

**COMPLETE PRACTICUM REPORT
INSTRUMENTATION ENGINEERING
(19G04122501)**

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FOREWORD

Praise be to Allah SWT. who has given His grace and guidance so that the author can complete this Instrumentation Engineering Practicum Report properly.

The purpose of writing this report is to fulfill the laboratory exam requirements in the Instrumentation Engineering Practicum course. In addition, this report also aims to add insight into instrumentation in everyday life for readers and also for writers.

The author would like to thank all parties who cannot be mentioned one by one for their help so that the author can complete this report.

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TABLE OF CONTENTS

TITLE PAGE	i
ENDORSEMENT PAGE	ii
TABLE OF CONTENTS	vi
LIST OF FIGURES	x
LIST OF TABLES	xi
LIST OF APPENDICES	xii

INTRODUCTION TO INSTRUMENTATION COMPONENTS

INTRODUCTION	1
Background	1
Purpose and Usefulness.....	2
LITERATURE REVIEW	2
Electronics.....	2
Basic Components of Electronics	2
Capacitors.....	3
Transistor.....	3
Transformer.....	3
Resistor.....	3
Inductor	3
IC (Integrated Circuit).....	4
Diode	4
PRACTICUM METHODOLOGY	4
Time and Place.....	4
Tools.....	4
Materials.....	4
Practical Procedure.....	4
RESULTS AND DISCUSSION	5
Reultss	5
Discussion	7
CONCLUSION	7
BIBLIOGRAPHY	8
APPENDIX	9

PROTEUS AND FRITZING SOFTWARE

INTRODUCTION	10
Background.....	10
Purpose and Usefulness.....	11
LITERATURE REVIEW	11
Power Supply	11
Proteus.....	11
Fritzing	12
PRACTICUM METHODOLOGY	13
Time and Place.....	13
Tools.....	13
Materials.....	13
Practical Procedure.....	14
RESULTS AND DISCUSSION	14
Results	14
Discussion	17
CONCLUSIONS	18
BIBLIOGRAPHY	19
APPENDIX	20

OPERATIONAL AMPLIFIER

INTRODUCTION	24
Background	24
Purpose and Usefulness.....	25
LITERATURE REVIEW	25
Operational Amplifier	25
Inverting	25
Non Inverting	26
Differential	26
Buffer	27
PRACTICUM METHODOLOGY	27
Time and Place.....	27
Tools.....	27
Materials.....	27
Practical Procedure.....	27
Formulas Used	27
RESULTS AND DISCUSSION	28
Results	28
Discussion	30
CONCLUSION	30
BIBLIOGRAPHY	31
APPENDIX	32

VOLTAGE DIVIDER CIRCUIT

INTRODUCTION	35
Background.....	35
Purpose and Usefulness.....	35
LITERATURE REVIEW	36
Voltage.....	36
Voltage divider circuit.....	36
Series and Parallel Circuits.....	37
Voltage Divider Function.....	37
PRACTICUM METHODOLOGY	37
Time and Place.....	37
Tools.....	37
Materials.....	37
Practical Procedure.....	38
Formulas Used.....	38
RESULTS AND DISCUSSION	38
Results.....	38
Discussion.....	39
CONCLUSIONS	40
BIBLIOGRAPHY	41
APPENDIX	42

INTRODUCTION TO VARIOUS SENSORS

INTRODUCTION	44
Background.....	44
Purpose and Usefulness	45
LITERATURE RIVIEW	45
Sensor	45
Ultrasonic Sensor.....	45
DHT 11 Temperature Sensor.....	46
LM35 Sensor	46
Soil Moisture Sensor	46
LDR Sensor	47
PRACTICUM METHODOOLOGY	47
Time and Place	47
Tools	47
Materials	47
Practicum Procedure.....	47
RESULTS AND DISCUSSION	48
Results	48
Discussion.....	49
CONCLUSIONS	50
BIBLIOGRAPHY	51
APPENDIX	52

ARDUINO IDE SOFTWARE

INTRODUCTION	53
Background	53
Purpose and Usefulness.....	54
LITERATURE REVIEW	54
Microcontrollers.....	54
Arduino	55
Arduino Software	56
Application in Agriculture	56
PRACTICUM METHODOLOGY	56
Time and Place.....	56
Tools.....	56
Materials.....	56
Practical Procedure.....	57
RESULTS AND DISCUSSION	59
Results	59
Discussion	59
CONCLUSIONS	60
BIBLIOGRAPHY	61
APPENDIX	62
APPENDIX	
REPORT COVER	
PRELIMINARY TASK	
CONTROL CARD	

FIGURE LIST

No.	Image	Page
1.	Testing electronic components using a multimeter.	9
2.	Proteus Software Design.	14
3.	Power Supply Simulation Using Proteus Software.	16
4.	Fritzing Software Design.	16
5.	PCB Design Simulation Fritzing Software.	17
6.	Opening Proteus Application.	20
7.	Selecting New Project.	20
8.	Selecting Electronics Components.	20
9.	Assembling the Power Supply.	21
10.	Simulating a Power Supply.	21
11.	Opening the Fritzing Application.	21
12.	Breadboard Menu.	22
13.	Mounting Components on the PCB Board.	22
14.	Connecting Components with Wires.	22
15.	Documentation of Proteus and Fritzing Software Practicum.	23
16.	Opening Proteus.	32
17.	Library view.	32
18.	Component input view.	32
19.	Assembling Components.	33
20.	Creating an operational amplifier circuit.	34
21.	Opening Proteus.	42
22.	Library View.	42
23.	Component input view.	42
24.	Assembling Components.	43
25.	Creating a voltage divider circuit.	43
26.	Documentation of Sensor Introduction Practicum.	52
27.	Opening Arduino Software.	57
28.	Opening the Examples Menu.	57
29.	Clicking the Helloworld Menu.	57
30.	Helloworld View.	58
31.	Program View.	58
32.	Saving the Program.	58
33.	Arduino Software Program Results.	59
34.	Documentation of Arduino Software Introduction Practicum.	62

LIST OF TABLES

No.	Tables	Page
1.	Results and Testing of Instrumentation Components.	5
2.	Features of Proteus.	14
3.	Features of Fritzing.	16
4.	Results and Testing of the Operational Amplifier Circuit.	25
5.	Voltage Divider Circuit.	38
6.	Results of the Sensor Assortment Recognition Picture Show.	48

LIST OF ATTACHMENTS

No.	Attachments	Page
1.	Practicum Documentation.	9
2.	Proteus Software Working Procedure.	20
3.	Fritzing Software Work Procedure.	21
4.	Practical Documentation.	23
5.	Experiment Procedure.	32
6.	Calculation.	33
7.	Practical Documentation.	34
8.	Experimental Procedure.	42
9.	Calculation.	43
10.	Practical Documentation.	43
11.	Practical Documentation.	52
12.	Practical Documentation.	62



INTRODUCTION TO INSTRUMENTATION COMPONENTS

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ABSTRACT

Electronics plays an important role in life. The agricultural and industrial fields require an electronic circuit to make a tool and machine in which there are electronic components. Electronic components include capacitors, transistors, transformers, resistors, inductors, ICs, diodes and so on. The purpose of this practicum is to understand the concept of electronics and recognize the components of instrumentation. The method carried out in the practicum of Introduction to Instrumentation Components by measuring each material and then recording the results. Electronic components consist of passive components and active components. Active components such as diodes, transistors and IC (*Integrated Circuit*). Passive components such as resistors, capacitors and inductors. The tool used in measuring each material is a multimeter. The results obtained are the resistance value of each component. Based on the practicum that has been done, it can be concluded that each component has a different resistance value.

Keywords: Electronics, Instrumentation, Components

INTRODUCTION

Background

The development of technology in the field of electronics requires students and teachers to be able to recognize, know and understand components related to electronics. This is because all electronic media used to access information and knowledge apply electronic components in it. One of the electronic media that applies electronic principles in everyday life is gadgets.

Electronics and instrumentation also play a role in various fields of life such as agricultural engineering and industry. In agriculture, electronics is important in controlling various agricultural tools and machines, such as automatic control in sorting products such as fruits, vegetables or other finished products. In addition, agricultural tools such as tractors and *reapers* are also the result of the application of electronics. These tools are a reference that electronics are very useful in agriculture. The application of technological developments is a solution in increasing production to meet human food needs. In the industrial sector, electronics plays a role in measuring and controlling tools and machines such as chemical reaction measuring devices.



Electronics itself has two main components called active and passive components. These two divisions have their respective functions and uses, where these components are very varied and diverse. This component plays an important role in life. Active components are electronic components that require a source of electric current from outside or external. These active components are diodes, transistors and IC (*Integrated Circuit*). Passive components include electronic components that do not require an external electric current source. We can see and encounter these passive components in life such as resistors, capacitors and inductors.

Based on the description above, it is necessary to conduct a practicum to find out the types, functions and examples of application of various components commonly used in instrumentation and be able to test electronic components, so that they can be applied in life, especially in the field of agricultural engineering.

Purpose and Usefulness of Practicum

The purpose of the practicum Introduction to Instrumentation Components is that students are able to understand the concepts of electronics and instrumentation and students are able to recognize instrumentation components.

The usefulness of the practicum of Introduction to Instrumentation Components is that it can be applied in the field of agriculture such as in the manufacture of tools and drying machines for agricultural products.

LITERATURE REVIEW

Electronics

Electronics as a study of weak current electrical devices that are operated by controlling the flow of electrons or electrically charged particles in a device. Electronic components are tested using a device called a multimeter. The science that studies tools like this is a branch of physics, while its design and electronic forms are part of electrical engineering, computer engineering, electronics and instrumentation (Farhan, 2022).

Electronics has many types of components that have different characteristics. Basically, components in electronics are divided into three parts, namely active components, passive components, and supporting components. Some basic electronic components are resistors, capacitors, diodes, transistors, transformers, potentiometers, ICs, multimeters, indicators and conductors (Maulana & Purnama, 2017).

Basic electronic components are a tool or object that has a supporting function to form an electronic circuit whose work must be the same as its use. Basic electronic components basically consist of two parts, namely active components and passive components. (Pranata & Sundaygara, 2018).

Basic Components of Electronics

Electronic components consist of components that are paired or used in the need to build a circuit. The circuit is a simple circuit to a complex circuit with certain conditions and requirements so that the circuit can be used in accordance with its purpose. Electronic components are also defined as components that are almost present in every need in life to assemble electronic devices (Ramadhani *et al.*, 2021).



Capacitors

Capacitors are passive components commonly used in a system as a filter and store electrical energy. The capacitor structure consists of two metal plates separated by a dielectric. If both ends of the metal plate receive a potential difference, a positive charge will accumulate on one of the electrodes and at the same time a negative charge will accumulate at the other end of the electrode. Positive charges cannot go to the cathode and negative charges cannot flow to the anode. (Senja & Sumiran, 2014).

Transistors

Transistors have 3 semiconductor component terminals on one terminal is to function as an opener (*open*) circuit. Transistors are usually more widely made of silicon material. The different legs forming a bipolar transistor are the emitter, base and collector. Transistors are combined into NPN (*Negative Positive Negative*) or PNP (*Positive Negative Positive*) types. Transistors are electronic components designed as current amplifiers. Transistor legs are expressed by base, collector and emitter (Jafar et al., 2016). (Jafar *et al.*, 2021).

Transformers

Transformers are electronic components that function to increase or decrease AC voltage. Transformers are arranged using coils. The coil is wound using copper. The primary coil is used as input and the secondary coil is used as output. The transformer functions as an alternating current (AC) converter. The transformer consists of a primary winding and a secondary winding in which the two windings are electrically unrelated but coupled by an electric field. The coupling device can be in the form of an iron core in layers or using a ferrite core. The primary winding is the winding connected to the input voltage while the secondary winding is connected to the output (Senja & Sumiran, 2014).

Resistors

Resistors are basic electronic components used to limit the amount of current flowing in an electronic circuit. The function of a resistor is to block the flow of current. Its resistance value is expressed in units called Ohms (Ω). Resistors are divided into two types, fixed resistors and variable resistors. If divided according to the material used, there are carbon resistors and also metal films. Potentiometer is a kind of *rheostat* whose resistance value can be measured according to the needs of the electronic circuit or user needs. LDR (*Light Dependent Resistor*) is a type of resistor whose resistance value is affected by the light received. Resistance can also be measured with a digital multimeter. Digital multimeters are used to measure current in Amperes, voltage in Volts and resistance in *Ohms*. (Senja & Sumiran, 2014).

Inductor

Inductor is a component capable of storing magnetic energy. Inductors are also known as coils which include passive electronic components that function as frequency regulators, filters and as coupling devices. Inductors or coils are found in many electronic devices or frequency-related circuits such as tuners for radio sets. Inductor types include fixed value inductors and adjustable value inductors or commonly known as variable inductors (Senja & Sumiran, 2014).



IC (*Integrated Circuit*)

IC (*Integrated Circuit*) is an active electronic component consisting of a combination of hundreds or even millions of transistors, resistors and other components integrated into an electronic circuit in a small package. IC (*Integrated Circuit*) also varies, ranging from three legs to hundreds of legs (terminals). IC functions also vary, ranging from amplifiers, *switching*, controllers to storage media. Generally, IC is an electronic component that is used as the brain in an electronic equipment. (Kurniadi *et al*, 2015).

Diodes

Diodes are electronic components that make electric current flow in only one direction. Diodes are also commonly referred to as rectifiers. Diodes are electronic components that have two electrodes, namely the anode (a) and cathode (k). Electric current flows in only one direction, namely from the anode to the cathode (Santoso, 2018).

PRACTICUM METHODOLOGY

Time and Place

Practicum on the Introduction of Instrumentation Components was held on Saturday, September 10, 2022, at 08.00 WITA until completion, at the Soil and Water Engineering Laboratory, Agricultural Engineering Study Program, Department of Agricultural Technology, Faculty of Agriculture, Hasanuddin University.

Tools

The tools used in this practicum are multimeters, stationery and *cellphone* cameras.

Material

The materials used in this practicum are resistors, capacitors, transistors, inductors, diodes, IC (*Integrated Circuit*), transformers, LEDs, gray wires, tin, Im 35, Im 741, LDR and potentiometers.

Practicum Procedure

The practicum procedure for Introduction to Instrumentation Components is:

A. Resistors

1. Turn the multimeter switch to ohms.
2. Calibrate the multimeter by touching both *probes* and *adjusting the* multimeter needle to show zero.
3. Touch each end of the multimeter *probe* to a resistor leg.
4. Record observations on the observation table.
5. Repeat with another type of resistor.

B. Potentiometer

1. Turn the multimeter switch towards ohms.
2. Calibrate the multimeter by touching both *probes* and *adjusting the* multimeter needle to show zero.
3. Touch the red *probe to the* end of the potentiometer leg and the black *probe* to the center leg of the potentiometer. Then move the black *probe* to the other end of the potentiometer leg.
4. Record observations on the observation table.
5. Repeat with another type of resistor.



C. Capacitors

1. Turn the multimeter switch towards ohms.
2. Calibrate the multimeter by touching the two *probes* and *adjusting the* multimeter needle to show number 1.
3. Touch each of the multimeter *probe* tips to the capacitor legs.
4. Record observations on the observation table.

D. LDR

1. Set the multimeter selector scale position to ohms.
2. Touch the red *probe* and black *probe of* the multimeter to both legs of the LDR (no polarity).
3. Close the surface of the LDR so that there is no light or in dark conditions.
4. Provide light on the surface of the LDR to get light or in bright conditions.
5. Record the resistance value on the multimeter display for each LDR condition.


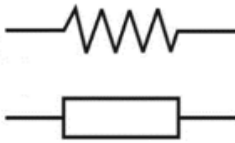

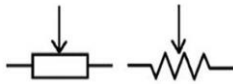
E. Diodes

1. Test first by turning the multimeter switch towards ohms.
2. Calibrate a digital multimeter.
3. Test electronic components using a multimeter.
4. Calculate the diode resistance value resulting from testing using a digital multimeter.
5. Record observations on the observation table.

RESULTS AND DISCUSSION

Results

Table 1. Results and Testing of Instrumentation Components.

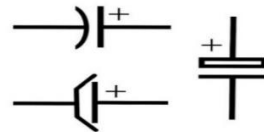
NO	Name and Image
1. Resistors	Symbol
	
	Test results: a. Maximum value: 49,3 Ω b. Minimum value: 0 Ω
2. Potentiometer	Symbol
	
	Test results: a. Maximum value: 97.5 k Ω b. Minimum value: 0 k Ω



3. Capacitors



Symbol



Test results: 25 volts

4. LDR



Symbol



Test results: In the dark: 16.92 k Ω
In the light: 0.60 k Ω

5. Diodes



Symbol



Test results: 10, 25 k Ω

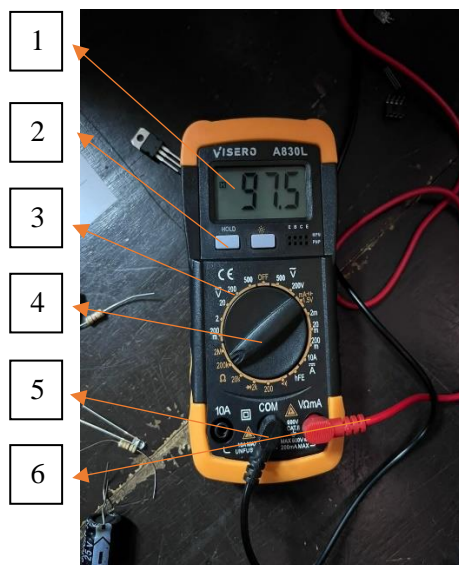


Image caption:

1. The display is used to read the measurement results.
2. The data hold button functions to lock the measurement results on the display so that they will not change.
3. The measuring limit serves to determine the working position on the multimeter.
4. The measuring range switch functions to determine the working position and measuring limit (range).
5. The COM input jack serves as the connector for the black (negative) cable.
6. The V/Ohm /mA input jack serves as the red (positive) wire connector for all measurements.



Discussion

Based on the results of the practicum that has been carried out, it is known that electronic devices included in instrumentation components have different types and functions.

different. The preparation of a component into a tool, it is necessary to introduce the function and testing of each component first. Therefore, the practicum on the introduction of instrumentation components aims to identify the types and functions of these electronic devices. Electronic components consist of active components and passive components. Active components are components that require a source of electric current from outside (external) such as diodes, transistors and IC (*Integrated Circuit*). Passive components include components that are not

requires an external electric current source such as resistors, capacitors and inductors. This is in accordance with the statement of Pranata (2018), which states that the basic components of electronics basically consist of two parts, namely active electronic components and passive electronic components.

The tool used in measuring electronic components is a digital multimeter. A digital multimeter or often referred to as a digital multitester is a type of multimeter that has used a digital display as a viewer of the measurement results. In the experiment of testing electronic components, a digital multimeter is used as a measuring instrument to measure and test several electronic components such as measuring the resistance of electric current and the resistance value of a component of an electronic device. This is in accordance with the statement of Senja & Sumiran (2014), which states that digital multimeters are used to measure current strength (amperes), voltage (volts) and resistance whose units are Ohms.

The test results carried out on electronic components resulted in a potentiometer value of 97.5 k Ω at the maximum value and 0 k Ω at the minimum value, a resistor value of 49.3 Ω , a capacitor value of 25 volts, an LDR value in the dark state of 16.92 k Ω and in a bright position of 0.60 k Ω and a diode value of 10.25 k Ω . This is in accordance with the statement of Maulana (2017), which states that electronic components have various types, functions and different characteristics.

CONCLUSIONS

Based on the practicum that has been carried out, it can be concluded that electronic components play a role in life, especially in the field of agricultural engineering. Electronic components have different types and functions. Electronic components consist of passive components and active components. Active components are components that require an external source of electric current such as diodes, transistors and IC (*Integrated Circuit*). Passive components include components that do not require an external electric current source such as resistors, capacitors and inductors. The tool used to test electronic components is a digital multimeter.



BIBLIOGRAPHY

- Endrih M., Purnama, A. (2017). Utilization of Mobile Phone SMS Services Based on Atmega328p Microcontroller as a Home Light Control System. *Journal of Computer Engineering AMIK BSI* 93 ISSN. 2442-2436 3(1): 93-99.
- Farhan, M. (2022). Presentation of Introduction to Electronic Components. *Journal of Data Portal*, 2(4), 1-8.
- Jafar, Akbar, Rahman, E.S., & Kasim, S. (2021). Android-based Electronic Component Introduction Application: Case Study in Analog and Digital Electronics Course Vol. 19.
- Kurniadi, Dede, Mulyani. A. (2015). Computer-based Electronic Equipment Control System Software Prototype. Vol. 7.
- Ostfeld, Aminy E., Igal Deckman, Abhinav M. Gaikwad, Claire M. Lochner, & Ana C. Arias. (2015). "Screen Printed Passive Components for Flexible Power Electronics." *Scientific Reports* 5.
- Pranata, K.B., M. Si, and Sundaygara, C. (2018). Basic Electronics 1.
- Ramadhani, S., Asri, E., & Gusman, T. (2021). Augmented Reality as a Learning Media on the Introduction of Basic Electronics Components Based on Android. *JITSI: Scientific Journal of Information Systems Technology*, 2(4), 134-140.
- Senja, S. Pd, M. T., & Sumiran S. ST, M. Pd. (2014). *Basic Electronics Engineering*.



APPENDIX

Documentation of Practicum on Electronic Components .

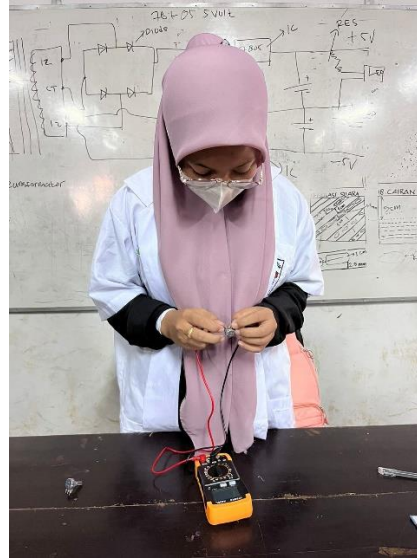


Figure 1. Testing electronic components using a multimeter.



PROTEUS AND FRITZING SOFTWARE

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ABSTRACT

There are many kinds of electronic devices that can even help human life in agriculture, information and others. However, most people do not know how these tools can work according to their functions. The purpose of the practicum of Proteus and Fritzing *Software* is to find out the function of the features contained in the ISIS and ARES programs. The tool used in this practicum is a laptop. The materials used in this practicum are Proteus and Fritzing *Software*. The method is in the form of designing components into a power supply. Based on the practicum of Proteus and Fritzing *Software*, the output results on the power supply component are close to the output of the simulation results in the Proteus *software*. The conclusion of the practicum of Proteus and Fritzing *Software* is the ability to design a tool to be made in real form. Proteus and Fritzing *software* is divided into two programs, namely ISIS and ARES.

Keywords: Fritzing, Proteus, *Software*

INTRODUCTION

Background

As time progresses, technology is getting more sophisticated as well as electronic devices. Various tools can be obtained, be it the work of others or their own work. There are many kinds of electronic devices that can help human life in the field of information and others but most people do not know how these devices can work according to their functions.

The emergence of various new technologies has become a trend in a country. This trend is related to tools that have the creativity to design and simulate electronic components precisely. Daily life will require an electronic network to support all activities that will be carried out. It should also be noted that the widespread use of electronic components has covered all areas of human life that are increasingly sophisticated. One of the electronic circuits that is often heard is the power supply.

Power supply circuit design can use Proteus and Fritzing *software* to simulate the circuit using a computer. The use of *software* in circuit testing can be done more easily and faster because the components needed are available in the *library of the software* and do not require much time to connect each component in the circuit. This *software* is great for microcontroller circuit design and learning electronics such as the basics of electronics to microcontroller applications. In addition, it has the ability to simulate the design results both digital and analog and test the circuit using this *software* the *input* value given can be adjusted easily.



Based on the description above, it is necessary to conduct a practicum to find out how to simulate electronic circuits and their application in life, especially in the field of agricultural engineering.

Purpose and Usefulness of Practicum

The purpose of this practicum is to know the function of and how to use Proteus and Fritzing *software* which is very useful in the assembly process and simulating the circuit.

The purpose of this practicum is to be able to design and simulate electronic devices such as power supplies which are very useful as a guide to the assembly process of electronic devices from electronic components.

LITERATURE REVIEW

Power supply

Power supply or *power supply* is an electronic circuit that converts alternating electric current into direct electric current. The power supply is an important part of electronics that functions as a source of electricity, for example in batteries or *batteries*. A *power supply* can also be used as a device that supplies electrical energy to one or more electrical loads (Dhitya, 2016).

In general, the principle of the power supply circuit consists of the main components, namely transformers, diodes and condensers. Making a power supply circuit, in addition to the main components, supporting components are also needed so that the circuit can function properly. These supporting components include switches, *fuses*, indicator lights, voltmeters and ammeters, *jacks* and *plugs*, PCB (*Printed Circuit Board*), cables and *plugs* and *chassis* (Dhitya, 2016).

Both the main components and supporting components play an important role in the power supply circuit. Power supply is the most important circuit for electronic systems. There are two sources of power supply, namely AC sources and DC sources. AC sources are alternating voltage sources while DC voltage sources are direct voltage sources (Dhitya, 2016).

Proteus

Proteus is a simulation *software* that also designs circuits and PCBs. Proteus combines the ISIS program to create a circuit design schematic with the ARES program to create a PCB layout from the schematic created. Proteus *software* is a combination of ISIS and ARES programs. Combining these two programs, electronic circuit schematics can be designed and simulated and made into PCB *layouts*. ISIS (*Intelligent Schematic Input System*) is the main program integrated with Proteus. ISIS is designed to draw electronic circuit schematics according to SI. (Jayanti *et al.*, 2020).

According to Jayanti (2020), using this program is expected to make it easier to assemble the circuit and reduce production costs and save time. The *screen layout* in ISIS Proteus contains several basic elements, which are as follows:

- a. *Title bar*, contains information about the active *file* name and indicates whether the simulation animation is running or not.
- b. *Menu bar*, there are several main menus namely *file*, *view*, *edit*, *tools*, *design*, *graph*, *source*, *debug*, *library*, *template*, *system* and *help*.
- c. *Toolbars*, there are 3 types: *command toolbar*, *mode selector* and *orientation*.
- d. *The command toolbar* is an alternative access to the menu bar.



- e. *The mode selector* cannot be hidden and its function is not in the menu bar.
- f. *Orientation* to display and control the direction of objects placed on the worksheet. Draw, edit and simulate circuit schematics.
- g. *Window overview*, to present objects or components that are in the *editing window*.
- h. *Object selector*, used to store various components before they are placed in the *editing window*.
- i. *Animation control panel*, used to run and stop the circuit simulation.

According to Indartono *et al.*, (2019) the features of Proteus *software* are as follows:

- a. Can simulate digital circuits or analog circuits that we create either alone or together or combined.
- b. Supports symbols of measuring instruments or test equipment for electronic components such as *Voltmeters*, *Ampere Meters* and *Oscilloscopes*.
- c. It has an *interactive peripheral design* such as LED, LCD display and RS232.
- d. Supports graphical display of various types of analysis such as *transient*, frequency, *noise*, distortion, AC and DC.
- e. Supports simulation of various types of ICs such as ATMEGA328
- f. Supports open *architecture* so that we can *upload* programs such as C++ / Arduino for circuit simulation purposes.
- g. Supports the creation of PCBs that are *updated* directly from the ISIS program to the PCB-ARES authoring program.

The hardware system uses microcontroller components, one of which is a *power supply* (voltage source). *Power supply* converts one type of electrical power to another but is capable of changing different forms of energy. The *power supply* generates voltage and converts it into DC power. This process sends the unstable voltage generated from the *power supply*. For example, solar, mechanical, or chemical into electrical energy. *Power supplies* provide components with electrical power, for example a computer *power supply* converts AC current into DC. The *power supply* for the computer is on the back side of the CPU (Kasmira *et al.*, 2018).

One form of Proteus modeling is Proteus *virtual system modeling* (VSM). VSM was introduced for industrial and educational use. Proteus VSM combines circuit simulation, animated components, and microprocessor models to facilitate co-simulation of complete *microcontroller-based* designs. Proteus VSM develops designs before physical prototypes are built (Mukherjee, 2014).

Fritzing

Fritzing is an *open source* software that can be used to visualize a *project* related to electronic circuits. The official website of Fritzing is Fritzing.org. Fritzing can help users learn and understand electronic circuits, document *projects* and create PCB designs (Fahmizal, 2022).

Fritzing is a free *software* used by designers, artists and electronics hobbyists for designing various electronic equipment. Fritzing is made as interactive and easy as possible so that it can be used by people who have minimal knowledge of the symbols of electronic devices. Fritzing has ready-to-use schematics of various Arduino microcontrollers and shields. This *software* is specifically designed for designing and documenting creative products that use a microcontroller in the form of an arduino uno. (AkAkhyar, 2021).



According to Fahmizal (2022) there are three views that can be used in Fritzing, these three views have different functions, including:

1. *Breadboard Display*

This display has visualizations of electronic components with shapes and scales that have been adjusted to the original. These components can be assembled and placed on the breadboard that has been displayed on the screen. Components that are not yet available in the *library* can also be created by the user.

2. *Schematic View*

This view is used by users to create and edit an electronic circuit in the form of a schematic.

3. *PCB Display*

This view is used by users to visualize the placement of electronic components on a PCB (*Printed Circuit Board*). PCB designs that have been made can also be *exported* to a print-ready format.

Fritzing can be useful at development stages such as assembly of prototype schematics on dummy boards and also for automated generation of schematic diagrams and printed circuit boards. The target audience of the program is creative people, researchers, designers, radio amateurs working with interactive electrical devices. Work on a new project in Fritzing begins with the selection of ready-made components, the full list of which is located in the upper corner of the working window on the right side. There is a whole set of radio parts capacitors, transistors, resistors, LEDs, batteries, buttons and more. When the user hovers the cursor over the device, a *tooltip* appears and under the component list window, the inspector shows a view, a scheme and simulates the workflow of the properties of the selected model. When the PCB window is selected, start wiring and element placement procedures can begin. The result of the work is exported to a *file* for printing with subsequent creation of the board by drawing on *textolite foil*. Fritzing contains its own software development that makes it possible to write and edit sketches, as well as send them to the microcontroller of the *platform*, specifying in advance through which serial *port it is* connected to the PC (Kryvonos *et al.*, 2022).

PRACTICUM METHODOLOGY

Time and Place

The practicum of Proteus and Fritzing *Software* was held on Saturday, September 17, 2022, at 08.00 WITA until completion, at the Laboratory of Agricultural Equipment and Machinery Engineering, Agricultural Engineering Study Program, Department of Agricultural Technology, Faculty of Agriculture, Hasanuddin University.

Tools

The tools used in the practicum of Proteus and Fritzing *Software* are laptops.

Material

The materials used in the practicum of Proteus and Fritzing *Software* are Proteus and Fritzing *software*.



Practicum Procedure

The practicum procedures for Proteus and Fritzing *Software* are:

A. Proteus

1. Open the Proteus *software* then click *new project* until the circuit schematic appears.
2. Select the components that will be used for making catudaya in the *component mode* menu and then select electronic components such as capacitors, diodes, LEDs, resistors, IC 7805 and IC 7905.
3. Assemble the selected components into a power supply.
4. Simulate the circuit results by looking at the LEDs or indicators.
5. Perform a screenshot on the final result of the power supply circuit.

B. Fritzing

1. Open the laptop, then click the Fritzing menu on the laptop.
2. Selecting the components to be used.
3. Assemble the selected components into a power supply.
4. Perform *layer capture* on the final output of the power supply circuit.

RESULTS AND DISCUSSION

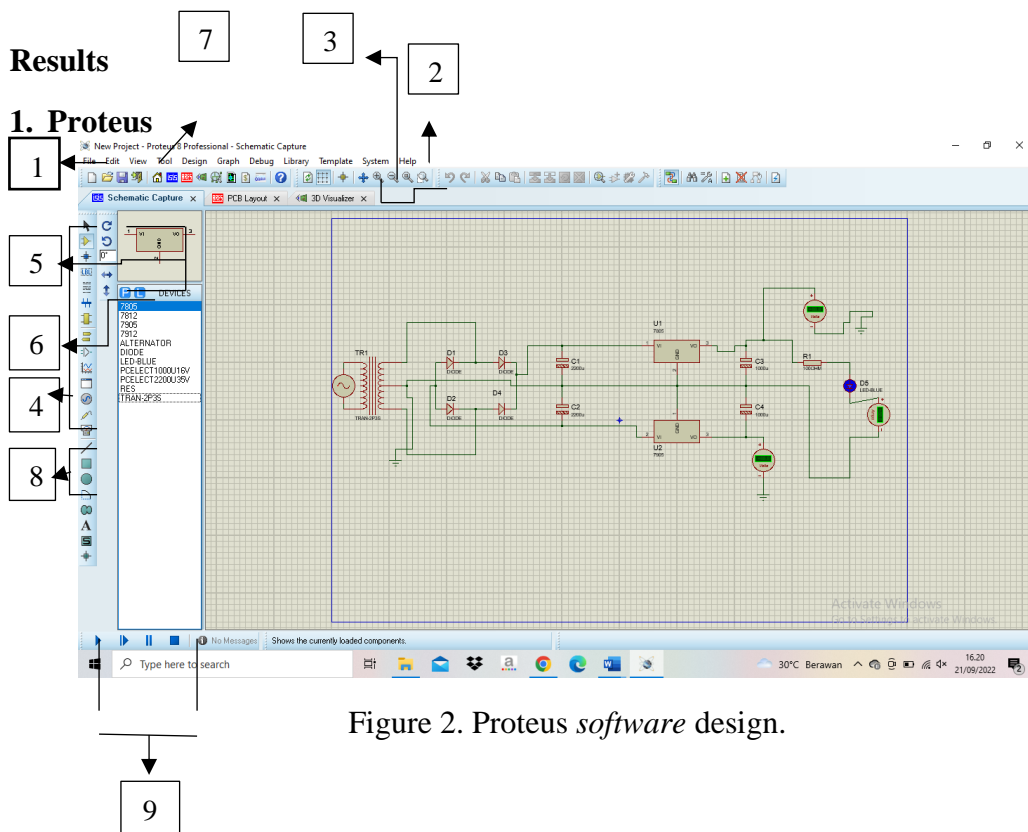




Table 2: Features of Proteus.

No.	Component Name	Description
1.	<i>Open save data includes New file, Open, Save</i>	Create a new <i>file</i> with a new drawing area, open a saved <i>file</i> , save a created <i>file</i> .
2.	<i>Toggle grid</i>	<i>The grid toggle is used</i> to display help guide points on the drawing area.
3.	<i>Zoom sheets include Center at cursor Zoom in Zoom out Zoom to view sheet Zoom to area</i>	Defines the center area of the image display by resting on the cursor. Enlarge the image. Zoom out the image. Display the entire image in the <i>layer</i> . Enlarge the image by selecting the desired area.
4.	<i>Component modes include Selection mode Component mode Terminal mode Generator mode Voltage probe Current probe Virtual Instrument mode</i>	Select and perform actions on the selected component. Retrieve components in the <i>library</i> . Retrieve and use the terminals required in the circuit. Select the pulse generator to be used. A terminal with a value display of the component's connection line with a voltage display. A terminal with a display of the value of the component connection line with a display of the current magnitude. Pick up the measuring instruments to be used.
5.	<i>Rotate and mirror covers Clockwise rotater Anticlockwise rotater X minor Y minor</i>	Rotate the object clockwise. Rotate the object counterclockwise. Mirror the object in the X direction. Mirror the object in the Y direction.
6.	<i>Pick from library</i>	Retrieve the document in the <i>library</i> that will be placed in the <i>component list</i> .
7.	<i>Mini view</i>	<i>Mini view is used</i> to display an image in the form of a small view of the entire image area.
8.	<i>Drawing tool and text includes 2D Graphic line mode 2D Graphic box mode 2D Grapic 2D Grapic ARC mode</i>	Create 2D circuit path lines. Create a 2D box drawing. Draw a 2D circle on the drawing area. Create a 2D <i>arc</i> or line in the drawing area.



9. *Operations include*
Play

Run the circuit simulation that has been made.

Step

Run the simulation in stages.

Pause

Stop the circuit simulation.

Stop

Stop the circuit simulation.

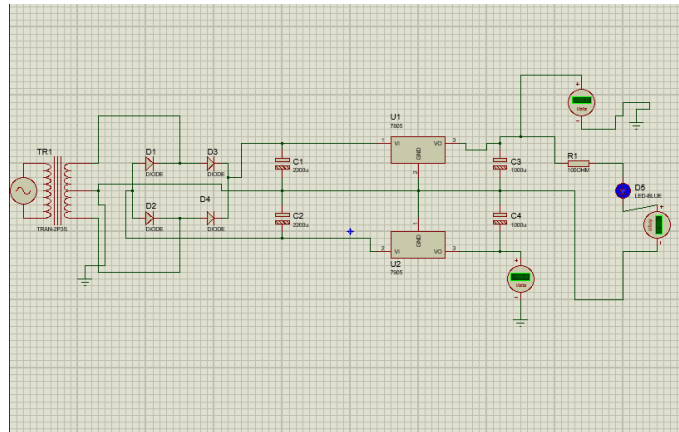


Figure 3. Power supply simulation using Proteus software.

2. Fritzing

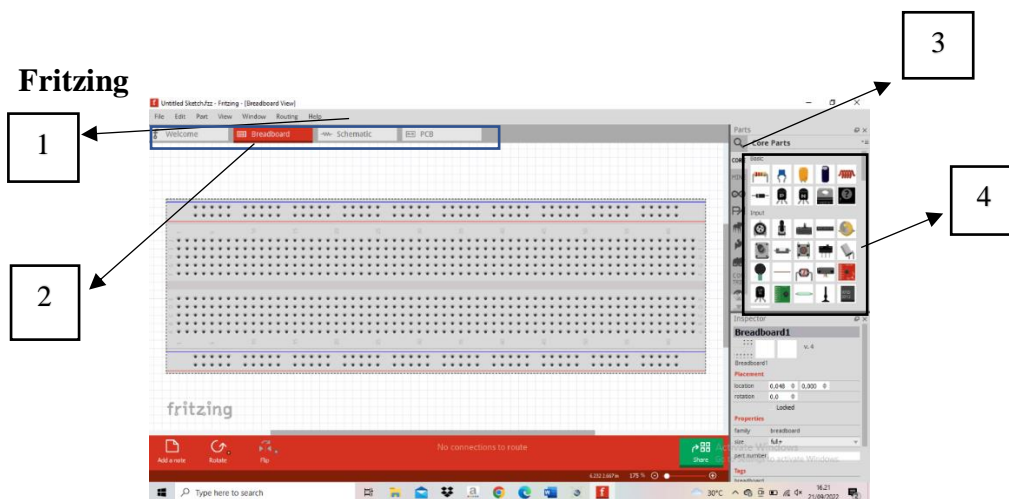


Figure 4. Fritzing Software Design.

Table 3. Features of Fritzing.

No.	Component Name	Description
1.	<i>Menu bar</i>	<i>List</i> menu used in designing and processing circuit images.
2.	<i>Layout</i>	<i>Layout</i> includes schematic <i>breadboards</i> and PCBs that function to describe electronic components in physical form, describe the shape of a symbol or logo of an electronic component and a description of the <i>layout</i> or path to be printed.



3. *Menu search* Speed up searching for components in the *library*.
4. *Tool bar* The *tool bar* includes *core, mine, arduino board, parallax, picaxe* and *sparkfun* which serves to select components from the *library*, select the type of *arduino, libraries* that work with *arduino* and provide microcontroller boards and *breakout boards*.

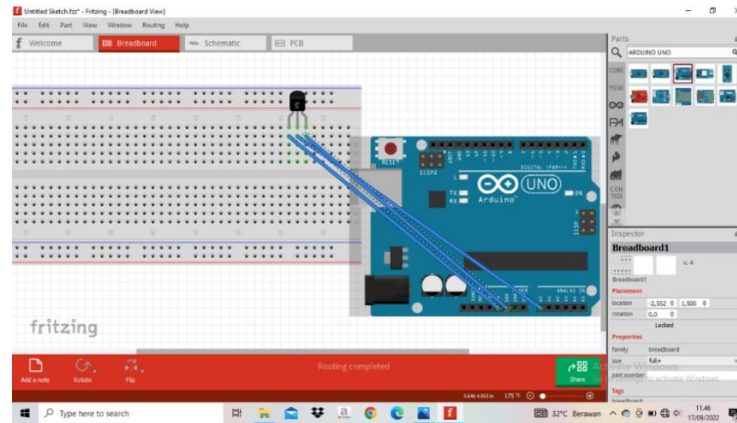


Figure 5. PCB Design Simulation Fritzing Software.

Discussion

Proteus software is one of the software consisting of a combination of ISIS (*Intelligent Schematic Input System*) and ARES (*Advanced Routing and Editing Software*) programs so that it can simulate circuits or designs on PCB layouts. ISIS (*Intelligent Schematic Input System*) is used to assemble circuits or create schematics while simulating the circuits created, and ARES (*Advanced Routing and Editing Software*) is used to create PCB layouts. This is in accordance with Jayanti's statement (2020), which states that the Proteus application is a combination of the ISIS and ARES programs. The combination of these two programs will result in an electronic circuit scheme that can be designed and simulated and made into a PCB layout.

Proteus software has different functions and features. Proteus software has many features so that the process of designing electronic circuits can be completed quickly and easily. Component values can be set as needed. Proteus software can function as a very practical and flexible electronic learning media, because it can be used to design, analyze an electronic circuit without having to assemble the actual components. This is in accordance with the statement of Indartono (2019), which states that Proteus software has various features of different functions.

Fritzing software is one of the software that is usually used by designers. Fritzing software can be accessed for free so that it is possible to learn electronic components well and contains software development. This is in accordance with the statement of Kryvonos (2022), which states that Fritzing software contains software that can be used to write and edit sketches and is usually used by designers.



CONCLUSIONS

Based on the practicum, it can be concluded that Proteus and Fritzing *software* have different features and functions. Proteus *software* consists of a combination of two programs, namely IRIS and ARES. Proteus *software* is used to simulate a circuit or design and then convert it into a PCB *layout*. Fritzing *software* can be used for free to learn various electronic components well.



LITERATURE

- Akhyar, T., Zuli F. (2021). Implementation of *Voice Recognition System as an Android-Based Remote Light Controller*. *Scientific Journal of the Faculty of Engineering LIMIT'S*, 17 (1).
- Dhitya, L. 2016. Development of Power Supply Learning Media in Basic Electronics Subjects for Vocational Schools. Thesis.
- Fahmizal, et al. (2022). Easy to learn Arduino with Fritzing, *Tinkercad* and Proteus based approach. Sleman: Budi Utama.
- Indartono, K., Tama, T. J. L., & Mushthofa, A. J. (2019). Emergency Button Wireless Based on Arduino Uno. *Techno (Journal of the Faculty of Engineering, University of Muhammadiyah Purwokerto)*, 20(1), 17.
- Jayanti, P. D., Septiani, S. D., Sofiawati, D., & Antarnusa, G. (2020). BCD coding to *Seven Segment Display* with Proteus Simulation. *Proceedings of the National Seminar on Physics Education*, 3(1), 308-322.
- Kasmira¹, Abdul Waris¹, M. T. sapsal. (2018). Design of DC Motor Rotary Speed Control System using *PID Controller* on Stirring Machine. *Agritechno Journal*, 11(1), 81-92.
- Kryvonos, O., Strutynska, O., & Kryvonos, M. (2022). *The Use of Visual Electronic Circuits Modeling and Designing Software Fritzing in the Educational Process*. *Zhytomyr Ivan Franko state university journal. Pedagogical sciences*, 1(1(108)), 198-208.
- Mukherjee, A., Ray, S., & Das, A. (2014). Development of Microcontroller Based BLDC Motor Speed Control Scheme Using Proteus VSM Software. *International Journal of Electronics and Electrical Engineering*, 2 (1), 1-7.



APPENDIX

Proteus Software Work Procedure.

1. Opened the Proteus application on the laptop.



Figure 6. Opening the Proteus application.

2. Selecting *new project* in the features in the Proteus application.

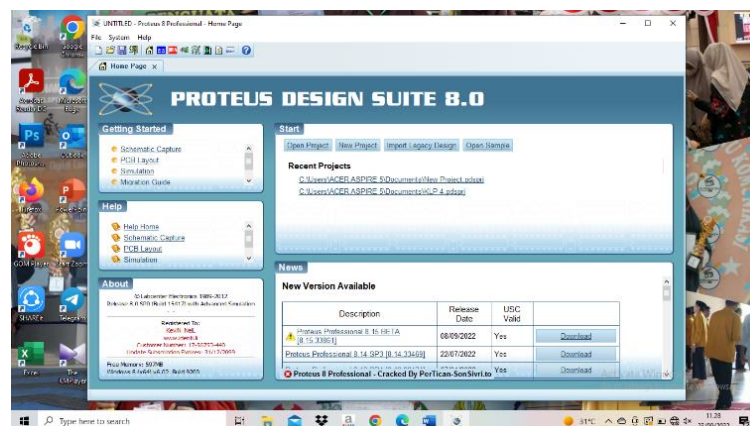


Figure 7. Selecting *New Project*.

3. Select the electronic component to be designed by pressing the P button.

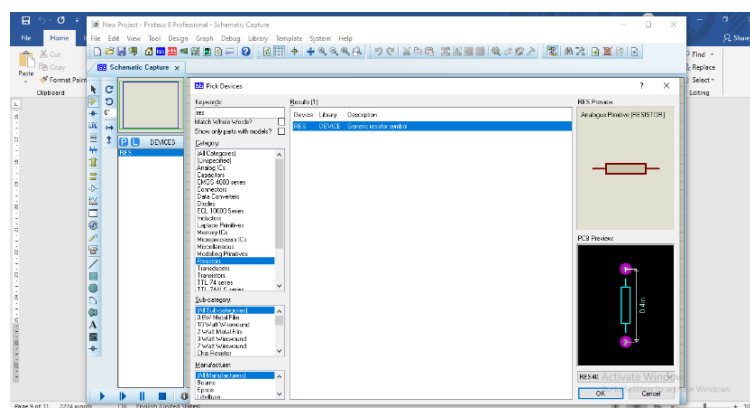


Figure 8. Selecting electronic components.



4. Assemble the power supply based on the selected components.

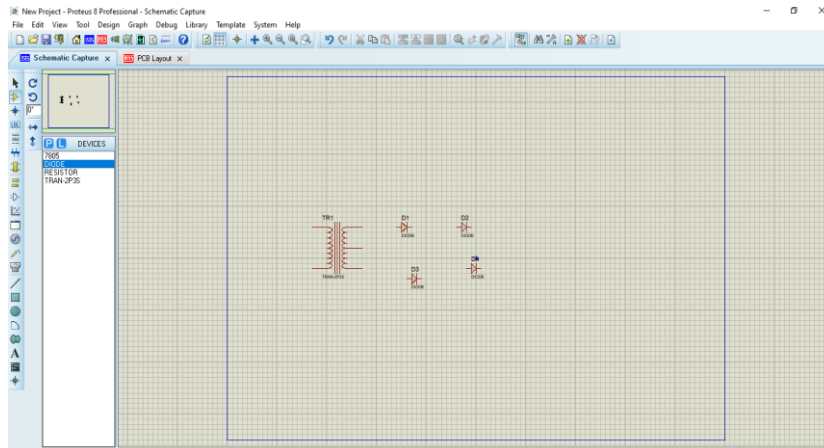


Figure 9. Assembling the Power Supply.

5. Perform simulations on the power supply circuit.

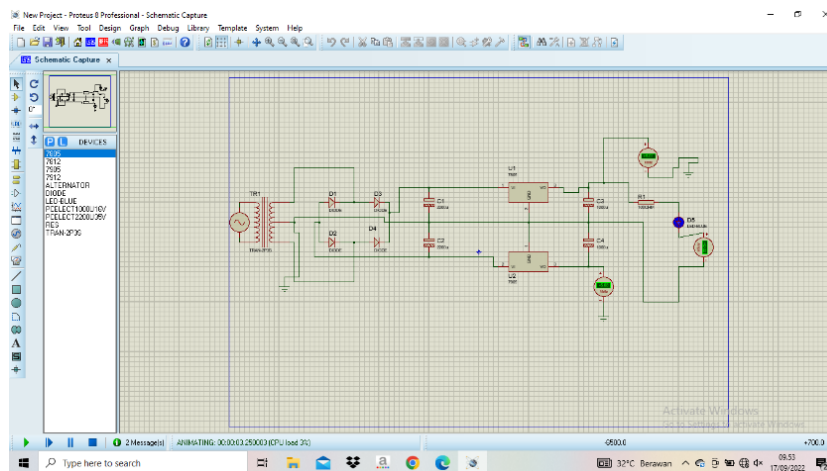


Figure 10. Simulating the Power Supply.

Fritzing Software Work Procedure.

1. Open the Fritzing application on the laptop.



Figure 11. Opening the Fritzing Application.



2. Select the *breadboard* menu.

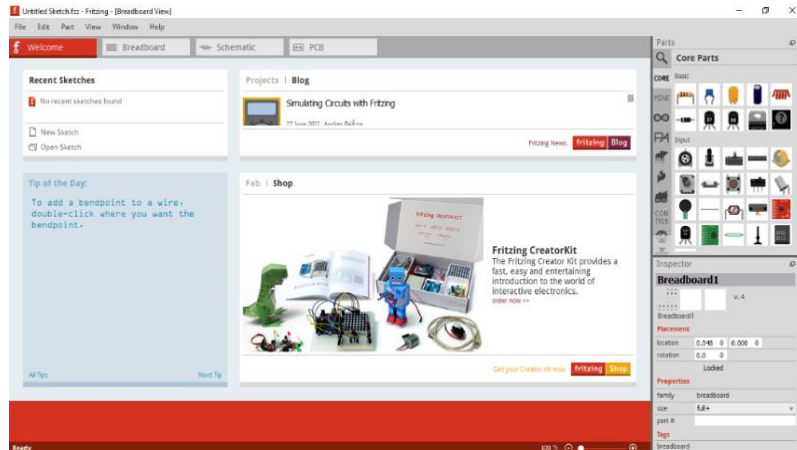


Figure 12. Breadboard menu.

3. Mount the components on the PCB board based on the selected components.

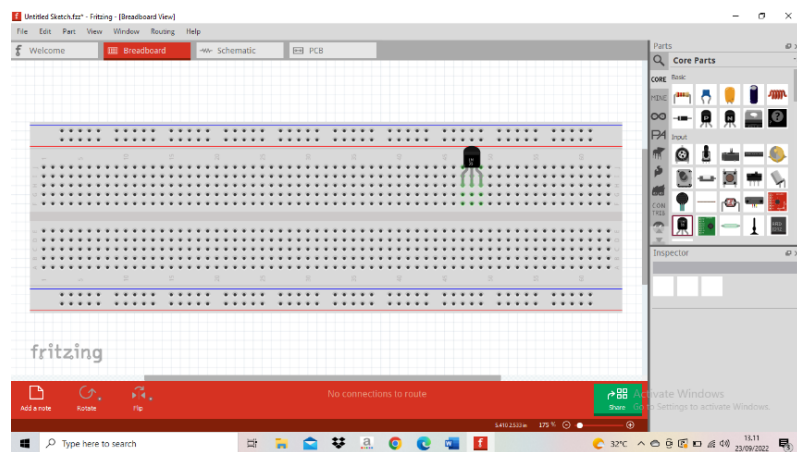


Figure 13. Mounting the Components on the PCB Board.

4. Connecting electronic components by pulling wires on a PCB board.

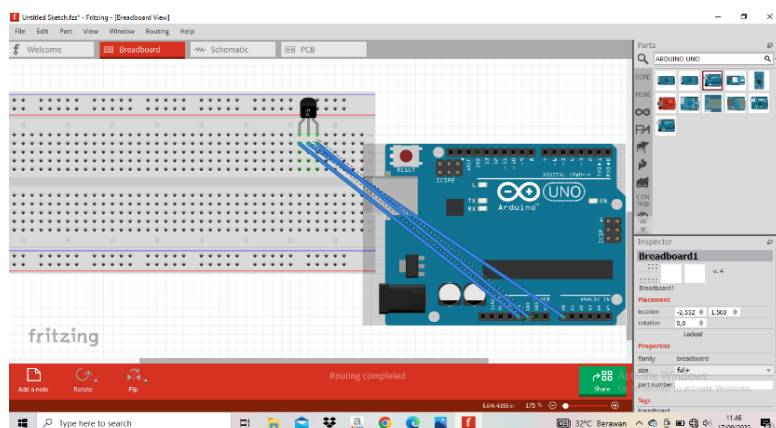


Figure 14: Connecting Components with Cables.



Documentation of Proteus and Fritzing *Software* Practicum.



Figure 15. Documentation of Proteus and Fritzing *Software* Practicum.



OPERATIONAL AMPLIFIER

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ABSTRACT

Operational amplifiers are among the most useful electronic components, one of which is for amplification. The most widely used amplifier for measurement, instrumentation, or control is the instrumentation amplifier. These amplifiers are equipped with several *Op-Amp* and precision resistors that make the circuit very stable. This is very useful for accurate measurements. The purpose of the Operational Amplifier practicum is to find out the performance functions and differences between *inverting*, *non-inverting*, *buffer* and *differential*. The method used in the Operational Amplifier practicum by assembling or designing *inverting*, *non-inverting*, *buffer* and *differential* components and then checking the output or *output* issued from each component. The results obtained by the voltage coming out of the *inverting* circuit are negative. The voltage that comes out in the *non-inverting circuit* is positive. The voltage that comes out in the *differential circuit* is the difference between the voltage in the *inverting* and *non-inverting circuits* because the voltage that comes out is zero and in the *buffer* circuit the output voltage is the same as the incoming voltage. The conclusion obtained in the Operational Amplifier practicum is that the operational amplifier consists of an *inverting* circuit, *non-inverting*, *buffer* and *differential circuits*.

Keywords: *Inverting*, Operational, Amplifier

INTRODUCTION

Background

Microcontrollers and digital technology are developing rapidly nowadays. A wide variety of microcontrollers, peripherals and digital ICs make design easier for practitioners. Even so, analog technology cannot be abandoned. Certain applications such as sensors and measuring instruments often still require analog technology.

Amplifiers are required in the manufacturing of various applications that use sensors. *Amplifiers* are used because the sensor output is too small or because the manufacturing tool requires high accuracy or high resolution. Operational amplifiers include the most useful electronic components, one of which is for amplification and in making electronic circuits, always need an external voltage source to supply digital circuits to work.

The most widely used amplifier for measurement, instrumentation or control is the instrumentation amplifier. This amplifier is equipped with several *Op-Amp* and precision resistors that make the circuit very stable. This is very useful for accurate measurements.



Based on the description above, the Operational Amplifier practicum is carried out *in order* to help know the difference between *inverting*, non-inverting, *buffer* and *differential* and know its performance function.

Purpose and Usefulness of Practicum

The purpose of the Operational Amplifier practicum is to determine the performance function and the difference between *inverting*, *non-inverting*, differential and *buffer*.

The usefulness of the Operational Amplifier practicum is to know the concepts used and know how to design or assemble a device in which there is an operational amplifier.

LITERATURE REVIEW

Operational Amplifier

An operational amplifier or commonly known as *Op-Amp* is an electronic component consisting of resistors, diodes, and transistors. *Op-Amp* is arranged in a circuit, which is called an (*Integrated Circuit*). *Op-Amp* in its application is used as an amplifier. An operational amplifier is an amplifier composed of several circuits including *inverting*, non-inverting, *buffer* and *differential* circuits. Operational amplifiers are electronic components that function to amplify direct current (DC) and alternating current (AC) signals. Operational amplifiers consist of transistors, resistors and capacitors that are assembled and packaged in an IC integrated circuit. (Nuryanto, 2017).

An operational amplifier (*Op-Amp*) is an amplifier block that has two inputs and one output. The operational amplifier (*Op-Amp*) is packaged in an integrated circuit (IC). One popular type of *operational amplifier* is the LM741. IC LM741 is an *operational amplifier* that is packaged in the form of a *dual in-line package* (DIP). DIP type IC packaging has a circle mark on the corner to mark the direction of the IC pins (Sitohang *et al.*, 2018).

Operational Amplifier (*Op-Amp*) or operational amplifier consists of analog components that are often used in various electronic circuit applications. *Op-Amp* is defined as an amplifier block that has two inputs and one output, where the output voltage is proportional to the voltage difference between the two inputs. *Op-Amp* is also called a differential amplifier with high *input* impedance and low impedance *output* (Palendeng *et al.*, 2012).

The use of *Op-Amp* is divided into two types, namely linear amplifier and non-linear amplifier. Linear amplifiers include amplifiers that maintain the shape of the input signal, which include non-inverting amplifiers, *inverting* amplifiers, *differential* summation and instrumentation amplifiers. While the non-linear amplifier is an amplifier whose output signal shape is not the same as the input signal shape, such as integrators and differentiators. (Nuryanto, 2017).

Inverting

One of the amplifier configurations with an *Op Amp* is an *inverting* amplifier. The *output* of this configuration reverses the *input* polarity while amplifying with a specific gain function. The gain is built and determined by two resistors R_f and R_i . This amplifier is more widely used because of better stability and easier calculation of gain. (Mandayatma, 2019).



This amplifier is called an inverting amplifier because the *input of the* amplifier is the inverting *input of the Op Amp*. of the *Op Amp*. The output signal produced by this type of amplifier is in phase with the input signal. The use of an inverting amplifier is identical to operate as a transimpedance amplifier and voltage comparator which guarantees zero input *offset current* regardless of how the inverting *amplifier* is implemented, this allows the *amplifier to* be simple which drives the load current allowing the exchange of power delays by adjusting the load current. This inverting amplifier circuit has an inverting amplifier with a very low input impedance. This *inverting* amplifier is called an operational amplifier which is always connected with feedback (Suriyavejwongs et al., 2014). (Suriyavejwongs *et al.*, 2017)..

Non Inverting

The basic circuit of an *inverting* amplifier is shown where the input signal is made through a *non-inverting input*. The output voltage of this circuit will be in phase with *its input* voltage. If $V_{in}=V_{+}$ and $V_{+}=V_{-}$ in. Based on this, it is known that the pinch voltage at R_f is $V_{out}-V_{-}=V_{out}-V_{in}$, or $i_{out}=(V_{out}-V_{in})/R_f$. The pinch voltage at R_1 is $V_{-}=V_{in}$, which means the current $i_{R1}=V_{in}/R_1$. Kirchoff's law at the *inverting input* point that $i_{out} + i_{(-)}=i_{R1}$ and $i_{(-)}=0$ and if it is subsumed into the previous formula, it is obtained $i_{out} = i_{R1}$ and If written with each pinch voltage, it is obtained $(V_{out}-V_{in})/R_f = V_{in}/R_1$ which can then be simplified into: $V_{out} = V_{in} (1+R_f/R_1)$. Gain G is the ratio of the output voltage to the input voltage, then the gain of the Op-Amp is obtained *non-inverting Op-Amp gain*: $G=V_{out}/V_{in}=(1+R_f/R_1)$ (Triyono., 2019).

Differential

A differential amplifier has two inputs that function only to amplify the difference signal between V_1 and V_2 the difference between the two input voltages. The differential amplifier in an operational amplifier (*Op Amp*) is made using direct coupling (DC coupling) which aims to eliminate the effects caused by the addition or installation of *bypass* capacitors and coupling capacitors. The use of DC coupling in this differential amplifier aims to avoid the slowdown problem that occurs due to charging on the coupling capacitors (coupler) by the DC source voltage, thus the DC working point to reach a stable point also requires a *time* delay (*time constant*). So that it results in the effect of increasing the lower frequency limit (f_L) due to the increase in time to reach a stable (*time constant*) which is slower., because the differential pair amplifier consists of two transistors, then to get a symmetrical DC working point, two transistors are needed that have a physis shape configuration with the same characteristics, while to avoid the effect of different temperature changes on the two transistors, the installation of the two transistors should be made in such a way as to pair with each other. (Setiadi, 2015).

The hardware system uses microcontroller components, one of which is a *power supply* (voltage source). *Power supply* converts one type of electrical power to another. But it is capable of changing different forms of energy. The *power supply* generates voltage and converts it into DC power. This process sends the unstable voltage generated from the *power supply*. For example, solar, mechanical, or chemical into electrical energy. *Power supply* provides components with electrical power (Kasmira *et al.*, 2018).



Buffer

A *buffer* circuit is a circuit that produces a voltage whose output is equal to *its input* voltage. An example is like a *common collector* circuit that has an amplifier equal to one. The function of the *buffer circuit* on the equipment electronics is as a buffer, where the basic principle is a current amplifier without voltage gain. The *buffer* circuit is built from an *operational amplifier (Op Amp)*. The *buffer* circuit of the *Op Amp* becomes very simple because no additional components are needed in the non-inverting buffer configuration. *non-inverting buffer configuration*. Connecting the *inverting input* line to the *output* line of the *operational amplifier (Op Amp)*, the *buffer circuit* will provide the ability to drain the maximum current according to the maximum ability of the *operational amplifier (Op Amp)* to drain the *output* current. A *buffer* circuit with an *operational amplifier (Op Amp)* produces a gain of +1. This circuit is very beneficial because we can get an amplifier with a very high *input* resistance (*input* impedance) and with a very low *output* resistance (*output* impedance) which is close to ideal conditions. This *buffer* circuit is also referred to as a follower circuit, an improved form of emitter follower amplifier. (Setiadi, 2015).

PRACTICUM METHODOLOGY

Time and Place

Operational Amplifier Practicum was held on Saturday, September 24, 2022, at 08.00 WITA until completion, at the Laboratory of Agricultural Equipment and Machinery Engineering, Agricultural Engineering Study Program, Department of Agricultural Technology, Faculty of Agriculture, Hasanuddin University.

Tools

The tool used in the Operational Amplifier practicum is a laptop.

Material

The material used in the Operational Amplifier practicum is Proteus *software*.

Practicum Procedure

The procedure for the Operational Amplifier practicum, namely:

1. Prepare tools and materials.
2. Opening Proteus.
3. Locate the components to be assembled.
4. *Inputting* and assembling components.
5. Simulate the circuit created
6. Practitioner documentation.

Formula Used

a. Inverting circuit

$$V_{out} = -\frac{R_f}{R_{in}} V_{in}$$

Description:

V_{out} = output voltage (V)

V_{in} = input voltage (V)

R_f = resistance 2 (Ω)

R_{in} = resistance 1 (Ω)



b. Non-Inverting Circuit

$$V_{out} = 1 + \frac{R_2}{R_1} \times V_{in}$$

Description:

- V_{out} = output voltage (V)
- V_{in} = input voltage (V)
- R_f = resistance 2 (Ω)
- R_{in} = resistance 1 (Ω)

c. Buffer circuit

$$V_{out} \approx V_{in}$$

Description:

- V_{in} = input voltage (V)
- V_{out} = output voltage (V)

d. Differential circuit

$$V_{out} = \left(\frac{R_1 + R_2}{R_3 + R_4} \right) \frac{R_4}{R_1} V_2 - \frac{R_2}{R_3} V_1$$

Description:

- V_{out} = input voltage (V)
- R_1 = resistance 1
- R_2 = resistance 2
- R_3 = resistance 3
- R_4 = resistance 4

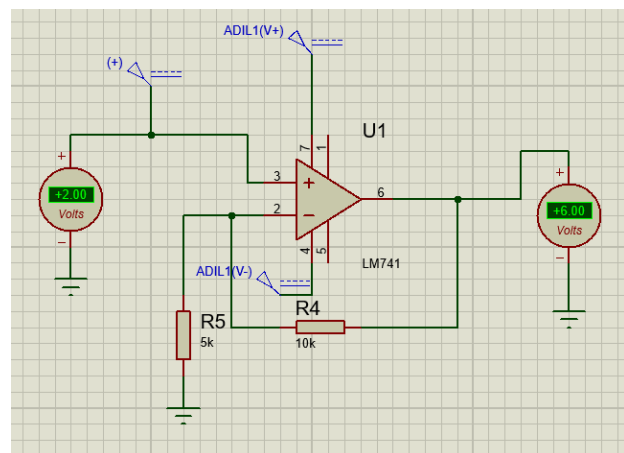
RESULTS AND DISCUSSION

Results

Table 4. Results and Tests of the Operational Amplifier Circuit.

No.	Circuit Name	Image
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1. Proteus Software:

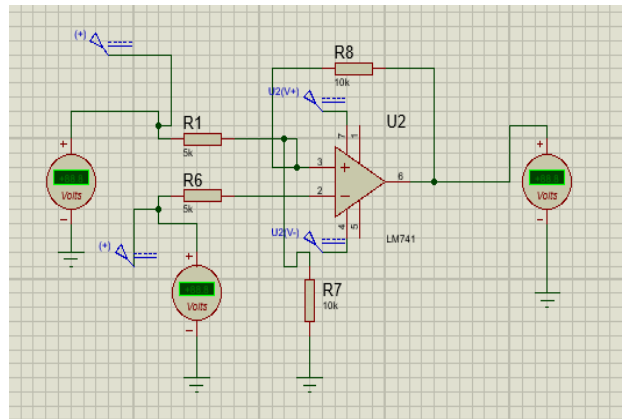


V_{in} : +2.00
 V_{out} : -4.00
 Manual: -0,15



2. *Non-Inverting*

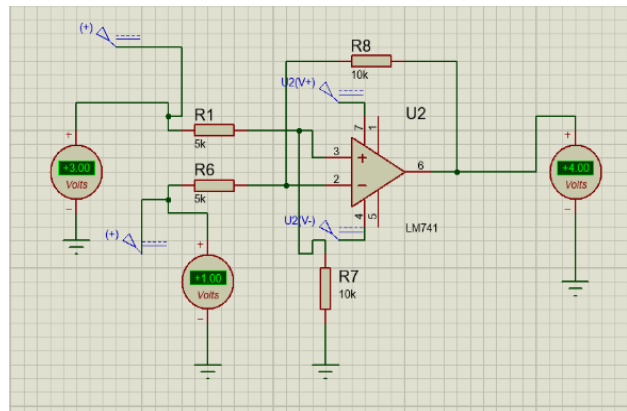
Proteus Software:



V_{in} : +2.00
 V_{out} : +6.00
Manual: +2.60

3. *Differential*

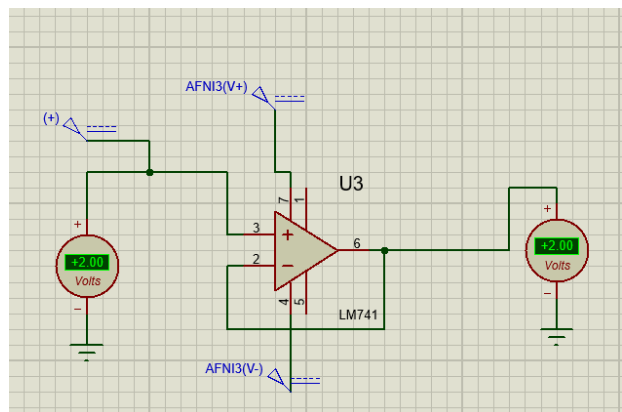
Proteus Software:



V_{in} : +3.00
 V_{out} : +4.00
Manual: 0

4. *Buffer*

Proteus Software:



V_{in} : +2.00
 V_{out} : +2.00
Manual: +2



Discussion

Based on the Operational Amplifier practicum that has been carried out, namely measuring the outgoing voltage *in the inverting, non-inverting, buffer and differential* circuits, it is known that the *inverting amplifier* is an amplifier block that has two inputs and one output. This amplifier is called an inverting amplifier because the *input of the amplifier* is the inverting *input of the Op Amp*. The voltage that comes out in the *inverting* circuit is negative because the *inverting amplifier* will always be inverse to the incoming voltage and to find out the *output* value of the voltage is not inverted phase then it must use a non-inverting amplifier circuit. *The non-inverting* amplifier is called an inverting amplifier because the *input of the amplifier* is the inverting *input of the Op Amp*. The voltage that comes out in the *non-inverting* circuit is positive because it is an amplifier that does not invert the voltage. The output voltage of this circuit will be in phase with the input voltage. A *differential* amplifier is an amplifier whose output voltage (V_{out}) is the difference between the two voltages *in inverting and non-inverting*. *The* voltage that comes out in the *differential circuit* is the difference between the voltage *in the inverting and non-inverting circuits and* in the *buffer* circuit the output voltage is the same as the incoming voltage. This is in accordance with the statement of Nuryanto (2017), which states that the operational amplifier is composed of several circuits including *inverting* circuits, non-inverting, *buffer* and *differential*.

CONCLUSIONS

The conclusion of the Operational Amplifier practicum is that there are four circuits in the operational amplifier including *inverting, non-inverting, buffer and differential*. *The* output of this *inverting amplifier* will always be inverse to its input when the circuit is measured. The output voltage of the *non-inverting* circuit will be in phase with the *input* voltage. The voltage that comes out in the *differential circuit* is the difference between the voltage *in the inverting and non-inverting circuits and* in the *buffer* circuit the output voltage is the same as the incoming voltage. In designing or assembling a device in which there is an operational amplifier, skills and understanding are needed regarding how the difference between the four amplifiers and simulate it in the Proteus *software* circuit so that the input and output voltage can be known.



LITERATURE

- Kasmira, Abdul Waris, M. T. sapsal. (2018). Design of DC Motor Rotary Speed Control System Using PID Controller on Stirring Machine. *Agritechno Journal*, 11(1), 81-92.
- Mandayatma, E. (2019). Optimization of *Feedback* Resistance and *Input* Resistance in Inverting Amplifier for Signal Conditioning. *Eltek Journal*, 17(1), 44.
- Nuryanto, L. E. (2017). Application of *Op-Amp (Operational Amplifier)*. *Orbith*, 13(1), 43-50.
- Sitohang, E. P., Mamahit, D. J., & Tulung, N. S. (2018). Design of DC Power Supply Using Atmega 8535 Microcontroller. *Journal of Electrical and Computer Engineering*, 7(2), 135-142.
- Suriyavejwongs, P., Leelarasmee, E., Pora, W., & Tontisirin, S. (2017). *Inverting Amplifier Based Ultra Low Power Low Offset Current Comparator*. 2017 International Electrical Engineering Congress, IEECON 2017, April 2018.
- Setiadi, D.A. (2015). Effectiveness of *Adobe Flash Professional Cs6 Based Differential Amplifier Learning Media* on Electrical Engineering Student Learning Outcomes. Effectiveness of *Adobe Flash Professional Cs6 Based Differential Amplifier Learning Media on Electrical Engineering Student Learning Outcomes Semarang State University*. Thesis.
- Triyono. (2019). *Op-Amp Application Design with Gui Matlab Software*. *Engineering Journal*, 1(2), 16-25.
- Palendeng, I. H., Wuwung, J. O., Allo, E. K., Narasiang, B. S., & Elektro-ft, J. T. (2012). Design of a Wireless Audio System Using Fm Radio Waves. *Journal of Electrical and Computer Engineering*, 1(4), 1-5.



APPENDIX

Experimental procedure.

1. Open the Proteus application.



Figure 16. Opening Proteus.

2. Search for components to be assembled.

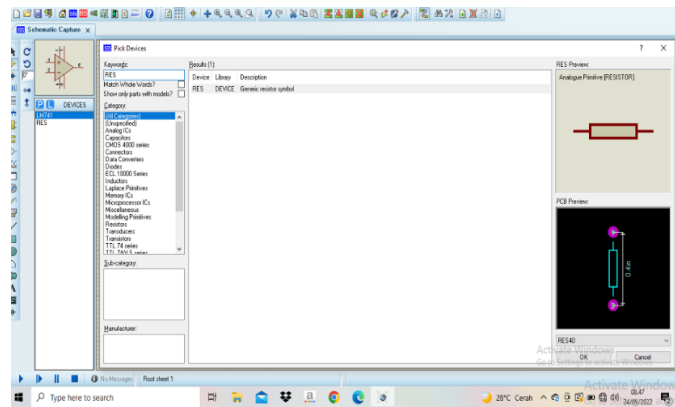


Figure 17. Library view.

3. Inputting components.

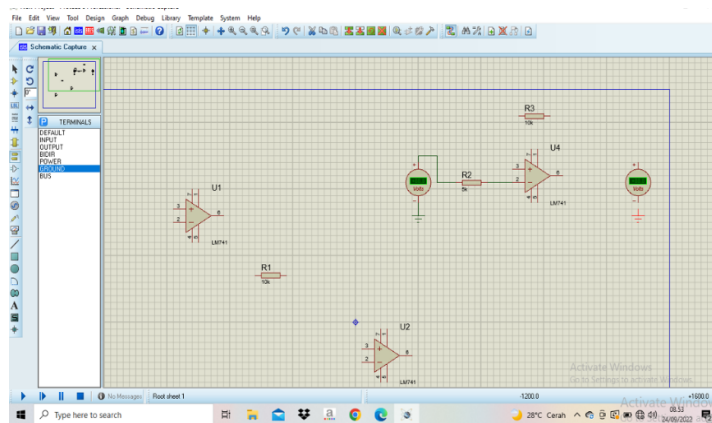


Figure 18. Component input view.



5. Assemble the selected components.

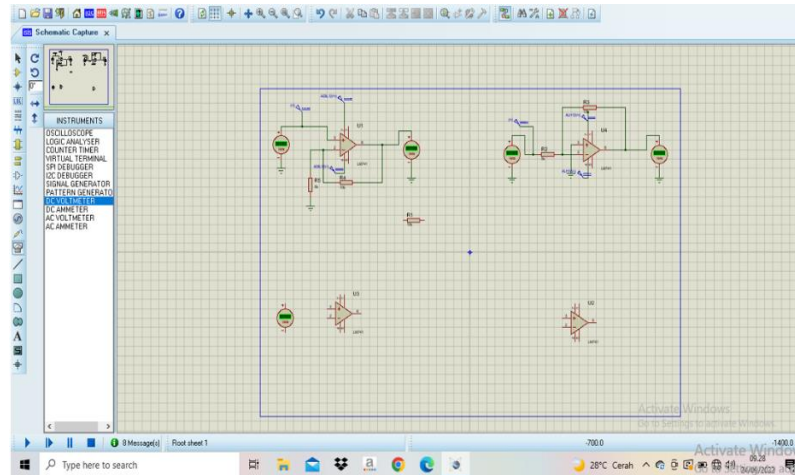


Figure 19. Assembling the Components.

Appendix 6. Calculations.

a. Inverting

$$V_{out} = - \left(\frac{R_f}{R_{in}} \right) V_{in}$$

$$\begin{aligned} V_{out} &= - \left(\frac{10}{5} \right) 2 \\ &= - (2) 2 \\ &= - 4 \end{aligned}$$

b. Non-inverting

$$V_{out} = \left(\frac{R_f}{R_1} + 1 \right) V_{in}$$

$$\begin{aligned} V_{out} &= \left(\frac{10}{5} + 1 \right) 2 \\ &= (3) 2 \\ &= 6 \end{aligned}$$

c. Differential

$$V_{out} = \left(\frac{R_f}{R_g} + \frac{R_1}{R_2} \right) \frac{R_g}{R_1} V_2 - \frac{R_f}{R_1} V_1$$

$$\begin{aligned} V_{out} &= \left(\frac{10}{10} + \frac{5}{5} \right) \frac{10}{5} 3 - \frac{10}{5} 1 \\ &= (2) 3 - 2 \\ &= 6 - 2 \\ &= 4 \end{aligned}$$



d. Buffer

$$V_{out} \approx V_{in}$$

$$2 = 2$$

Documentation of Operational Amplifier Practicum .



Figure 20: Creating an operational amplifier circuit.



VOLTAGE DIVIDER CIRCUIT

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ABSTRACT

Voltage dividers are often found in various electronic equipment to prevent excess current flowing. Voltage divider is used as a tool to regulate the incoming voltage so that the output current becomes stable. The purpose of the Voltage Divider practicum is to determine the performance function and the difference between the voltage divider circuit using a resistor and potentiometer. The method used in the practicum of the Voltage Divider circuit by assembling or designing a voltage divider circuit using a resistor and potentiometer which then checks the output or *output* issued from each component. The results obtained from the practicum of Voltage Divider Circuit in the form of the same *output* value between the voltage divider circuit using Proteus *software* or manually. The conclusion of the Voltage Divider circuit practicum is that the voltage value contained in the circuit using a resistor is fixed while the voltage value contained in the potentiometer circuit cannot be changed.

Keywords: Circuit, Voltage, Divider

INTRODUCTION

Background

Voltage is related to the charge of electric current. This flow is in the form of electron flow or ion flow. This flow must pass through an electrically conductive medium commonly referred to as a conductor. The most widely used conductor in everyday life is metal cable. When two ends of the cable are connected to a voltage source, such as a battery, electrons will flow through the conductor cable from the negative pole to the positive pole of the battery. This flow of electrons is referred to as electricity.

In electronic circuits sometimes we need a voltage of a certain value, for example 3V while the existing voltage source is 5V, then we can make it by using a voltage divider circuit (*voltage divider*). Voltage dividers are often found at the input of measuring instruments to prevent excess current flowing in μ -ampere. Voltage divider circuits are usually used to create a reference voltage from a larger voltage source, a reference voltage point on the sensor, to provide bias to the amplifier circuit or to bias the active component.

Based on the description above, the Voltage Divider practicum is important to do in order to help determine the difference between the difference between the voltage divider circuit using a resistor and potentiometer and know its performance function.

Purpose and Usefulness of Practicum

The purpose of the Voltage Divider Circuit practicum is to find out the performance functions and differences between voltage divider circuits using resistors and potentiometers.



The purpose of the practicum Voltage Divider Circuit is to know the concepts used and know how to design or assemble a device in which there is a voltage divider.

LITERATURE REVIEW

Voltage

Voltage or often people call it a potential difference (*voltage*) is the work done to move one charge (by one *coulomb*) on an element or component from one terminal to another, or on both terminals will have a potential difference if we move a charge of 1 C from one terminal to another. The relationship between the work done is actually the energy released, so the above understanding can be shortened that voltage is energy per unit charge. (Rosman *et al.*, 2019).

Voltage Divider Circuit

Voltage divider circuit is a circuit consisting of two or more resistors, assembled in series and then connected to a *Direct Current* (DC) voltage source. The voltage divider circuit serves to convert a large DC voltage to a smaller voltage. In general, DC voltage sources use batteries as a stable source of electricity to supply energy to a circuit. (Fuada *et al.*, 2022).

The voltage divider circuit is a simple circuit that can convert a high voltage into a lower voltage using only two resistors installed in series and with an *input voltage*, it can create an *output voltage* where this *output* voltage is the result of the calculation of the *input voltage*. Voltage divider circuits are usually used to create a reference voltage from a larger voltage source, a reference voltage point on a sensor, to provide bias to an amplifier circuit or to bias an active component. The voltage divider circuit can basically be made with 2 resistors, an example of a basic voltage divider circuit with VO *output* from source voltage VI using voltage divider resistors R1 and R2. *Voltage divider* circuit (*voltage divider*) is also known as a potential divider circuit (*potential divider*). The *input* to a voltage divider circuit is the V_{in} voltage. The V_{in} voltage drives the current I to flow through both resistors. Because the two resistors are connected in series, the same current flows through each resistor. The effective resistance of the two resistors in series is $R1 + R2$. The voltage drop on the combination of these two resistors is V_{in} or V_{input} (Sudirham, 2002).

A voltage divider circuit is a circuit that divides the voltage by a certain value, which is proportional to the value of the resistor that composes it. Generally, the voltage divider circuit is composed of at least 2 resistors in series. The *output* voltage value in the voltage divider circuit can be calculated by the formula $V_{output} = V_{input} \times R2 / (R1 + R2)$ (Artanto, 2017).

Voltage dividers are often used in potentiometers, which are electronic components used to design a voltage divider whose *output voltage* can be adjusted. Potentiometers are used to convert translational or angular motion into a change in resistance that can be directly converted into a voltage signal or electric current. Resistive potentiometers are one of the simplest shift transducers. This voltage divider can be used to create a reference voltage from a relatively large voltage source that provides bias to active electronic components, amplifier circuits and so on. The principle of the voltage divider circuit consists of one or two more components assembled in series and connected to a voltage source (Ponto, 2019).



Series and Parallel circuits

The series circuit is one of the electrical circuits arranged in parallel (series). The series circuit consists of two or more electrical loads connected to the power supply through one circuit. Parallel circuit is one of the electrical circuits arranged in a row (parallel). Parallel circuit is one that has more than one part of the circular line to drain the current. Motorized vehicles, most of the electrical loads are connected in parallel. The characteristic of the series circuit is that the voltage from the source will be divided by the amount of resistance installed on each branch. While the current flowing in the load is the same. The parallel circuit is the current flowing on each branch depending on the value of the resistance installed on the branch, while the voltage on the electrical load is the same as the source voltage. (Rosman *et al.*, 2019).

Voltage Divider Function

A voltage divider is used as a tool to divide the voltage so that it can be measured by a measuring instrument. Voltage dividers can be resistive, capacitive or inductive voltage dividers. Each voltage divider has a maximum voltage specification that can be connected, the higher the maximum voltage limit, the more expensive the price of the voltage divider, to overcome the maximum voltage limit, a series circuit of several voltage dividers can be done to measure a higher voltage. (Haryono & Bambang, 2017).

The voltage amplifier serves to amplify the voltage generated from *electrical conductivity*. The voltage generated in the form of AC voltage is then converted to DC voltage by DAC. After that, the voltage is filtered by a filter before entering the microcontroller. The voltage divider circuit is usually used to divide the voltage or convert from resistance to a voltage. Usually the function of this voltage divider is to convert or convert from a larger voltage voltage to bias the active components in the circuit. (Azizah *et al.*, 2019).

One of the measuring instruments or sensors that utilize a voltage divider circuit is the *Force Sensitive Resistor (FSR) Sensor*. *Force Sensitive Resistor (FSR)* sensor is a type of resistive sensor that receives a force in the form of pressure and has an impact on changing the resistance value of the FSR. By placing this FSR sensor in a voltage divider circuit, this sensor can be used to measure pressure values and produce voltage changes caused by changes in pressure values (Wahyu *et al.*, 2017). (Wahyu *et al.*, 2017).

PRACTICUM METHODOLOGY

Time and Place

The Practicum of Voltage Divider was held on Saturday, October 1, 2022, at 08.00 WITA until completion, at the Laboratory of Agricultural Equipment and Machinery Engineering, Agricultural Engineering Study Program, Department of Agricultural Technology, Faculty of Agriculture, Hasanuddin University.

Tools

The tool used in the Voltage Divider practicum is a laptop.

Material

The material used in the Voltage Divider practicum is Proteus *software*.



Practicum Procedure

The procedure for the Voltage Divider practicum, namely:

1. Prepare tools and materials.
2. Opening Proteus.
3. Locate the components to be assembled.
4. *Inputting* and assembling components.
5. Simulate the circuit created
6. Document the circuit results.

Formula Used

$$V_{out} = V_{in} \frac{R_2}{R_1 + R_2}$$

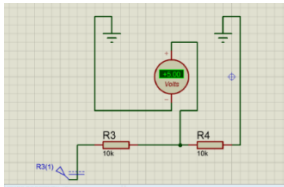
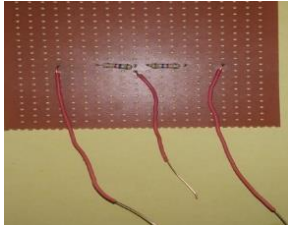
Description:

- V_{in} = input voltage (V)
 V_{out} = output voltage (V)
 R_1 = resistance 1
 R_2 = resistance 2

RESULTS AND DISCUSSION

Results

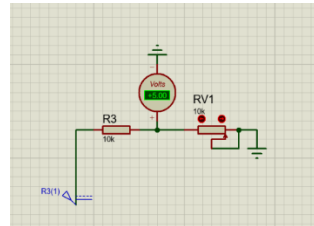
Table 5. Voltage Divider circuit.

No.	Circuit Name	Image
1.	Voltage Divider with Resistor	<p>Proteus Software:</p>  <p>Maximum Value: +5.00 Minimum Value: 0.00</p> <p>Series:</p>  <p>Input: 10 V Output: 2.06</p>



2. Voltage Divider with Potentiometer

Proteus Software:



Maximum Value: +5.00

Minimum Value: 0.00

Series:



Input: 10 V

Minimum Output: 0.37 V

Maximum Output: 4.04V

Discussion

The practicum of the Voltage Divider circuit is carried out using Proteus *software*. The value obtained from the voltage divider circuit using a resistor is +5.00. The value is also the same when calculating with the formula. This voltage divider circuit is composed of two resistors, using two resistors mounted in series and with a voltage *input*, can create an *output voltage*. Besides using Proteus *software*, the voltage divider circuit is also assembled manually. The *output voltage* obtained is the result of the calculation of the *input voltage*. The *output voltage* of the voltage divider circuit using a resistor is fixed. This is in accordance with the statement of Artanto (2017), that generally the voltage divider circuit is composed of at least 2 resistors in series.

Apart from using a resistor, a voltage divider circuit can also use a potentiometer. The value obtained from the voltage divider circuit using a potentiometer is +5.00. The value is also the same when calculating with the voltage divider formula. The voltage divider circuit with a potentiometer is slightly different from the one using a resistor, because the *output voltage* can be changed. The principle of a voltage divider circuit using a potentiometer consists of one or two more components assembled in series and connected to a voltage source as an *input voltage* source. The *output voltage* is the result of the calculation of the *input voltage*. This is in accordance with the statement of Ponto (2019), that a voltage divider is often used on a potentiometer, which is an electronic component used to design a voltage divider whose output voltage can be adjusted.



CONCLUSIONS

Based on the practicum of the Voltage Divider Circuit, it can be concluded that the voltage divider circuit is a simple circuit that can convert a high voltage into a lower voltage. The resistance value in the voltage divider circuit using a resistor is fixed or cannot be changed, in contrast to the voltage value in the voltage divider circuit using a potentiometer whose value can be changed. The function of this voltage divider is to change or convert from a larger voltage to give a bias to the active components in the circuit.



LITERATURE

- Artanto, Dian. (2017). *Sensor and Actuator Interface Using Proteus, Arduino, and Labview*. Deepublish Publisher: Yogyakarta.
- Azizah, A., Waris, A., & Sapsal, M. T. (2019). Application of *Fuzzy Logic* System in Measuring Nutrient Levels in Hydroponic Systems. *Agritechno Journal*, 12(2), 85-93.
- Fuada, S., Yasmin, M., Yustina, M. C., Amalia, A., Pratiwi, D. A., Annisa, A., Kubro, N. Z., Sutia, D., Parulian, S., Gani, M., Darussalam, B., Febriliana, R., Tiyastanti, Y., Ilham, R., Rukmantara, A., Fujiyanti, V., & Nazarudin, G. A. (2022). *Analysis of Voltage Divider Circuit and Comparison of Simulation Results Using Offline Simulator*. 6(1), 28-46.
- Haryono, & Bambang. (2017). Use of Low Voltage Divider to Measure Higher Voltage. *Thesis*: Gajah Mada University.
- Ponto, H. (2018). *Basic Electrical Engineering*. Deepublish Publisher: Yogyakarta.
- Rosman, A., Risdayana, Yuliani, E., & Vovi. (2019). Current and voltage characteristics in series and parallel circuits using resistors. *Scientific Journal d'Computare*, 9, 40-43.
- Sudirham, S. (2002). *Electrical Circuit Analysis*. Bandung: ITB Publisher.
- Wahyu, R., Simandjuntak, L., Pasila, F., Khoswanto, H., Studi, P., Elektro, T., Petra, U. K., & Siwalankerto, J. (2017). Volume Level Detection of Liquid Milk in Laminated Cardboard Packaging Box for Refrigerator Shelf. *Journal of Electrical Engineering*, 10(2), 60-64.



APPENDIX

Experimental Procedure.

1. Open the Proteus application.



Figure 21. Opening Proteus.

2. Search for components to be assembled.

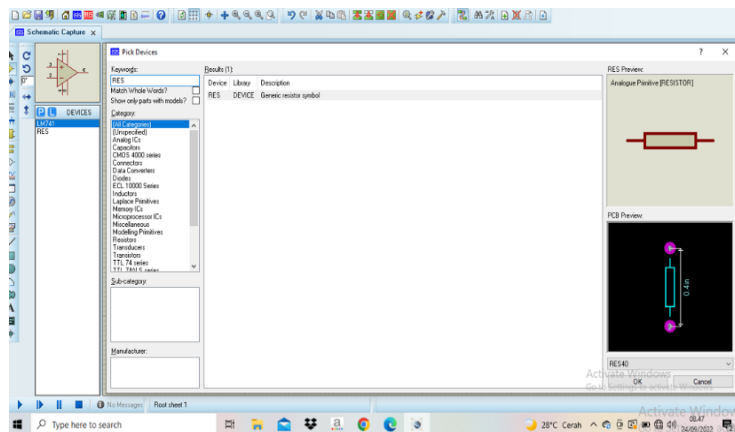


Figure 22. Library view.

3. Inputting components.

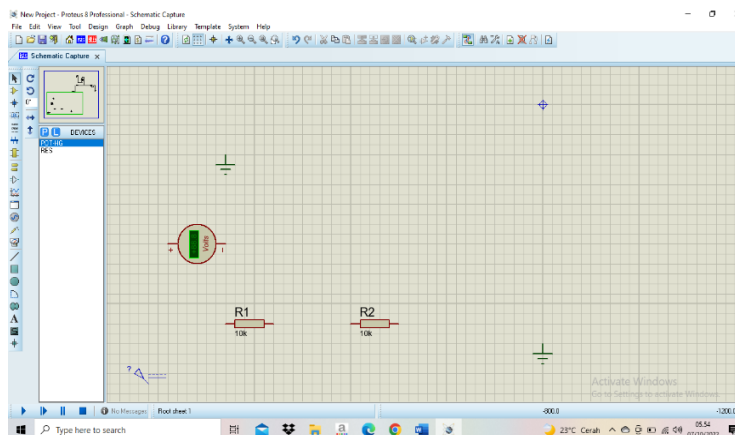


Figure 23: Component input view.



4. Assemble the selected components.

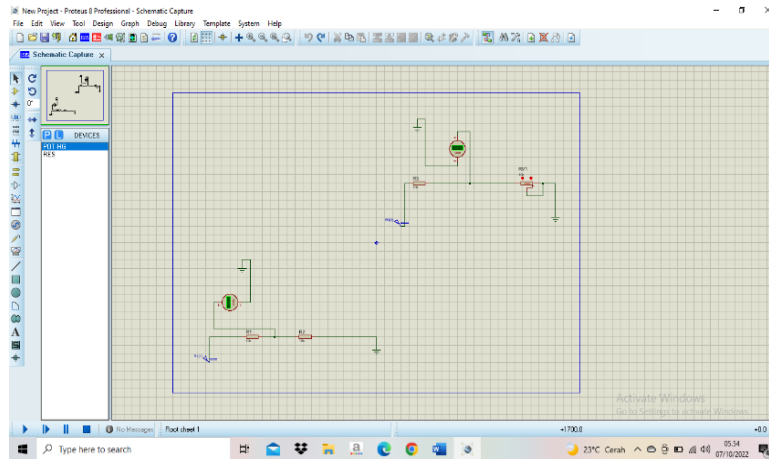


Figure 24. Assembling the Components.

Appendix 9. Calculations.

$$V_{out} = V_{in} \left(\frac{R_2}{R_1 + R_2} \right)$$

$$\begin{aligned} V_{out} &= 10 \frac{10}{10+10} \\ &= 10 \times 0,5 \\ &= 5 \end{aligned}$$

Documentation of Voltage Divider Practicum .



Figure 25. Creating a voltage divider circuit.



INTRODUCTION TO VARIOUS SENSORS

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ABSTRACT

Sensors are closely related to everyday life. This is because we encounter many electronic devices equipped with sensors. This equipment helps and facilitates human activities. Sensors include devices used to detect a change in physical quantities in the environment. The purpose of this practicum is to know the types of sensors and know the components that can be used to detect changes in physical quantities in the environment. types of sensors and know the components that can be used to assemble sensors. The method used is to observe each sensor and determine the *datasheet of* each sensor. The results obtained in this practicum are the grouping of sensors based on their type, which includes analog sensors, namely LM35 sensors and *water level* sensors, which includes digital sensors, namely DHT11 sensors and ultrasonic sensors, and which includes analog and digital sensors, namely soil moisture sensors, MQ2 sensors and LDR sensors. Based on the practicum that has been carried out, it can be concluded that there are two types of sensors, namely analog and digital sensors. Analog sensors are sensors that produce continuous *output* signals and digital sensors are sensors that produce discrete output signals.

Keywords: Analog, Digital, Sensor

INTRODUCTION

Background

The development of science and technology is increasingly rapid in today's globalization era. The development of various sciences and technologies continues to be intensified to support human work in order to complete their work easily. Everyone, especially students, must be able to adapt to the development of science and technology in order to apply it in life.

The application of the development of science and technology can be seen in sensors. Sensors are closely related to everyday life. This is because we encounter many electronic devices equipped with sensors. One of the electronic household appliances equipped with sensors such as irons and lamps. This equipment helps and facilitates human activities, even without sensors, human activities may not be smooth. For example, when using *smartphone* and computer devices, these two tools are widely used by people every day, especially smartphones. everyday, especially *smartphones*, if there are no sensors, these two objects do not function properly as they should.

Sensors are used to convert a certain quantity into analog units so that it can be read by an electronic circuit. Sensors include devices used to detect changes in physical quantities such as pressure, force, electrical quantities, light, motion, humidity, temperature, speed and other environmental phenomena. This sensor has the desired



output and can be read directly. This output signal is not directly an electrical signal but through a combination of several kinds of transducers.

Based on this description, it is important to do this practicum in order to find out what are the types of sensors, their constituent components and their application in life, especially in the field of agricultural engineering.

Purpose and Usefulness of Practicum

The purpose of the practicum is to know the types of sensors and know the components that can be used to assemble sensors.

The usefulness of the practicum of Sensor Assortment Introduction is to be able to assemble and make sensors to detect and measure the amount of a certain physical change and can apply it to the agricultural field.

LITERATURE REVIEW

Sensor

Sensors are supporting devices to convert physical quantities into electrical quantities. Sensors are devices used to detect changes in physical quantities in the environment. Based on the variables in the senses, sensors are categorized into two types, namely physical sensors and chemical sensors. A physical sensor is a type of sensor that detects a quantity based on the laws of physics. While the type of chemical sensor is a sensor that detects the amount of a chemical substance. In addition, sensors are also divided into analog sensors and digital sensors. Analog sensors are sensors that produce continuous or continuous *output signals*. The continuous output signal produced by this analog sensor is proportional to the measurement. Digital sensors are sensors that produce a discrete output signal (Setiawan, 2011). (Setiawan, 2011).

A good sensor to use is one that has been previously calibrated. The purpose of sensor calibration is to match the sensor reading with the actual value. This process can be done if the conversion results from the sensor are linear and stable. Sensors that are still linear will give linear results and vice versa. Calibration is needed to ensure that the measurement results are accurate and consistent with various other instruments. (Azizah *et al.*, 2019).

Ultrasonic Sensor

Ultrasonic sensors are sensors that convert physical quantities (sound) into electrical quantities and vice versa. Ultrasonic sensors, ultrasonic waves are generated through a device called a piezoelectric with a certain frequency. This piezoelectric will produce ultrasonic waves (generally 40 kHz frequency) when an oscillator is applied to the object. The work of this sensor is based on the principle of the reflection of a sound wave so that it can be used to interpret the existence (distance) of an object with a certain frequency. (Adella *et al.*, 2020).

Ultrasonic sensors are sensors that can work based on the principle of sound wave reflection and are used to detect the presence of an object or object in front of the working frequency in the area above the sound waves from 20 kHz to 2 MHz. The ultrasonic sensor consists of two units, namely the transmitter unit and the receiver unit of the transmitter and receiver unit structure. It is very simple that a *piezoelectric* crystal is connected to a mechanical anchor and only connected to an alternating voltage vibrating diaphragm with a working frequency between 20 Hz to 2 MHz. (Arsada, 2017).



DHT11 Temperature Sensor

One type of sensor *family* that can also measure temperature and humidity at one time is DHT. This sensor consists of several variants with the variants that are often used are DHT11 and DHT22. This type of sensor is quite widely chosen because the output data produced is already in digital form so it no longer requires the conversion process from analog signals. Overall, DHT11 is better than DHT22 in temperature measurement for the arduino *platform* both indoors and outdoors. Outdoor humidity measurement used for the AVR *platform*. The DHT11 has a wider relative error range of 1 to 7% in temperature measurements and 11 to 35% in humidity measurements. (Saptadi, 2015).

The DHT11 sensor is a sensor with digital signal calibration that is capable of providing air temperature and humidity information. This sensor is classified as a component that has a very good level of stability and a very accurate calibration feature. The calibration coefficient is stored in (OTP) *program memory*, so that when the internal sensor detects something, this module includes the coefficient in its calculation with signal transmission up to 20 meters, with specifications *Supply Voltage +5V, Temperature range 0-50 ° C error of ± 2 ° C, Humidity 20-90% RH ± 5 % RH error*. The working principle is to utilize capacitive changes in the position of the dielectric material between the two chips, shifting the position and area of the facing chips. (Budi & Pramudya, 2017).

LM35 Sensor

A temperature sensor is a device to detect or measure the temperature in a particular space or system which is then converted into an electrical quantity. There are several types of sensors that can be used especially in temperature measurements such as thermocouples, RTD (*Resistance Temperature Detector*), *thermistors* and ICs. The temperature sensor that is often used in everyday life is the LM35 temperature sensor because of its accuracy compared to other sensors. (Suherman *et al.*, 2015).

The LM35 sensor is a temperature sensor that is packaged in the form of an *Integrated Circuit*. LM35 temperature sensor which has three pins, pin 1 serves as a source of working voltage from LM35, pin 2 or the middle leg is used as an output voltage or *Vout* with a working range from 0 volts to 1.5 volts with sensor operations that can be used between 4 volts to 30 volts, pin 3 serves as *ground*. This sensor has a coefficient of 10 mV / C which means that every 1 C increase in temperature will increase the voltage by 10 mV. (Desyantoro *et al.*, 2015).

Soil Moisture Sensor

Soil moisture sensor is able to measure the moisture content in the soil, with 2 *probes* at the end of the sensor. YL-69 sensors include sensors that can detect moisture in the soil. A set of YL-69 type *moisture* sensors contains a module in which there is an IC LM393 which functions for a low *offset* comparator process lower than 5mV, which is very stable and precise. This sensor is used to assist in the process of measuring a moisture moisture contained in the soil. The detection sensitivity can be adjusted by turning the potentiometer installed in the processing module. Precision sensor detection using a microcontroller or arduino, can use an analog output (connection



with the ADC pin or analog *input* on the microcontroller) which will provide a humidity value on a scale of 0V to vcc. (Galih & Kartadie, 2019).

The soil moisture sensor measures the moisture content in the soil. The soil moisture *probe* consists of several soil moisture sensors. neutron moisture meter, utilizing the moderating properties of water for neutrons. Soil moisture content can be determined through its effect on the dielectric constant by measuring two electrodes embedded in the soil, where soil moisture is mostly in the form of free water e.g. in sandy soil, directly proportional to the moisture content. The *probe* is usually given a frequency excitation to allow measurement of the dielectric constant. Readings from the *probe* are not linear with soil moisture content and are affected by soil type and soil temperature. (Galih & Kartadie, 2019).

LDR Sensor

LDR or *Light Dependent Resistor* is a type of resistor whose resistance value is influenced by the light it receives. This sensor is very sensitive to light. The amount of resistance value on the LDR depends on the amount of light received. LDR is a type of resistance that is very sensitive to light. The nature of this LDR resistance is that the resistance value will change if exposed to light. The way the LDR sensor works is that when the light intensity in the place decreases, the *photo* diode will reduce the resistance so that the resistance to the current will be smaller and the lights will turn on automatically. Light sensors convert light intensity into electrical resistance. The working principle of this sensor is to convert photon energy into electrons. (Siswanto & Winardi, 2015).

PRACTICUM METHODOLOGY

Time and Place

The practicum on the Introduction of Various Sensors was held on Saturday, October 22, 2022, at 08.00 WITA until completion, at the Soil and Water Engineering Laboratory, Agricultural Engineering Study Program, Department of Agricultural Technology, Hasanuddin University.

Tools

The tools used in this practicum are stationery and arduino.

Material

The materials used in this practicum are LM35 sensor, ultrasonic sensor, YL 69 sensor, MQ2 sensor, DHT11 sensor, LDR sensor and *water level* sensor.

Practicum Procedure

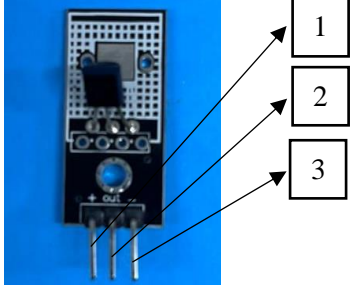
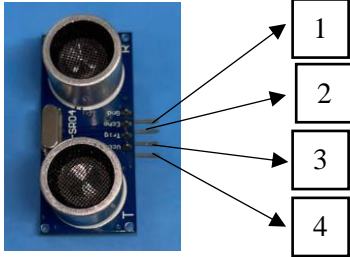
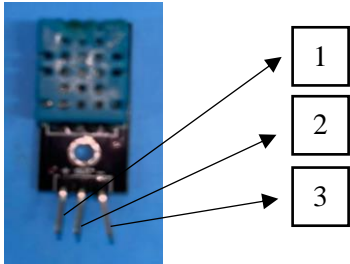
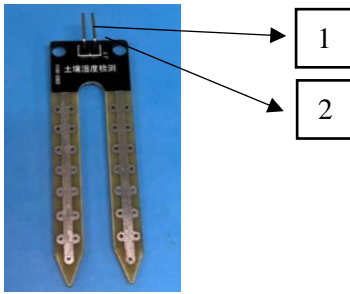
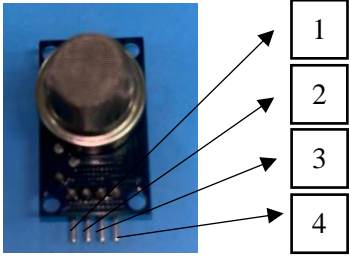
1. Prepare the tools and materials to be used.
2. Identify the name, type and function of various sensors.
3. Classify sensors based on their type.
4. Documenting the practicum.



RESULTS AND DISCUSSION

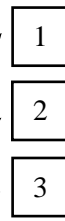
Results

Table 6: Results of Sensor Assortment Recognition Picture Show.

NO	Name	Image	Description	Type
1.	LM35 Sensor		1. 4-20 Volts 2. <i>Output</i> 3. <i>Ground</i>	Analog
2.	Ultrasonic Sensor		1. <i>Ground</i> 2. <i>Eho</i> 3. <i>Trigger</i> 4. <i>Vcc</i>	Digital
3.	DHT11 Sensor		1. <i>Vcc</i> 2. <i>Data</i> 3. <i>Ground</i>	Digital
4.	YL 69 Sensor		1. Connector to module 2. Connector to module	Analog Digital
5.	MQ2 Sensor		1. <i>Vcc</i> 2. <i>Ground</i> 3. <i>Digital Output</i> 4. <i>Analog Output</i>	Analog Digital



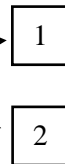
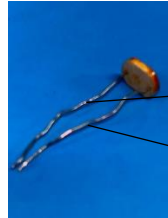
6. Water Level Sensor



1. Ground
2. Vcc
3. Signal

Analog

7. LDR Sensor



1. Terminal 1
2. Terminal 2

Analog

Digital

Discussion

Sensors are devices of a larger system that serve to provide *input* to the main control system. Sensors are also understood as devices that can convert signals from one energy domain to the electrical domain. Sensors are often used for detection when measuring or controlling. This is in accordance with the statement of Setiawan (2011), which states that sensors are used to detect changes in physical quantities in the environment.

Sensors can be divided into two types, namely analog sensors and digital sensors. Analog sensors are sensors that produce a continuous or continuous *output* signal. The continuous output signal produced by these analog sensors is proportional to the measurement. Various analog parameters include temperature, voltage, pressure, movement and others. The sensors used in this practicum and included in analog sensors are LM35 sensors and *water level* sensors. Digital sensors are sensors that produce discrete output signals. The discrete signal will be non-continuous with time and can be represented in "bits". A digital sensor usually consists of a sensor, cable and transmitter. The sensors used in this practicum and included in digital sensors are DHT11 sensors and ultrasonic sensors, which are included in analog and digital sensors, namely soil moisture sensors, LDR sensors and MQ2 sensors. This is in accordance with the statement of Setiawan (2011), which states that analog sensors are sensors that produce continuous *output* signals and digital sensors are sensors that produce discrete output signals.

Each sensor has its own function. LM35 sensors are used to detect or measure the temperature in a particular room or system which is then converted into electrical quantities. Ultrasonic sensors detect the presence of an object or object. The DHT11 sensor is used for measuring temperature and humidity at one time. The YL 69 sensor is used to measure the water content in the soil. MQ2 sensor is used to detect the concentration of gas and smoke. The *water level* sensor is used to detect the water level. LDR sensor to convert light intensity into electrical resistance. Before use, each sensor needs to be calibrated so that its readings can be matched with the actual value. This is in accordance with the statement of Azizah (2019), which states that a good



sensor to use is a sensor that has been previously calibrated and the purpose of this sensor calibration is to match the sensor reading with the actual value.

CONCLUSIONS

Based on the practicum that has been carried out, it can be concluded that there are two types of sensors, namely analog and digital sensors. Analog sensors are sensors that produce continuous *output* signals and digital sensors are sensors that produce discrete output signals. Sensors included in analog sensors are LM35 sensors and *water level sensors*. Sensors included in digital sensors are DHT11 sensors and ultrasonic sensors, which are included in analog and digital sensors, namely soil moisture sensors, MQ2 sensors and LDR sensors. Sensors are used to detect changes in physical quantities in the environment. A sensor can be assembled from various components such as Arduino, cables, whole sensors, modules and others.



LITERATURE

- Adela, A. F., Fardika P.P., M., Taufiqurrahman, F., & Kaswar, A. B. (2020). Ultrasonic Based Automatic Door *Internet of Things*. *Journal of Electronic Media*, 17(3), 80-84.
- Arsada, B. (2017). Ultrasonic Sensor Application for Distance Position Detection in Space Using Arduino Uno. *Journal of Electrical Engineering*, 6(2), 1-8.
- Azizah, A., Waris, A., & Sapsal, M. T. (2019). Application of *Fuzzy Logic* System in Measuring Nutrient Levels in Hydroponic Systems. *Agritechno Journal*, 12(2), 85-93.
- Budi, K. S., & Pramudya, Y. (2017). Development of Humidity and Temperature Data Acquisition System Using Dht11 Sensor and Arduino Based IOT.
- Desyantoro, E., Rochim, A. F., & Martono, K. T. (2015). Automatic Home Electronic Equipment Control System Using PIR Sensor, LM35 Sensor, and LDR Sensor. *Journal of Computer Technology and Systems*, 3(3), 405.
- Galih M., A., & Kartadie, R. (2019). Regulating soil moisture using Arduino-based Y1-69 soil moisture sensor in agarwood tree planting media. *Journal of Education and Information Communication Technology*, 3, 130-140.
- Setiawan, S.T., M. T. (2011). Sensor and Transducer Textbook. *Semarang, Diponegoro University*, 1-49.
- Saptadi, A. H. (2015). Comparison of Temperature and Humidity Measurement Accuracy between DHT11 and DHT22 Sensors Comparative Study on ATMEL AVR and Arduino Platforms. *Journal of Informatics, Telecommunications and Electronics*, 6(2).
- Siswanto, D., & Winardi, S. (2015). Automatic clothesline using rain sensor. *Narodroid*, 1(2), 66-73.
- Suherman, Andriyanto, I., & Dwiyatno, S. (2015). Design of a Temperature Measurement Tool for *Server* Devices Using Lm35 Sensor Based on Sms Gateway. *Prosisko*, 2(1), 42-63.



APPENDIX

Documentation of the Practicum on the Introduction of Various Sensors.



Figure 26: Documentation of the practicum on the introduction of various sensors.



ARDUINO IDE *SOFTWARE*

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ABSTRACT

Automatic control is inseparable from various types of electronic components that support the creation of the desired automatic control system. One of the electronic components of the automatic system and the controller or brain in the circuit is a microcontroller. Arduino includes a microcontroller system that is programmed by the *Arduino software*. The purpose of the *Arduino IDE Software* practicum is to find out the components that make up the arduino, can find out the *tools* in the *arduino software* and can create a program in the *arduino software*. The method used is to analyze the constituent components of arduino and create one of the programs in the *arduino software*. The results obtained in the form of a display of the name, number, group and practicum of each student seen on the LCD connection arduino. Based on the practicum that has been done, it can be concluded that arduino includes an *open source* microcontroller that can be easily programmed at any time. The constituent components of arduino are IC, *programmer*, *voltage regulator*, *serial to USB converter* and *input and output*. The *software* used to program into the *arduino board* is called arduino IDE. The application of microcontrollers to irrigation systems can control water delivery automatically.

Keywords: Arduino, Microcontroller, *Software*

INTRODUCTION

Background

Currently, technological developments have penetrated into various fields to meet the demands of human life. Almost all aspects of human life technology has its own role, especially in the field of agriculture. This technology solves problems that arise from the running of a system.

The development of science and technology allows various efforts to provide comfort and convenience for the community. Various things or human activities are facilitated by the existence of an automation system. Automatic systems cannot be separated from various types of electronic components that support the creation of the desired automatic control system. One of the most important electronic components of the automatic system and the controller or brain in the circuit is called a microcontroller.

Automation technology in its development is widely used in agriculture to control various processes that require high speed and accuracy. It also aims to minimize *human error* in agricultural cultivation. One of the problems that often arises is erratic weather



so that the moisture needed by plants becomes a problem. Therefore, a technology is needed that can help existing problems such as microcontrollers.

Based on the description above, it is necessary to do this practicum to know the components that make up the arduino, be able to know the *tools in the arduino software*, be able to create a program in the arduino *software* and can be applied in everyday life, especially in agriculture.

Purpose and Usefulness of Practicum

The purpose of the Arduino IDE *Software* practicum is to know the components that make up the arduino, be able to know the *tools* in the arduino *software* and be able to create a program in the arduino *software*.

The usefulness of practicing Arduino IDE *Software* is that it can be applied in everyday life, especially in agriculture such as the application of microcontrollers to automatic irrigation systems.

LITERATURE REVIEW

Microcontroller

A microcontroller is an *on-chip* computer used to control electronic equipment, which regulates efficiency and cost-effectiveness. Technically microcontrollers are divided into 2 types namely RISC (*Reduced Instruction Set Computer*) and CISC (*Computer Complex Instruction Collection*), each of which has a family. RISC is limited but with more facilities. CISC is more complete instructions with limited facilities. A microcontroller is a device created by a *programmer*. This program instructs the microcontroller to perform long *interlacing* of simple actions to perform more complex tasks as desired by the programmer. (Hafidhin *et al.*, 2020).

A microcontroller is a complete computer system on a single *chip*. Microcontroller is more than just a microprocessor. This microcontroller has several parts, namely ROM (*Read-Only Memory*), RAM (*Random-Access Memory*), consisting of several input and output ports, and several *peripherals* such as enumerators or timers, ADC (*Analog to Digital Converter*), DAC (*Digital to Analog Converter*) and serial communication. (Raharja & Setyobudi, 2019).

A microcontroller is a microcomputer *chip* that is physically an IC (*Integrated Circuit*). Microcontrollers are usually used in systems that are small, inexpensive and do not require very complex calculations such as in PC applications. Microcontrollers are widely found in equipment such as *microwaves, ovens, keyboards, CDs, remote controls* and others. Microcontroller contains main parts, namely CPU (*Central Processing Unit*), RAM (*Random-Access Memory*), ROM (*Read-Only Memory*) and I/O (*Input/Output*) *ports*. Besides these main parts, there are several hardware devices that can be used for many purposes such as enumeration, serial communication, interrupts and others. Certain microcontrollers even include ADC (*Analog-To-Digital Converter*), *USB controller, CAN (Controller Area Network)* and others (Dharmawan, 2017).

According to Hafidhin *et al.* (2020), the features contained in the microcontroller are explained as follows:

1. RAM (*Random Access Memory*), used as a variable storage area. This memory is unstable which means it will lose all its data if it does not get a power supply.



2. ROM (*Read Only Memory*), often referred to as code memory because it functions as a storage place for programs provided by the programmer.
3. SFR, stands for Special Function Register. SFR is a special register that serves to organize the running of the microcontroller. This SFR is located in RAM.
4. *Input and output pins*, function as receivers of signals from outside, these pins can be connected to *input* media such as sensors. The *output* pin is a part that functions to produce a signal from the results of the microcontroller algorithm process.
5. *Interrupt*, functions as a part that can perform intrusions. When the main program is running, the main program can be interrupted internally.
6. *External interrupt*, an interrupt that comes from outside the computer microcontroller. An interrupt will occur if there is *input* from the interrupt pin.
7. *Interrupt timer, intrusion* will occur at certain times according to the specified time. For example, it is used for a one-second delay which in programming languages is written with the word "*delay*" in milliseconds.
8. *A serial interrupt*, occurs when receiving data during serial communication or when a register is full during the receive process. The receive process is where the processor receives serial data from outside.

Arduino

Arduino is an *open source* microcontroller that can be easily programmed, erased and reprogrammed at any time. Introduced in 2005, the arduino *platform* was designed to provide a cheap and easy way for hobbyists, students and professionals to create devices that interact with their environment using sensors and actuators. Based on a simple microcontroller, it is an open-source computing *platform* used to build and program electronic devices. Arduino is also capable of acting as a mini computer like other microcontrollers by taking *inputs* and controlling *outputs* for various electronic devices, also capable of receiving and sending information over the internet with the help of various arduino programs. Arduino uses hardware and software to develop code known as arduino IDE. (Louis, 2016).

Arduino is a microcontroller system programmed by Arduino *software*. The IC used in Arduino is the AVR ATmega328 IC which is already equipped with a *bootloader* from Arduino. This system will process the data or code entered by the vehicle owner. If the code entered is wrong, the arduino will sound the *buzzer* for 0.5 seconds but if the code entered is correct then the arduino will provide data to the *Automatic Control*. (Saleh & Subijanto, 2013).

Arduino Uno is one of the products labeled arduino which is actually an electronic board containing an *ATMega328* microcontroller (a chip that functionally acts like a computer). The *device* can be used to realize electronic circuits from simple to complex. Controlling LEDs to controlling robots can be used through implementation using this relatively small-sized board. Even with the addition of certain components, this *device* is used for monitoring patient conditions in hospitals and controlling equipment at home. (Destiarini & Kumara, 2019).

Arduino Uno is a microcontroller *board* based on *ATmega328*. Arduino Uno has 14 *input* or *output* pins where 6 pins can be used as PWM outputs, 6 analog *inputs*, a 16 MHz *crystal oscillator*, USB connection, *power jack*, ICSP head and reset button. Arduino Uno is capable of supporting microcontrollers, can be connected to a computer using a USB cable and can be supplied with an AC to DC adapter or using a battery. (Widyo *et al.*, 2019).



Arduino Software (IDE)

The software used to develop and program into the arduino board is called the arduino IDE. IDE stands for *Integrated Development Environment*, or in plain language is an integrated environment used for development. It is called an environment because it is through this software that arduino programming is carried out to perform the functions that are embedded through programming syntax. Arduino uses its own programming language that resembles the C language. The arduino programming language (*Sketch*) has been changed to make it easier for beginners to do programming from the original language. Before being sold to the market, the arduino microcontroller IC has been implanted with a program called *Bootlader* which functions as an intermediary between the arduino compiler and the microcontroller. Arduino IDE is made from JAVA programming language. Arduino IDE is also equipped with a C/C++ library commonly called *wiring* that makes *input* and *output* operations easier. Arduino IDE was developed from *processing software* which was overhauled into an arduino IDE specifically used for programming with arduino. (Anwar, 2019).

Application in Agriculture

The application of microcontrollers to irrigation systems can make it possible to control water delivery automatically based on the commands given. Efforts to control irrigation systems with microcontrollers, need to be supported by electronic components that can be controlled by the microcontroller itself. There are components that act as *input* (input) to provide information that will be processed by the microcontroller and *output* (output) as an executor of the information that has been processed by the microcontroller. (Salman *et al.*, 2016).

In addition, in agriculture, a variable rate granular fertilizer rationing device for corn plants can be found. The rationing unit is made using a 24 V 200 rpm DC motor and controlled using an arduino mega module. Rationing uses a rotor with a volume of 26.52 cm³ /rotation. The control uses PID and the fertilizer used is NPK fertilizer. (Sapsal & Samsuar, 2020).

The implementation of automatic watering and opening and closing tools based on Arduino Uno can also be designed on tomato plants. This tool is made to monitor the automatic watering of tomato plants with soil moisture sensors and arduino Uno. This system is made using arduino Uno, EP8266, LDR sensor to detect light intensity and soil moisture sensor to detect soil moisture in tomato plants. (Asih *et al.*, 2021).

PRACTICUM METHODOLOGY

Time and Place

Arduino IDE Software Practicum was held on Saturday, October 29, 2022, at 09.50 WITA until completion, at the Laboratory of Agricultural Equipment and Machinery Engineering, Agricultural Engineering Study Program, Department of Agricultural Technology, Faculty of Agriculture, Hasanuddin University.

Tools

The tools used in the practicum of Arduino IDE Software are laptop, arduino Uno, LCD, USB cable, stationery and *cellphone*.

Material

The material used in the practicum of Arduino IDE Software is arduino software.



Practicum Procedure

The Arduino IDE *Software* practicum procedure is as follows:

1. Open the *arduino software*.

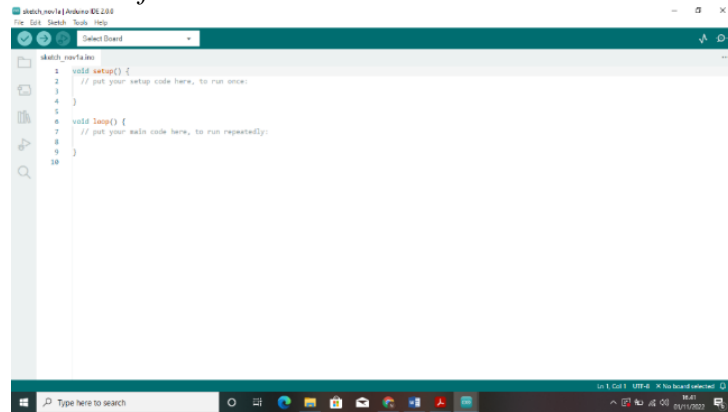


Figure 27. Opening the *Arduino software*.

2. Click on the *file* menu, then *examples* and click on the bottom.

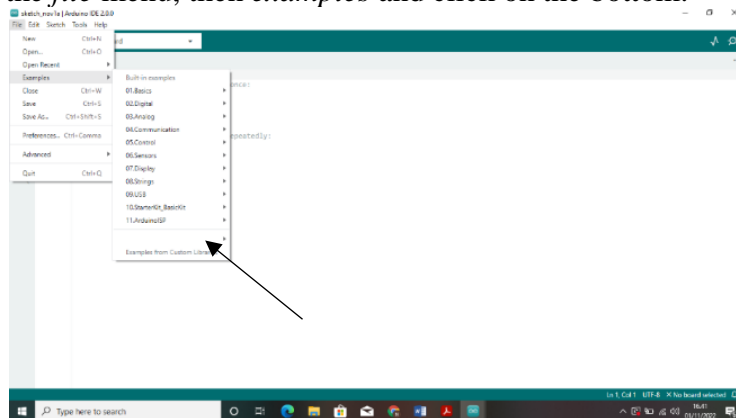


Figure 28. Opening the *Examples Menu*.

3. Then click on the *HelloWorld* menu.

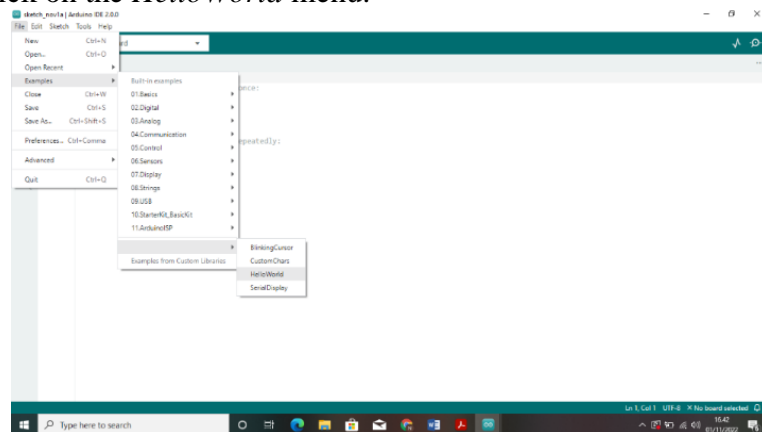


Figure 29. Clicking on the *HelloWorld Menu*.



4. After that, the display will appear as below.

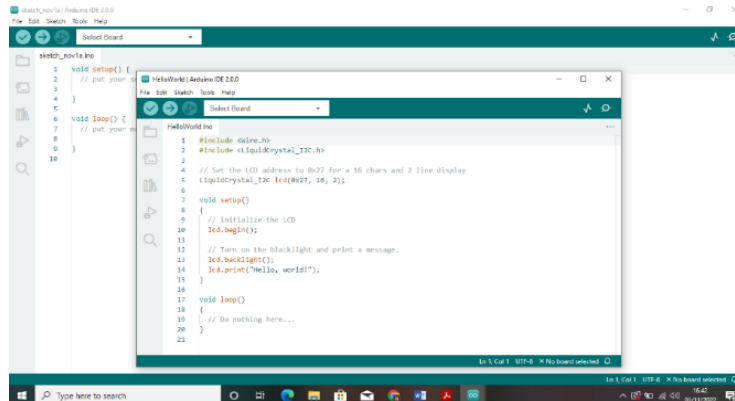


Figure 30. Hello World view.

5. Entering name, nim, group and practicum name into the program.

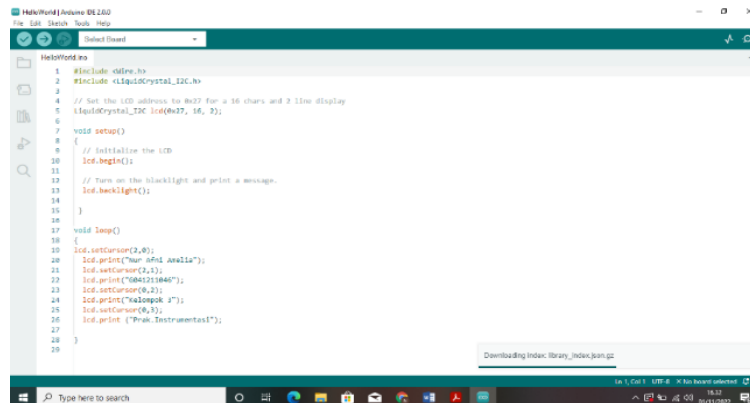


Figure 31. Program view.

6. Save the *program* results and connect it to the arduino using a USB cable.

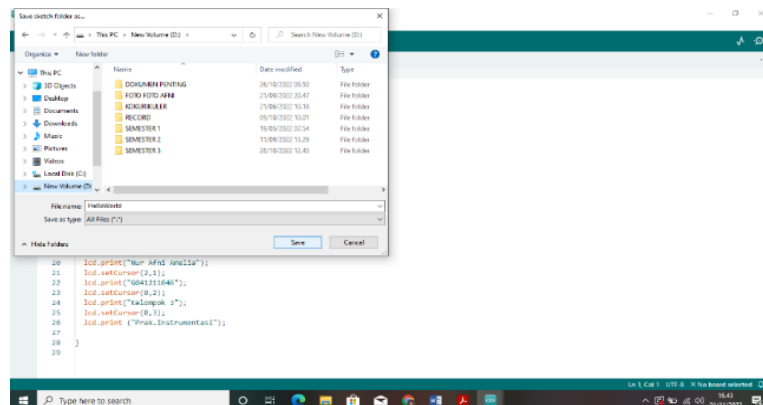


Figure 32. Saving the program.



RESULTS AND DISCUSSION

Results



Figure 33. Arduino *Software* Program Results.

Discussion

Arduino is an electronic device that is *open source* and is often used to design and create electronic devices and *software*. Arduino is also able to act as a mini computer like other microcontrollers by taking *input* and controlling *output* for various electronic devices, also able to receive and send information via the internet with the help of various arduino programs. This is in accordance with the statement of Louis (2016), which states that arduino is an *open source* microcontroller that can be easily programmed, deleted and reprogrammed at any time.

Arduino consists of its constituent components. These components are in the form of a microcontroller in the form of a small IC that functions as the brain of the arduino, a *programmer* that translates programming language into machine language, a *voltage regulator* that regulates the current and voltage of the power *supply* on the device, a *serial to USB Converter* as a communication bridge between the arduino and the computer, as well as *inputs* and *outputs* that receive and output information or data. This is in accordance with the statement of Widy (2019), which states that arduino has 14 *input* or *output* pins where 6 pins can be used as PWM outputs, 6 analog *inputs*, a 16 MHz *crystal oscillator*, USB connection, *power jack* and ICSP head.

The software used to develop and program into the arduino *board* is called arduino IDE. Arduino IDE is *software* that is used to create programming *sketches* or in other words arduino IDE as a medium for programming on the *board* that you want to program. This Arduino IDE is useful for editing, creating, *uploading* to the specified *board* and *coding* certain programs. This is in accordance with the statement of Anwar (2019), which states that IDE stands for *Integrated Development Environment*, or in simple language is an integrated environment used for development. It is called an environment because it is through this *software* that arduino programming is carried out to perform functions that are embedded through the syntax of programming.

Arduino uses a simplified C++ programming language. This C language is a high-level language used by programmers. The basic structure of the arduino program is very simple, consisting of only two main functions, namely *void setup ()* and *void loop ()*, where *setup ()* is an initialization that is only run once, at the beginning of the program, while *loop ()* is used to execute the part of the program that will be run until



the program stops running. This is in accordance with the statement of Anwar (2019), which states that Arduino uses its own programming language that resembles the C language.

CONCLUSIONS

Based on the practicum that has been done, it can be concluded that Arduino is an *open source* microcontroller that can be easily programmed, deleted and reprogrammed at any time. The constituent components of arduino are IC, *programmer*, *voltage regulator*, *serial to USB converter* and *input* and *output*. The *software* used to develop and program into the arduino *board* is called arduino IDE. The application of microcontrollers to irrigation systems can make it possible to control water delivery automatically based on commands given to the system.



LITERATURE

- Anwar, F. Al. (2019). Design and Implementation of Arduino Uno-based *Smartlamp* using *Android Smartphone*. *11*(2).
- Asih, D. R., Prihandoyo, T., & Afriliana, I. (2021). Design of an Arduino Uno-based Automatic Watering and Opening and Closing Tool for Tomato Plants Dian. *Harapan Bersama Polytechnic*, 1-6.
- Destiarini, & Kumara, P. W. (2019). *Line Follower Robot Based on Arduino Uno Atmega328 Microcontroller*. *Informanika Journal*, *5*(1), 18-25.
- Galang Yudha Murih Raharja, & Padjar Setyobudi. (2019). Design of a Motorcycle Security System Using Rfid and Personal *Identification Number* (Pin) Based on Atmega16 Microcontroller. *Elkom: Journal of Electronics and Computers*, *12*(1), 6-12.
- Gofur Saleh, M., & Subijanto. (2013). Design and manufacture of microcontroller-based security code prototype for motorcycles. *Issn 2087 - 9245*, *3*(3), 38.
- Hafidhin, M. I., Saputra, A., Ramanto, Y., & Samsugi, S. (2020). Arduino Uno Microcontroller-Based Salted Fish Drying Tool. *Jtikom*, *1*(2), 1372525.
- Louis, L. (2016). Working Principle of Arduino and Using It As A Tool for Study and Research. *International Journal of Control, Automation, Communication and Systems*, *1*(2), 21-29.
- Salman, M., Chaer, I., Abdullah, S. H., Priyati, A., & Mataram, U. (2016). Application of Arduino Microcontroller in Drip Irrigation System for Mustard Crops (*Brassica Juncea*). *Scientific Journal of Agricultural Engineering and Biosystems*, *4*(2), 228-238.
- Sapsal, M. T., & Samsuar, S. (2020). Variable Rate Granular Fertilizer Rationer for Maize Crops. *Agritechno Journal*, *13*(1), 51-56.
- Widyo, L. Jati, Humaidillah, Indahwati, E., Yanuansa, N., & Ummah, I. (2019). *Arduino Uno Learning Module*. Jombang: Hasyim Asy'ari University.



APPENDIX

Arduino IDE *Software* Practicum Documentation.

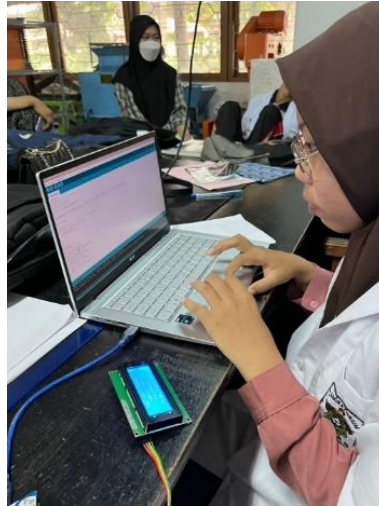


Figure 34. Documentation of Arduino *Software* Introduction Practicum.