Strong Current Basic Electrical Trainer

Final Project

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2024

Final Project Authenticity Statement

I, the undersigned, declare that the contents of part or all of my Final Project entitled: "Basic Strong Current Electrical Trainer" are **own work, completed without using unauthorized materials**,and **is not the work of another party that I acknowledge as my own work.** All references cited or referenced have been written in full in the bibliography. If it turns out that my statement is not true, I am willing to accept sanctions in accordance with applicable regulations.

Batam,04 Juli 2024

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Validity sheet

The Final Project is structured to fulfill one of the requirements for obtaining a degree
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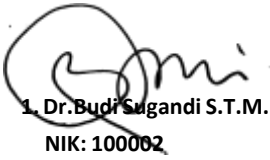

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Strong Current Basic Electrical Trainer

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Abstrak

. Tujuan dari pembuatan proyek akhir ini adalah untuk mengetahui rancang bangun dari pembuatan unit modul trainer praktik instalasi listrik industri. Modul praktik ini diharapkan dapat menunjang proses pembelajaran khususnya untuk memahami prinsip kerja dan fungsi dari sebuah instalasi listrik di industri.

Modul trainer ini dirancang dengan menggunakan konsep modular yaitu masing-masing komponen dibuat secara terpisah, dilengkapi dengan nama komponen, simbol serta keterangan tentang komponen gambar desain wiring Diagram sehingga dapat dengan mudah dalam penggunaan, perawatan dan yang utama adalah dapat mempermudah pemahaman dari konsep instalasi motor induksi 3 phase. Proses perancangan dan pembuatan trainer ini melalui beberapa tahapan yaitu tahap pengumpulan materi dan informasi, perancangan modul masing-masing komponen, perancangan bingkai geser dan box penyimpanan, pembuatan alat, pengujian alat dan terakhir penulisan laporan proyek akhir.

Hasil dari pembuatan proyek akhir ini yaitu dihasilkan sebuah trainer instalasi listrik industri yang dirancang dengan konsep modular. Layout dari unit modul ini dirancang menggunakan banana plug. Berdasarkan hasil pengujian dari segi teknis dan unjuk kerja yang meliputi mode manual dan otomatis berfungsi sebagaimana mestinya sesuai dengan petunjuk pemakaian trainer instalasi listrik industri.

Kata kunci:Trainer, Media pembelajaran, Instalasi listrik industri

Abstract

The aim of making this final project is to find out the design and construction of the industrial electrical installation practice trainer module unit. This practical module is expected to support the learning process, especially to understand the working principles and functions of electrical installations in industry.

This trainer module is designed using a modular concept, namely that each component is made separately, equipped with component names, symbols and information about the component wiring diagram design images so that it can be easily used, maintained and most importantly, it can make it easier to understand the motorbike installation concept. 3 phase induction. The process of designing and making this trainer goes through several stages, namely the stage of collecting material and information, designing modules for each component, designing sliding frames and storage boxes, making tools, testing tools and finally writing a final project report.

The result of this final project is to produce an industrial electrical installation trainer designed with a modular concept. The layout of this module unit is designed using a banana plug. Based on the test results from a technical and performance perspective which includes manual and automatic modes, it functions as it should in accordance with the instructions for using the industrial electrical installation trainer.

I. Introduction

1.1. Background

Basic electrical trainer: Strong current is part of one of the most widely used energies in the industrial world. We obtain electricity, which is a secondary energy source, from the conversion of motors. Starting from the story, the idea of electric lights is not a new idea, several scientists have developed it and even made several forms. electric lights decades earlier. In lectures there were not only lectures in the form of theory but also lectures in the form of practical research. Especially studying at engineering faculties such as electrical engineering. There are lots of electrical programming courses. There are also practicum/research tools that can be used to share space.

Therefore, based on this, this research aims to create a practical tool for installing a 3-phase motor. This tool is very easy to use for practice. In this research, the design for making a 3-phase motor controller practical tool for star delta connection and a motor

control research tool is discussed and studied. This tool is useful for students in learning practical courses on electric motor installation. Apart from being useful for students, this tool is also useful for the community so that it can be used as a reference for many people.

1.2. Formulation of the problem

Based on the background of the problem, the problem can be formulated as follows:

1. What is the design concept for making trainer module units for Industrial Electrical Installations?

2. How is the work performance of Industrial Electrical Installation trainers?

1.3. Objective

The objectives obtained in designing the final project are:
1 Design and manufacture a Basic Electrical Trainer.
2 MCB/ELCB Basic Electrical Trainer component design & others.
3 To find out and measure the output voltage of the basic electric trainer.

1.4. Benefit

Final project benefits include:

1) Basic electrical equipment, this can be made as simple as possible so that it is easy to use and is portable and can be moved anywhere.

2) This tool is made with all components that are not connected to each other, meaning these components are made separately from the trainer tool.

1.5. Limitation

In designing and creating this final project, there were several limiting problems, including:
1 The limitations of this research are the creation, performance and level of feasibility of the Basic Electronics Trainer learning media in the form of practicum support modules and trainers consisting of passive and active component introduction blocks.
2 Half wave and full wave rectifier circuits, variable power supply, charging and discharging capacitors, transistors as switches, transistor amplifiers.
3 How many aspects are there to measure the level of suitability of the module learning media and Basic Electrical Trainer, including looking at the quality of content and objectives, learning quality and technical quality?

II. Literature Review

2.1. 3 phase electric motor, AC and DC

Direct current motors, as the name suggests, use direct current that is not direct/unidirectional. DC motors are used in special applications where high starting torque or constant acceleration is required over a wide speed range. The following figure shows a DC motor that has three main component.
Field poles. In simple terms, it can be described that the interaction of two magnetic poles will cause rotation in a DC motor. DC motors have stationary field poles and a dynamo that moves bearings in the space between the field poles. Simple DC motors have two field poles: a north pole and a south pole. The magnetic lines of energy expand across the openings between the poles from north to south. For larger or larger motors, they receive electricity from external power sources as providers of the field structure.

Dynamo. When current enters the dynamo, this current will become an electromagnet. The cylindrical dynamo is connected to the drive axle to move the load. In the case of a small DC motor, the dynamo rotates in a magnetic field formed by the poles, up to the north pole. and the south magnet changes location. If this happens, the current reverses to change the north and south poles of the dynamo.
Commutator.This component is mainly found in DC motor dynamo.Commutator also helps in transmitting current between dynamo and power source.

Gambar Bentuk Fisik Motor listrik: 3 fasa Dan 1 Fasa
(Sumber: http://www.geyosoft.com/2013/motor induksi)

2.2. NFB No Fuse Breaker

If NFB is translated into Indonesian it means "breaker without fuse". That means this type of Circuit Breaker uses another method to cut off electricity without using a fuse. So this Molded Case Circuit Breaker cuts off electricity when a short circuit and overload occurs using two methods, namely:
1 This Magnetic Method MCB utilizes magnetic force to cut off the flow of electricity.
2 Thermal MCB method uses bimetal material to cut off electricity

Gambar B 10A, 220VAC
https://www.teknikelektro.com/2021/10/nfb-adalah.html?m=1

1.3 ELCB Earth-Leakage Circuit Breaker 1 PHASE

We can think of electrical energy as a double-edged sword that can both benefit and harm us if we are not careful. Unfortunately, there are still many people who do not pay attention to the safety of the electrical system at home. In fact, the number of fires caused by electric currents that occurred in Jakarta in 2016 reached 73%. Apart from being a cause of fire, electric current is also very dangerous for the human body. An electric current flowing through the human body of 80mA can cause heart problems which can lead to death. In fact, according to Law No. 30 Article 29 of 2009, consumers are obliged to carry out safeguards against dangers resulting from the use of electric power.

Earth-Leakage Circuit Breaker (ELCB): is an electrical safety device against the risk of electric current leakage. Ordinary ELCBs can be found inside electrical panels, such as MCBs. At first glance, ELCB is similar to MCB, but ELCB and MCB have different functions. MCB functions as protection in the event of an overload or short circuit. Meanwhile, the ELCB works by detecting unbalanced electric current. For example, when a person touches an open electrical cable from an electrical appliance that is on, an electric current will leak and flow through the person. The ELCB will immediately detect this leakage current by comparing the electric current flowing in the phase and neutral, which turns out to be unbalanced, so it will activate the relay to trip/switch off.

Gambar Bentuk Fisik ELCB 1 Fasa dan ElCB 3 Fasa
(Sumber: https://www.se.com/id/id/faqs/FA409990/)

1.4 MCB (Miniature Circuit Breaker 1 PHASA

1 phase MCB is a type of MCB specifically designed to overcome problems in single phase electrical circuits. Single-phase MCBs and the importance of these devices in maintaining the safety and performance of household and commercial electrical systems.

1. Protecting Electronic Equipment: One of the main functions of a 1-phase MCB is to protect electronic and electrical equipment from damage due to excessive current. When there is a disturbance in the circuit, such as a short circuit or a load that is too large, the MCB will cut off the electricity supply automatically. This helps avoid damage to expensive electronic equipment such as computers, televisions or other household appliances.

2. Preventing Fires: MCBs also play an important role in preventing fires that can be caused by short circuits or excessive current. When the current exceeds the capacity specified by the MCB, this device will cut off the electricity, stopping the potential danger of a fire before it can develop into a serious fire.

3. Avoiding Overload: 1 phase MCB is designed to overcome overload problems in single phase circuits. Overload occurs when too much equipment or load is placed on a single circuit, exceeding the power capacity that the cables and electrical devices can handle. MCB will cut off electricity if there is an overload, protecting the circuit and equipment from damage.

Gambar Bentuk Fisik MCB 1 Fasa
(Sumber: https://www.mcblistrik.com/2023/11/apa-fungsi-mcb-1-phase.html?m=1)

1.5 MCB (Miniature Circuit Breaker 3 Phase

usually used in industrial or commercial electrical installations that have relatively large electrical power. However, before using it, make sure the MCB used matches the required electrical power capacity, so that it can provide maximum protection. Apart from that, 3 phase MCB also has several additional features, such as the ability to avoid leakage currents and overloads, and can also be used as a additional safety devices (supplements) to existing electrical protection systems.
3 phase MCB has several advantages, including:
1. Able to secure electrical installations that have three phases, so that they are more effective in protecting electrical equipment and preventing the danger of fire due to excessive electric current.
2. The size is relatively small, making it more practical to use and easier to install.
3. Can be reset after a power cut occurs, making it more practical and economical to use.

Gambar Bentuk Fisik MCB 3 Fasa
(Sumber : https://tagihanlistrik.com/4-fungsi-utama-mcb-3-fasa-dan-manfaatnya/)

1.6 Contactor (contactor) K and Protection Relay

usually we often encounter it on electrical control panels. In the panel, the contactor is used as a connector and breaker for AC type electric current. With this function, the contactor can also be used in other electronic circuits to control electric current. The existence of this contactor can help when someone assembles electronic equipment with large amounts of energy. In electrical control panels, contactors are often used as transfer switches and interlocks on ATS platforms. Contactors can also be controlled automatically using pilot devices or sensitive sensors. Being a contactor will be useful if electricity flows through its copper coil (Coil). So that inside the contactor there is a magnetic field that causes the NO (Normally Open) contact to close and the NC (Normally Close) to open.

Gambar Bentuk Fisik Supply contactor, 220VAC
(Sumber : https://lieneticjaya.com/kontaktor/)

The contacts on the contactor consist of 2, namely the main contact and the auxiliary contact.
Main Contact: Used for the power circuit
Auxiliary Contact: Used for control circuits.

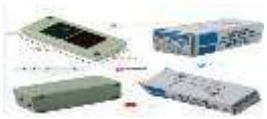
1.7 TDR (TIME DELAY RELAY)

TDR (Time Delay Relay): often called a timer relay or time delay relay, it is widely used in motor installations, especially installations that require automatic time setting. Timer This control equipment can be combined with other control equipment, for example with MC (Magnetic Contactor), Thermal Over Load Relay, etc. The function of this control equipment is as a timer for the equipment it controls. This timer is intended to regulate the on or off time of the contactor or to change the star system to a triangle within a certain time delay. Timers can be distinguished by how they work, namely timers that work using motor induction and using electronic circuits. A timer that works on the principle of motor induction will work when the motor receives AC voltage so that it rotates the mechanical gear and pulls and closes the contacts mechanically within a certain period of time. Meanwhile, relays that use electronic principles consist of a series of R and C connected in series or parallel. When the signal voltage has fully charged the capacitor, the relay will be connected. The length of delay time is set based on the size of the capacitor charge.
The input part of the timer is usually expressed as a coil and the output part as a NO or NC contact. The coil in the timer will work as long as it has a current source. When the desired time limit has been reached, the timer will automatically lock and make the NO contact become NC and NC become NO.

Gambar Bentuk Fisik Timer
(Sumber:https://electricmechanic.blogspot.com/2010/10/timer.html?m=1)

1.8 Push Button

Each color on the push button has its own function, for example red for the Stop button, green for the Start button, and yellow for the Reset button. Therefore, the push button can be said to be an important component in industrial machines, especially in turning the machine on and off. After discussing push buttons, you need to know that various symbols are used to represent push buttons in electronic design. The three main symbols that are often used are NC and NO (double), as well as single NC and NO. Each push button symbol represents a type of push button and shows how the button works and is controlled in the system. These symbols are usually used in making 3-phase electrical circuit diagrams. Therefore, it is important to understand the concept.



Gambar Bentuk Fisik Push button NO/NC
(Sumber; https://www.rekomend.id/pengertian-push-button/)

Single Switch

How to Install Single and Double Light Switches - Surely we often turn on and turn off the lights at home by pressing the switch. And the switches that are often found in homes are single and double switch types. However, have you ever thought about how to install the light switch?

1. How to Install a Single Switch: A single light switch is the simplest type of switch. Because it consists of one lever. So, we can turn the lights on and off using just one switch button.

2. How to Install a Single Light Switch: From the picture above, we can see that the switch is installed on the phase cable. Why is that? This aims to avoid electrocution when changing lights or installing a new circuit.

3. How to Install a Double Switch: Installing a double switch is slightly different from a single switch. This double switch is capable of turning on and off two lights located in different places. For example, the lights in room 1 and room 2.

2.9. Cross Cable

Crossover cable or better known as cross cable is a cable that has a different arrangement at each end. Crossover functions to connect the same device or equipment. Apart from that, cross cables are also usually used in point to point or peer to peer networks. Examples of using cross cables include:

Connecting laptop to laptop.
Connecting a computer to a computer.
Connecting router with router.
Connecting hub to hub.
Connecting switch with switch.

The use of cross cables is usually not used thoroughly. Of the eight cables, at least four cables are often used. Where these four cables are useful for receiving and sending data packets between devices.

Gambar Bentuk Fisik Cross switch
(Sumber https://www.dewaweb.com/blog/apa-itu-kabel-cross/)

2.10.Series Switches

An inbow switch is a switch that is installed in the wall or a switch that is installed on the wall so it cannot be moved. Because it is embedded in the wall, this type of switch is suitable for those of you who are buying a new house or are renovating it because once the building is finished then we will You will be bothered by breaking down the wall to install this switch. The advantage of this switch is of course the interior of the house. Your building or structure can look neater.

Gambar Bentuk Fisik Series switch
(Sumber : https://www.sentrakalibrasiindustri.com/jenis-saklar-lampu-dan-cara-pemasangannya-di-gedung-atau-rumah/)

Single switch Single switch

Generally found in houses, apartments, hotels, or industry. The function of a single switch is to turn one or more lights on and off. This switch only consists of a lever so you can turn multiple lights on or off with just one press.

Gambar Bentuk Fisik Single switch
(Sumber : https://www.sentrakalibrasiindustri.com/jenis-saklar-lampu-dan-cara-pemasangannya-di-gedung-atau-rumah/)

2.1.1.1. Stop Contact

In everyday life, of course, we cannot be separated from the use of sockets and switches, whether in the house, office or other buildings. Stop Contact: itself is a terminal that functions to connect the main electrical line to other electronic devices so that these electronic devices can receive electric current and function as they should.

Apart from the shape of the socket, what you also need to pay attention to is the main electrical voltage used in the destination country, because each country may also have different electrical voltage and frequency standards even though the electrical current used is alternating current or AC (Alternating Current). For example, Indonesia uses a standard AC electricity voltage of 220V 50 Hz on its single phase, while America uses a standard AC electricity voltage of 120 V 60 Hz. So you also need to pay attention to whether the electronic devices you carry can receive electrical input according to the specifications in the destination country.

Gambar Bentuk Fisik Stop contact
(Sumber:https://www.s-gala.com/blog-post/saklar-dan-stop-kontak)

2.1.1.2. S10 Starter Philips S10-P4 65 Watt

The TL lamp consists of a small glass balloon filled with noble gas. Inside the balloon there are two dual metal electrodes as filaments. The distance between the two electrodes is set to a certain distance so that the starter will turn on at a voltage of 100V– 200V. The starter functions as a time delay switching which is connected in parallel with two TL lamp legs.

Gambar Bentuk Fisik Starter S10 Philips S10
(Sumber:https://www.elektronikabersama.web.id/2012/04/ballast-dan-starter-lampu-tl.html)

Socket Lamp Left – Starter?

Fluorescent (FL) technology is a lamp in the form of a vacuum tube with glowing wires at both ends (electrodes), the tube is filled with low pressure mercury and argon gas. The lamp tube which is made of glass is also coated with a phosphor layer.
is that when an electric current flows through it, the electrode will heat up and cause the electrons to move from one end to the other. This electrical energy will also cause mercury, which was previously a liquid, to turn into gas. The moving electron will collide with the Mercury atom so that the electron's energy will increase to a higher level. The electrons will release light when the energy of the electrons returns to its normal level.

Gambar Bentuk Fisik Socket lamp right,lamp left.
(Sumber:
https://www.gudanglistrik.com/produk/938/lampu-tl-d-philips-lifemax-36w765)

2.1.1.3. Travo Ballast/Neon Lamp Ballast

Transformer ballast also known as magnetic ballast is an iron core inductance coil. The nature of inductance is that when the current in the coil flows, a magnetic flux will flow in the coil which will produce an induced electromotive force. Thus inhibiting the current change. Travo Ballast/Neon Lamp Ballast is when the circuit switch is closed at 220V, 50Hz AC power, electric current flows through the ballast to the starter, the lamp filament, the filament heats up (at the start the starter is damaged, because it is greater than 180V, the starter has skipped the gas in the release of light bubbles , the jump bimetallic strip is heated in the bubble expansion deformation, the two electrodes together form a filament heating path).

When two starter electrodes are close together due to no arc discharge, the bimetal sheet cools down and the electrodes disconnect. lamp tube and causes an arc discharge (High pulse voltage-time around 1 ms 600V-1500V, the voltage value depends on the type of lamp). During the normal lighting process, the ballast self-inductance functions to stabilize the current in the circuit.

Gambar Bentuk Fisik Ballast Induktif
(Sumber:https://www.elektronikabersama.web.id/2012/04/ballast-dan-starter-lampu-tl.html)

2.1.1.4. Voltmeter and Ammeter?

A voltmeter is a tool that functions to measure electrical voltage. By adding a multiplier, you will be able to increase the measuring capability of the voltmeter many times over. The magnetic force will arise from the interaction between the magnetic field and the current strength. This magnetic force will be able to make the voltmeter needle move when there is an electric current. The greater the electric current flowing, the greater the deviation of the needle that occurs. Ohm meter: is a tool used to measure electrical resistance, which is a force capable of resisting the flow of electricity in a conductor. This tool uses a galvanometer to see the amount of electric current which is then calibrated to ohms.

An ammeter is a tool used to measure the strength of an electric current. Generally, this tool is used by electronics technicians in an electrical multi tester called an avometer, a combination of the functions of an ammeter, voltmeter and ohmmeter.

Ammeter meters can be made from a microammeter and shunt arrangement which functions to detect current in circuits, both for small currents, while for large currents, a shunt resistance is added.

Ammeters work according to the Lorentz force, magnetic force. The current flowing in the coil which is surrounded by a magnetic field will cause a Lorentz force which can move the ammeter needle. The greater the current flowing, the greater the deviation.

C AC
(http://www.organisator.org/1970/01/fungsi-pengertian-amperemeter-voltmeter-ohmmeter-alat-ukur-listrik-ilmu-fisika.html?m=1)

2.1.1.5. Thermal Overload Relay

is an electronic component used to assemble a circuit in an electrical panel. In electrical circuits, this component has a very important role, because it can protect against excessive electric current with the working principle of heat or thermal. So, this TOR can be useful for cutting off the electric current to an electric motor circuit, when a disturbance occurs, such as excessive electric current, short circuit, voltage difference between motor pole phases and so on.

Thermal Overload Relay is a safety or protective component in the main contactor, namely when excessive current occurs which can cause damage to the electric motor circuit. This tool will cut off the current to the circuit if it detects that the incoming current exceeds the setting.

Gambar Bentuk Fisik Thermo relay,3 fasa
(Sumber:https://rakhman.net/electrical-id/thermal-overload-relay/
)

2.1.1.6. Pilot Lamp

indicates that there is electricity entering the electrical panel. Pilot Lamp when there is an incoming electrical voltage, namely phase and neutral, the lamp or LED on the pilot lamp will light up. Working Voltage on the Pilot Lamp. Now, LED technology is widely used. This LED has the advantage of being brighter and energy efficient. So, to turn on the Pilot Lamp using an LED, you need to know the working voltage. There are several voltages that are commonly used, such as: 24 V AC/DC-110 … 120 V AC-230 … 240 V AC

Color Choices for Pilot Lamps: We have to know, color is very important for . Color can help us to analyze information more easily. White, Green, Red, Orange or yellow, Blue

The colors below are usually used by electrical panel makers or what are usually called panel makers, so we can quickly understand what is going on.

Gambar Bentuk Fisik Indicator lamp 220 VAC, merah, kuning, hijau
(Sumber: ***https://www.kelasplc.com/pilot-lamp/***)

2.1.1.7. Selector Switches

Selector Switch or commonly called Rotary Switch is a switch that is operated or functioned by rotating. This switch is used to select one of two or more positions. There are those that act like a toggle switch where the selector can stop in one position, and there are those that act like a push button, where after making a selection the selector will return to its original position or the neutral position of the selector switch which is adjusted to its use, such as a selector switch to measure phase voltage. or phase current connected to a voltmeter and ammeter. And many more.

Gambar Bentuk Fisik Selector switch
(Sumber:***https://www.plcdroid.com/2020/11/pengertian-selector-switch.html***)

Jumper cable: is an electrical cable that has connector pins at each end and makes it possible to connect two components involving the Arduino without the need for soldering. In essence, the use of jumper cables is as an electrical conductor to connect electrical circuits.
Jumper cables are usually used on breadboards or other prototyping tools to make it easier to tinker with the circuit. The connectors at the end of the cable consist of a male connector and a female connector. The female connector functions for piercing and the male connector functions for piercing.

The jumper cables will show colorful cable colors. There are black, brown, red, orange, yellow, green, blue, purple, gray and white. Actually, these colors have no special meaning or purpose. Basically, jumper cables have the same function. Each color does not have a special function.

Gambar Bentuk Fisik Kabel Jumper
(Sumber
:https://www.arduinoindonesia.id/2022/11/pengertian-jenis-dan-cara-kerja-kabel-jumper-arduino.html)

III. Implementation Methods

3.1. Planning

This chapter includes research time and place, tools and materials, tool design, research methods, and research procedures. In the research procedure, several test steps will be carried out to find out how basic electricity works. So a more detailed explanation of the research methodology will be presented as follows:

1. Time and Place of Research

This research was carried out from 04 September 2023 to 15 May 2024 at PT ROWELLIN PERSADA UTAMA, East Java Province, Malang City. Data collection was carried out for 7 days starting from 8:00 am to 17:00 pm at a location on Jalan Ikan Cucut No. 6, Tujungekar, Lowokwaru Blimbing, Malang City, East Java.

2. Method of collecting data

The data collection method in this research is

a. Field study: In this field study, it is carried out by designing basic electrical equipment that needs to be used at this time.

b. Component Design: This stage includes designing components using a trainer, making tools, analyzing and studying basic electrical trainer concepts from existing components. This stage is also the most important stage where the initial form of basic electrical trainer will be designed. At this stage, component design and existing processes are designed.

c. Implementation: At this stage, the tool design that has been created is implemented. This stage relates what was contained in the previous stage into an input that is in accordance with what was planned.

d. Trial and Evaluation: At this stage, a trial is carried out on the series of current measurements issued with some data involving several journals and then corrections are made if there are errors so that an evaluation of the trial results can be carried out.

3.2.1 Literature review

Literature studies are carried out by collecting and studying files, documents and archives in libraries as well as supporting books about the tools being designed. Next, these data become references and try to apply existing theories.

3.2. Research methods

The research method that has been studied by the author uses a tool design method which is divided into several experiments or types of experiments. The types of experiments that the author made and analyzed will be explained below:

A Principles of Electrical design

1. Tools and materials

A Tools

- Laptops
- Pliers
- Soldering
- -Screwdriver
- -Knife
- Multimeter

B. Material

- Assembled iron
- LED lights
- Cable
- Papa Acrylic
- Banana
- Glue
- Components

B DC Pilot Lamp Design

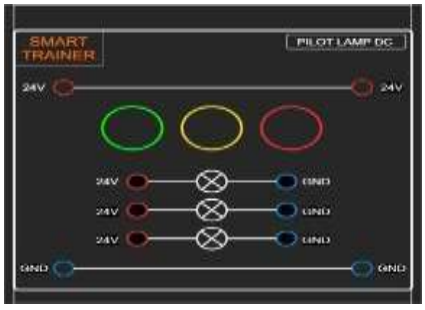


Figure 3.1 DC Pilot Lamp Design

C How the DC Pilot Lamp tool works

To create or design electricity requires experimentation. Here are some experiments to make basic electricity. The steps are:

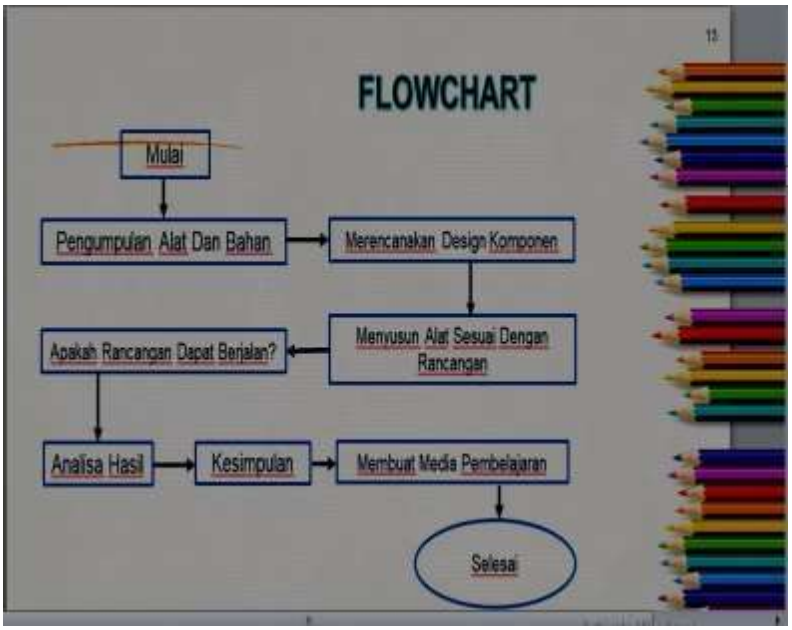
The workings of a basic electrical block diagram are:

As for how to make or design a basic electrical trainer, experimentation is required.

1. Provide fuel by using stickers to stick to the acrylic board.
2. Prepare shampoo soap to stick to the sticker with water so that it can get maximum results so that it sticks firmly.
3. After that, place it in the sun to dry in water or let it dry with a fan.
4. Once dry, install the components provided.
5. After installing the components, test them with a multimeter to make sure.
6. Thus, the wiring diagram becomes mechanical and the basic electricity becomes electricity.

3.3. flowchart

From the flowchart explanation above the author can explain that:



Gambar 3.3 Flowehart

a. Collecting data - data is taken from various sources such as books, journals and social media.
b. Plan the tool in accordance with existing resources and prepare everything needed to make the tool and also design the tool so that it can run well or as expected.
c. Arrange tools according to designs obtained from existing sources.
d. If the designed tool can work then the results of the analysis of the tool that have been designed continue, and if the tool that is designed does not work, we return to the design section of designing the tool.
e. Continuing to the analysis section, if the tool does not match the analysis that has been made by the author, then go back to designing the tool.
f. If the analysis system is in accordance with the results of making the tool then a conclusion is made for the tool.

3.4. Basic Electrical Trainer Exposure

The basic electrical trainer from the wiring diagram process that produces components so that it can produce electricity in such a way as in this research is:

Figure 3.2 Single Switch

3.5. Basic Electrical Trainer Research

In the basic electrical trainer, what I did was referring to what I explained in the tool design discussed in the previous chapter.

As for the working system of the following trainer, I will explain how the system works in the section below:

A. 1 Phase MCB

To make a basic electrical trainer, the following experiments are the results of experiments on how to make basic electrical equipment:

1 MCB 1 Phase. Can be interpreted as an electric circuit breaker device that has a single pole, making it possible for this device to cut off the electric current with just one lever. That way, electricity can be cut off more quickly when overload or overheating occurs.

2 Assembled iron as a stand for the basic electrical trainer.

3 Iron assembly for component tubes as a place for component fillers.

4 Basic Electrical Training Tools Used to practice basic introduction to electricity as well as studying electrical components where students create electrical circuits, measure and calculate electrical parameters and troubleshoot.

5 LED lights are used as output or electrical output. So that from the rotation of the propeller the lights can turn on.

3.6. Basic Electrical Design

The procedure for designing electrical trainer component tools can be carried out in the following steps:

The first step taken is to prepare the component materials using these components. The trainer is directly used as a starter to make it easier to know how to install the components later.

Figure 3.3. 3 Phase NFB

The second step taken is to make and prepare an MCB. A Miniature Circuit Breaker (MCB) or also called a Miniature Circuit Breaker is an electromechanical device that functions as a protector for electrical circuits from excessive current. In other words, the MCB can cut off the electric current automatically when the electric current passing through the MCB exceeds a specified value. However, when the current is in normal conditions, the MCB can function as a switch that can connect or disconnect the electric current manually.

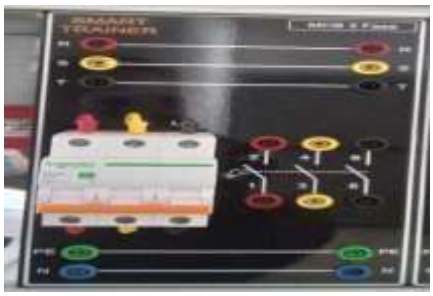


Image of 1-3 Phase MCB

The third step taken is to prepare To understand the Electrical Fundamentals Training System, part of the HVAC-R product line, is a complete program designed to introduce students to the basics of electricity. Components and Equipment: Switches, Indicator Lights, Resistors, Printed Circuit Boards, Capacitors/Inductors, Contactors, Push Buttons, Control Transformers, Relays, Residential Bimetallic Thermostat, Breaker, Disconnect Switch, Multimeteritch, Clampmeter, Test Lead Kit, User manual.

Figure 3.4 Front View

The fourth step to take is to prepare the FITTING, which is an electrical device to safely contact the lamp with wires in the electrical network. By using fittings for our electrical equipment such as lights, it will be safer to use and neater.

Figure 3.5 Lamp fittings

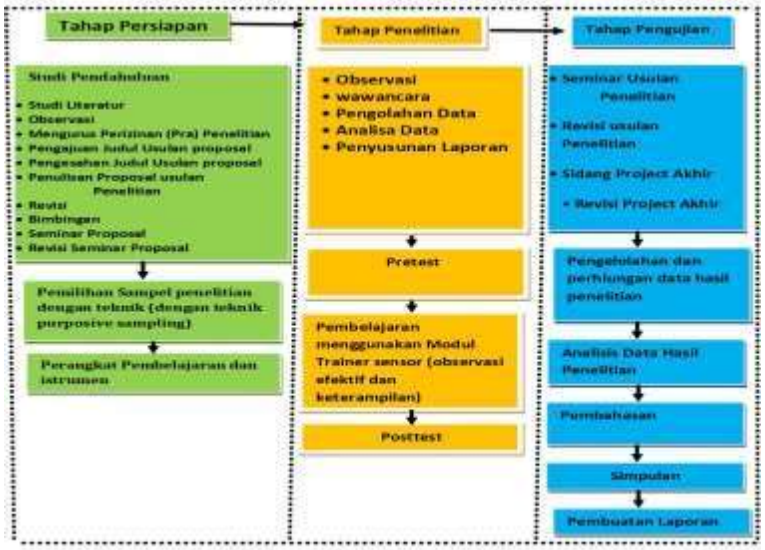
3.7. Table 1 Estimated Component Costs

NO	NAMA BARANG	RP	TOTAL
01	Schneider Electric	500,000 X1	500,000
02	ELCB ABB F202 AC 2P	350,000x1	350,000
03	elcb iid 4p 25a 300ma schneider	600,000x1	600,000
04	MCB SCHEINEDER DOMAI 1 phase 6A	150,000x1	150,000
05	MCB SCHNEIDER iC60N 3PHASE	350,000x1	350,000
06	Schneider Kontaktor 3P 7,5kW 16A	450,000x1	450,000
07	CONTACTOR LS METASOL MR-4 16 A	750,000x3	2,250,000
08	TIMER OMRON H3CR-A8	250,000x1	250,000
09	push button 22mm	50,000x1	50,000
10	Change Over Switch Control Push	50,000x1	50,000
11	Cross switch Joy Stick - 3Posisi +	50,000x1	50,000
12	SAKLAR SERI BROCO	60,000x1	60,000
13	Saklar Engkel IB Broco Galleo G161	50,000x2	100,000
14	STOPKONTAK AC KOMPLITE PANA	100,000x1	100,000
15	Fitting Voslo Fitting Kaki Neon TL	200,000 x 1 Set	200,000
16	Starter S10 Philips S10-P 4-65 Watt	150,000x1	
17	Lampu TLD 15W Watt Philips	0x1	150,000
18	Travo / Ballast / Balast Lampu Neon	125,000x1	125,000
19	oltmeter 0-500VAC, 96x96mm	350,000x1	350,000
20	Ampere Meter AC Analog 96	350,000x1	350,000
21	Thermal Overload Relay 40A LS	800,000x1	800,000
22	Pilot Lamp Hijau 20mm For	100,000x1	100,000
23	Selector switch 2posisi modular	250,000x1	250,000
24	Motor Listrik 3 Fasa Phasa Elmot	3,000,000	3,000,000
25	Dinamo Penggerak Wipro 1/4 HP	2,000,000	2.000.000
26	PAKET LENGKAP KABEL JUMPER	500.000	500.000
	TOTAL RP:12.635.500		

3.8. Schedule, Table 2. Implementation

3.9. FRAMEWORK

Learning can take place well if it is supported by good, complete and current learning facilities and infrastructure. One of the facilities and infrastructure that can be used is learning media, here the learning media referred to by researchers is in the form of modules and trainers. Trainers can make students more enthusiastic about the learning process, especially if trainers can generate great motivation and curiosity in students, of course this will lead to increased learning outcomes. Table 3



Penelitian ini meliputi tiga tahapan yaitu tahap persiapan, tahap pelaksanaan, dan tahap pengujian.

A. Preparation phase

The preparation stage is carried out before collecting research data in the field. The things that must be implemented in this stage are:

1. Preliminary Study, conducting literature studies regarding relevant theories and analyzing the basic electrical Trainer Module teaching material curriculum to determine the suitability of the material to be used in preparing the electrical Trainer Module. Literature Study, Observation, Managing (Pre) Research Permits, Submitting Proposal Titles, Ratifying Proposal Titles, Writing Research Proposals, Revisions, Guidance, Proposal Seminars, Revisions to Proposal Seminars, which are used previously and later.
2. Select a research sample which is discussed with the school, as well as consultation regarding the time and place of conducting the research.
3. Develop and create learning tools in the form of basic electrical trainer modules, as well as preparing research instruments in the form of pretest and posttest questions, research questionnaires and research observation sheets.
4. Discuss the instrument that has been prepared with the supervisor.
5. Carry out a feasibility test for the basic electrical Trainer Module with media experts and material experts.
6. Analyze the feasibility of the electrical Trainer Module and make repairs if necessary.

B. Implementation Stage

The implementation phase is carried out to collect research data, which will be carried out at Raden Rahmat Vocational School. The things that must be implemented in this stage are:

1. Give a pretest to find out the initial value of students' learning outcomes regarding the Sensors and Actuators teaching material.
2. Providing treatment to students through learning using the Sensor Trainer Module.
3. Assess students' attitudes and skills in learning through observation sheets.
4. Provide posttests and user questionnaires to students to find out the value of Sensor and Actuator learning outcomes after being given treatment using the Sensor Trainer Module.

C. Final Stage

1 The final stage is carried out after collecting research data in the field. The things that must be implemented in this stage are:

2 Process data from pretest, posttest results and observation sheets.

3 Analyze and discuss the results of research data processing.

4 Conclude the research results based on the analysis and discussion that has been obtained.

5 Prepare a report as proof that research has been carried out regarding the basic electrical Trainer Module.

3.10. Testing Trainer Body Electrical System Motorcycle headlights and components,.Table.4

A Petunjuk

1 Penilaian ditinjau oleh dua aspek,dimohon kepada bapak/ibuk memberikan penilaian umum dan saran-saran

2 Penilaian ditinjau dari beberapa aspek,dimohon kepada bapak/ibuk memberikan chek list pada kolom nilai yang sesuai

3 Hasil penelitian dapat menjadi media pembelajaran sistem kelistrikan lampu kepada komponen-komponen

B Penilaian Trainer Sistem Kelistrikan Dasar

Sekolah : SMK Raden Rahmat

Keahlian : program keahlian Teknik Instalasi Listrik

Mata Pelajaran : Dasar Listrik Dan Elektronika

Tahun Ajaran : 2023/2024

No	Pertanyaan	Jawaban	
		Yes	No
A	**Aspek Pembelajaran**		
	Apakah Rangkaian Sistem Lampu Kepala Komponen-Komponen Dapat Digunakan?	Yes	
B	**Aspek Ergonomi**		
	Apakah Media Pembelajaran Dapat Dipindahkan Dengan Mudah?	Yes	
	Apakah Penggantian Komponen Media Dapat Dipindahkan Dilakukan Dengan Mudah?	Yes	
	Apakah Ketinggian Dari Media Pembelajaran Ini Dapat Memperceput Kelelahan Pada Saat Melakukan Praktik?	Yes	
	Apakah Simbol-simbol Pada melihat Terlihat Jelas Dan Membanta Saat Praktik	Yes	
C	**Aspek Estetiika**		
	Apkah Tampilan Penempatan Komponen Media Terlihat Rapi?	Yes	
	Apakah Warna Simbol-Simbol Media Pembelajaran Terlihat Menarik?	Yes	
	Apakah Bentuk Media Pembelajaran Terlihat Menarik?	Yes	
D	**Aspek K3**		
	Apakah Rangkaian Media Pembelajaran Sistem Kelistrikan Aman Saat Digunakan?	Yes	
	Apakah Sekering Yang Di Pasang Pada Media Mampu Menjaga Keamaan Bila Terjadi Konleting?	Yes	

IV. Results and Discussion

4.2. Discussion

1 Product Development Results

Hasil The research results from the development of a trainer as a learning medium for basic electrical equipment repairs refer to the ADDIE model which includes Analysis, Design, Development, Implementation, Evaluation developed by Lee & Owen (2004). The following is an explanation of the steps for developing a trainer as a learning medium for basic electrical equipment repairs:

a. Analysis (Analisis)

The analysis stage is the first stage in developing the trainer as a learning medium. Analysis was carried out through discussions with teachers and observations made to obtain the information needed to develop trainers as learning media. Observation stage through curriculum analysis to determine core competencies and basic competencies for planning trainer development as a learning medium. The curriculum used in learning Basic Repair of Electrical Equipment in class XII is the 2013 Curriculum.

The interview or discussion stage was carried out by the teacher in charge of the Basic Electrical Equipment Repair subject at Raden Rahmat Vocational School with the results of the interview or discussion, namely the basic electrical trainers developed including NFB trainer, 1-phase ELCB trainer, 3-phase ELCB trainer, 1-phase MCB trainer, 3-phase MCB trainer phase, Timer trainer, Push button trainer, Change switch trainer, Push Button trainer, trainer, Cross switch trainer, Switch trainer, Single trainer, Stop contact trainer, Philips S10 Starter trainer, Socket lamp trainer, Ballast trainer, AC Voltmeter trainer , AC Ammeter trainer, Thermo relay trainer, 3 phases, Thermal Overload trainer, Indicator lamp trainer, Selector switch trainer, Electric motor trainer: 3 phases, Electric motor trainer: 1 phase, Jumper cable trainer, Banana trainer. trainer On/OFF switch. Based on the results of the analysis on the subject of basic repair of electrical equipment, obstacles were found during the learning process, namely (1) limited practical learning facilities, (2) Students had difficulty understanding the learning material, (3) Students' interest in learning was low.

b. Design (Desain)

The design stages in developing trainers as learning media for basic electricity and electronics subjects include (1) determining the content of the learning media; (2) analysis of component requirements; (3) creating a shape design that is ergonomic and safe to use.

c. Determine the content of learning media

The development of trainers as a learning medium for basic electricity and electronics subjects is tailored to basic competencies, namely applying how to maintain electrical equipment using electricity and implementing basic repair procedures for electrical equipment that uses lights. The trainer creation focuses on household electrical equipment that uses lights. Determining the electrical equipment used in the trainer as a learning medium through observations and interviews with teachers who teach basic electrical equipment repair subjects. Household electrical equipment used in making trainers includes 1-phase MCB, 3-phase MCB, 1-phase ElCB, 3-phase ElCB trainer, and pilot lamp. Electrical equipment trainers also determine accompanying practical job sheets.

d. Analisis kebutuhan komponen

Component requirements analysis is carried out as the first step in creating a trainer design. The results of component analysis activities will determine the trainer design, trainer box size and placement for the 1 Phase MCB electrical equipment trainer. Elcb electrical equipment and components for making trainers are selected with appropriate specifications and are safe to use for practical needs by teachers and students.

The trainer as a learning medium for basic repairs of electrical equipment uses two safety components, namely 1 Phase MCB. 3 Phase MCB is used as protection against short circuits and overloads. The MCB used is a 1 Phase MCB with safety dimensions adapted to basic electrical equipment, namely 2 A and 4 A.

Based on the results of the analysis of component requirements calculations, the overall material requirements for the trainer to be made can be seen in Table 1. as follows:

Table 1. Component Requirements

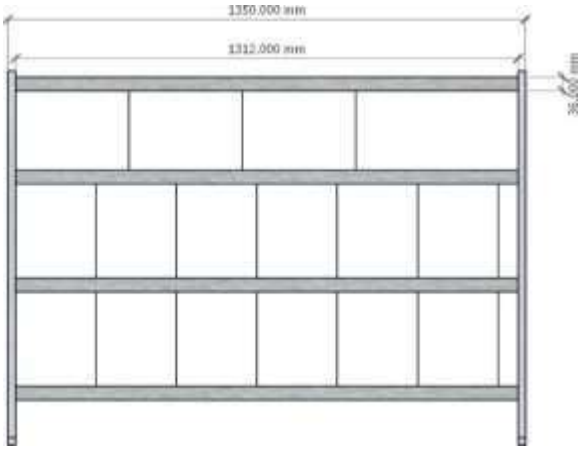
No	Nama Komponen/Bahan	Jumlah Kebutuhan
1	No Fuse Breaker (NFB)	5 buah
2	ELCB (Earth Leakage Circuit Breaker (ELCB)1 Fasa	1 buah
3	Pilot Lamp	2 buah
4	ELCB (Earth Leakage Circuit Breaker (ELCB)3 Fasa	1 buah
5	Single Switch	3 buah
6	Akrilik 3mm	27 lembar
7	Tiang Besi	6 lembar
8	Sakelar On/OFF	3 buah
9	Voltmeter AC Dan Amperemeter DC	2 buah
11	Miniatur Circuit Breaker (MCB) 1 Phasa	3 buah

e. Making trainer designs

Making this trainer design is a step that needs to be taken into account in terms of aesthetics and safety when used, therefore the design must be really thorough. Making electrical trainer designs using Corel Draw X7 software. SketchUp Pro 2021, This trainer design consists of a trainer box design and a trainer interface.

f. Trainer Box Design

The trainer design as a learning medium was created using Corel Draw X7 software. Based on the analysis of component requirements, 27 electrical trainers will be made. The box for each trainer is made using 3mm thick milky white acrylic. The box is made to the size of each trainer, namely 1350 cm x 1312 cm x 12 cm. Image of a box without parts that can be seen.



Figure,4.1. Design place the trainer

The radius of the box is arranged so that it is sturdy without using glue on the top. That part is not glued so that if there is damage or repairs it is easier to do. On the side of the box there is a hole for the cable to go to the basic electrical equipment and place the source terminal, fuse housing and ON/OFF button. The bottom of the box has holes around the sides for attaching the box with wooden boards. The top of the box will be joined using bolt nuts. The part in the box contains the basic electrical circuit for electrical equipment, the MCB safety section and the basic electrical source. The design of the top of the box for each trainer is shown in the following pictures.

g. Interface Design Trainer Design

The interface for five basic electrical trainers as learning media uses the same size, namely 1350,000 cm x 1312,000 cm. The interface display contains a 220V 1-phase AC source terminal, a 1-phase MCB safety device that is adjusted to the power of the basic electrical equipment and a circuit drawing

1 Voltage Source

This source terminal functions as a power supply for the trainer to be connected to the connecting cable to assemble the circuit according to the job sheet.

2 Miniature Circuit Breakers (MCB)

MCB is one of the safety components in the trainer. MCB functions to protect the basic electrical trainer equipment circuit from short circuit currents and overloads. There are two types of MCB sizes used in trainers

Basic electricity is 2 A for 1 phase MCB trainer, 3 phase MCB trainer, 4 A ElCB trainer for NFB trainer and other trainers consisting of 27 basic electrical trainers.

3 Indicator Lights

Indicator lights are output components to show electricity flowing through basic electrical elements. Many lights are adapted to the many component elements on each trainer.

4 Basic Electrical Equipment Circuits

The series of basic electrical equipment is an illustration of the basic electrical working principles that exist in everyday life. The design is made in accordance with the working principles of the electrical circuit of equipment components that are already available. Picture of the basic electrical circuit for MCB electrical equipment, electric ElCB, pilot lamp, contactor and as follows.

a. Wiring Diagram, 1-3 Phase MCB trainer

Figure 4.2. MCB Electrical Circuit Wiring

b. Elcb 1.3 Phase trainer Wiring Diagram

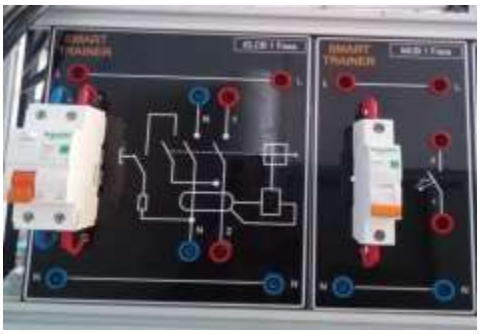


Figure 4.3. Wiring Electrical Equipment ELCB Electrical

c. Wiring Diagram trainer Contactor 4 NO 1NC

Figure 4.4. Wiring Electrical Equipment Contactors 4 NO I NC

d. Wiring Diagram trainer Push Button

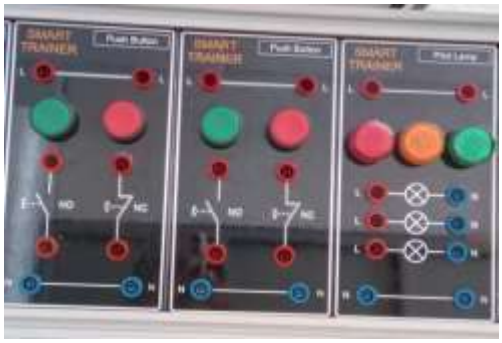


Figure 4.5. Wiring Push Button Electrical Equipment

e. Ammeter trainer Wiring Diagram

Figure 4.6. Ammeter Electrical Equipment Wiring

f. Selector Switch Wiring Diagram

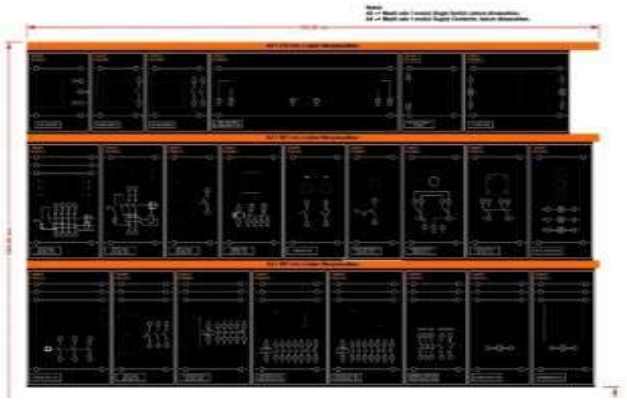
Figure, 4.7 Wiring Diagram Selector Switch

The iron pole board is used as a place to attach the trainer box and basic electrical equipment. Use a position to make it easier to carry the trainer and to prevent cables between the trainer box and electrical equipment or components from being pulled. The size of the iron pole board varies according to the size of the existing basic electrical equipment. Table 2 shows the seat sizes for each trainer as follows.

Table 2. Board Size

No	Peralatan Listrik Pemanas	Ukuran Papan Dudukan
1	MCB	30cm X 40cm X 1cm
2	NFB	30cm X 50cm X 1cm
3	ELCB	30cm X 55cm X 1cm
4	Kontaktor	30cm X 40cm X 1cm
5	Puh button	30cm X 50cm X 1cm
6	Semua sama 27 buah Komponen-komponen	

The trainer box with the iron baseboard is attached using bolts, while the electrical equipment is only placed on the baseboard because there is some electrical equipment that is disassembled through the top. Design the box and electrical equipment on a wooden board as shown in Figure 17 below.



Figure,4.8. All Trainees

4.3. Development

1. Trainer development Development stage
is the stage for producing a product that has been previously designed. The aim of the development stage is to produce the final form of learning media after being designed by the researcher himself with the help of Corel Draw X7 software which is then created and will be tested for feasibility by media experts and material experts.

The process of making a trainer begins by cutting acrylic according to the trainer design for existing basic electrical equipment. The next stage is to print stickers containing symbols and information to be attached to the acrylic board that has been cut previously. The holes cut in the acrylic are then installed with banana plugs which are connected to the electrical equipment components and the display on the trainer box. Using banana jumpers will make the process of assembling the basic electrical equipment repair trainer easier. Banana jumpers and banana plugs are made using

1.5mm NYAF cables.The trainer box contains several components in the form of terminals for the voltage source, on/off switch and safety fuse. The bottom of the box has a hole to connect the mounting board for electrical equipment and the trainer box. Results from the basic electrical equipment repair trainer.

2. Due diligence by experts

Feasibility tests are carried out to determine the feasibility level of the learning media being developed. The feasibility test step was carried out by involving one teacher from Raden Rahmat Vocational School as a media expert. The teacher in charge of the Basic Electrical Equipment Repair subject, . The results of the feasibility test are assessment scores and suggestions for media development as material for product revision. After the learning media was declared suitable by experts, the research continued with the implementation stage of direct use for students and teachers at school.

3.) Media Expert

The feasibility test by media experts was carried out by administering a four-scale questionnaire containing assessments on design aspects, technical quality aspects and material usefulness aspects. The teacher as media expert 1 is Younky Wira Putra, S.T.

Advice from media expert 1 is to adapt the work steps on the job sheet to the existing trainers, adding tasks and explanations for each trainer. Media expert 1 suggested that the trainer usage guide be more complete and that the circuit schematic drawing be equipped with a picture of the measurement points. Media expert 1 stated that the trainer as a learning medium for basic electrical equipment repairs that was developed was "suitable for use with revisions according to suggestions". Data from the questionnaire distributed to media experts 1 obtained data with an average score of 84 out of a maximum score of 96 so it was included in the "Very Appropriate" category as a learning medium.

4.) Media Expert

Feasibility testing by material experts is carried out by administering a four-scale questionnaire containing assessments on aspects of material quality and aspects of material usefulness. The teacher as material expert 1 is Sapto Budiyono S.Pd.

Material expert 1 suggested that the trainer's job sheet as a learning medium for observation tables develop an analysis of electrical energy usage and costs used and add score points for making reports. Material expert 1 suggested adding basic theory to each job, symbols

adjusted to standards and adjustments to tools and materials. Material expert 1 also stated that as a trainer the learning media for basic repairs of electrical equipment that was developed was "suitable for use with revisions according to suggestions". Data from the questionnaire distributed to material experts 1 obtained data with an average score of 77.5 out of a maximum score of 92 so it was included in the "Very Appropriate" category as a learning medium.

1.4. Implementation

The implementation stage is carried out by applying trainers as learning media for basic electricity and electronics subjects in the learning process directly to students. At this stage, trials were carried out to determine user responses and input on the trainer developed by researchers. The implementation phase involved users, namely 22 class XII students majoring in Electrical Installation Engineering at Raden Rahmat Vocational School and two teachers majoring in Electrical Installation Engineering at Raden Rahmat Vocational School.

a. Evaluation

After the trainer product as a learning medium is tested on users, namely students and teachers. The trainer is then assessed by the user through a questionnaire and then research data is obtained in the form of data on the trainer's suitability as a learning medium from user responses. The research data is analyzed so that conclusions can be drawn regarding whether or not trainers are suitable as learning media that are being developed.

b. Data analysis

a. Validity of Research Instruments (development)

Instrument validation is carried out to determine the validity of a research instrument. Research questionnaire instruments tested for validity include material expert questionnaires, media expert questionnaires, teacher questionnaires and student questionnaires. The validity test of the research questionnaire instrument was carried out by expert assessors who were 1 expert teacher. The assessors in this study were 1 expert assessor and 1 expert assessor.

1. Based on the results of the research questionnaire instrument validation test, expert assessor 1 stated that the research questionnaire instrument was suitable for use with revisions in research and expert assessor 1 stated that the research questionnaire instrument was suitable for use with revisions in research. The results of the validation of the research questionnaire instrument can be seen in the attachment.

b. Data Analysis of Material Expert Validation Results

The results of the material validation data analysis are used to test the feasibility of the trainer as a learning medium based on the material for trainer development. Data from validation results by material experts were obtained through a questionnaire that was filled in by one teacher who teaches basic electricity and electronics subjects at Raden Rahmat Vocational School. The data from the questionnaire was converted into four scale score intervals (Appendix 4) to determine the level of suitability of the trainer as the learning media being developed. There are 23 statement items in the questionnaire for material experts so that the highest ideal score is 92, the lowest ideal score is 23, the ideal average score is 57.5 and the ideal standard deviation score is 11.5. The results of the average score when converted according to the eligibility criteria in Table 3 are as follows:

Table 3. Conversion of Material Expert Mean Score Values

Interval Skor	Kategori
$74,75 < X \leq 92$	Sangat layak
$63,25 < X \leq 74,75$	Layak
$51,75 < X \leq 63,25$	Cukup layak
$40,25 < X \leq 51,75$	Tidak layak

Assessment by material experts includes two aspects, namely: material quality and material usefulness. Data on the results of the feasibility test assessment by material experts can be seen in Table 4 below:

Table 4. Material Expert Assessment Results

NO	Aspek	Responden	Skor Maks	Rerata Σ Skor
		Ahli 1		
1	Kualitas Materi	41	60	48
2	Kebermanfaatan Materi	28	32	29,5
Total		86	92	77,5
Kategori				Sangat Layak

The results of the assessment of the trainer's suitability test as a learning medium by material experts from the aspect of material quality obtained an average score of 48 from the maximum value
60 so it is declared "Very Decent", and the usefulness aspect of the material gets an average score of 29.5 out of a maximum score of 32 so it is declared "Decent". Both aspects of material quality and material usefulness obtained an average score of 77.5 from a maximum score of 92 so that in terms of feasibility testing by experts
material for trainers as a learning medium for the Basic Repair of Electrical Equipment subject was declared "Very Appropriate" to be used as a learning medium.

c. Data Data Analysis of Media Expert Validation Results

The results of validation data analysis by media experts are used to test the suitability of trainers as learning media based on the media trainer's perspective. Data from validation by media experts was obtained through a questionnaire filled in by media expert teachers from Raden Rahmat Vocational School. The questionnaire data was then converted into four scale score intervals (Appendix 4). There are 24 statement items in the questionnaire for media experts so that the highest ideal score value is 96, the lowest ideal score value is 24, the ideal average score value is 60 and the ideal standard deviation score value is 12. The results of the average score value if converted according to the eligibility criteria in Table 5. are as follows:

Table 5. Conversion of Material Expert Mean Score Values

Interval Skor	Kategori
$78 < X \leq 96$	Sangat layak
$66 < X \leq 78$	Layak
$54 < X \leq 66$	Cukup layak
$42 < X \leq 54$	Tidak layak

Assessment by media experts covers several aspects, namely design aspects, technical quality aspects, and material usefulness aspects. Data on the feasibility test assessment by media experts can be seen in Table 6 below:

Table 6. Assessment Results by Media Experts

NO	Aspek	Responden	Skor Maks	Rerata Σ Skor
		Ahli 1		
1	Desain	33	36	32,5
2	Mutu Teknis	31	36	32
3	Kebermanfaatan Materi	19	24	19,5
Total		83	96	84
Kategori				Sangat Layak

The results of the trainer feasibility test assessment as a learning medium by media experts from the design aspect got an average score of 32.5 out of a maximum score of 36 so it was declared "Very Feasible", the material quality aspect got an average score of 32 out of a maximum score of 36 so it was declared "Very Feasible", and The usefulness aspect of the material received an average score of 19.5 out of a maximum score of 24 so it was declared "Decent". For these three aspects, an average score of 84 was obtained from a maximum score of 96, so that in terms of feasibility tests by media experts for trainers as a learning medium for Basic Electrical and Electronics subjects, it was declared "Very Feasible" to be used as a learning medium.

d. Data Analysis of Assessment Results by Teachers

Results of data analysis obtained from a questionnaire that was distributed to teachers majoring in Electrical Power Installation Engineering at Raden Rahmat Vocational School. There are 24 statement items in the questionnaire for teachers so that the highest ideal score value is 96, the lowest ideal score value is 24, the ideal average score value is 60 and the ideal standard deviation score value is 12. The results of the average score value when converted are in accordance with the eligibility criteria in Table 7. as follows.

Table 7. Conversion of Teacher Average Scores

Interval Skor	Kategori
$78 < X \leq 96$	Sangat layak
$66 < X \leq 78$	Layak
$54 < X \leq 66$	Cukup layak
$42 < X \leq 54$	Tidak layak

Assessment by teachers includes material quality aspects, design aspects, technical quality aspects, and material usefulness aspects. Data on the results of the teacher's feasibility test can be seen in Table 8 as follows.

Table 8. Teacher Assessment Results

No	Aspek	Responden		Skor Maks	Rerata Σ Skor
		Guru 1	Guru 2		
1	Kualitas Materi	27	31	32	29
2	Desain	23	24	24	23,5
3	Mutu Teknis	23	24	24	23,5
4	Kebermanfaatan Materi	16	15	16	15,5
Total		89	94	96	91,5
Kategori					Sangat Layak

The results of the trainer's assessment as a learning medium by teachers from the material quality aspect got an average score of 29 out of a maximum score of 32 so it was declared "Very Decent", the design aspect got an average score of 23.5 out of a maximum score of 24 so it was declared "Very Decent", the technical quality aspect got the average score was 23.5 out of a maximum score of 24 so it was declared "Very Decent", and the usefulness aspect of the material got an average score of 15.5 out of a maximum score of 16 so it was declared "Very Decent". For these four aspects, an average score of 91.5 was obtained from a maximum score of 96, so from a test perspective

The teacher's feasibility for trainers as a learning medium for Basic Electrical and Electronics subjects was declared "Very Suitable" for use as a learning medium.

e. Analysis of Student Assessment Results Data

Results of data analysis obtained from a questionnaire that was distributed to class XII students of the Department of Electrical Power Installation Engineering, Raden Rahmat Vocational School. There are 24 statement items in the questionnaire for teachers so that the highest ideal score value is 96, the lowest ideal score value is 24, the ideal average score value is 60 and the ideal standard deviation score value is 12. The results of the average score value when converted are in accordance with the eligibility criteria in Table 9. is as follows.

Table 9. Conversion of Student Average Score Values

Kategori	Interval Skor
Sangat layak	$78 < X \leq 96$
Layak	$66 < X \leq 78$
Cukup layak	$54 < X \leq 66$
Tidak layak	$42 < X \leq 54$

Assessment by students includes material quality aspects, design aspects, technical quality aspects, and material usefulness aspects. Data on the results of the teacher's feasibility test can be seen in Table 10. They are as follows:

Table 10. Student Assessment Results

No	Responden	Kualitas Materi	Desain	Mutu Teknis	Kebermanfaa tan Materi	Skor Maks	ΣSkor
1	Siswa 1	23	18	18	16	96	75
2	Siswa 2	22	21	20	15	96	78
3	Siswa 3	23	22	21	15	96	81
4	Siswa 4	23	21	20	15	96	79
5	Siswa 5	23	18	18	16	96	75
6	Siswa 6	22	17	14	15	96	68
7	Siswa 7	23	17	18	16	96	74
8	Siswa 8	23	22	21	15	96	81
9	Siswa 9	24	20	20	15	96	79
10	Siswa 10	28	24	22	15	96	89
11	Siswa 11	21	20	17	16	96	74
12	Siswa 12	21	18	17	15	96	71
13	Siswa 13	22	17	19	16	96	74
14	Siswa 14	25	23	21	15	96	84
15	Siswa 15	26	24	22	18	96	90
16	Siswa 16	26	24	21	18	96	89
17	Siswa 17	24	22	21	17	96	84
18	Siswa 18	25	20	22	17	96	84
19	Siswa 19	23	22	22	16	96	83
20	Siswa 20	26	24	21	17	96	88
21	Siswa 21	25	22	21	17	96	85
22	Siswa 22	23	20	18	17	96	78
Rata-rata Σ Skor		23,7	20,7	19,7	16	96	80,1
Skor Maks		28	24	24	20		96
Kategori						Sangat Layak	

The results of the trainer's assessment as a learning medium by students from the material quality aspect got an average score of 23.7 out of a maximum score of 28 so it was declared "Very Decent", the design aspect got an average score of 20.7 out of a maximum score of 24 so it was declared "Very Decent", the quality aspect The technical aspect received an average score of 19.7 out of a maximum score of 24 so it was declared "Very Decent", and the usefulness aspect of the material got an average score of 16 out of a maximum score of 20 so it was declared "Decent". These four aspects were obtained

The average score is 80.1 out of a maximum score of 96 so that in terms of suitability tests by students for trainers as learning media for Basic Electricity and Electronics subjects it is declared "Very Suitable" to be used as a learning media.

1.5. Final Product Review

1. Trainer Development as a Learning Media

The development of learning media for basic electrical trainers, basic electricity and electronics subjects for class The aim of the research is to develop basic electrical trainer learning media, to determine the level of suitability of students and teachers for using trainers as learning media in Basic Electrical and Electronics Engineering subjects. This research develops a trainer that is in accordance with the results of the analysis and design. The trainer as a learning medium consists of two main parts, namely: (1) trainer box and (2) basic electrical equipment and place it. Trainers as learning media are equipped with job sheets to simplify the learning process.

The trainer box is made using acrylic as the raw material for the box with dimensions of 17cm X 25cm X 7cm. The function of the trainer box is as a place to store electrical circuits from basic electrical equipment which is equipped with a power supply and 1Phasa MCB safety. The trainer box design is assembled with glue for the bottom and sides, while for the top using bolt nuts to make it easier to remove the circuit for maintenance or subsequent repairs. Acrylic is used because the material is sturdy and light and makes it easy to cut and shape.

There are two seven electrical trainers consisting of Trianer NFB basic electrical equipment trainer, ELCB trainer, 3 phase ELCB trainer, 1 phase MCB trainer, 3 phase MCB trainer, Timer trainer, Push button trainer, Change switch trainer, Push Button trainer, trainer, trainer Cross switch, trainer Switch, trainer Single, trainer Stop contact, trainer Starter S10 Philips S10. Watt 220-240 Vol, trainer Socket lamp right. 2-15 Socket lamp left., trainer Ballast / Ballast, trainer AC Voltmeter, trainer Ammeter AC, Thermo relay trainer, 3 phase, Thermal Overload trainer, Indicator lamp trainer, Selector switch trainer, 3 phase electric motor trainer, 1 phase electric motor trainer, Jumper Cable trainer, banana trainer 220V AC source and so on. Each circuit is connected with a banana jumper so that to connect the basic electrical components, use a cable with a banana plug end.

Wooden boards are made to seat the trainer box and electrical equipment is made with designs and sizes tailored to basic electrical equipment.

The iron pole board with the box is attached with bolts, while the electrical equipment is only placed on a wooden board next to the trainer box. Wooden boards are used to make carrying the trainer easier and to keep the cables between the trainer box and the basic electrical equipment from pulling.

The trainer as the learning media developed functions as an alternative practical tool that still prioritizes students' cognitive and psychomotor aspects. It is hoped that the practice of basic repair of component equipment can be simulated with a basic electrical trainer as a learning medium, making it easier for students to understand electrical parts and the working principles of basic electrical equipment. The electrical trainer as a learning medium for basic electricity and electronics subjects for class XII at Raden Rahmat Vocational School still has shortcomings in the final product when compared to other similar learning trainers. Therefore, it is necessary to carry out an analysis to determine the advantages and disadvantages of trainers as learning media being developed. Analysis

The advantages and disadvantages of learning media are carried out using SWOT analysis (Strength, Weakness, Opportunities, Threat). The Strength aspect is an aspect to determine the strengths of the trainer as a learning medium, the Weakness aspect is an aspect to analyze the weaknesses of the trainer as a learning medium, the Opportunities aspect is an aspect to determine opportunities from the learning media and the Threat aspect is an aspect used to determine existing threats to the trainer. as a developed learning medium. The SWOT analysis of the trainer as a learning medium for basic electricity and electronics subjects can be seen in Table 11.

Table 11. SWOT Analysis of Trainers as Learning Media

No.	Aspek	Uraian
1.	Strength	Easy to move and store when not in use Can be used for repeated circuit simulations.Easy to do maintenance.Has a power source switch.
1.	Weakness	The effectiveness of trainers as learning media has not been tested This does not include all trainer equipment on the market.
2.	Opportunities	Other basic electrical equipment can be added to become an additional trainer The number of trainers has been increased so that it is ideal for use in one class Adding material to the job sheet in accordance with existing trainers.
3.	Threat	There are other trainers that can be used in Basic Electricity and Electronics subjects, so the development must be tailored to needs so that it has good use value more.

4.6 Eligibility of Trainers as Learning Media

1.Aspects of Material Expert and Media Expert

Based on the results of feasibility trials by two material experts in the material quality aspect, an average score of 48 was obtained with a maximum score of 60, so it is included in the "Decent" category, and in the usefulness aspect, an average score of 29.5 was obtained with a maximum score of 36, so it is included in the "Very Eligible" category. These two aspects have a total average score of 77.5 with a maximum of 92 so they are included in the "Very Appropriate" category as a learning medium. The results of research into the feasibility test of the trainer as a learning medium which was carried out through material experts for the material quality aspect obtained results in the feasibility category which were in line with the results of previous research on relevant research with the same aspect by Arvin Heri W in 2016 and Bagas Purnomo Aji in 2017 and obtained better feasibility category results compared to the results of research by Ahmad Lufti Setiawan in 2017 and Hermawan Rizki W in 2016.

The usefulness aspect of the material obtained results in the feasibility category which were in line with the results of relevant research by Ahmad Lufti Setiawan in 2017. The results of the feasibility test by two media experts in the design aspect obtained an average score of 32.5 with a maximum score of 36 so it was included in the "Very Feasible" category. in the technical quality aspect, the average score was 32 with a maximum score of 36, so it was included in the "Very Decent"

category, in the material usefulness aspect, the average score was 19.5 with a maximum score of 24, so it was included in the "Decent" category. These three aspects have a total average score of 84 with a maximum of 96 so they are included in the "Very Appropriate" category as learning media.

The results of research into the feasibility test of the trainer as a learning medium which was carried out through media experts for the design aspect obtained results in the feasibility category which were in line with the results of previous research on relevant research with the same aspect by Arvin Heri W in 2016, Ahmad Lufti Setiawan in 2017 and Bagas Purnomo Aji in 2017. Obtained better feasibility category results compared to research results by Hermawan Rizki W in 2016. Technical quality aspects obtained feasibility category results that were in line with relevant research results by Arvin Heri W in 2016, Ahmad Lufti Setiawan in 2017 and Bagas Purnomo Aji in 2017. The usefulness aspect of the material received results in the feasibility category which were in line with the results of research by Hermawan Rizki W in 2016.

2. Student and Teacher Aspects

Based on the results of the trainer's assessment as a learning medium by teachers, the material quality aspect received an average score of 29 out of a maximum score of 32 so it was declared "Very Decent", the design aspect got an average score of 23.5 out of a maximum score of 24 so it was declared "Very Decent", the technical quality aspect got an average score of 23.5 out of a maximum score of 24 so it was declared "Very Decent", and the usefulness aspect of the material got an average score of 15.5 out of a maximum score of 16 so it was declared "Very Decent". For these four aspects, an average score of 91.5 was obtained from a maximum score of 96, so that in terms of suitability tests by teachers for trainers as learning media for Basic Electricity and Electronics subjects, it was declared "Very Appropriate" to be used as a learning media.

The results of the trainer's assessment as a learning medium by students from the material quality aspect got an average score of 23.7 out of a maximum score of 28 so it was declared "Very Decent", the design aspect got an average score of 20.7 out of a maximum score of 24 so it was declared "Very Decent", the quality aspect The technical aspect received an average score of 19.7 out of a maximum score of 24 so it was declared "Very Decent", and the usefulness aspect of the material got an average score of 16 out of a maximum score of 20 so it was declared "Decent". For these four aspects, an average score of 80.1 was obtained from a maximum score of 96, so that in terms of suitability tests by students for trainers as a learning medium for Basic Electricity and Electronics subjects, it was declared "Very Suitable" for use as a learning medium.

declared "Very Decent", the design aspect got an average score of 23.5 out of a maximum score of 24 so it was declared "Very Decent", the technical quality aspect got an average score of 23.5 out of a maximum score of 24 so it was declared "Very Decent", and the usefulness aspect of the material got an average score of 15.5 out of a maximum score of 16 so it was declared "Very Decent". For these four aspects, an average score of 91.5 was obtained from a maximum score of 96, so that in terms of suitability tests by teachers for trainers as learning media for Basic Electricity and Electronics subjects, it was declared "Very Appropriate" to be used as a learning media.

The results of the trainer's assessment as a learning medium by students from the material quality aspect got an average score of 23.7 out of a maximum score of 28 so it was declared "Very Decent", the design aspect got an average score of 20.7 out of a maximum score of 24 so it was declared "Very Decent", the quality aspect The technical aspect received an average score of 19.7 out of a maximum score of 24 so it was declared "Very Decent", and the usefulness aspect of the material got an average score of 16 out of a maximum score of 20 so it was declared "Decent". For these four aspects, an average score of 80.1 was obtained from a maximum score of 96, so that in terms of suitability tests by students for trainers as a learning medium for Basic Electricity and Electronics subjects, it was declared "Very Suitable" for use as a learning medium.

The results of research into the feasibility test of the trainer as a learning medium which was carried out through student responses to aspects of material quality obtained results in the feasibility category which were in line with the results of previous research on relevant research with the same aspect by Arvin Heri W in 2016 and Ahmad Lufti Setiawan in 2017. Obtained better feasibility category results compared to research results by Hermawan Rizki W in 2016 and Bagas Purnomo Aji in 2017. The design aspect obtained feasibility category results that were in line with previous research by Ahmad Lufti Setiawan in 2017 and obtained better results from previous research conducted by Hermawan Rizki W in 2016. The technical quality aspect obtained results in the feasibility category which were in line with previous research by Arvin Heri W in 2016 and Ahmad Lufti Setiawan in 2017. Obtained results in the feasibility category which were better than previous research by Bagas Purnomo Aji in 2017.

1. Research Limitations

The implementation of trainer development research as a learning medium for basic electrical equipment repair subjects has several limitations, namely:

1. Limited product implementation is carried out only in class XII A of the Electrical Installation Engineering skills program at Raden Rahmat Vocational School.
2. The connecting cable between the trainer box and the basic electrical equipment is still pulled because the equipment is only placed on a wooden board without any locks. Limited to electrical equipment with basic electricity

testing consists of 2 types of experiments, namely manual mode and automatic mode. Manual mode uses a push button to operate from one operation to the next, while automatic mode uses a time delay relay (TDR) to operate from one operation to the next. The test results of all experiments show that this industrial electrical installation trainer module unit has worked as expected. Based on the results of the feasibility test research, the design of this industrial electrical installation trainer module unit was

V. CONCLUSIONS AND SUGGESTIONS

Conclusion

Based on the test results and discussion of the industrial electrical installation trainer, it can be concluded:

1. This industrial electrical installation trainer module unit is designed using a modular concept so that it is more effective for use as a learning medium and competency test at the tertiary and vocational high school levels. The design of the trainer module unit is that all components in the trainer unit are connected to a banana plug, so they can be assembled repeatedly. To assemble the components in this trainer module, use connecting cables (jumpers). The components used in this industrial electrical installation trainer module include: 1 phase and 3 phase MCB, magnetic contactor, thermal overload relay, time delay relay, push button (NO, NC, and jog), auto-manual selector switch, selector switch (ammeter, voltmeter), voltmeter, ammeter, emergency stop. All components are designed to use a banana plug from the output terminal of each component which is equipped.

Suggestion

Based on the conclusions presented above, suggestions that can be made include:

1. A special 3 phase motor is needed for delta-start control so that you can find out the current ratio between motor 1 and the others.
2. It is necessary to improve the design of working drawings for automatic 3 phase motor control operation so that the TDR after activating the next circuit can be turned off.
3. It is necessary to improve the design of working drawings for automatic 3 phase motor control operation so that the TDR after activating the next circuit can be turned off

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FORMULIR LOOGBOOK BIMBINGAN DAN PENGAJUAN
SEMINAR PROPOSAL/
SIDANG TUGAS AKHIR*

Nama : **TIMAYUS MIRIN**

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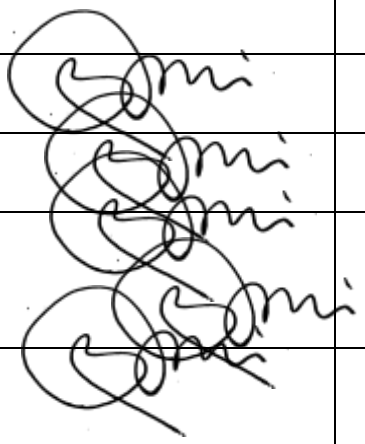
PembimbingI :**Dr.BudiSugandi,S.T.M.Eng**

Judul : **Strong Current Basic Electrical Trainer**

No	Hari/Tgl	Rincian Kegiatan	TTD Pembimbing I & II	
1	27/02/2024	Awal semester-6 melaporkan rencana untuk penyusunan PA (Project Akhir) Bab-4 dan mohon bimbingan		
2	08/03/2024	Melaporkan rancangan penyusunan laporan PA Project Akhir Bab-4		
3	11/03/2024	Bimbingan laporan TA format word dan minta persetujuan dari Dosen pembimbing untuk maju sidang Tugas Akhir		
4	29/04/2024	Melaporkan revisi laporan format word dan Bimbingan laporan Melaporkan revisi laporan format word da Bimbingan laporan TA format PPT		
5	20/05/2024	Melaporkan hasil revisi laporan dalam format word dan mohon review laporan dalam PPT yang akan dipakai untuk sidang Proyek Akhir		
6				
7				
8				
9				
10				

Berdasarkan hasil bimbingan yang telah dilaksanakan selama 4 bulan dan telah disetujui oleh dosen pembimbing, maka dengan ini saya mengajukan diri sebagai peserta Seminar Proposal/Sidang Tugas Akhir*.

Batam,03 Juli 2024
Peserta

TIMAYUS MIRIN
NIM: 3222101043

***Hapus yang tidak perlu.Jumlah bimbingan minimal 10 kali. Dalam satu minggu maksimal bimbingan yang dihitung adalah 2 kali.**