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Development of Mini Project Kit for Project 1 Course In Electrical Engineering Department, POLIMAS

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Abstract: In the educational challenges of the era, teachers need to proactively adapt to all teaching needs. This includes teaching aids and various teaching delivery methods online so that students can receive and understand the knowledge learned in the best possible way. This step is in line with the strategic objective of 4B, Core 4, the Polytechnic's Strategic Plan, which is to lead the education system through TVET 4.0 by increasing the effectiveness of the delivery mechanism. The Mini Project Kit was developed to meet the needs at the Polytechnic Sultan Abdul Halim Mu'adzam Shah. This kit is a printed circuit board (PCB) that will have various uses in Teaching and Learning (T&L). By examining the requirements and syllabus that have been set by the Department of Polytechnic Studies and Community College, this kit is compiled to move in tandem with the Course Learning Outcome (CLO) and Program Learning Outcome (PLO). This allows the kit to integrate well and run smoothly for two semesters. In Project 1 course this kit will be one of the assessment tools in Mini Project assessments.

Key words: *electronics, teaching & learning, internet of things, esp32*

1.0 Introduction

Today more and more electronic devices are designed with access to the global internet network, widely known as the Internet of Things (IoT). Nowadays an IoT technology would widely implement in various objects: from connecting people, services, vehicles to home and buildings. With such a large infrastructure of devices, there is a growing need in the integration of these smart things into a network, the development of rules for interconnection and the determination of interaction scenarios.

IoT also is a key part of our industry in Malaysia where we also evolving our strategy in industry to Industry 4.0. In this new strategy, IoT will play a medium to connect and create flexible connected digital factories where communication is facilitated between all parts of the system. IoT also aims at making the industry smarter with interconnectivity, automation, and real-time data monitoring and exchange. In Polytechnic we can help this evolution by providing education to the students in IoT related courses.

This project is based on the results carried out by our research group, which aims to design a Kit that will transform a better way of teaching and learning in Electronics and IoT in particular. The Kit was developed to meet the needs at the Politeknik Sultan Abdul Halim Mu'adzam Shah. This kit is a printed circuit board (PCB) that will have various uses in Teaching and Learning (T&L). By examining the requirements and syllabus that have been set by the Department of Polytechnic Studies and Community College, this kit is compiled to move in tandem with the Course Learning Outcome (CLO) and Program Learning Outcome (PLO). This allows the kit to integrate well and run smoothly for two semesters. In Project 1, this kit will be used as one of the assessment tools in Mini Project.

Figure 1 : Front and Back view of the Mini Project Kit PCB Board

Figure 1 shows the main PCB circuit board of the Mini Project Kit. This circuit board is the main element that will contain various functions and provides experience as well as skills to the user. This circuit board uses ESP32 as a microcontroller. ESP32 is a popular controller microcircuit used in electronic projects with IoT features.

2.0 Problem Statement

This kit was developed based on the following problems:

a) The absence of a kit that can help the T&L process for the DEE40082 Project 1 course at Polimas.
b) The students still do not have any prototype circuits at the end of the semester for the Project 1 course.
c) Students consume a lot of time in building their project prototype circuit because of lack of knowledge and right tools.
d) Without prototype circuit, students were not be able apply their idea, and test their project circuit.
e) Lack of early exposure to electronic skills such as soldering and circuit troubleshooting causes students to not be able to build their projects faster.
f) There are students who are weak in soldering and circuit design skills.

3.0 Objective

a) Develop a Printed Circuit Board (PCB) or shield board compatibles with "ESP32 DEVKIT"
b) Designing the PCB equipped with:
    i. Complete input and output components
    ii. Various power source options
    iii. A section where users can design their own circuits.
c) Design a circuit that can improve the students' skills in the Project 1 and Project 2 courses.

4.0 Methodology

Design Thinking technique is used to design the process of this project. There are five phases involved:

1. Identify who the user is
2. Identify their needs
3. Brainstorm ideas
4. Develop a prototype
5. Testing

Phase 1: Identify who the user is.

For the first phase, the identified users are the students and lecturers of Polytechnic. These two categories are directly involved with teaching and learning. In details, the targeted students are 4th semester students whose proceed Project 1 course and the lecturers that have been assigned as the Project Supervisor.

Phase 2: User requirements

The identified user needs are as follows:

Lecturers: Teaching Aids to help the lectures on practical sessions. This Kit will make it easier for lecturers to conduct the lessons because it can attract students' interest and provide good understanding for them. This kit also needs to have a clear evaluation method to make it easier for lecturers to evaluate students.

Students: Students need skills and knowledge. This kit can help students gain the knowledge and skills. In the process of completing this Kit assignment, the students can learn either through the video tutorials or by hands-on.

Phase 3: Brainstorming

In this phase some ideas and sketches have been produced to achieve the objectives that have been listed. Every suggestion has been considered and discussed to ensure that this Kit can be accepted by the users. Among the elements emphasized in brainstorming are:

a) Power supply
b) PCB shape
c) Number of input and output devices
d) Types of Microcontrollers
e) Evaluation Rubric
f) Circuit Design / Do it Yourself room
g) Packaging

Phase 4: Prototype Development

The prototype development process is divided into three main parts; start with designing a schematic, printed circuit board (PCB) and PCB fabrication. The first process which is circuit design, includes the process of designing a schematic circuit, printed circuit board, silkscreen process, 3D modeling and gerber file generation. In the circuit design process, the selection of the microcontroller circuit board is very important to ensure that each selected component can be integrated with the main circuit board and other components that have been discussed before.

The selected microcontroller circuit board must be capable of internet Wi-Fi connection technology and have a sufficient number of input and output pins to be connected to other components. For the e-meter board, the microcontroller circuit board selected is the ESP32 DEVKIT Board as shown in the Figure 2 below which uses 3.3V as a power supply, has 18 Analog-to-Digital Converter (ADC) channels,3 SPI interfaces,3 UART interfaces,2 I2C interfaces,16 PWM output channels, 2 Digital-to-Analog Converters (DAC), 2 I2S interfaces, and 10 Capacitive sensing GPIOs.

Figure 2: ESP32 DEVKIT DO IT

ESP32 Dev Kit can support Wi-Fi connection, normal Bluetooth connection and Bluetooth low energy BLE connection too. This board is selected for a lot features that suitable with the project objective.

The power supply for Mini Project Kit circuit boards uses several sources, namely DC 2.1mm adapter, two-way terminal block 5mm and USB micro female adapter. For the use of the terminal block can support from 5V up to 15V input using a battery or any dry cell. The process of drawing the schematic circuit for these two circuits is by using Proteus software. The schematic circuit is drawn according to the diagram below.

Then the PCB design process is made based on the schematic connection. Components are arranged to fit the requirements that have been set. This arrangement is very important to ensure that the PCB can fit in the casing and can have a suitable size and be easy to hold. Figure 3 show the PCB that have been design for the Mini Project Kit.

After the process of arranging the components, the PCB will go through the routing process where the schematic connection will be changed to copper track. This track connection is very important to ensure current can flow and data can be sent and received. After the routing process, the PCB will be labeled with the appropriate label. This label is like the process of labeling polarity and pin name. This process is called Silkscreen, where the writing and label

will be placed in the appropriate location to make it easier for board users to use this PCB later after it has been fabricated. Once the silkscreen process is complete, a 3D display is generated to help see the pre-result of the PCB being designed. This 3D display can also help us check the clearance for each component that has been placed on the board as shown in Figure 3.

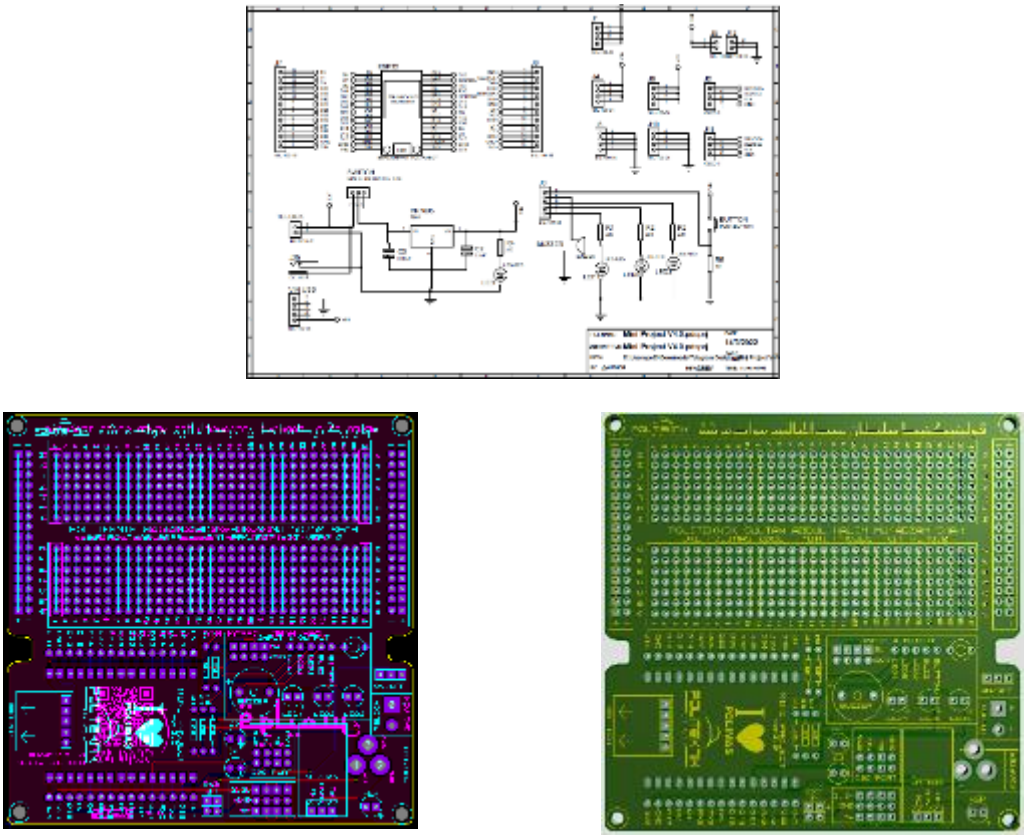

Figure 3: Prototype PCB using Proteus software

Phase 5: Testing

In the 5th phase, this Kit has been tested on students of semester 1 session 2021 / 2022 for three diploma programs in the Department of Electrical Engineering. The programs involved are:

a) Diploma in Electrical Engineering

b) Diploma in Electrical & Electronics Engineering

c) Diploma in Electronics Engineering (Communication)

The students were briefed and followed every procedure that had been arranged. This kit has been applied for Mini Project evaluation. The students are required to complete the assigned tasks of this Mini Project by using the Kit that has been produced. The implementation of this Kit in the Mini Project is as follows:

a) Identifying Components

b) Solder the ESP32 Shield part

c) Design a Relay circuit

d) Evaluation

5.0 Result

The Mini Project Kit that has been fabricated and packaged as shown in Figure 5 and Figure 6. This Mini Project Kit can be used in Mini Projects for three Diploma programs in the Department of Electrical Engineering, POLIMAS. In semester 2 session 2021/2022 as many as 10 classes have used this Kit in the Mini Project assessment. Figure 5 and Figure 6 below show the PCB board for Mini Project in 3D mode view. In the figure also show two parts that have been design specially for the ESP32 DEVKIT shield and the circuit design part. The circuit design part will allow student show their skill and knowledge in circuit design.

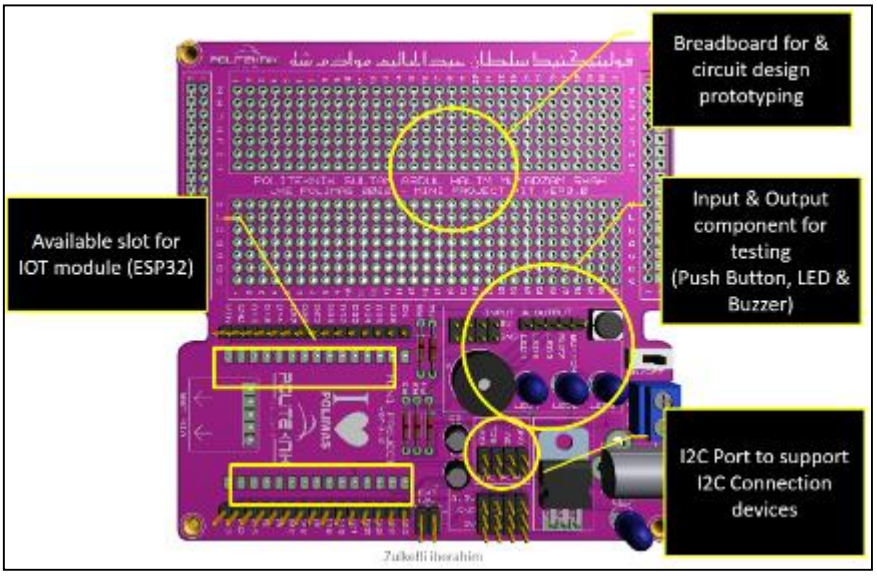

Figure 5: Features of the Mini Project Kit.

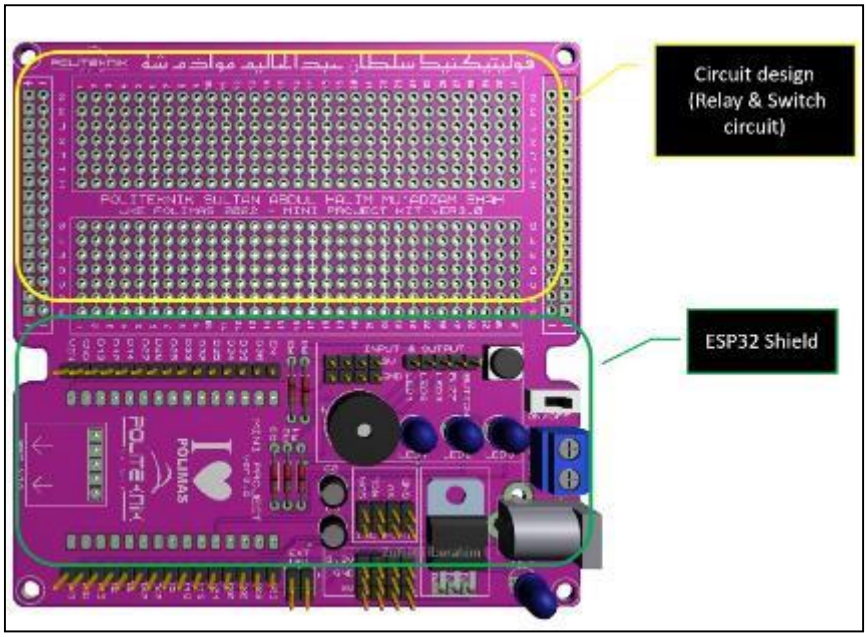

Figure 6: Features of the Mini Project Kit.

This board will be included with components, ESP32DEVKIT, Dupont Cable and put it in a box as shown in Figure 7. Each student will have one each and implement their Mini Project using this kit. All the components are the common part in electronics project, so this will allow students to know and remember the common part in their project.

Figure 7: Mini Project Kit set

The features found in this prototype are as follows:

a) 19 male pin header normal GPIO
b) 8 male pin headers for +5V
c) 8 male pin headers for GND
d) 4 male pin headers for +3.3V
e) 2 sets of I2C sockets
f) 1 Buzzer
g) 3 Multiple color LEDs
h) 3 types of power source (Micro USB, Terminal Block, DC Jack)

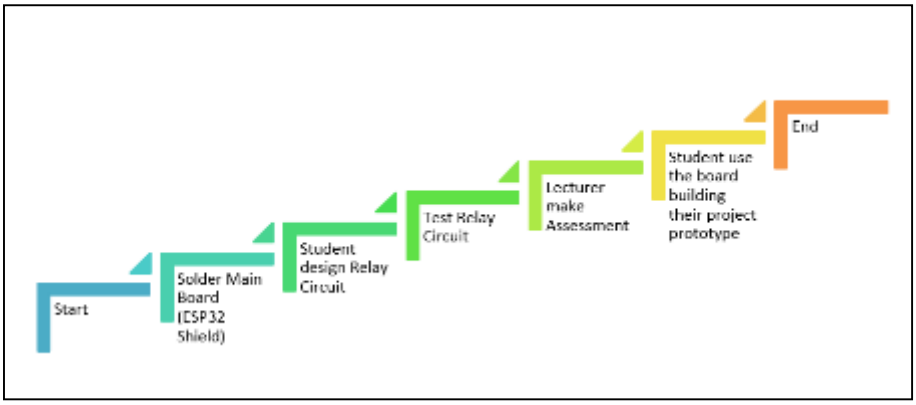

Figure 8: Implementation of the Mini project for Project 1 using the Mini Project Kit.

The flow chart shown in Figure 8 is how the implementation of the Mini project for Project Course 1 is carried out. The use of this Kit in the Mini Project is divided into two parts

a) Relay Circuit Design Section

b) Part of the ESP32 Shield

This implementation is carried out successfully for all classes and programs, has made it easier for lecturers to make evaluations and organize teaching and learning more efficiently. Students will start with assembly and soldering all the components for the ESP32 DEVKIT shield as shown on Figure 9. This part is straight forward concept where student will solder by following all the label. A video with a complete instruction also has been created so students can refer and complete the task on their own. Each method, connection, pin, and polarity has already been clearly indicated for this part. This is to make it easier for users who have no basic electronics to install these circuits and components.

Figure 9: Implementation of the Mini project for Project 1

In the Relay Circuit section, students will design their own circuits, with the help of appropriate software such as Proteus, Livewire, Tinkercad, and Fritzing. In this section, students will be assessed on their ability to design electronic circuits.

D.	Circuit design techniques	Not able to use proper techniques and produce correct results/ displays for most part of the project circuit.	Able to use proper techniques and produce correct results/ displays for most part of the project circuit and require major improvement	Able to use proper techniques and produce correct results/ displays for parts of the project circuit and require minor improvement	Able to use proper techniques and produce correct results/ displays for parts of the project circuit	Able to use proper techniques and produce correct results/ displays successfully		/5
E.	Circuit Assembly techniques	Not able to assemble the component properly on the board	Able to assemble the component properly on the board and require major improvement	Able to assemble the component properly on the board and require minor improvement	Able to assemble the component properly on the board with good arrangement	Able to install components correctly on the board with excellent arrangement		/5
F.	Component Testing	Not able to use proper tools and techniques for component testing	Able to use proper tools and techniques for component and require major improvement	Able to use proper tools and techniques for component and require minor improvement	Able to use proper tools and techniques for component	Able to use proper tools and techniques for component testing successfully		/5
G.	Soldering tools and techniques	Not able to properly handle the soldering and desoldering tools. Produce many cold-joints and bulky solder	Able to properly handle the soldering and desoldering tools. Produce many cold-joints and bulky solder and require major improvement	Able to properly handle the soldering and desoldering tools. Produce a few cold-joint or bulky solder and require minor improvement	Able to properly handle the soldering and desoldering tools. Produce a few cold-joint or bulky solder	High ability to properly handle the soldering and desoldering tools. Solder is shiny and of proper size.		/5
H.	Circuit Testing	Not able to use proper tools and techniques for circuit testing	Able to use proper tools and techniques for circuit testing and require major improvement	Able to use proper tools and techniques for circuit testing and require minor improvement	Able to use proper tools and techniques for circuit testing	Able to use proper tools and techniques for circuit testing successfully		/5
							0	/25

Figure 10: Mini Project Kit scoring rubric with using the Mini Project Kit.

In the assessment section, the lecturers will follow the mark rubric shown in Figure 10. This rubric has been matched with the Mini Project Kit and complies with the Course Learning Outcome (CLO) set by the Department of Polytechnic Studies and Community College.

The students will be evaluated from several aspects:

a) Circuit design techniques
b) Circuit Installation Techniques
c) Component Testing
d) Soldering tools and techniques
e) Circuit Testing

6.0 Conclusion

This project has been successfully fabricated according to the design. Its function as ESP32 shield and compaltibetible to ESP32 devkit in the market. This mini project kit is equipped with complete input and output component, multiple power source option and have a section for circuit design. This board can help students train and gain new skill for their Project 1 and Project 2 courses.

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