, a voltage divider brings down the input voltage to within a measurable range.

Formula:
V input = V measured / resistor ratio

Implementation:
An analog pin reads the divided voltage, and the actual voltage is computed using the inverse of the resistor ratio (1000 / 11000 in this project).

---

2. Current Measurement

Principle:
A small-value shunt resistor (0.5Ω) is placed in series with the load. The voltage drop across it is measured to compute the current.

Formula:
I = V shunt / R shunt

Implementation:
The analog pin measures the voltage drop, and the current is calculated using Ohm's Law, with the result displayed in milliamps.

3. Resistance Measurement

Principle:
The unknown resistor is connected in series with a known resistor. A voltage divider is formed, and the voltage at the junction is measured.

Formula:

$$R_{unknown} = ((V_{in} - V_{out}) / V_{out}) \times R_{known}$$

Implementation:
The Arduino reads Vout from the divider, then calculates the unknown resistance using the voltage and known resistor value (950Ω in this case).

---

4. Capacitance Measurement

Principle:
Based on the RC time constant, a capacitor is charged through a known resistor. The time taken to reach 63.2% of full voltage (≈0.632 × Vin) is measured.

Formula:

$$C = t / R$$

Implementation:
The Arduino uses micros() to measure the time taken to reach the threshold voltage, then calculates the capacitance using the known resistor (10kΩ).

6. Code Explanation

The sketch starts by setting up pin modes and initializing the LCD. It continuously checks DIP switch states and performs measurement logic accordingly. For example, resistance is calculated using the voltage divider formula; capacitance uses RC timing.
Serial output is also provided for debugging and additional accuracy verification.

GitHub Repository:

7. Measurement Formulas

- Voltage: V = analog Read * (Vin / 1023.0) / resistorRatio
- Current: I = (V shunt / R shunt) * 1000
- Resistance: R = (Vin - Vout) * R known / Vout
- Capacitance: C = (elapsedTime / R) * 1e6 (uF)

.