PROJECT ABSTRACT

Digital Capacitance Meter using 555 Timer and Arduino

A digital capacitance meter that converts capacitance to frequency with a 555 astable circuit and reads the value on an Arduino LCD with auto-ranging — built-to-order with meter unit, firmware, report, PPT and viva kit.

01. Title

Digital Capacitance Meter using 555 Timer and Arduino

02. Introduction / Background

Capacitors are the components students trust the least — the markings are cryptic, salvaged parts are unmarked, and a dried-out electrolytic looks identical to a good one. A capacitance meter answers the question in seconds, and the 555-timer method is the classic student-buildable approach: wire the unknown capacitor into a 555 astable oscillator, and its value becomes a frequency through the timing equation f = 1.44 / ((R1 + 2R2) × C). This project turns that equation into a complete bench instrument — 555 oscillator stage, Arduino frequency counter using input-capture timing, auto-ranging across three resistor ranges via relay switching, and a 16×2 LCD reading directly in nF/µF. The student solders a real analog front end, writes real measurement firmware, and calibrates the whole chain against known capacitors.

03. Problem Statement

Students cannot verify capacitor values with a multimeter alone, and the 555 astable equation is usually left as a textbook formula. The project closes both gaps: a genuinely useful bench instrument built around that very equation, with auto-ranging and calibration turning the formula into a trustworthy reading.

04. Objectives

- Build a 555 astable front end with the unknown capacitor as timing capacitor.
- Measure oscillator period precisely with Arduino input capture and multi-cycle averaging.
- Compute capacitance from the 555 timing equation in firmware.
- Auto-range across three relay-switched resistor ranges (approx. 1 nF–470 µF design).
- Display the reading with automatic pF/nF/µF unit selection on an LCD.
- Compensate stray capacitance with open-terminal zeroing.
- Provide a calibration mode with per-range EEPROM correction factors.
- Deliver the complete student kit: meter, firmware, schematics, report, PPT and viva Q&A.;

05. Proposed Methodology

The system is developed in three stages. (1) Analog front end: the 555 astable stage on stripboard/PCB with relay-switched timing resistors and front-panel test clips plus a discharge resistor. (2) Firmware: input-capture period measurement over multiple cycles, capacitance

computation by rearranging the timing equation, auto-range selection keeping the 555 in its stable band, stray-capacitance zeroing, and unit-formatted LCD output. (3) Calibration: reference capacitors are measured in calibration mode and a correction factor per range is stored in EEPROM, absorbing resistor tolerances and 555 threshold variation.

06. System Architecture / Working

The unknown capacitor sets the 555's oscillation frequency; the Arduino measures the period with hardware-timer precision, averages over cycles, and inverts the timing equation to get capacitance. If the frequency sits outside the current range's sweet spot, the firmware switches the range relay and re-measures. The LCD shows value, unit and range; calibration mode stores per-range correction factors from reference capacitors.

07. Hardware / Software Requirements

- 555 timer astable oscillator front end (stripboard/PCB)
- Arduino Nano/Uno with input-capture period measurement
- Relay-switched timing resistor network, 3 ranges
- 16×2 LCD with I2C backpack
- Front-panel test clips + discharge resistor
- 5 V regulated supply
- Reference capacitor set for calibration
- Arduino firmware: capture, averaging, auto-range, calibration, display (C++)

08. Expected Outcomes

A working meter that reads clipped-in capacitors directly in pF/nF/µF with automatic ranging across approximately 1 nF–470 µF (design target). Calibrated accuracy is established on the buyer's build with the supplied reference capacitors and procedure — no accuracy figure is claimed before that calibration is performed.

09. Applications

- Verifying capacitor values before circuit assembly
- Sorting unmarked and salvaged capacitors
- Detecting dried-out electrolytics by value shift
- Teaching 555 astable theory as a working instrument

10. Future Scope

- ESR measurement add-on for electrolytic health
- In-circuit guarded measurement technique notes
- Auto-discharge relay for large capacitors
- PC logging of measurement sessions