NATIONAL UNIVERSITY OF SCIENCES & TECHNOLOGY

SCHOOL OF MECHANICAL AND MANUFACTURING ENGINEERING

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SEMESTER # 03 **CLASS: - ME 15 [SEC A]**

ELECTRICAL ENGINEERING

LAB No. 06

Battery Level Indicator Circuit and Use of Cathode Ray Oscilloscope (CRO)

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Submitted to SANIA SHAHEEN

Assessment Rubrics for EE-103 Electrical Engineering Lab

	Excellent (9-10)	Good (7-8)	Fair (4-6)	Poor (1-3)
Introduction and Theory	Complete and well written; provides all necessary background principles for the experiment	Nearly complete, missing some minor points	Some introductory information, but still missing some major points	Very little background information provided, or information is incorrect
Experimental Procedure	Well-written in paragraph format, all experimental details are covered	Written in paragraph format, important experimental details are covered, some minor details missing	Written in paragraph format, still missing some important experimental details	Missing several important experimental details or not written in paragraph format
Results: data, figures, graphs, tables, etc.	All figures, graphs, tables are correctly drawn, are numbered and contain titles/captions.	All figures, graphs, tables are correctly drawn, but some have minor problems or could still be improved	Most figures, graphs, tables OK, some still missing some important or required features	Figures, graphs, tables contain errors or are poorly constructed, have missing titles, captions or numbers, units missing or incorrect, etc.
Discussion	All-important trends and data comparisons have been interpreted correctly and discussed, good understanding of results is conveyed.	Almost all the results have been correctly interpreted and discussed, only minor improvements are needed.	Some of the results have been correctly interpreted and discussed; partial but incomplete understanding of results is still evident.	Very incomplete or incorrect interpretation of trends and comparison of data indicating a lack of understanding of results.
Conclusion	All-important conclusions have been clearly made, student shows good understanding	All-important conclusions have been drawn, could be better stated	Conclusions regarding major points are drawn, but many are misstated, indicating a lack of understanding	Conclusions missing or missing the important points
Report Formatting, structure and referencing	All sections in order, well formatted, very readable. References provided appropriately	All sections in order, formatting generally well, but could still be improved. References provided, but not entirely	Sections in order, contains the minimum allowable amount of handwritten copy, formatting is rough but readable. Improper References	Sections out of order, too much handwritten copy, sloppy formatting. No referencing at all.

Plagiarism in any case will result in zero mark in that session. *LE Sania Shaheen*

Contents

LAB No. 06: Battery Level Indicator Circuit and Use of Cathode Ray Oscilloscope (CRO)

➢ Objectives

1. To construct an LED-Resistive circuit and understand its significance in battery level indication.
2. To familiarize with the use of Cathode Ray Oscilloscope (CRO) and Function Generator (F.G.).
3. To analyze signals using CRO for the constructed circuit.

➢ Tools Used

- Resistors
- Light Emitting Diodes (LEDs)
- DC Power Supply (variable supply)
- Cathode Ray Oscilloscope (CRO)
- Function Generator (F.G.)
- Connecting wires

In this experiment, we designed a battery level indicator circuit using four LEDs and four resistors connected in series for each pair but arranged in parallel across the whole circuit. As the input voltage is increased, each LED lights up at a specific voltage threshold, indicating different levels of the battery's charge.

The voltage at which each LED turns on individually is measured, and the total voltage at which all LEDs are fully illuminated (V_{total}) is recorded. By calculating the percentage of each LED's turn-on voltage relative to V_{total}, we can assess the voltage distribution across the LEDs.

Additionally, the use of a function generator and a CRO allows for the generation and visualization of different waveforms, aiding in the understanding of electronic signals.

o <u>**Series Circuit:**</u>

In a series configuration, branches are connected end-to-end. The same current flows through all the branches, but the voltage drop across each resistor is different.

o <u>**Parallel Circuits:**</u>

In a parallel circuit, a branch is connected across the same two points, creating multiple paths for the current to flow. The voltage across each branch in a parallel circuit is the same, but the current is different based on the power consumption.

- **LEDs:**

Light Emitting Diodes that light up when a certain threshold voltage is applied.

- **Multimeter**

A digital multimeter (DMM) is a versatile electronic device used to measure various electrical properties, including voltage, current, and resistance. The device displays the measurements on a digital screen, making it easy to read and understand the results accurately. [1]

- **Power supply**

A power supply is an electrical device that offers electric power to an electrical load such as laptop computer, server, or other electronic devices. The main function of a power supply is to convert electric current from a source to the correct voltage, current, and frequency to power the load. It could be AC to DC or DC to DC. [2]

- **Breadboard**

A breadboard (sometimes called protoboard) is essentially the foundation to construct and prototype electronics. A breadboard allows for easy and quick creation of temporary electronic circuits or to carry out experiments with circuit design. [3]

- **Cathode Ray Oscilloscope (CRO)**

A cathode ray oscilloscope is an electrical test device used to produce waveforms in response to several input signals. It was originally known as an oscillograph. The standard four components of a Cathode ray oscilloscope. Display, vertical controllers, horizontal controllers, and triggers. [4]

- **Function Generator**

A function generator is an electronic test equipment that generates standard waveforms, such as sine, square, ramp, or sawtooth waves, to a device under test (DUT). [5]

➢ Procedure

Firstly, we found the values of each led voltage at which they turned on.

Setting Up the Circuit:

- We connected four LEDs and four resistors in series for each LED-resistor pair, then connected all four pairs in parallel across the circuit.
- The circuit was powered by a DC power supply, starting at around 1.5 to 2 volts.

Measuring Turn-On Voltages:

- Using the multimeter, we measured the voltage at which each LED turned on (V_1, V_2, V_3, and V_4).
- The voltage was gradually increased until all LEDs were fully glowing, and this voltage was recorded as V_{total}.

Calculating Voltage Percentages:

- We calculated the percentage of voltage for each LED using the formula:

$$\textbf{Percentage of Voltage} = (V_n / V_{total}) \times 100$$

where V_n is the voltage at which each LED turns on, and V_{total} is the final voltage when all LEDs are glowing.

Using the Function Generator and CRO:

- We connected the function generator to generate different types of waveforms (sine, square, and triangular waves).
- The CRO was used to visualize the waveform signals. For this experiment, we primarily focused on sine waves.

➢ Lab task

In this experiment, we built a battery level indicator circuit using four LEDs and resistors connected in series for each LED but arranged in parallel for the entire circuit. As the input voltage increased, each LED lit up at a specific threshold, representing different levels of the battery charge. We measured the turn-on voltage for each LED and calculated the total voltage (V_{total}) when all LEDs were fully illuminated. The percentage of each LED's voltage relative to V_{total} was calculated to show how the voltage is distributed. A function generator and a CRO were used to produce and visualize waveforms, enhancing our understanding of signal behavior.

Table 6.1: Table for value of voltages of each led without any resistance

Serial no	LED no	LED colour	Voltage
1	LED1	Green	2.2
2	LED2	Purple	2.8
3	LED3	Green	2.2
4	LED4	Blue	2.4

Table 6.2: Table for values of voltages of LED when connected in circuit

Serial no	LED no	LED colour	Voltage	%Voltage
1	LED1	Green	4	27.4
2	LED2	Purple	7.2	49.31
3	LED3	Green	10.3	70.54
4	LED4	Blue	14 .6	100

Minimum voltage at which all LED light up is **14.6V.**

➢ Discussion:

In this experiment, we observed that as the input voltage was gradually increased from the DC power supply, the LEDs turned on one by one at different voltages. LED 1 turned on at a lower voltage compared to LED 4, which turned on last. The voltage at which all LEDs were fully glowing was defined as Vtotal or the final voltage.

We calculated the percentage voltage for each LED based on the total voltage, which helped in understanding how the LEDs are distributed in terms of their turn-on voltages relative to the overall circuit voltage.

The use of the Cathode Ray Oscilloscope (CRO) and Function Generator allowed us to visualize the frequency signals generated in the circuit. We worked with sine waves, which provided a clear representation of voltage changes over time. There were also options to switch to square or triangular waveforms, but for the purposes of this experiment, sine waves were observed.

➢ Results

The results indicate that each LED turned on at specific voltage values when directly connected to the power supply without any resistors. The blue LED required 2.4V, the green LEDs turned on at 2.2V, and the purple LED lit up at 2.8V. In the complete circuit, which included resistors, the blue LED turned on at 14.6V, the green LEDs at 10.3V and 4V respectively, and the purple LED at 7.2V. Additionally, the voltage percentages relative to the total circuit voltage were calculated, with the blue LED operating at 100%, the first green LED at 70.54%, the purple LED at 49.31%, and the second green LED at 27.4%. The minimum voltage required to light up all LEDs in the circuit was 14.6V.

➢ Conclusions

The experiment successfully demonstrated the construction and analysis of a battery level indicator circuit using LEDs and resistors. We were able to measure the individual turn-on voltages of each LED and calculate their percentages relative to the total voltage. The experiment also provided practical experience with using a Cathode Ray Oscilloscope and Function Generator to generate and visualize different types of waveforms.

➢ References

[1] Fluke Corporation, "What is a digital multimeter?," *Fluke*, https://www.fluke.com/en/learn/blog/electrical/what-is-a-digital-multimeter#:~:text=Electrical%2C%20Multimeters,and%20understand%20the%20results%20accurately. [Accessed: 24-Oct-2024].

[2] Cincon Electronics Co., Ltd, "What is a DC-DC power supply and how does it work?," *Cincon*, https://www.cincon.com/newsdetail_en.php?id=7659. [Accessed 24-Oct -2024].

[3] "Breadboard," *ScienceDirect*, https://www.sciencedirect.com/topics/engineering/breadboard#:~:text=A%20breadboard%20(sometimes%20called%20protoboard,out%20experiments%20with%20circuit%20design. [Accessed: 24-Oct-2024].

[4] Cathode Ray Oscilloscope (CRO): Learn Definition, Working, Uses." *Testbook*, [Online]. Available: https://testbook.com/electrical-engineering/cro-cathode-ray-oscilloscope. [Accessed: 24-Oct-2024].

[5] Waveform and Function Generators." *Keysight*, [Online]. Available: https://www.keysight.com/us/en/products/waveform-and-function-generators.html. [Accessed: 24-Oct-2024].