IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE)
e-ISSN: 2278-1676,p-ISSN: 2320-3331, Volume 15, Issue 1 Ser. I (Jan–Feb 2020), PP 10-15
www.iosrjournals.org

Arduino Based Smart AC-DC Voltmeter for Electronic Circuit Analysis.

Mohammad Yunus, Sharmin Rahman, Ariful Alam*, KhondokarNazmusSakib
Department of Physics, MawlanaBhashani Science and Technology University, Tangail, Bangladesh.
Corresponding Author: Mohammad Yunus

Abstract:*An Arduino UNO microcontroller based digital voltmeter has been designed and developed with liquid crystal display and voltage range indicator. A regulated low voltage power supply circuit (5 volt) has been developed to power up Arduino microcontroller. Arduino senses the input voltage, converts the analog voltage into digital value and displays the value through a liquid crystal display. The arduino also calculate the value and indicate the voltage range by turning on LED lights. A green LED indicates 0.1 to 5 volt range which is low voltage and can be used for powering up low voltage operated integrated circuits such as LM741, CA3140. A yellow LED indicates mid voltage range of 6 to 50 volt while red LED indicates higher than 50 volt which can be harmful and should be operated carefully for small integrated electronic circuits.*
Key word:*Arduino UNO R3, liquid crystal display, LED, resistor, connecting wires.*

Date of Submission: 10-01-2020 Date of Acceptance: 27-01-2020

I. Introduction

Voltage is one of the fundamental parameters associated with any electrical or electronic circuit, it is considered as the pressure that forces the charged electrons to flow in an electrical circuit. The operating voltage of an electrical device is very important. Electronic devices need to connect to their correct operatingvoltagesto operate smoothly [1]. Connecting a small 5 volt operating electrical device to a high voltage supply can harm even burn up the device. Hence the measurement of the supplied voltage before connecting it to the circuit is compulsory.

A Voltmeter or a Voltage Meteris used for measuring the potential difference between two points in a circuit. Voltmeters are an important piece of equipment which are associated with any kind of electrical circuit operation. They are used for measuring both AC and DC voltages. Voltmeters are classified in two types; namely Analog Voltmeter and Digital Voltmeter. Analog Voltmeter consists of pointer that moves across a scale and the movement is proportional to the voltage measured. Digital Voltmeter is a voltage sensitive device which measures AC or DC voltage and displays the value directly in numeric form instead of pointer deflection [2].
Microcontroller can be used to develop a digital voltmeter. The Arduino UNO is an open-source microcontroller board based on the microchip ATmega328P microcontroller. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various devices, sensors or other circuits. The project goal was to develop a low-cost smart voltmeter for electronics or physics lab.

II. Design Consideration

The main part of the proposed system is Arduino UNO R3 microcontroller. Other parts of the developed system are: low voltage power supply circuit, voltage range selector, liquid crystal display and voltage range indicator.

2.1 Arduino UNO R3 Microcontroller

A microcontroller is a compact integrated circuit designed to govern a specific operation in an embedded system. A typical microcontroller includes a processor, memory and input/output units on a single chip [3].

In our design Arduino UNO R3 microcontroller has been used. The Arduino UNO R3 is a microcontroller board based on removable, dual inline package AT328 AVR microcontroller having flash memory 32 KB, SRAM 2 KB, EEPROM 1 KB, clock speed 16 MHz. It has 20 input/ output pins. It is a high performance easily programmable microcontroller which receives analogue voltages from its analogue pin A0, converts the analogue voltage into digital value and display the result through a liquid crystal display [4].

2.2Low voltage power supply circuit

A low voltage well regulated power supply of around 5 volt is required to power up the Arduino microcontroller. Here a low voltage power supply circuit was developed to provide 5 volt regulated dc power supply. The main power was collected from 220 volt ac line. A step down transformer having primary winding 400 turn and secondary winding 40 turn was used in this design to convert 220 volt ac to 22 volt ac.

A bridge rectifier circuit was connected to rectify the 22 volt ac voltage to 22 dc voltage. This output voltage from the rectifier circuit may fluctuate, so a regulator should be used to regulate the output of the rectifier circuit. A L7805 IC was used to regulate the dc output and finally 5 volt regulated dc power supply was obtained from the circuit[5].

2.3 Voltage Sensor Circuit

A voltage sensor was interfaced with Arduino to sense and measure the external voltages. The voltage sensor was developed by using diodes and resistors. The diode acted as a half wave rectifier and allowed just the positive half cycle of the AC voltage to reach the Arduino [6].

For measuring 0 to 5 volt, the voltage was connected directly to the analogue terminal of Arduino. For measuring 6 to 50 volt, a voltage divider circuit was developed by using 100 kΩ and 10 kΩ resistors and for 50 to 500V,1MΩ and 10 kΩ resistance were used. The output voltage from the divider was feed to the analogue input terminal of the Arduino [7].

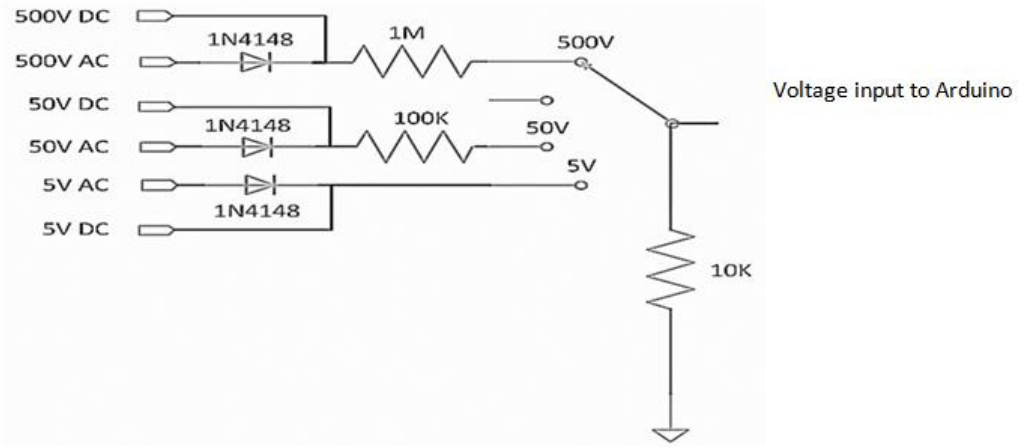

Figure 1: Voltage sensor circuit

2.4 Voltage Range Indicator

The voltage range indicator circuit was developed simply by using light emitting diodes (LED), 220 Ω resistors and Arduino [8]. The microcontroller weigh the value and indicate the voltage range by turning on LED lights. A green LED indicates 0 to 5 volt, yellow LED indicates mid voltage range of 6 to 50 volt while red LED indicates higher than 50 volt.

2.5 Display Circuit

For displaying the measured voltage a (16x2) liquid crystal display was employed which can show the analog AC or DC voltage in digital way [9]. The LCD is aelectrically modulated optical device that uses the light modulating properties of liquid crystal. These kind of crystal does not emit light directly unless a reflector is used to produce image in monochrome [10].

The LCD display is more convenient to connect and configure with Arduino which can display wide range of numerical value with associated data.

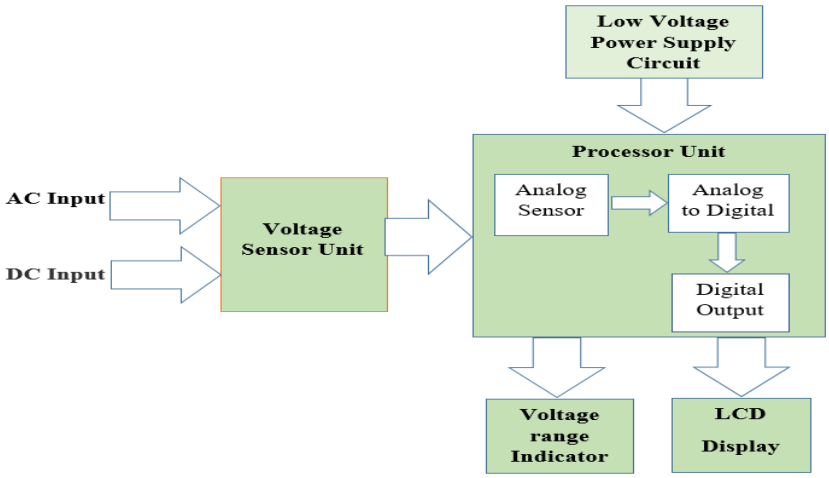

Figure 2: Block diagram of the proposed system

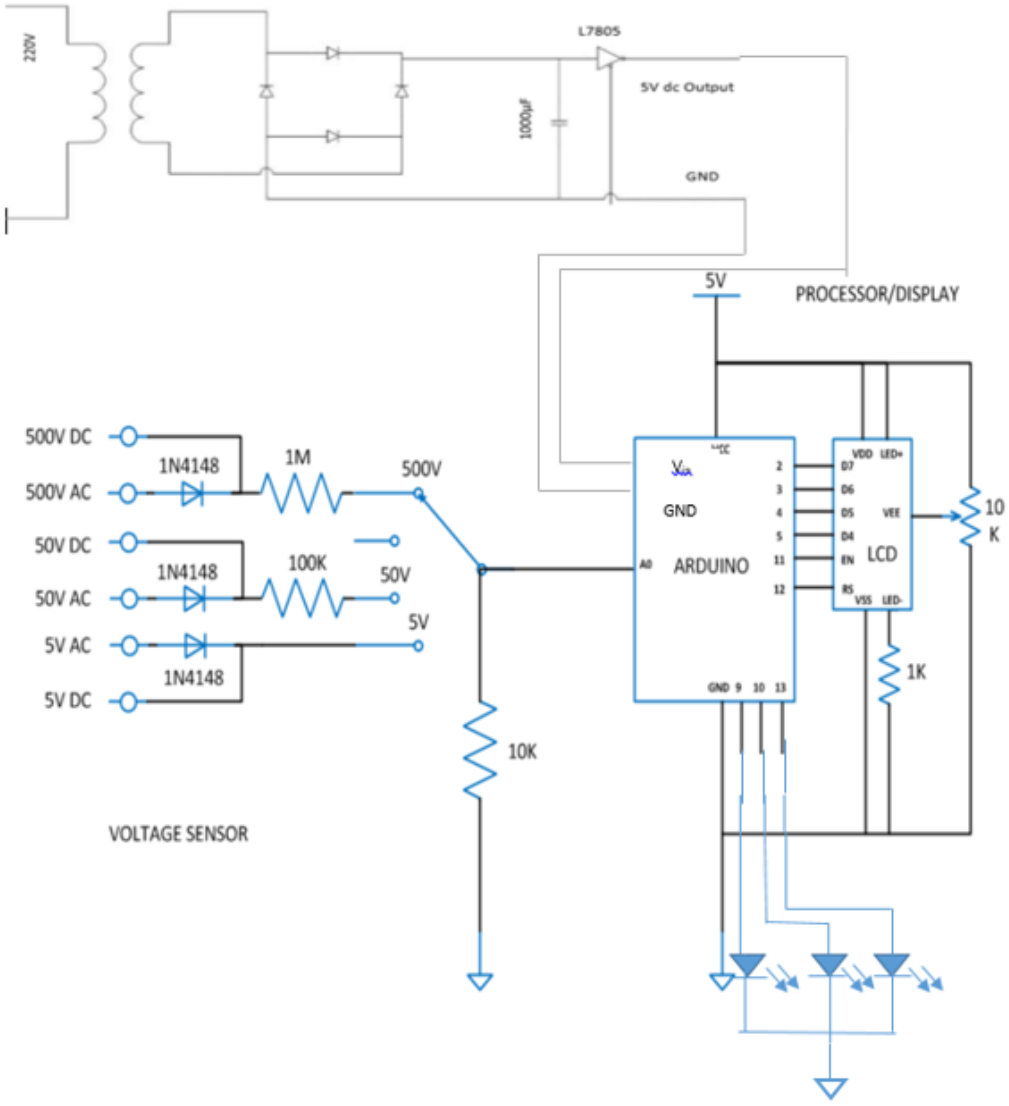

Figure 3: Complete circuit diagram of proposed the system

III. Programming

AnArduino UNO R3 microcontroller has been used to senses the voltage and convert it to a digital value. Suitable programming should be uploaded to the microcontroller in order to perform the tasks and display the result. "C" programming language has been used to instruct the Arduino microcontroller [11]. The ArduinoGenuino software is used to design the program and to upload it to the microcontroller from a PC. Flowchart of the program are given below:

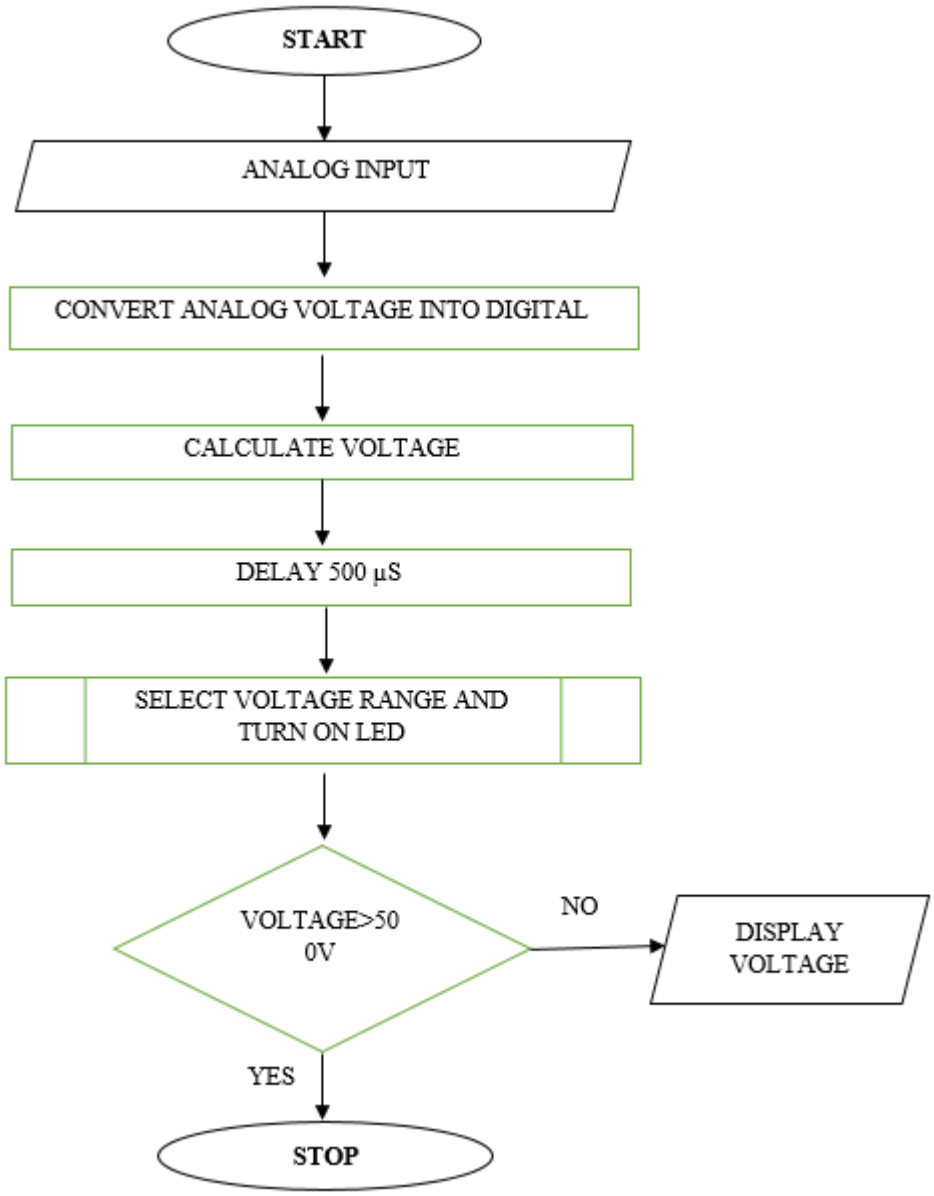

Figure 4: Flow-chart of the programming

IV. Results and Discussions

The presented work has been planned and done in step-by-step process in a systematic way. At first we planned about the system and then developed different small parts of this system like low voltage power supply circuit in order to power up the microcontroller, voltage sensor circuit to senses the voltage and converts the AC voltage into DC voltage. A liquid crystal display was used to display the result besides we used three types of LED to indicate the voltage range. Finally we combined different parts of the system.

The developed system is calibrated with other voltage measuring instruments and the data collection for both low voltage (0v-5v) and medium voltage (6v-15v) are given below:

Table No 1: Data for low range of voltage

No. of Obs.	Voltage in our developed system	SAKO DC Power Supply
0	0.00	0.00
1	0.51	0.5
2	1.10	1.0
3	1.51	1.5
4	2.03	2.0
5	2.58	2.5
6	3.04	3.0
7	3.55	3.5
8	4.19	4.0
9	4.56	4.5

Table 1 shows that our experimental data maintains a good consistency with the results of standard low voltage measurement instrument with a very little fluctuation. Hence it can be concluded that the developed system is reliable and good efficient.

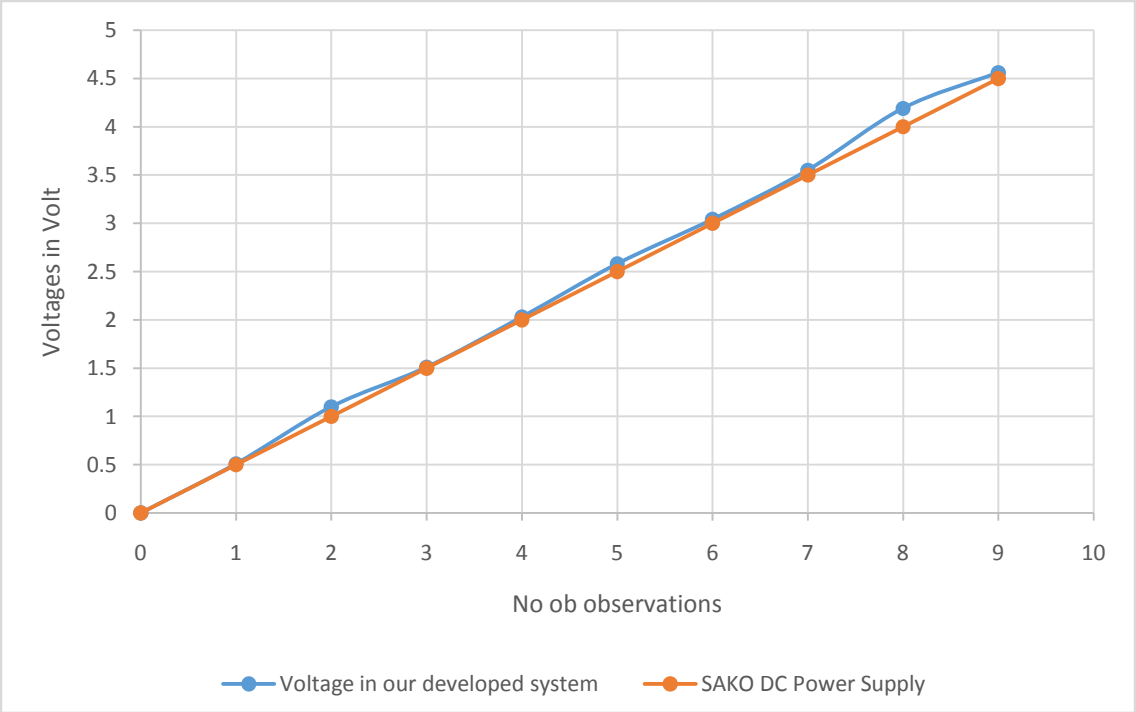

Figure 5:Comparison between developed system and SAKO DC power supply

Table 2: Data for medium range of voltage

No. of Obs.	Voltage in our developed system	Voltage in Sanwa digital multimeter
1	6.17	6.13
2	7.23	7.20
3	8.30	8.25
4	9.19	9.15
5	10.11	10.09
6	11.51	11.43
7	12.55	12.51
8	13.09	13.04
9	14.69	14.55
10	15.98	15.93
11	16.75	16.72
12	17.34	17.29
13	18.39	18.30
14	19.45	19.39
15	20.27	20.21

The corresponding data of table 2 shows that the developed system also provides a good result for medium range of voltages.

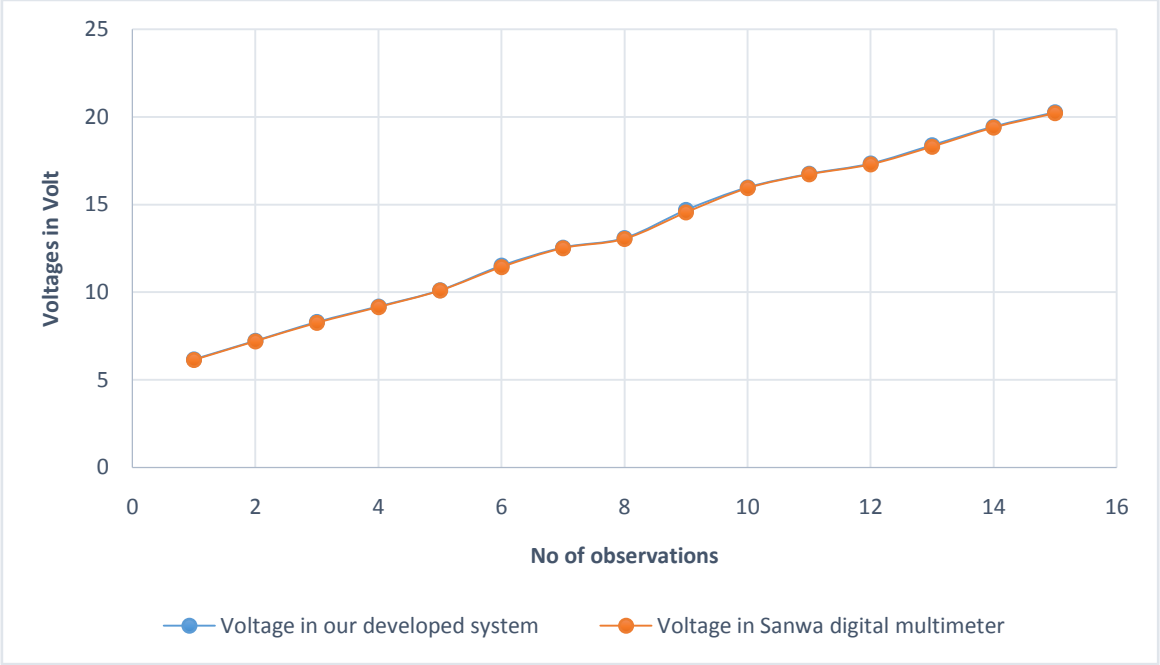

Figure 6: Comparison between developed system and SANWA digital multi meter.

The developed system are calibrated for 0 to 20 volt range and it shows a satisfactory result. The developed system can also measure high voltage upto 500 volt.But the result for high voltage can't be presented here due to time constraint.

V. Conclusion

The complete system has been designed, developed and tested with 'SAKO DC POWER SUPPLY' and 'SANWA DIGITAL MULTIMETER'. Here a regulated low voltage power supply (5 volt) has been developed to power up Arduino microcontroller. Arduino senses the input voltage, converts the analog voltage into digital value and displays the value through a liquid crystal display. The developed system is easy to operate and reliable. It has been designed using the components that are readily available in the local market and the cost of the developed system is very less than the price of readymade portable voltage meter.

References:

[1]. Brunner, H., Hierholzer, M., Laska, T., &Porst, A. "Progress in development of the 3.5 kV high voltage IGBT/diode chipset and 1200 A module applications." Proceedings of 9th International Symposium on Power Semiconductor Devices and IC's. IEEE, (1997).
[2]. Pili, U., Violanda, R., &Pili, J. "Using a digital voltmeter and a smartphone camera to investigate the RC circuit." Physics Education 54.3 (2019): 033004.
[3]. Alam, A., Chowdhury, M. A. M., &Akter, F. "Design and Development of Arduino Based Radiation Survey Meter with Two Scintillation Detectors." (2019).
[4]. Pan T., Zhu Y., "Designing Embedded System with Arduino", Springer, New York, P- 17, 45, (2017).
[5]. Roly, N. A., Habiba, U., Kabir, H., Martuza, K. G., Akter, F., & Chowdhury, M. A. "Design and Development of Microcontroller Based Digital Soil pH Meter."
[6]. V.K. Mehta, "PRINCIPLES OF ELECTRONICS" Revised Edition, S. Chand & Company Ltd. Page 136-138 (2003).
[7]. Mashud, M. A. A., Bhuiyan,M.R.A. &Islam,M. S. "Design and Development of A Microcontroller Based Regulated High Voltage Power Supply for GM Detectors " ResearchGate, (2013).
[8]. Edwards, K. D. "Light Emitting Diodes." University of California at Irvine. p. 2. Retrieved January 12 (2019).
[9]. Embree, P. M., Bruce, K. & James F. B. "C language algorithms for digital signal processing." (1991).
[10]. Gray, G. W., & Stephen M. K. "Liquid crystals for twisted nematic display devices." Journal of Materials Chemistry 9.9 (1999).
[11]. Evans, B. "Beginning Arduino Programming." Apress (2011).

Mohammad Yunus, et.al. "Arduino Based Smart AC-DC Voltmeter for Electronic Circuit Analysis."*IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE)*, 15(1), (2020): pp.10-15.