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JUDUL: **MULTIUSE EXPERT ELECTRICAL CALCULATOR
SYSTEM**

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MULTIUSE EXPERT ELECTRICAL CALCULATOR SYSTEM

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This thesis is submitted as partial fulfillment of the requirements for the award of the
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*Specially dedicated to
My beloved family and those people who have guided and inspired me
throughout my journey of education*

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ABSTRACT

With the technological demands of today, we must increase the number of individuals that successfully complete a degree in science and engineering. To accomplish this goal, the first obstacle to overcome is the year semester mathematical calculating course. It has historically been a graveyard for students in engineering and science. Multiuse Expert Electrical Calculator System designed as a system which has many functions and also user friendly. This system is an expert system because by using this system, we can show formula and also can analyze the calculation. Calculator technologies nowadays not widely use because we cannot get the analysis of the calculation after we get the result of calculation. Most of calculator cannot appear circuit that we want to calculate and need a lot of time to get an accurate result and make learning slower, difficult and not interesting. This system was designed by using Visual Basic Language and window based to produce the calculator system and for the learning purpose. Multiuse Expert Electrical Calculator System was covered certain calculation in electrical such as Basic Circuit in Electrical and Robotics. So, for all calculation, this system will show analysis to make users more understand about the circuit connection in a short time. In order to make this system become user friendly, the guidelines and more information about the topics will be inserted as a learning purpose. This system built not only for student but it can be used by lecturers, teachers, engineers and also non-technology person even they not familiar with electrical calculations. So, this system will make a user's find the accurate result faster, easy and more interesting.

ABSTRAK

Permintaan teknologi hari ini membuatkan bilangan individu-individu yang berjaya dalam bidang sains dan kejuruteraan mesti ditingkatkan. Untuk mencapai cita-cita ini, halangan yang pertama untuk menyelesaikan masalah ini adalah bidang pengiraan matematik. Secara sejarahnya, ia bagaikan perkuburan kepada pelajar-pelajar yang berada dalam bidang sains dan kejuruteraan. *Multiuse Expert Electrical Calculator System* dibuat sebagai satu sistem yang mempunyai pelbagai fungsi dan senang digunakan. Sistem ini dikatakan *expert* kerana ia boleh menunjukkan formula dan juga analisis untuk pengiraan. Teknologi kalkulator hari ini tidak digunakan secara meluas kerana kita tidak boleh mendapatkan analisis untuk setiap pengiraan selepas kita mendapat jawapan daripada pengiraan tersebut. Kebanyakan kalkulator juga tidak dapat memaparkan litar dan memerlukan masa yang panjang untuk mendapatkan jawapan yang tepat, serta membuatkan proses pembelajaran menjadi lambat, susah dan tidak menarik. Sistem ini dibina menggunakan *Visual Basic Language* dan *window based* untuk menghasilkan kalkulator sistem dan sebagai alat bantuan pembelajaran. *Multiuse Expert Electrical Calculator System* meliputi litar-litar asas dalam Elektrik dan Robot. Jadi, untuk semua pengiraan, sistem ini akan memaparkan analisis bagi memudahkan pengguna lebih memahami tentang sambungan litar dalam jangka masa yang pendek. Dalam proses menjadikan sistem ini mudah digunakan, panduan pengguna dan maklumat-maklumat yang berkaitan dengan tajuk disertakan. Sistem ini dibina bukan sahaja untuk pelajar, tetapi boleh juga digunakan oleh pensyarah, guru-guru, jurutera-jurutera dan orang-orang yang diluar bidang teknologi walaupun mereka tidak mahir dengan pengiraan elektrik. Jadi, sistem ini akan menjadikan pengguna lebih mudah mendapatkan jawapan yang lebih tepat dengan cepat, senang dan lebih menarik.

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LIST OF ABBREVIATIONS

SDLC	Software Development Life Cycle
GUI	Graphical User Interface
VB	Visual Basic
RAD	Rapid Application Development
AI	Artificial Intelligence
OOP	Object Oriented Programming

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

With the technological demands of today, we must increase the number of individuals that successfully complete a degree in science and engineering. To accomplish this goal, the first obstacle to overcome is the year semester mathematical calculating course. It has historically been a graveyard for students in engineering and science. This is even more pronounced for beginning high risk students. Calculator technologies nowadays not widely use because we cannot get the analysis after we get the result of calculation. Most of calculator cannot appear circuit that engineering students want to calculate and need a lot of time to get an accurate result. Hence, the process of learning more quick, easy and interesting.

When calculators were making their appearance on college campuses in the early **70s** they could not determine the bound of a function, could not evaluate a limit, could not plot a function, could not find the roots of a function, could not take the derivative of a function, or evaluate indefinite integrals [1]. It is true that a calculator was convenient when it came time to determine the value of a function, or any other number crunching activity, but the calculator really wasn't a major teaching or learning tool.

Do the calculators alone help students' learn? Or do they understand more of what they are learning? This project cannot provide definite answers to these questions. However, our findings do support those of others such as LaTorre, who states that: "The effective integration of the graphical and numerical solve features of the plotting calculator has been especially beneficial in helping students to establish for themselves important visual and numerical connections to the analytic presentations that are characteristic of most text books"[1]. It became obvious during our study that one thing the calculators do is provide immediate positive feedback for the student who is trying. Maybe this positive feeling of being able to solve calculus problems have more to do with the student success than anything else. If this is the case, then the calculator is doing more for calculus reform than anyone would have dreamed possible.

There is a direct correlation between success in the engineering area and a complete understanding of the basic mathematics principles. As the academic skills of the average scholar are honed, the relationship between these skills and the "world of engineering" becomes clearer to the engineering recruit. I believe that the course of calculus supplies the collegian with this necessary skill. I also believe, that if you provide proper placement along with supplying additional assistance to the students with the higher probability of failure, they can persist in engineering because of the skills they acquire in these courses. The use of plotting calculators within the computer program has shown to be very successful. We are taking individuals with a much lower incoming academic background, and allowing them to compete with individuals with a much higher incoming standard.

Multiuse Expert Electrical Calculator System designed as a system which has many functions and also user friendly. This system is an expert system because by using this system, we can show the analysis of the calculation. Beside that, this system also has the other function which the users can found terms in electrical field. This

system will be design by using Visual Basic Language and will be cover certain calculation in electrical such as Basic Circuit in Electrical.

So, for some calculation, this system will show graph to make users more understand about the circuit connection in a short time. This system built not only for student but it can be used by lecturers, teachers, engineers and also non-technology person even they not familiar with electrical calculations. So, this system was designed as a learning instrument because it also may show analysis for the calculation and give an accurate result. This system can display circuit to facilitate users to do calculations in a short time.

In order to make this system become user friendly, the guidelines and more information about the topics was inserted as a learning purpose. So, this system is built in window based for the Visual Basic Programming to produce the calculator system and to complete the requirements of all the learning purpose.

1.2 OBJECTIVES

The main objectives to produce this Multiuse Electrical Calculator System are as follows:

- To calculate the simple and complex equation in electrical field in a short time with accurate result
- To analyze and provide information about the circuit, according to the result by showing graph

1.3 SCOPES

In order to fulfill the main objectives, there are a few scopes as a guideline to fulfill the requirements of this Final Year Project:

- 1) Basics Laws: Ohms Law
- 2) Capacitors and Inductors: Series and Parallel Connection (two until five connections)
- 3) Three Phase Connection:
 - I. Balanced Wye-Wye Connection
 - II. Balanced Wye-Delta Connection
 - III. Power in a Balanced System
- 4) Robotics: Inverse Kinematics

1.4 PROBLEM STATEMENTS

Calculator technologies nowadays not widely use in electrical field because we cannot get the other features except calculation. They also cannot show any figure such as graph after we get the result of calculation.

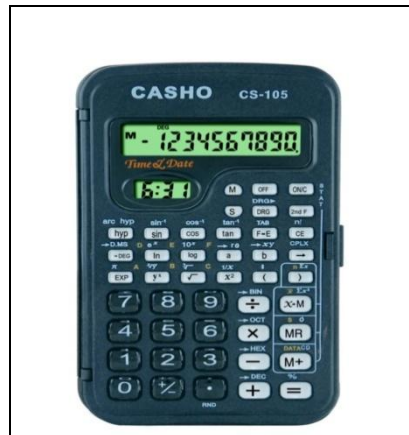


Figure 1.1: Example of Normal Electronic Scientific Calculator

Can this calculator produce circuit such as below?

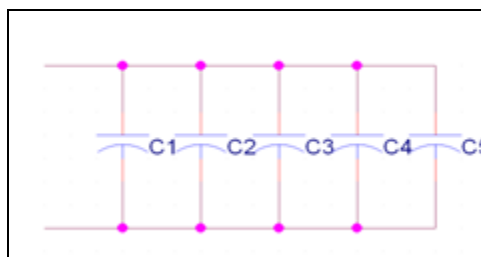


Figure 1.2: Five Parallel Capacitors Connection

As an engineering student, there are so many things to do and learn day by day and remembered all of them in a short period. But normal calculator only can do basic things and have limited function.

To success in education, student must learn more and more to get unlimited information. So, students must open books or something else to get the valuable information in order to get what they need in their studies. As we know normal electrical calculator cannot provide the information needed by the users and it is hard to user and takes time to get the valuable information. For an example, the basic calculations, ohm's law. The formula for this simple calculation is $V=IR$. When $V=8V$, and $R=3\Omega$, what the value for current, I ? The normal electrical calculator can appear the answer $I=V/R$ and the users must insert the value of the calculations, $8/3$. The answer will appear on the screen of the calculator: 2.666666667. So, the users can simplified the answer is 2.67A. But, to get the circuit for this calculation, users must opened books or something else to get the right circuit for this information. How can a user know if this answer wrong? How the users want to approve that and how can they get the right accurate and fast answer?

Most of calculator cannot appear circuit that we want to calculate and need a lot of time to get the accurate result. So the users of the normal calculator can only imagine the circuit and they do not know either it right or wrong. Instead of want to get the right result in the calculation, as a user, we also want to get more and more information about what we want to learn, but we cannot get the valuable things like that by using the normal calculator.

1.5 THESIS OUTLINE

Chapter 1 discuss on the background of the project, objectives, scope of the project, problem statement and also the thesis outline.

Chapter 2 focuses on literature reviews of this project based on journals and other references.

Chapter 3 explains the details of language that have been used in this project and the methods which used in order to finish this project.

Chapter 4 mainly discuss on the system design of the project. Details of the progress of the project are explained in this chapter.

Chapter 5 concludes overall about the project. Obstacle faces and future recommendation are also discussed in this chapter.

CHAPTER 2

LITERATURE REVIEW

2.1 CALCULATOR

A calculator is a device for performing mathematical calculations, distinguished from a computer generally by a limited problem domain and an interface optimized for interactive calculation rather than programming. Calculators can be hardware or software, and mechanical or electronic, and are often built into devices such as PDAs or mobile phones.

Modern electronic calculators are generally small (often pocket-sized) and usually inexpensive. In addition to general purpose calculators, there are those designed for specific markets; for example, there are scientific calculators which focus on advanced math like trigonometry and statistics. Modern calculators are more portable than most computers, though most PDA's are comparable in size to handheld calculators. [2]

2.2 ELECTRICAL CALCULATOR

Electrical Calculator that can quickly and easily calculate different electrical parameters. Automatic Calculations and Conversions with every unit and value changes. A must have utility for every pocket PC user. [3]

2.3 EXPERT SYSTEM

Expert system is a software system that incorporates concepts derived from experts in a field and uses their knowledge to provide problem analysis to users of the software.

The most common form of expert system is a computer program, with a set of rules, which analyzes information (usually supplied by the user of the system) about a specific class of problems, and recommends one or more courses of user action. The expert system may also provide mathematical analysis of the problems. The expert system utilizes what appears to be reasoning capabilities to reach conclusions.

A related term is wizard. A wizard is an interactive computer program that helps a user solves a problem. Originally the term wizard was used for programs that construct a database search query based on criteria supplied by the user. However, some rule-based expert systems are also called wizards. Other "Wizards" are a sequence of online forms that guide users through a series of choices, such as the ones which manage the installation of new software on computers, and these are not expert systems. [4]

An expert system is a computer program designed to simulate the problem-solving behavior of a human who is an expert in a narrow domain or discipline. An expert system is normally composed of a knowledge base (information, heuristics, etc.), inference engine (analyzes the knowledge base), and the end user interface (accepting inputs, generating outputs). The path that leads to the development of expert systems is

different from that of conventional programming techniques. The concepts for expert system development come from the subject domain of artificial intelligence (AI), and require a departure from conventional computing practices and programming techniques.

A conventional program consists of an algorithmic process to reach a specific result. An AI program is made up of a knowledge base and a procedure to infer an answer. Expert systems are capable of delivering quantitative information, much of which has been developed through basic and applied research (e.g. economic thresholds, crop development models, pest population models) as well as heuristics to interpret qualitatively derived values, or for use in lieu of quantitative information. Another feature is that these systems can address imprecise and incomplete data through the assignment of confidence values to inputs and conclusions. [5]

2.4 TYPES OF LANGUAGE

2.4.1 Visual Basic

This language was designed to be easy to learn and use. The language not only allows programmers to create simple many applications, but can also develop fairly complex applications as well.

Visual Basic (VB) is a third-generation event driven programming language and associated development environment from Microsoft for its computer programming model Visual Basic was derived from BASIC and enables the rapid application development (RAD) of graphical user interface (GUI) applications, access to databases and creation of ActiveX controls and objects. Scripting languages such as VBScript are syntactically similar to Visual Basic, but perform differently.

A programmer can put together an application using the components provided with Visual Basic itself. Programs written in Visual Basic can also use the windows application, but doing so requires external function declarations. [6]

VB has remained popular despite prior changes to the language. However, there may not have been as many viable alternatives as there are now. Today, other languages such as Java and C++ have become Web-development tools of choice. Developers may decide to use these languages because they are more mature and because VB.Net will be more complex to learn and use. Evans' North American Developer Survey didn't reveal a clear migratory path. However, the study found that the number of Java users increased 5 percent since last year's survey, while the portion of work time that developers used Java rose from 14 to 20 percent. Meanwhile, more than 15 percent of survey respondents—most of whom said they were VB users—indicated they will try Microsoft's soon-to-be-released C#.

Developers will also continue to use C and the object-oriented C++. However, Gartner's Driver said, "We believe 80 percent or more [of Web applications] will be based on either Java or Microsoft .NET products." Therefore, products such as Borland Software's Delphi and Sybase's PowerBuilder will have to fight for their share of the market's remaining 20 percent.[6]

Large companies may tend to use Java because the cross-platform technology provides better support for multiple environments and client devices than VB or VB.Net, according to Gartner. With the growing use of Java and Linux in servers, slightly more developers of Web applications for servers may adopt Java, said Dan Appleman, president of Desaware, which develops software products that work with VB and other Microsoft tools. Small companies may choose .NET technologies because they can be simpler and less expensive to use. However, Driver said, .NET will never compete head-to-head and feature-to-feature with Java until it works across platforms, which isn't planned for 12 to 18 months. [9]

2.4.2 Java

Java is an object-oriented programming language with syntax similar to C and C++, only simpler. Because Java is an interpreted language, the typical C or C++ compile-link-load-test-debug cycle is reduced. Java development environments actually let the entire software-development life cycle take place within a Web browser. Java applications are also arguably more robust than corresponding C or C++ applications, because the Java runtime system manages all memory. The same features that provide robustness also provide safety. Users are assured that applications are safe, even if downloaded over the Internet, because the Java runtime system has security mechanisms that protect against tampering. Finally, applications with concurrent threads run faster because Java has built-in support for multithreading. None of these are the primary reason there is so much interest in Java.

Rather, the main attraction is the fact that Java applications are completely portable. Write your code once and you never need to port or even recompile it. Rather than producing machine-specific instructions, the Java compiler produces vendor-neutral byte code. The Java runtime environment or virtual machine then translates the byte code into actual machine-specific instructions. The Java virtual machine (see the “Java virtual machine” sidebar) is installed on the user’s machine, either as part of a Web browser or as part of the underlying operating system. [7]

Gartner estimates that there are 2.5 million Java programmers in the world but fewer than a million with the skill and training to develop successful applications. Three of Java’s main advantages for Web development are its platform independence (particularly useful for servers, most of which are not Windows-based), maturity (reflected in such features as large standard libraries), and small footprint (useful in developing applications for smart cellular phones and handheld devices), said Sun spokesperson David Harrah. [8]

2.4.3 Microsoft's C#

C# is a new object-oriented programming language that combines C++'s memory flexibility and power with VB's programming ease and several of Java's features, such as its syntax, said Bixhorn. Some industry observers say C# is Microsoft's attempt to provide a Javalike language. C# is similar to Java in that it's object oriented and includes built-in garbage collection, which simplifies memory management.

C#, which Microsoft designed to work with its .NET platform, simplifies programming through its use of XML and SOAP. SOAP provides a way for programs running in different operating systems to communicate with one another by using HTTP and XML as information exchange mechanisms.

SOAP also gives developers access to a programming object or method without requiring them to write additional code for each step. Because this lets programmers build on existing code, proponents say C# will let vendors get new products and services to market more quickly and economically. [9]

C++ is a popular object-oriented programming (OOP) paradigm, which emphasizes high-level data abstraction (objects), and code reusability and maintenance. C++ provides great flexibility to help solve complex programming problems through techniques such as inheritance and polymorphism. Through these methods a "base" object can call functions of a "derived" object through the use of runtime-binding and virtual function tables.

Unfortunately, the cost of such flexibility is a penalty in performance. C++ programs have been known to run slower than programs written in a non-OOP language such as C. Driesen and Holzle showed the number of indirect calls increases because of runtime-binding of C++ programs. Radhakrishnan and John also showed that the execution speed of C++ programs is decreased as a result of branch misprediction.

2.4.4 Other languages

New versions of Borland's Delphi and Sybase's PowerBuilder are similar to VB in the way they work with Web objects and protocols, as well as their ease of use. In addition, like VB, they permit rapid application development via prebuilt objects, routines, and widgets—encapsulated in graphical icons—that users can drag and drop within a project window. With the recently released Delphi 6 and PowerBuilder 8, Borland and Sybase claim to have beaten Microsoft to the punch by offering the same support for Web services that .NET promises. Michael Swindell, Borland's director of product management, said the company also has released Kylix, a Delphicompatible development environment for native Linux Web applications. [8]

2.4.5 The Language Comparison

Microsoft's Bixhorn said, "The suggestion that VB developers are looking around for other opportunities is understandable. But VB.Net introduces a lot of new concepts, and we expect they'll continue to use VB." Gartner's Driver said VB.Net will become the dominant Web-development environment in part because it will be a key part of Microsoft's larger .NET platform. In fact, Desaware's Appleman said he expects the entire Visual Studio.Net to become important in the development marketplace. However, said Borland's Swindell, the goal of Web-application development will be to create remote procedure calls that are language and transport-independent. "More and more," he continued, "we're going to see application interoperability in which it doesn't matter what the application is built in. We'll be able to build C++ objects that integrate seamlessly with things written in Java or VB.Net or Delphi." In other words, he said, developers will be able to use whichever tool is best for the job. "What we're seeing is more and more development every year," Swindell said, "so what we'll continue to find is a more distributed use of all languages. Whereas VB dominated in the 1990s, we're [now] going to have a lot more Java, C and C++, Delphi, and other environments." [8]

2.5 SOFTWARE DEVELOPMENT LIFE CYCLE (SDLC)

Abstract-The classic waterfall model of software engineering is used throughout the production software development community. The escalating costs associated with software development and the unsatisfactory reliability, performance, and functionality of the resulting software have motivated software engineers to develop new alternate models of software development including prototyping, software synthesis, and reusable software. It is difficult to compare and contrast these new models of software development because their disciples often use different terminology, and the models often have little in common except their beginnings (marked by a recognition that a problem exists) and ends (marked by the existence of a software solution).

This project provides a framework which can serve

- 1) As a basis for analyzing the similarities and differences among alternate life cycle models
- 2) As a tool for software engineering researchers to help describe the probable impacts of a new life cycle model
- 3) As a means to help software practitioners decide on an appropriate life cycle model to utilize on a particular project or in a particular application area.

The use of such a model

- I. Encourages one to specify what the system is supposed to do (i.e., to define the requirements) before building the system (i.e., designing)
- II. Encourages one to plan how components are going to interact (i.e., designing) before building the components (i.e., coding)
- III. Enables project managers to track progress more accurately and to uncover possible slippages early
- IV. Demands that the development process generate a series of documents which can later be utilized to test and maintain the system
- V. Reduces development and maintenance costs due to all of the above reasons
- VI. Enables the organization that will develop the system to be more structured and manageable.[9]

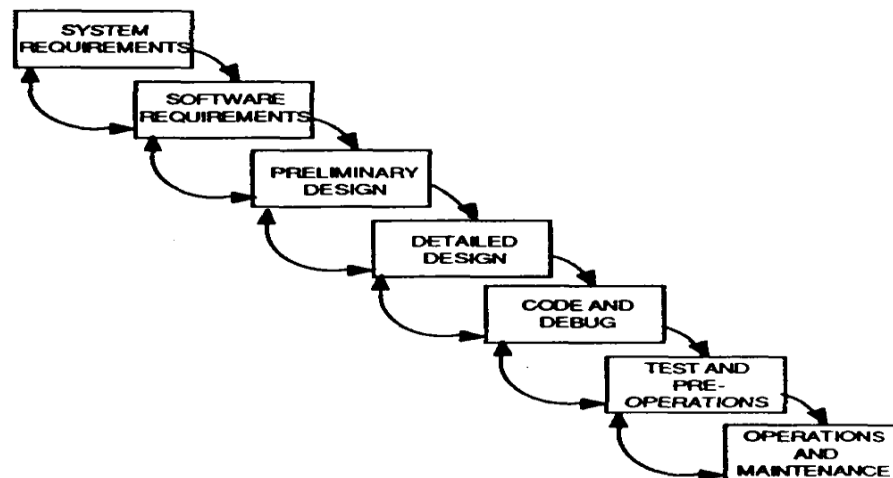


Figure 2.1: The waterfall model of software development

2.6 WEB AND WINDOWS BASED

Innovations are great, but there are so many coming at us so fast that it's hard for customers to stay on top of them all. This is especially true where innovations overlap between technologies.

Take the examples of a web-based vs. a windows-based approach to a user interface. The Web approach has almost no deployment issues, and is well-accepted. On the downside, it lags behind a Windows interface in terms of functionality richness, and is also somewhat slower to work with. And may have certain security issues for external use.

The Windows approach to a user interface is available to almost every user, is very fast, and comes with a very rich set of features. But the Windows approach requires deployment to each user – although Microsoft .NET's No-touch deployment is making this almost as easy as the Web approach.

Now for certain applications, the Web approach is a no-brainer – like booking plane tickets, or reserving a hotel room. But what about for a full-blown application like Microsoft Word or Excel? Are these better delivered in a Web or Windows client? Right now, it looks like the Web approach is getting better every day from a usability point of view, but yet Windows client deployment is also getting easier every day – especially with Microsoft and their .NET V2 Click Once technology behind it. [10]

Window Based	Web Based
Available to almost every user	No deployment issues, and is well-accepted
Very fast, and comes with a very rich set of features	Functionality richness, and is also somewhat slower to work with
No external security issue	Security issues for external use such as viruses
Easier in term of use	Have many functions, and sometimes it hard to follow

Table 2.1: Window based verses web based

CHAPTER 3

METHODOLOGY

3.1 VISUAL BASIC LANGUAGE

This system was designed by using Visual Basic Language. This is a fairly crude approximation of popularity, however, it's worth including, because all other things being equal, the more popular a language is, the more pages will exist mentioning it.

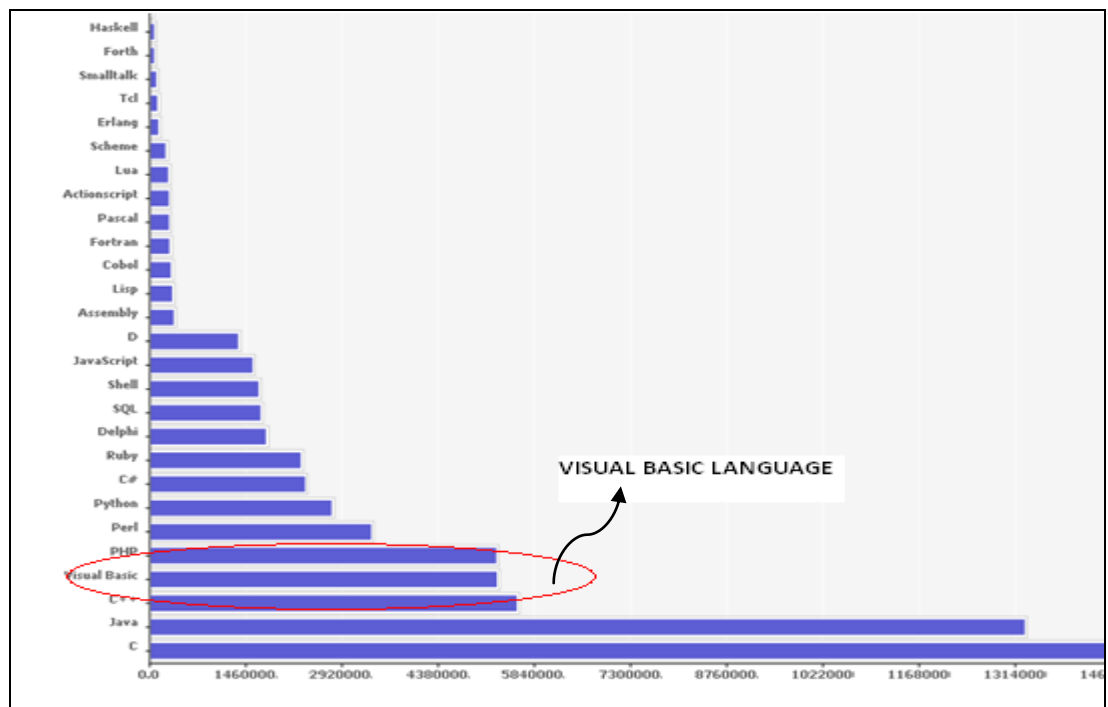


Figure 3.1: Popularity of Programming Language Usage (Last data update: *Sat Aug 02*

10:33:17 +0200 2008)

Visual Basic Programming Language is the most popular language which use in electrical field and it also one of the subjects that teach in the Engineering Laboratory for Electrical Engineering Student. Multiuse Expert Electrical Calculator System was developed by using Visual Basic Language because it is easy to learn and use. The language not only allows programmers to create simple many applications, but can also develop fairly complex applications as well.

3.2 SOFTWARE DEVELOPMENT LIFE CYCLE (SDLC)

By using Software Development Life Cycle (SDLC), this project was designed step by step until the objectives of this project achieve and success until it completely finish. All of related data will be collected to produce a good calculator system. Module of this system will be design first and then will be completed by all of the SDLC flow in order to get the results of calculations.

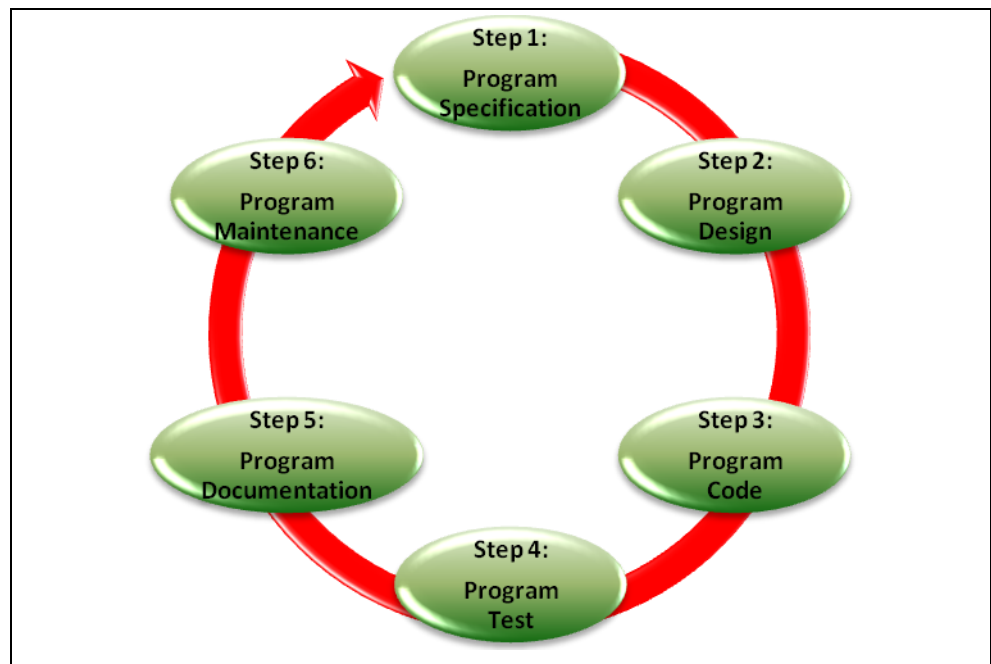


Figure 3.2: Software Development Life Cycle (SDLC)

Below are steps that used in order to build this system:

Step 1: Program Specification

First of all, the problem must be understanding and then get the solution to solve the problem. So, to get the inputs to solve the problem, some researching in literature review must be doing and detect if any formula or condition that must be use. This step makes us know the guides in order to get the best solution to settle any problems occur. So, this project can be upgraded time by time to produce a good system and make it become user friendly.

To understanding what the problem, I am doing researches in journals, webs and also interview some of Electronic and Electrical Engineering student. From all of the resources, I conclude that new systems for the calculator are very needed to solve complex calculation and to calculate in circuit form. So, I choose to use Visual Basic Language to produce a window based program, and to solve these problems.

Step 2: Program Design

In order to create this calculator system, a solution plan was designed to make the creating process more soft and manageable. Design of the circuit must be done by using P-Spice application to make the neat and good picture of circuits. The circuit design appearance must be clear and user friendly in order to make the calculator systems become more interesting and easy to use. This step is very important to produce a good system and save user's time.

So, to design this electrical calculator, flowchart was designed. To design the flowchart, all of the process which is related to build this calculator software must be considered. In this case, Software Development Life Cycle is

use in order to make this calculator making process easier and fluent. Besides that, story board was designed to facilitate the creation of this electrical calculator software step by step such as in figure 3.2.

Step 3: Program Code

To make sure this system able to operate softly, many coding about Visual Basic Language must be learned and have knowledge how to utilize it into various calculator functions. Some researches are done and learned from lecturers to get the right coding. For an example, the coding for this formula;

$$1/C_{eq} = 1/C_1 + 1/C_2$$

By using Visual Basic Programming, the above formula can be defined by this code:

```
a = TextBox1.Text  
b = TextBox2.Text  
  
c = 1 / ((1 / a) + (1 / b))  
TextBox3.Text = c
```

Step 4: Program Test

After finish the coding process, the program can be debugging to test either the program can be run or not. In order to finish the electrical calculator coding, there may many errors occur. So, the coding must be changed to get the output that want to show in this calculator. By searching and learning the right coding for this system, the best coding will be use and at the same time, avoid the errors occur during the programming process until this system operate softly and ready to use.

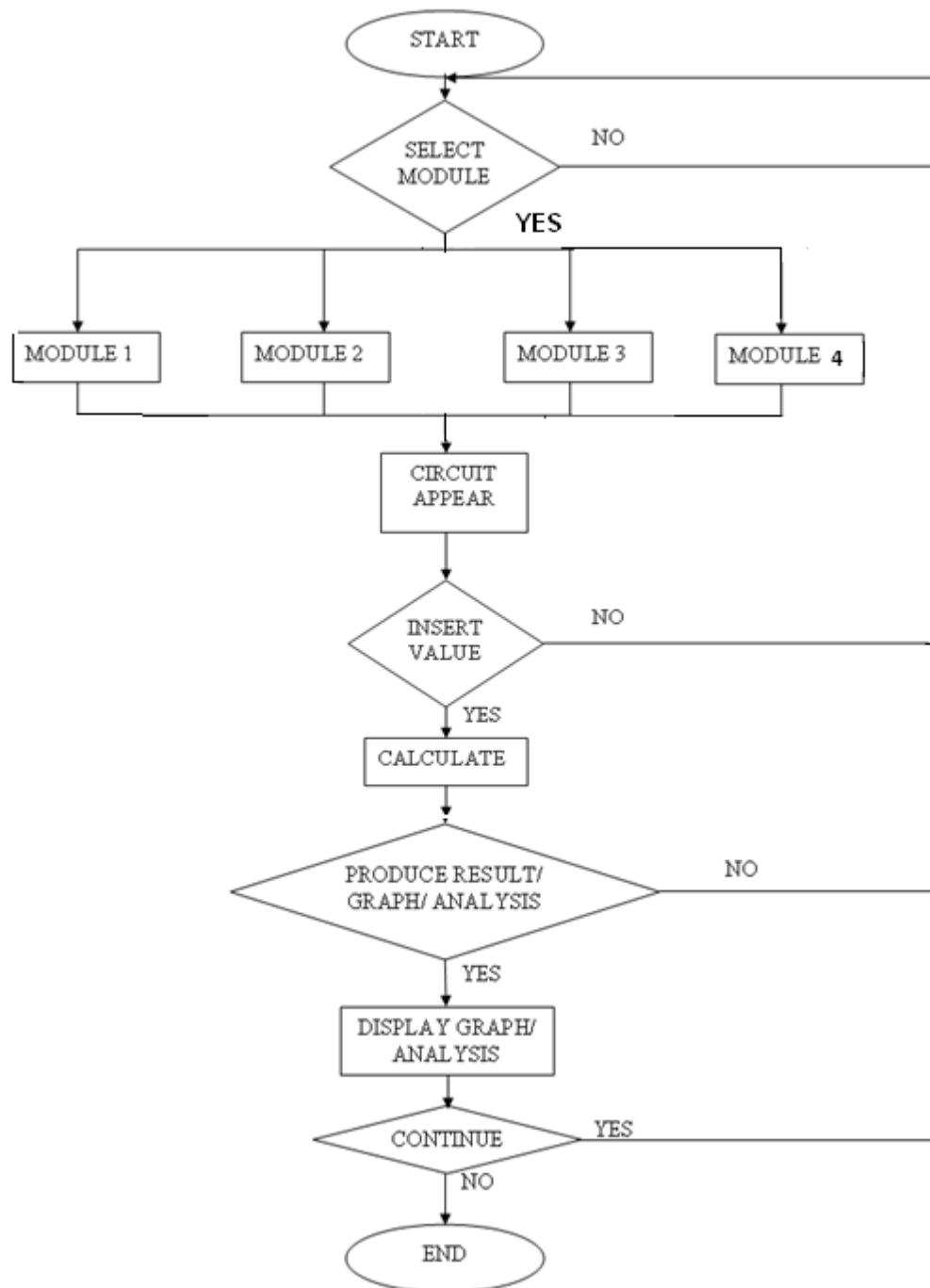
Step 5: Program Documentation

This software will be finished after the descriptions and all procedures that have been used were written into a thesis. So, in order to fulfill the requirement of this software, all of the coding must be generate into description, why and how its works. Beside that, in order to make this software become user friendly, the user guide or manual must be inserted into the program documentation.

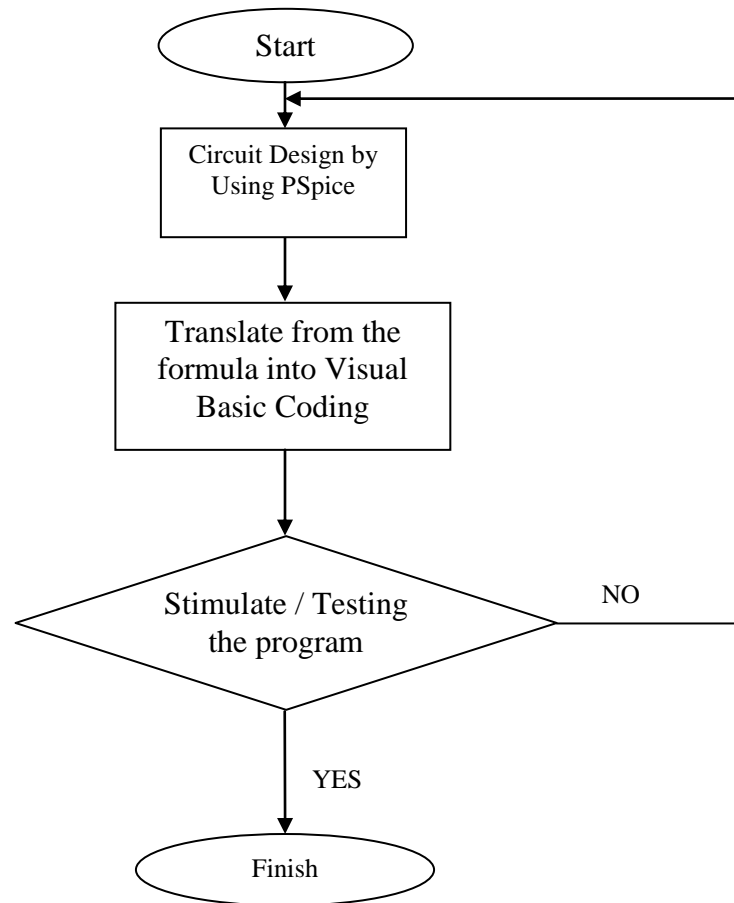
3.3 WINDOW BASED INTERFACE

The Web approach has almost no deployment issues, and is well-accepted. On the downside, it lags behind a Windows interface in terms of functionality richness, and is also somewhat slower to work with. And may have certain security issues for external use. The Windows approach to a user interface is available to almost every user, is very fast, and comes with a very rich set of features. But the Windows approach requires deployment to each user – although Microsoft .NET's No-touch deployment is making this almost as easy as the Window approach. In order to finish this Calculator System, Window Based approach was used.

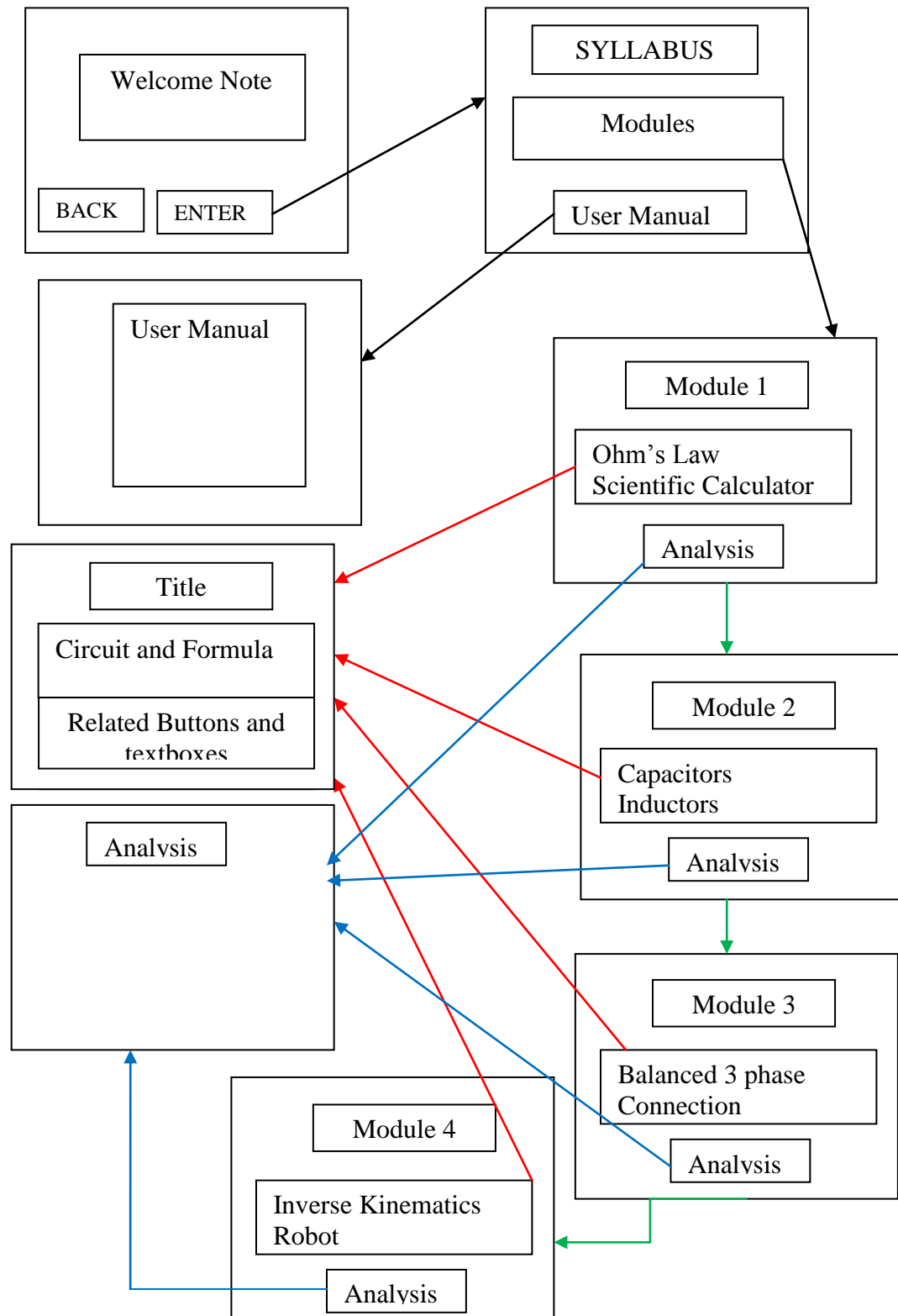
3.4 SYSTEM FLOWCHART



3.5 MODULE FLOWCHART



3.6 SYSTEM'S STORY BOARD



CHAPTER 4

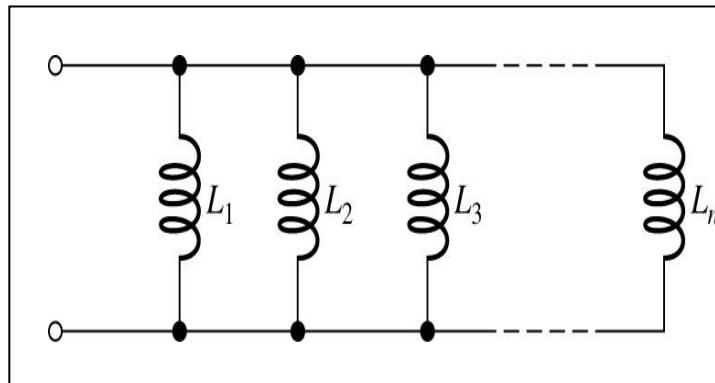
SOFTWARE DEVELOPMENT

4.1 VISUAL BASIC LANGUAGE

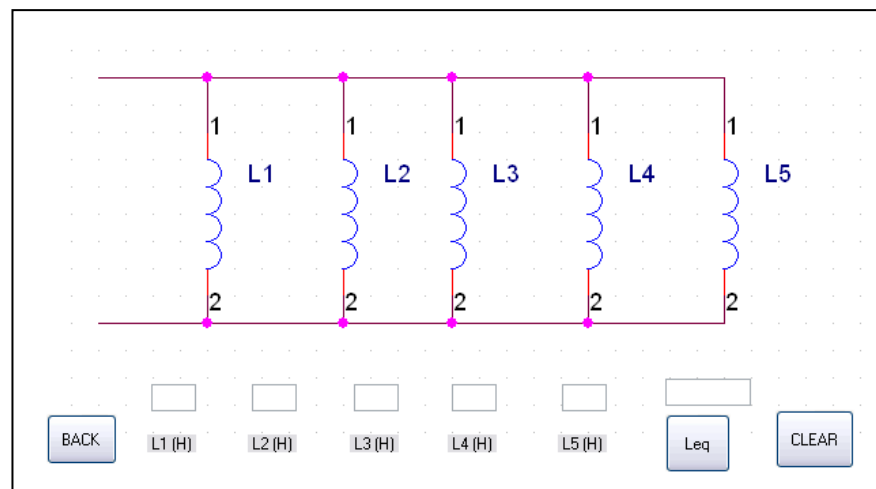
This project was designed by using Visual Basic language because it was easy to learn and use. The language not only allows programmers to create simple many applications, but can also develop fairly complex applications as well. A programmer can put together an application using the components provided with Visual Basic itself.

4.2 MULTIUSE EXPERT ELECTRICAL CALCULATOR SYSTEM

In education field, this system is a new system that produced to make the users easier to find the accurate answer without take long time and mistakes. For an example, we want to calculate the complex formula such as parallel inductor connection:

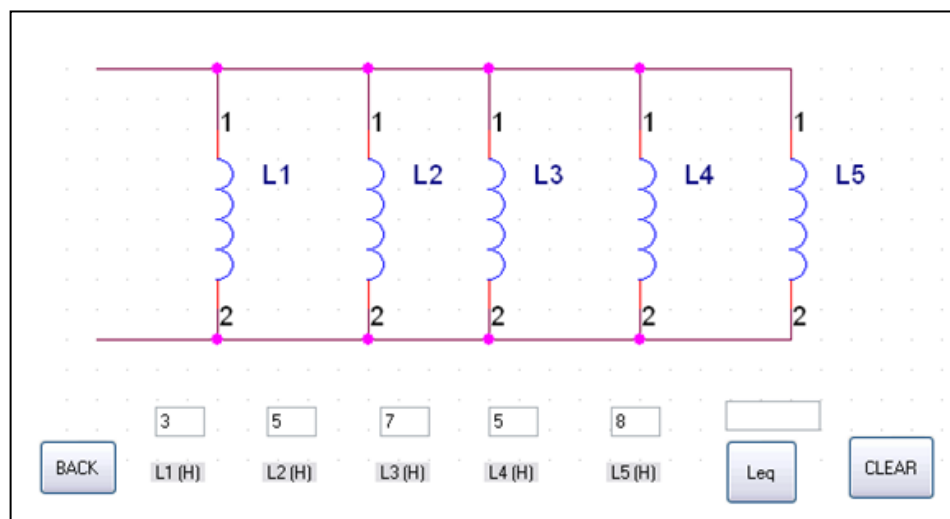


The formula that we must use in order to calculate this kind of connection is:
 $1/L_{eq} = 1/L_1 + 1/L_2 + 1/L_3 + \dots + 1/L_n$. By using normal calculator, it's hard to calculate this kind of formula, and it is also can occur mistakes in order to get the accurate and right answer. So, Multiuse Expert Electrical Calculator system was built in order to overcome this problem. So, a user only need to insert the exact value of the component, and the result will appear shortly such as below:

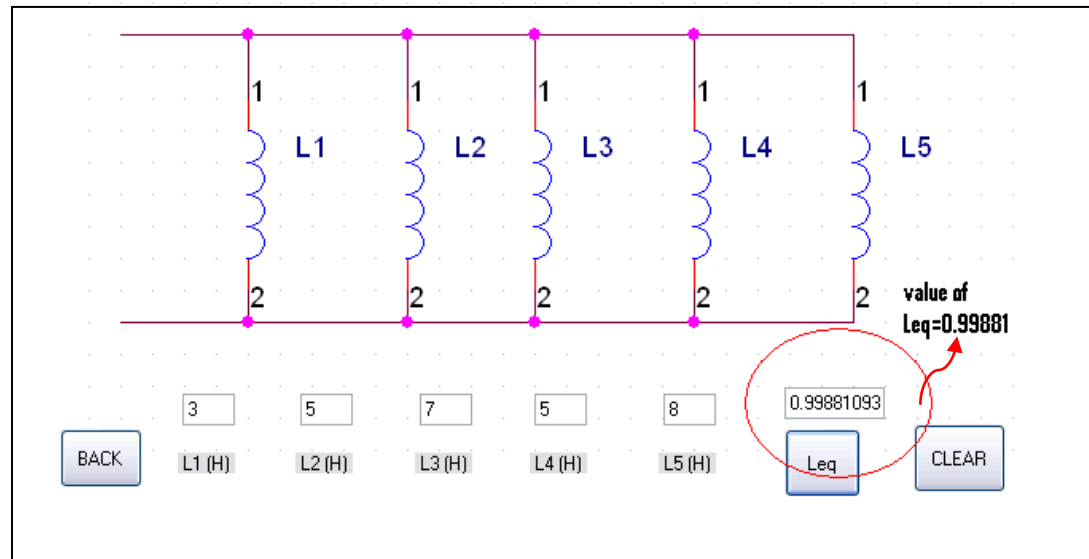


Then the users need to insert the value of each inductor by following the number of the inductors, such as below:

Example: $L1=3H$, $L2=5H$, $L3=7H$, $L4=5H$, $L5=8H$



To get the answer, users just need to click at Leq, and the result will appear at Leq box.



It is easy and fast to get the right and accurate result by only use this Multiuse
Expert Electrical Calculator System.

To analyze step by step of the module, there are the example used to proof the truth of this Multiuse Expert Electrical Calculator System

OHM'S LAW (Refer APPENDIX A)

MATHEMATICAL RELATIONSHIP OF V , I , and R

Three forms exist:

$$I = \frac{V}{R} \qquad V = IR \qquad R = \frac{V}{I}$$

Voltage = 25 V

Resistance = 25 Ω

$$I = \text{———} \qquad I = \frac{V}{R} = \frac{25 \text{ V}}{25 \Omega} = 1 \text{ Amp}$$

This answer was approved by using the calculator system such as figure 4.1

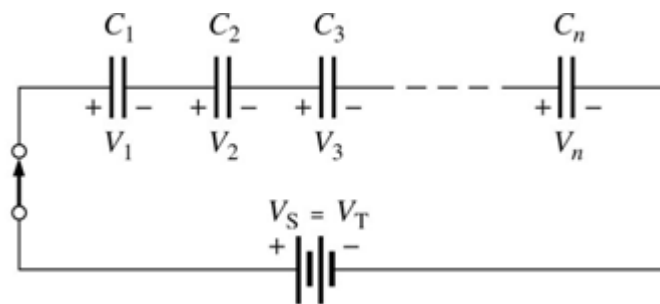
The screenshot shows a software window titled "ohms law". Inside, there's a pink background with a large white box containing the formula $I = \frac{V}{R}$. Below the formula, there are three tabs: "UNKNOWN", "CURRENT", and "RESISTOR". The "UNKNOWN" tab is selected. Under "UNKNOWN", there are three buttons: "V", "I", and "R". The "CURRENT" tab is also visible, showing input fields for "VOLTAGE (V)" (25), "RESISTOR (OHM)" (25), and "CURRENT (A)" (1). There are also buttons for "SHOW CIRCUIT", "ANALYSIS", "EXIT", "BACK", and "CLEAR".

Figure 4.1: Ohm's Law approved

CAPACITORS (Refer APPENDIX B)

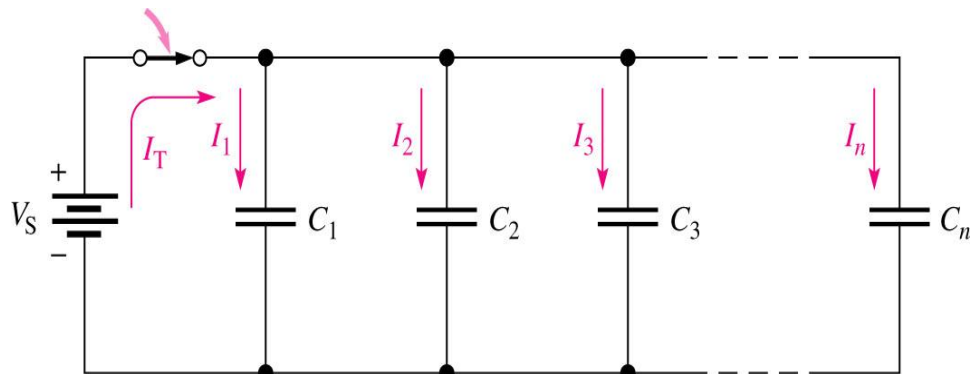
When capacitors are connected in series, the total capacitance can be calculated by using formula as state below:

$$1/C_{eq} = 1/C_1 + 1/C_2 + 1/C_3 + \dots + 1/C_n$$



When capacitors are connected in parallel, the total parallel capacitance is the sum of all capacitors in parallel.

$$C_{eq} = C_1 + C_2 + C_3 + \dots + C_n$$



As an example, for four series capacitors, $1/C_{eq} = 1/C_1 + 1/C_2 + 1/C_3 + 1/C_4$

Let $C_1 = 0.03 \text{ F}$, $C_2 = 0.32 \text{ F}$, $C_3 = 0.01 \text{ F}$, $C_4 = 0.045 \text{ F}$

$$1/C_{eq} = 1/C_1 + 1/C_2 + 1/C_3 + 1/C_4 + 1/C_5$$

$$1/C_{eq} = (1/0.03 + 1/0.32 + 1/0.01 + 1/0.045)$$

$$1/C_{eq} = 158.68$$

$$C_{eq} = 1/158.68$$

$$C_{eq} = 0.0063 \text{ F}$$

Above calculation was approved by the calculation by using the calculator system as in figure 4.2.

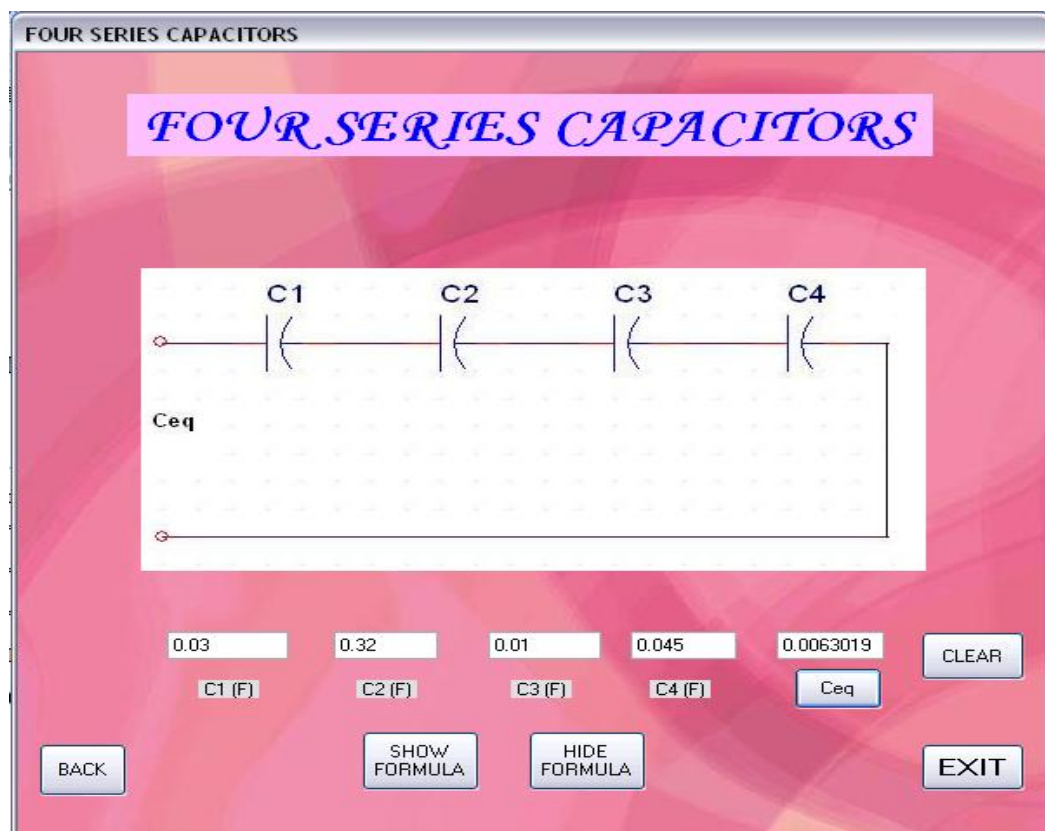
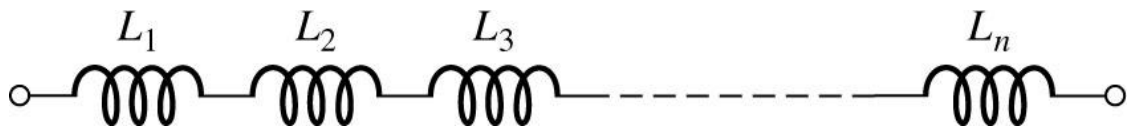


Figure 4.2: Series Capacitors approved

INDUCTOR (Refer APPENDIX C)

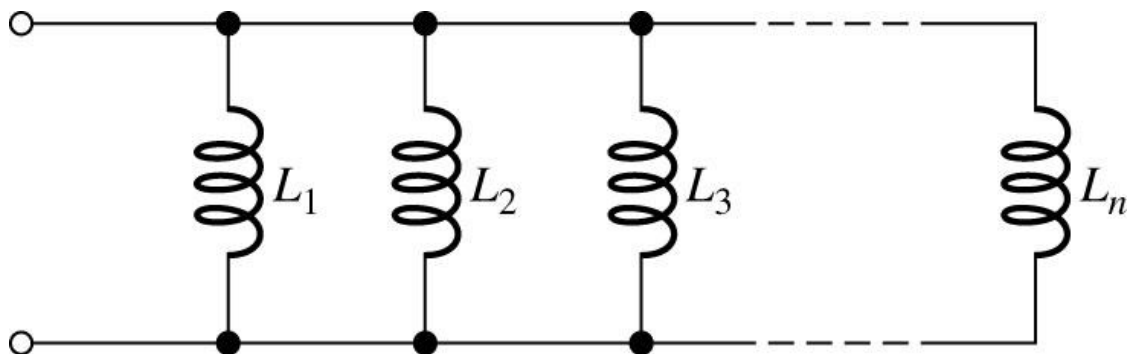
When inductors are connected in series, the total inductance is;

$$L_{eq} = L_1 + L_2 + L_3 + \dots + L_n$$



When inductors are connected in parallel, the total inductance is;

$$1/L_{eq} = 1/L_1 + 1/L_2 + 1/L_3 + \dots + 1/L_n$$



THREE-PHASE CIRCUIT

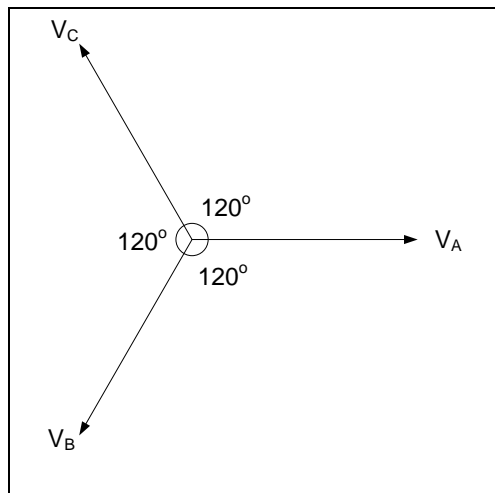
Balanced 3-Phase Voltages

A balanced 3-phase voltage consist of 3-sinusoidal voltage that have 3 identical amplitudes and frequencies but are out of phase with each other by exactly 120° . Standard practice is to refer to the 3-phase as ABC (sometimes RYB) and to the a-phase as the reference phase.

There are two possible phase relationship in a balanced 3-phase system.

Positive sequence (Refer APPENDIX D)

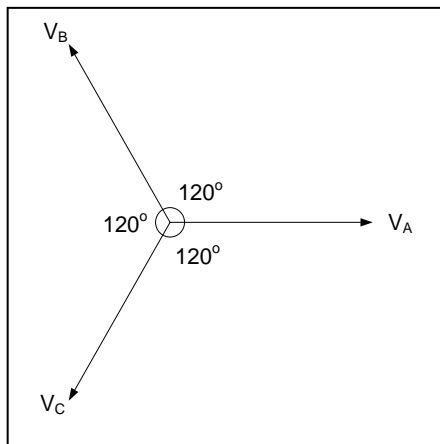
When the b-phase lags the a-phase and the c-phase lead the a-phase by 120° .



$$\begin{aligned} V_A &= V_m \angle 0^\circ \\ V_B &= V_m \angle -120^\circ \\ V_C &= V_m \angle -240^\circ \text{ OR } V_m \angle 120^\circ \end{aligned}$$

Negative sequence

When the b-phase lead the a-phase and the c-phase lags the a-phase by 120° .



$$\begin{aligned} V_A &= V_m \angle 0^\circ \\ V_B &= V_m \angle -120^\circ \\ V_C &= V_m \angle -240^\circ \text{ OR } V_m \angle 120^\circ \end{aligned}$$

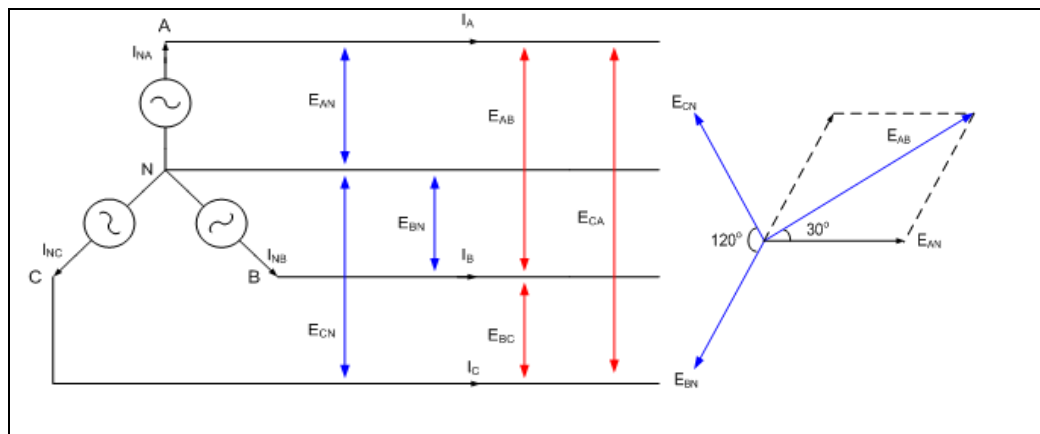
Characteristic of a balanced 3-phase;

- i. The sum of the three phase voltages is zero.
- ii. The circuit can operate in parallel only if they have same phase sequence.

Phase Voltage Source and The Relationship Between Line And Phase Voltages And Currents

- i. Wye connected system

Assume positive phase sequence.



E_{AB} , E_{BC} , E_{CA} – line to line voltage is called **line voltage generated** (E_L)

E_{AN} , E_{BN} , E_{CN} – line to neutral voltage is called **phase voltage generated** (E_P)

The phase voltages are given by;

$$E_{AN} = E \angle 0^\circ \text{ V}$$

$$E_{BN} = E \angle -120^\circ \text{ V}$$

$$E_{CN} = E \angle 120^\circ \text{ V}$$

In the star connection,

$E_L \neq E_P$

Using circuit analysis,

$$-E_{AN} + E_{AB} + E_{BN} = 0$$

$$E_{AB} = E_{AN} - E_{BN}$$

Referring to phasor diagram above

$$E_{AB} = 2 E_{AN} \cos 30^\circ$$

$$= \sqrt{3} E_{AN}$$

Notice that E_{AB} leads E_{AN} by 30°

OR
$$E_L = \sqrt{3} E_P \angle 30^\circ$$

$$E_{BC} = E_{BN} - E_{CN} = \sqrt{3} E \angle -90^\circ \text{ V (} E_{BC} \text{ leads } E_{BN} \text{ by } 30^\circ \text{)}$$

$$E_{CA} = E_{CN} - E_{AN} = \sqrt{3} E \angle 150^\circ \text{ V (} E_{CA} \text{ leads } E_{CN} \text{ by } 30^\circ \text{)}$$

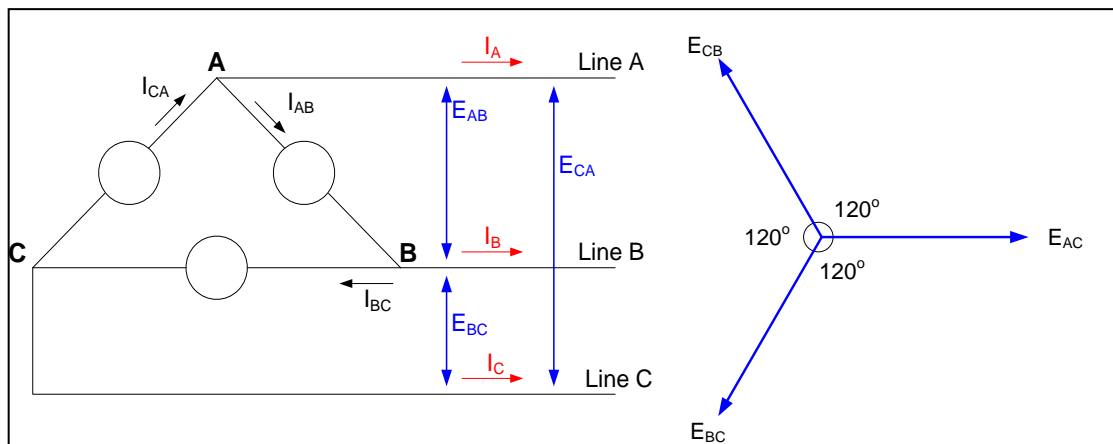
I_{NA} , I_{NB} and I_{NC} = Phase current (I_P)

I_A , I_B and I_C = Line current (I_L)

$$I_L = I_P$$

ii. Delta connected system

Assume positive phase sequence.



E_{AB} , E_{BC} and E_{CA} is the phase voltage (E_P)

E_{AB} , E_{BC} and E_{CA} is also the line voltage (E_L)

$$E_P = E_L$$

I_{AB}, I_{BC}, I_{CA} is the phase currents (I_P)

I_A, I_B, I_C is the line current (I_L)

From Fig. 3b it can be seen that the phase current are not the same as the line currents.

$$I_P \neq I_L$$

$$I_L = \sqrt{3} I_P \angle -30^\circ$$

Similar proof to line voltage in star connected source.

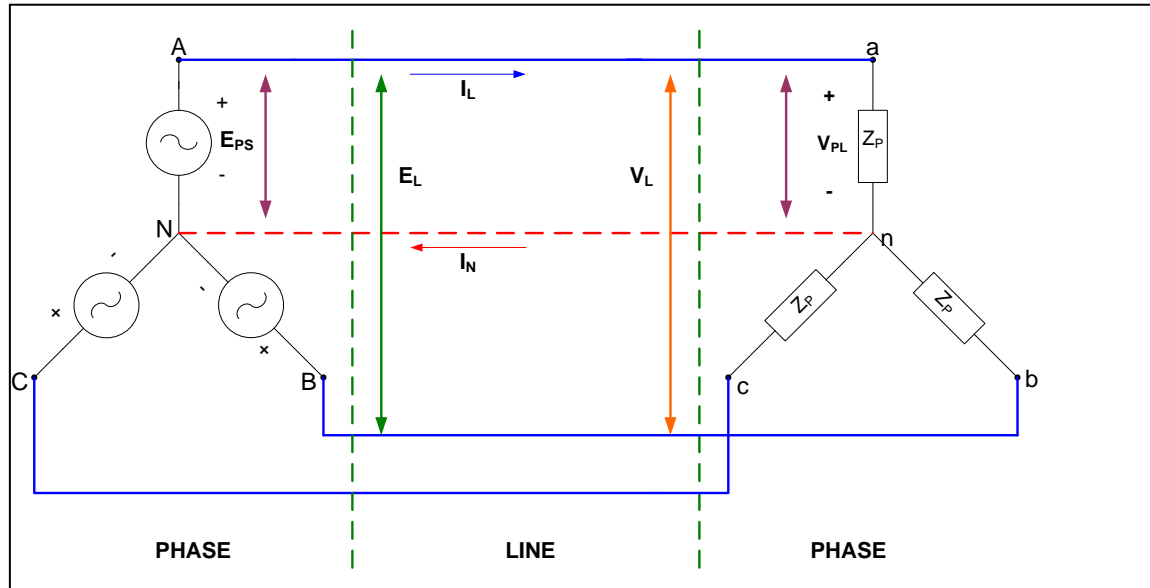
SOURCE AND LOAD CONNECTION

The 3-phase voltage source or generator can either be Y or Δ connected. Similarly the load can either be wye or delta connected.

A Y-Y circuits and Y- Δ circuit will be analysed in this topic.

THE Y-Y CONNECTION

If a Y-connected is connected to a Y-connected generator, the system is represented as **Y-Y connection**. The connection is as shown below:



I_{PS} = phase source current

E_{PS} = phase source voltage

I_{PL} = phase load current

V_{PL} = phase load voltage

I_L = line current

V_L, E_L = line voltage

For a balanced load, $Z_1 = Z_2 = Z_3$. The neutral N can be removed (no current flow in the neutral line, that is $I_N = 0$). From the above circuit, the relationship between the line and the phase value are;

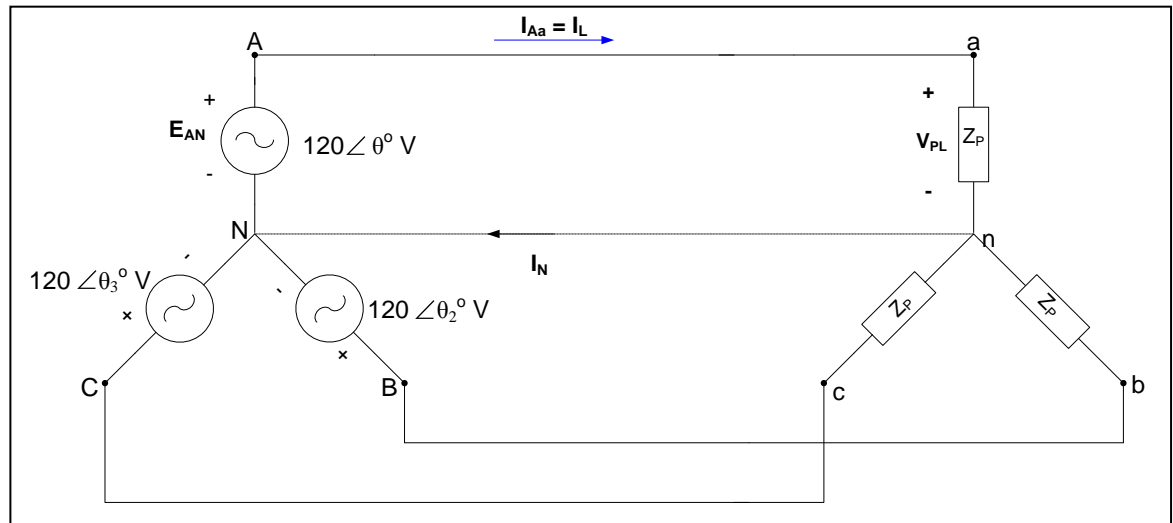
$$I_{PS} = I_L = I_{PL} \quad , \quad E_L = \sqrt{3} V_P$$

$$V_{PL} = E_{PS} \quad , \quad I_{PL} = \frac{V_{PL}}{Z_p}$$

Example of calculation (Refer APPENDIX D)

The phase sequence of a Y-connected generator is ABC. Find

- (a) phase angle θ_2 and θ_3
- (b) magnitude of line voltages
- (c) the line currents
- (d) verify that $I_N = 0$



(a) For an ABC phase sequence, $\theta_2 = -120^\circ$, $\theta_3 = 120^\circ$

(b) $E_L = \sqrt{3} E_P = \sqrt{3} (120) = 208 \text{ V}$

(c) $V_{PL} = E_{PS}$

$\therefore V_{an} = E_{AN}$, $V_{bn} = E_{BN}$, $V_{cn} = V_{CN}$

$$\begin{aligned} \therefore \text{Line current, } I_{an} &= \frac{V_{an}}{Z_{an}} \\ &= \frac{120\angle 0^\circ}{(3 + j4)} \\ &= 24\angle -53.13^\circ \text{ A} \end{aligned}$$

$$\begin{aligned}
I_{bn} &= \frac{V_{bn}}{Z_{bn}} \\
&= \frac{120 \angle -120^\circ}{(3 + j4)} \\
&= 24 \angle -173.13^\circ \text{ A}
\end{aligned}$$

$$\begin{aligned}
I_{cn} &= \frac{V_{cn}}{Z_{cn}} \\
&= \frac{120 \angle 120^\circ}{(3 + j4)} \\
&= 24 \angle 66.87^\circ \text{ A}
\end{aligned}$$

Since $I_{Aa} = I_L = I_{an} = 24 \angle -53.13^\circ \text{ A}$

$$\therefore I_{Bb} = 24 \angle -173.13^\circ \text{ A}$$

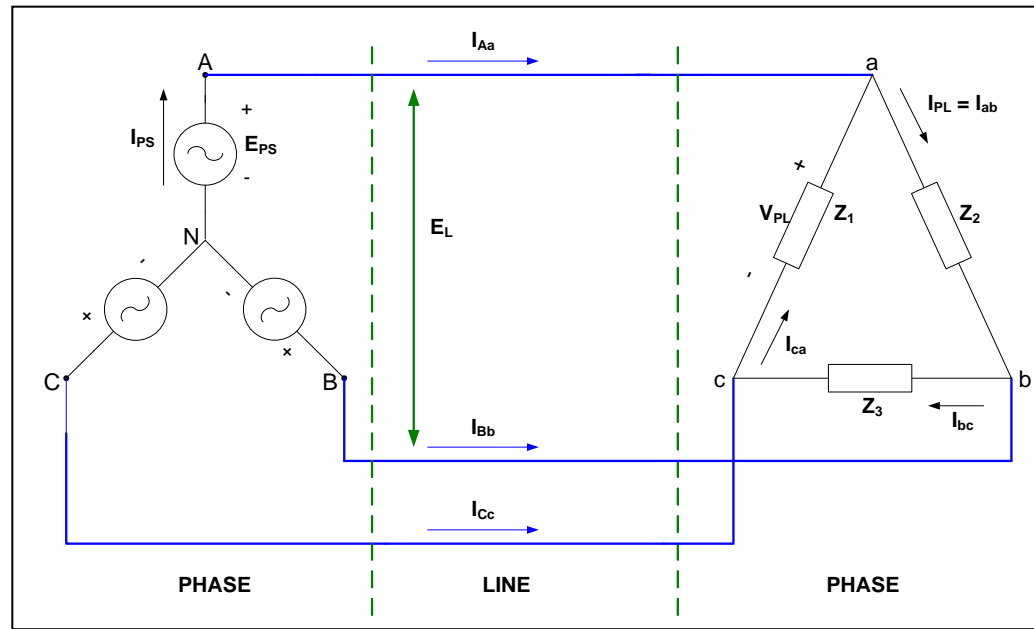
$$I_{Cc} = 24 \angle 66.87^\circ \text{ A}$$

(d) Applying Kirchhoff current law $I_N = I_{Aa} + I_{Bb} + I_{Cc}$

$$\begin{aligned}
\text{In rectangular form, } I_{Aa} &= 14.4 - j19.20 \text{ A} \\
I_{Bb} &= -23.83 - j2.87 \text{ A} \\
I_{Cc} &= 9.43 + j22.07 \text{ A}
\end{aligned}$$

$$\therefore \sum I_{Aa} + I_{Bb} + I_{Cc} = 0$$

THE Y-Δ CONNECTION



Y-connected source with Δ-connected load

For a balanced load $Z_1 = Z_2 = Z_3$. From the above circuits, the line current are obtained by

$$\mathbf{I}_{Aa} = \mathbf{I}_{ab} - \mathbf{I}_{ca}, \mathbf{I}_{Bb} = \mathbf{I}_{bc} - \mathbf{I}_{ab}, \mathbf{I}_{Cc} = \mathbf{I}_{ca} - \mathbf{I}_{bc}$$

In general, the relationship between the phase and line current is

$$I_L = \sqrt{3} I_{PL}$$

In the Δ-connected load, the line to line voltage is equal to the phase voltage of the load, where

$$E_L = V_{PL}$$

POWER IN THREE PHASE SYSTEMS (Refer APPENDIX E)

For Y-connected load and Δ-connected load

(a) Average power, P

The average power delivered to each phase is

$$P_P = V_P I_P \cos \theta, \text{ where } \theta \text{ is the phase angle between } I_P \text{ and } V_P$$

The total three phase power to the balanced load

$$\begin{aligned} P_T &= 3 P_P \\ P_T &= 3 V_P I_P \cos \theta \quad \text{Watt} \end{aligned}$$

$$V_P = \frac{E_L}{\sqrt{3}} \text{ and } I_P = I_L$$

$$\text{Then } P_T = 3 \left(\frac{E_L}{\sqrt{3}} \right) I_L \cos \theta$$

$$P_T = \sqrt{3} E_L I_L \cos \theta \quad (\text{Watt})$$

(ii) Reactive Power

The reactive power of each phase,

$$Q_P = V_P I_P \sin \theta$$

The total reactive power of the load is

$$\begin{aligned} Q_T &= 3 Q_P = 3 V_P I_P \sin \theta \quad \text{or} \\ Q_T &= \sqrt{3} E_L I_L \sin \theta \quad \text{VAR} \end{aligned}$$

(iii) Apparent Power

The apparent power per phase

$$S_P = V_P I_P$$

The total apparent power is

$$S_T = 3 S_P = 3 V_P I_P$$

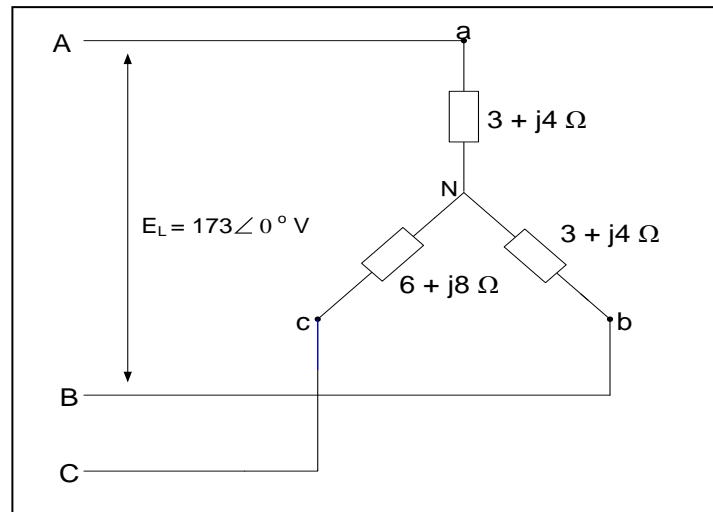
$$S_T = \sqrt{3} V_L I_L \quad (\text{VA})$$

(iv) Power factor

$$pf = \frac{P_T}{S_T} = \cos \theta \quad (\text{leading or lagging})$$

Example Calculation for Balanced Power

For a Y-connected load shown below, find the total real power, reactive power, apparent power and power factor.



Manual Calculation:

$$Z_P = (3 + j4) \Omega = 5 \angle 53.13^\circ \Omega$$

$$V_P = \frac{E_L}{\sqrt{3}} = \frac{173}{\sqrt{3}} = 100 \text{ V}$$

(i) The average power

$$P_P = V_P I_P \cos \theta = 100(20) \cos 53.13^\circ = 1200 \text{ W}$$

$$\therefore P_T = 3 P_P = 3(1200) = 3600 \text{ W}$$

$$\text{Or } P_T = \sqrt{3} E_L I_L \cos \theta = \sqrt{3} (172.3)(20) \cos 53.13^\circ = 3600 \text{ W}$$

(ii) The reactive power

$$Q_P = V_P I_P \sin \theta = 100(20) \sin 53.13^\circ = 1600 \text{ VAR}$$

$$\therefore Q_T = 3 Q_P = 3(1600) = 4800 \text{ VAR}$$

$$\text{Or } Q_T = \sqrt{3} E_L I_L \sin \theta = \sqrt{3} (172.3)(20) \sin 53.13^\circ = 3600 \text{ VAR}$$

(iii) The apparent power

$$S_P = V_P I_P = 100(20) = 2000 \text{ VA}$$

$$\therefore S_T = 3 S_P = 3(2000) = 6000 \text{ VA}$$

$$\text{Or } S_T = \sqrt{3} E_L I_L = \sqrt{3} (172.3)(20) = 6000 \text{ VA}$$

(iv) The power factor

$$pf = \frac{P_T}{S_T} = \frac{3600}{6000} = 0.6 \text{ lagging}$$

$$\text{Or } \cos \theta = \cos 53.13^\circ = 0.6 \text{ lagging}$$

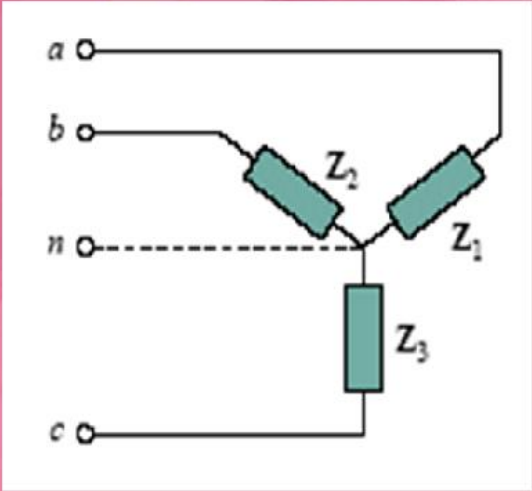
The calculation by using Multiuse Expert Electrical Calculator more accurate compared to the manual calculation as in figure 4.3.

POWER IN BALANCED SYSTEM

PLEASE SELECT THE CONNECTION YOU WANT TO CALCULATE

WYE CONNECTED LOAD

DELTA CONNECTED LOAD



WYE CONNECTED LOAD

INSERT VALUE

LINE VOLTAGE 172.3 V

LINE CURRENT 20 A

ANGLE 53.13 DEGREE

AVERAGE POWER 3581.196779139 WATT

REACTIVE POWER 4774.911269236 VAR

APPARENT POWER 5968.647082882 VA

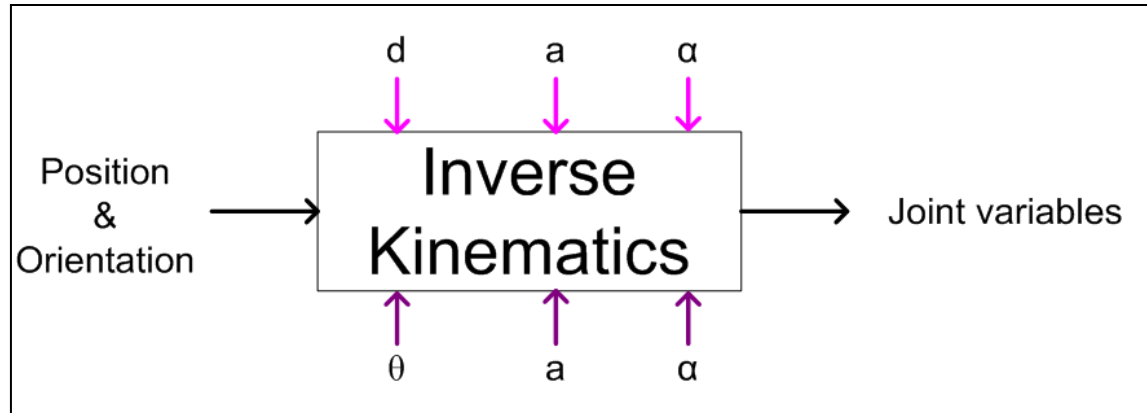
POWER FACTOR 0.600001429035

BACK CLEAR EXIT

Figure 4.3: Calculation of Balanced Three Phase Power

INVERSE KINEMATICS ROBOT (Refer APPENDIX F)

All of the calculation step below was used in order to built Inverse Kinematics 6 Degree of Freedom (DOF) Robot.



$$[\text{Total Motion}] = [\text{Arm Motion}] [\text{Wrist Motion}]$$

$$\begin{aligned}
 {}^0T_6 &= {}^0T_3 {}^3T_6 \\
 &= {}^0T_a {}^aT_w \\
 &= (A_1 A_2 A_3) (A_4 A_5 A_6) \\
 &= \begin{bmatrix} n_{ax} & s_{ax} & a_{ax} & P_{ax} \\ n_{ay} & s_{ay} & a_{ay} & P_{ay} \\ n_{az} & s_{az} & a_{az} & P_{az} \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} n_{wx} & s_{wx} & a_{wx} & P_{wx} \\ n_{wy} & s_{wy} & a_{wy} & P_{wy} \\ n_{wz} & s_{wz} & a_{wz} & P_{wz} \\ 0 & 0 & 0 & 1 \end{bmatrix} \\
 &= \begin{bmatrix} {}^0R_3 & {}^0P_a \\ 0 & 1 \end{bmatrix} \begin{bmatrix} {}^3R_6 & {}^3P_w \\ 0 & 1 \end{bmatrix} \\
 &= \begin{bmatrix} {}^0R_3 {}^3R_6 & {}^0R_3 {}^3P_w + {}^0P_a \\ 0 & 1 \end{bmatrix}
 \end{aligned}$$

$$\text{Therefore } P = {}^0P_a + {}^0P_w$$

$$\begin{bmatrix} P_x \\ P_y \\ P_z \end{bmatrix} = \begin{bmatrix} P_{ax} \\ P_{ay} \\ P_{az} \end{bmatrix} + \begin{bmatrix} P_{wx} \\ P_{wy} \\ P_{wz} \end{bmatrix}$$

or

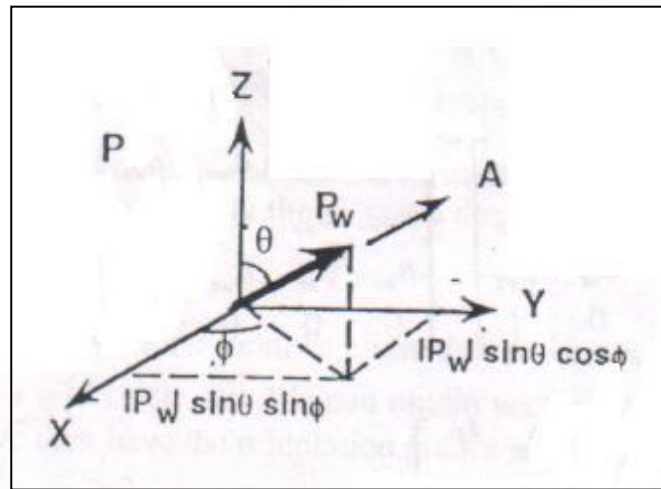


Figure : Angles and wrist position vector relationship

From the figure:

$$\phi = \tan^{-1} \frac{a_y}{a_x}$$

$$\theta = \tan^{-1} \frac{\sqrt{a_x^2 + a_y^2}}{a_z}$$

$$P_{wx} = |P_w| \sin \theta \cos \phi$$

$$P_{wy} = |P_w| \sin \theta \sin \phi$$

$$P_{wz} = |P_w| \cos \theta$$

We know that $P_a = P - P_w$

Or
$$\begin{bmatrix} P_{ax} \\ P_{ay} \\ P_{az} \end{bmatrix} = \begin{bmatrix} P_x \\ P_y \\ P_z \end{bmatrix} - \begin{bmatrix} |P_w| \sin \theta \cos \phi \\ |P_w| \sin \theta \sin \phi \\ |P_w| \cos \theta \end{bmatrix}$$

Thus we have

$$P_a = {}^0T_a \begin{bmatrix} 0 \\ 0 \\ d_4 \\ 1 \end{bmatrix}$$

$$\begin{bmatrix} C_1 S_{23} d_4 + a_2 C_1 C_2 + a_3 C_1 C_{23} - d_2 S_1 \\ S_1 S_{23} d_4 + a_2 S_1 C_2 + a_3 S_1 C_{23} + d_2 C_1 \\ C_{23} d_4 - a_2 S_2 - a_3 S_{23} \end{bmatrix} = \begin{bmatrix} Pax \\ Pay \\ Paz \end{bmatrix}$$

Solution for θ_1

To solve for the first joint angle, begin by multiplying (i) und (ii) by $-S_1$ and C_1 respectively, and then adding them up

Formula

In the form of $-U \sin \theta + V \cos \theta = W$ whereby the solution can be derived and is given by

$$\theta = \tan^{-1} \frac{V}{U} - \tan^{-1} \frac{\pm W}{\sqrt{U^2 + V^2 - W^2}}$$

Solution θ_2

Multiply (i) and (ii) by C_1 and S_1 respectively and adding them up

Solution for θ_3 $\frac{S_{23}}{C_{23}} = ?$

Solution for $\theta_4, \theta_5, \theta_6$

$$[\text{Total Rotation}] = [\text{Arm Rotation}][\text{Wrist Rotation}]$$

$$\mathbf{R} = \mathbf{0R3} \mathbf{3R6}$$

$$\mathbf{3R6} = (\mathbf{0R3})^{-1} \mathbf{R}$$

$${}^3R_6 = \begin{bmatrix} n_{wx} & s_{wx} & a_{wx} \\ n_{wy} & s_{wy} & a_{wy} \\ n_{wz} & s_{wz} & a_{wz} \end{bmatrix}$$

$${}^3T_6 = {}^3A_4 {}^4A_5 {}^5A_6 = \begin{bmatrix} C_4 C_5 C_6 - S_4 S_6 & -C_4 C_5 S_6 - S_4 C_6 & C_4 S_5 & \\ S_4 C_5 C_6 + C_4 S_6 & -S_4 C_5 S_6 + C_4 C_6 & S_4 S_5 & \\ -S_5 C_6 & S_5 S_6 & C_5 & \end{bmatrix}$$

$$= \begin{bmatrix} c_4 c_5 c_6 - s_4 s_6 & -c_4 c_5 s_6 - s_4 c_6 & c_4 s_5 & d_6 c_4 s_5 \\ s_4 c_5 c_6 + c_4 s_6 & -s_4 c_5 s_6 + c_4 c_6 & s_4 s_5 & d_6 s_4 s_5 \\ -s_5 s_6 & s_5 s_6 & c_5 & d_6 c_5 + d_4 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$({}^0\mathbf{R}_3)^{-1}$ is

$$({}^0\mathbf{R}_3)^{-1} = \begin{bmatrix} C_1 C_{23} & S_1 C_{23} & -S_{23} \\ -S_1 & C_1 & 0 \\ C_1 S_{23} & S_1 S_{23} & C_{23} \end{bmatrix}$$

$${}^0T_3 = {}^0A_1 {}^1A_2 {}^2A_3 = \begin{bmatrix} c_1 c_{23} & -s_1 & c_1 s_{23} & a_2 c_1 c_2 + a_3 c_1 c_{23} - d_2 s_1 \\ s_1 c_{23} & c_1 & s_1 s_{23} & a_2 s_1 c_2 + a_3 s_1 c_{23} + d_2 c_1 \\ -s_{23} & 0 & c_{23} & -a_2 s_2 - a_3 s_{23} \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

We are going to consider the wrist rotation in terms of Euler angles. From ${}^3\mathbf{R}_6 = ({}^0\mathbf{R}_3)^{-1} \mathbf{R}$

we have

$$\begin{bmatrix} n_{wx} & s_{wx} & a_{wx} \\ n_{wy} & s_{wy} & a_{wy} \\ n_{wz} & s_{wz} & a_{wz} \end{bmatrix} = \begin{bmatrix} C_1 C_{23} & S_1 C_{23} & -S_{23} \\ -S_1 & C_1 & 0 \\ C_1 S_{23} & S_1 S_{23} & C_{23} \end{bmatrix} \begin{bmatrix} n_x & s_x & a_x \\ n_y & s_y & a_y \\ n_z & s_z & a_z \end{bmatrix}$$

Premultiplying both sides by we obtain

$$\begin{bmatrix} C_4 & S_4 & 0 \\ 0 & 0 & -1 \\ -S_4 & C_4 & 0 \end{bmatrix} \begin{bmatrix} n_{wx} & s_{wx} & a_{wx} \\ n_{wy} & s_{wy} & a_{wy} \\ n_{wz} & s_{wz} & a_{wz} \end{bmatrix} = \begin{bmatrix} C_5 & 0 & S_5 \\ S_5 & 0 & -C_5 \\ 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} C_6 & -S_6 & 0 \\ S_6 & C_6 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} C_4 n_{wx} + S_4 n_{wy} & C_4 s_{wx} + S_4 s_{wy} & C_4 a_{wx} + S_4 a_{wy} \\ -n_{wz} & -s_{wz} & -a_{wz} \\ -S_4 n_{wx} + C_4 n_{wy} & -S_4 s_{wx} + C_4 s_{wy} & -S_4 a_{wx} + C_4 a_{wy} \end{bmatrix} = \begin{bmatrix} C_5 C_6 & -C_5 S_6 & S_5 \\ S_5 C_6 & -S_5 S_6 & -C_5 \\ S_6 & C_6 & 0 \end{bmatrix}$$

$$\begin{bmatrix} C_4 C_5 C_6 - S_4 S_6 & -C_4 C_5 S_6 - S_4 C_6 & \boxed{C_4 S_5} \\ S_4 C_5 C_6 + C_4 S_6 & -S_4 C_5 S_6 + C_4 C_6 & \boxed{S_4 S_5} \\ -S_5 C_6 & S_5 S_6 & C_5 \end{bmatrix}$$

θ_4 From equ (a)

$$\frac{S_4 S_5}{C_4 S_5} = \frac{aw_y}{aw_x} = \tan \theta_4$$

$$\theta_4 = \tan^{-1} \frac{aw_y}{aw_x}$$

$$\begin{bmatrix} C_4 n_{wx} + S_4 n_{wy} & C_4 s_{wx} + S_4 s_{wy} & \boxed{C_4 a_{wx} + S_4 a_{wy}} \\ -n_{wz} & -s_{wz} & \boxed{-a_{wz}} \\ -S_4 n_{wx} + C_4 n_{wy} & -S_4 s_{wx} + C_4 s_{wy} & -S_4 a_{wx} + C_4 a_{wy} \end{bmatrix} = \begin{bmatrix} C_5 C_6 & -C_5 S_6 & \boxed{S_5} \\ S_5 C_6 & -S_5 S_6 & \boxed{-C_5} \\ \boxed{S_6} & \boxed{C_6} & \boxed{0} \end{bmatrix}$$

$$\theta_5 \quad \frac{S_5}{-C_5} = \frac{C_4 aw_x + S_4 aw_y}{-aw_y} = \tan \theta_5$$

$$\theta_5 = \tan^{-1} \frac{C_4 aw_x + S_4 aw_y}{aw_y}$$

$$\theta_6 \quad \frac{S_6}{C_6} = \frac{-S_4 nw_x + C_4 nw_y}{-C_4 sw_x + C_4 sw_y} = \tan \theta_6$$

$$\theta_6 = \tan^{-1} \frac{-S_4 nw_x + C_4 nw_y}{-C_4 sw_x + C_4 sw_y}$$

CHAPTER 5

RESULT & DISCUSSION

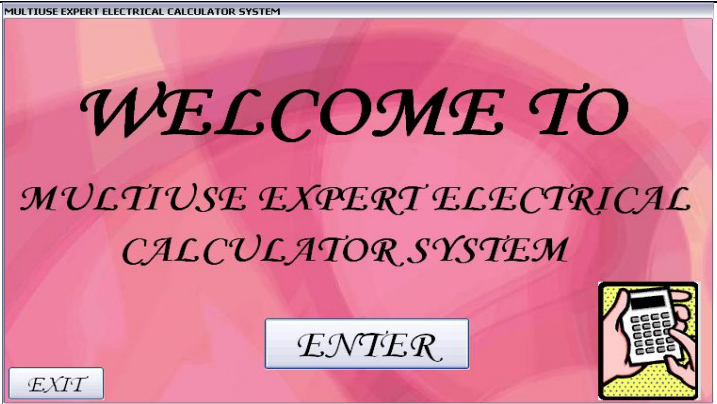

5.1 INTRODUCTION

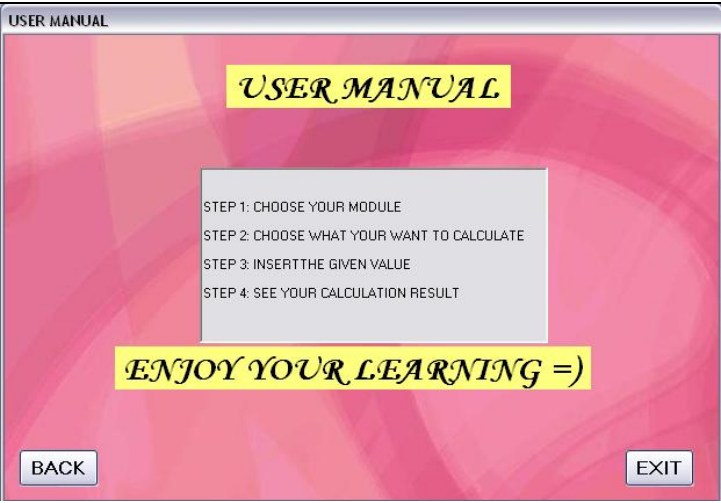
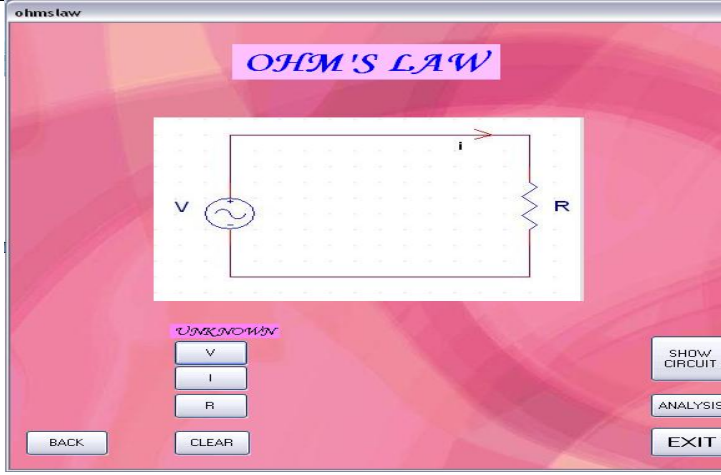
In this chapter, all results and the limitation of the project will be discussed. All discussions will focus on the result obtained and performance of the project.

5.2 RESULT AND DISCUSSION

Below is the syllabus that created in this Multiuse Expert Electrical Calculator System:

- 1) Basics Laws: Ohms Law
Scientific Calculator
- 2) Capacitors and Inductors: Series and Parallel Connection (two until five connections)
- 3) Three Phase Connection:
 - I. Balanced Wye-Wye Connection
 - II. Balanced Wye-Delta Connection
 - III. Power in a Balanced System
- 4) Robotics: Inverse Kinematics

MODULE / PAGES	EXPLANATION	WINDOW
Welcome page	To fulfill the GUI requirement, welcome note for user was created as an introduction to users when they want to use this system. When users click ENTER, they will enter to the list of syllabus. Button exit will close this system.	
Syllabus	<p>At this page, user able to select which module they want to use. There have 4 modules in this calculator system, there are</p> <ol style="list-style-type: none"> 1) Basics Laws: Ohms Law Scientific Calculator 2) Capacitors and Inductors: Series and Parallel Connection (two until five connections) 3) Three Phase Connection: 4) Robotics: Inverse Kinematics 	

User manual	<p>For users guide, there are user's manual as reference for users to use this calculator system. Users only need to follow the guide how to use this system, and they will learn many things by using this system. Users may enjoy this calculator system with more of confident and enjoyable. Button Back will allow users to go to welcome page.</p>	
Module 1.1: Ohm's Law	<p>Syllabus box will appear, and users may select the module. When users select Ohm's Law, this window will appear. At the first module, there are ohm's law which allows users to calculate the value of voltages, currents and resistances. Users may only insert the given value to calculate. When users click on the ohm's law at the syllabus page, this window will be appear first. So, users only need to click at unknown part, to get the calculation window.</p>	

For an example, users want to calculate the voltage of a circuit. So, users just need to click V at unknown part, and below window will appear.

The screenshot shows a window titled "ohmslaw" with a pink background. At the top, it says "OHM'S LAW" in a pink box. In the center, the equation $V = IR$ is displayed in a white box. Below the equation, there are two main sections: "UNKNOWN" and "VOLTAGE".

The "UNKNOWN" section has three buttons: "V", "I", and "R". The "V" button is highlighted in pink, indicating it has been selected.

The "VOLTAGE" section has a label "Insert Given Value" in pink. Below it, there are three input fields: "CURRENT (A)", "RESISTOR (OHM)", and "ANSWER". The "ANSWER" field is currently empty. To the right of these fields are three buttons: "SHOW CIRCUIT", "ANALYSIS", and "EXIT".

At the bottom left, there are two buttons: "BACK" and "CLEAR".

At this stage, users only need to insert the value of current and resistor into the textbox in the window.

This screenshot shows the same "ohmslaw" window as the previous one, but with values entered into the input fields. The "UNKNOWN" section still has "V" selected.

In the "VOLTAGE" section, the "CURRENT (A)" field now contains the value "5" and the "RESISTOR (OHM)" field contains the value "3". The "ANSWER" field remains empty.

The "SHOW CIRCUIT", "ANALYSIS", and "EXIT" buttons are still present on the right side of the window.

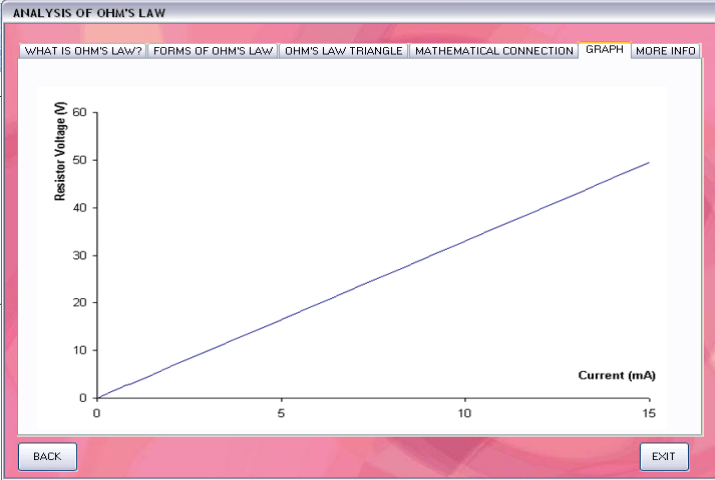
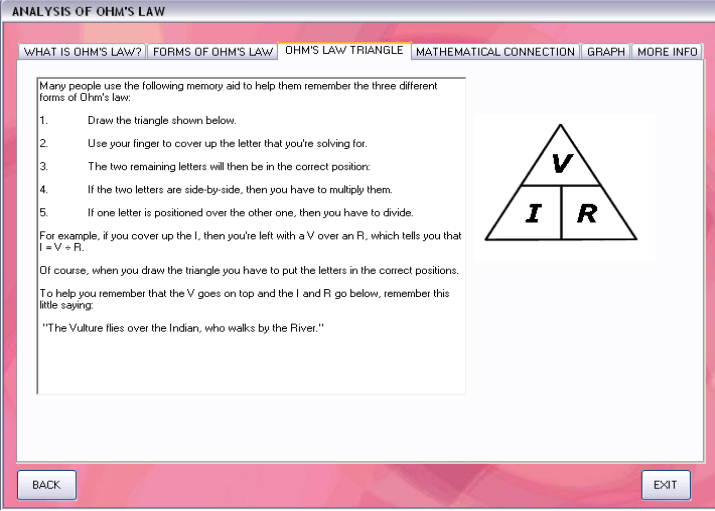
The "BACK" and "CLEAR" buttons remain at the bottom left.



Then, to get the answer, user only need to click VOLTAGE (V) button, and the answer will appear shortly. It's easy, and we can get an accurate answer in a short time.

The screenshot shows a software window titled 'ohmslaw' with a pink background. At the top, it says 'OHM'S LAW' in a pink box. Below that, the formula $V=IR$ is displayed in a white box. On the left, there is a vertical stack of buttons: 'V', 'I', 'R', 'BACK', and 'CLEAR'. The 'UNKNOWN' label is next to these buttons. On the right, there is a 'VOLTAGE' section with a pink 'Insert Given Value' button. Below it are three input fields: 'CURRENT (A)' with the value '5', 'RESISTOR (OHM)' with the value '3', and 'ANSWER' with the value '15'. There are also buttons for 'SHOW CIRCUIT', 'ANALYSIS', and 'EXIT'.

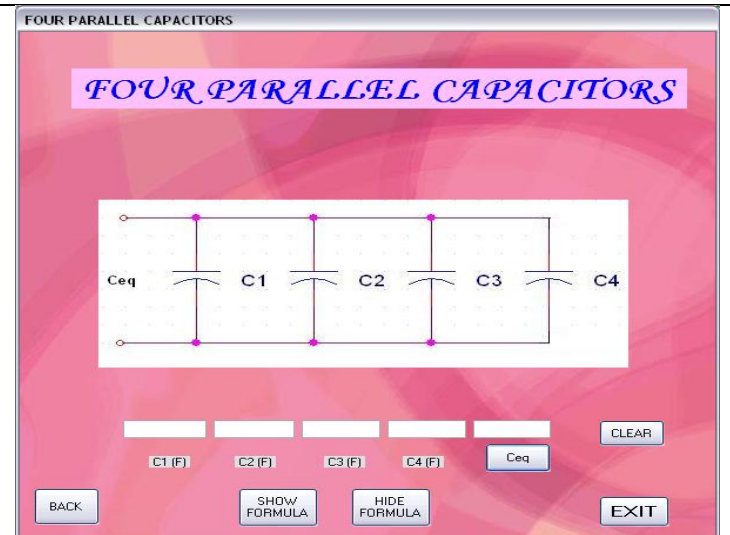
Users may also use the HIDE FORMULA button to refer the circuit when doing the calculation. It is easy to users to learn more by only open this calculator system.

This screenshot shows the same 'ohmslaw' window, but with a circuit diagram instead of the formula. The circuit consists of a voltage source 'V' (represented by a circle with a tilde) and a resistor 'R' (represented by a zigzag line) connected in a loop. The current 'i' is indicated by an arrow pointing to the right. The interface elements (buttons and input fields) are the same as in the previous screenshot, but the 'VOLTAGE' section is currently empty.

	<p>In analysis part, users may look forward to graph which tell users the relationship between the voltages and current used in the calculation. Users may not only know the answer for the calculation but also may know the other things beside the calculations.</p>	
	<p>The voltage v across a resistor is directly proportional to the current I flowing through the resistor $V \propto i$</p> <p>Ohm defined the constant of proportionality for a resistor to be the resistance, R. Thus become</p> $V = iR$ <p>which is the mathematical form of Ohm's Law.</p> <p>R is measured in the unit of ohms(Ω)</p>	

<p>Module 1.2: Scientific Calculator</p>	<p>This calculator system also provided a basic scientific calculator for users. It's comes only with the sine, cosine, and tangent function. This scientific calculator was function just like the normal calculator, but the different is the way of produced this calculator only by using Visual Basic Language.</p>	
<p>Module 2.1 Capacitors</p>	<p>When users select Capacitors, this window will appear automatically. So, the users can choose the connection. In this module, offers users to calculate parallel and series capacitors connections. As the first stage, there are only from two until five connections of capacitors. So, users can select the connection depends on how many capacitors in the calculation's problem to get the value for the equivalent capacitor (C_{eq}).</p>	

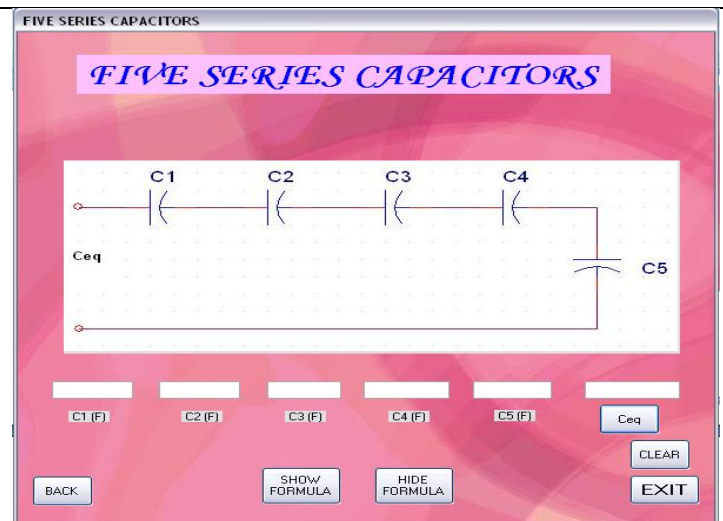
Let say users want to calculate C_{eq} for four parallel capacitors. So, users only need to click “FOUR PARALLEL CAPACITORS” button, and then a window such as below will appear. So, users may start the calculation process.



Because of this calculator system created as a learning purpose, so the formula for each calculation was provided. Users can learn more in this calculator system.

The screenshot shows the same window titled "FOUR PARALLEL CAPACITORS", but now it displays the formula for equivalent capacitance: $C_{eq} = C_1 + C_2 + C_3 + C_4$. The circuit diagram is hidden. The input fields and buttons remain the same as in the previous screenshot.

There is an example for five series capacitors connection.



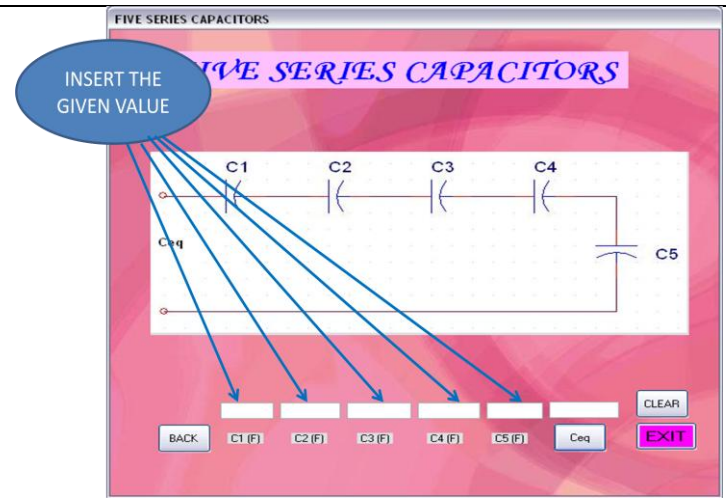
For user's reference, they may click at the SHOW FORMULA button, to get the formula for the calculation. The, when users click at the HIDE FORMULA button, the circuit of the calculation will appear.

The screenshot shows the same software window, but now the formula for calculating the equivalent capacitance is displayed in a large white box:
$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \frac{1}{C_4} + \frac{1}{C_5}$$
 Below the formula, there are input fields for C1 (F), C2 (F), C3 (F), C4 (F), C5 (F), and Ceq. At the bottom, there are buttons for BACK, SHOW FORMULA, HIDE FORMULA, CLEAR, and EXIT.

As the result, we can use this system to calculate certain of complex calculation that require long time, such as below:

$1/C_{eq} = 1/C_1 + 1/C_2 + 1/C_3 + 1/C_4 + 1/C_5$
Given that only the value of each capacitors, such as below:

$C_1 = 0.03 \text{ F}$, $C_2 = 0.32 \text{ F}$, $C_3 = 0.01 \text{ F}$, $C_4 = 0.045 \text{ F}$,
 $C_5 = 0.005 \text{ F}$



Manually calculations:

$$1/C_{eq} = 1/C_1 + 1/C_2 + 1/C_3 + 1/C_4 + 1/C_5$$

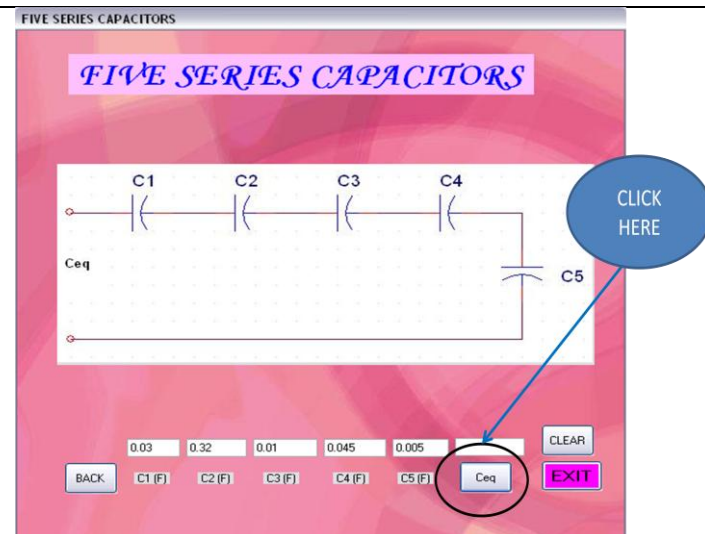
$$1/C_{eq} = (1/0.03 + 1/0.32 + 1/0.01 + 1/0.045 + 1/0.005)$$

$$1/C_{eq} = 358.68$$

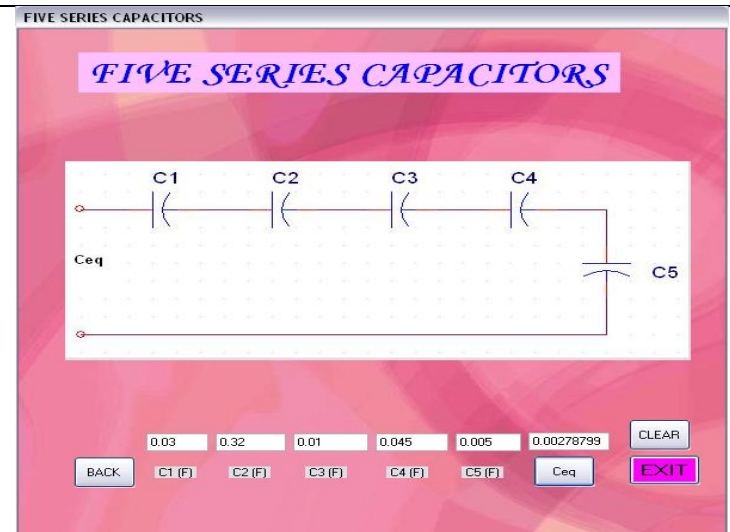
$$C_{eq} = 1/358.68$$

$$C_{eq} = 0.002788 \text{ F}$$

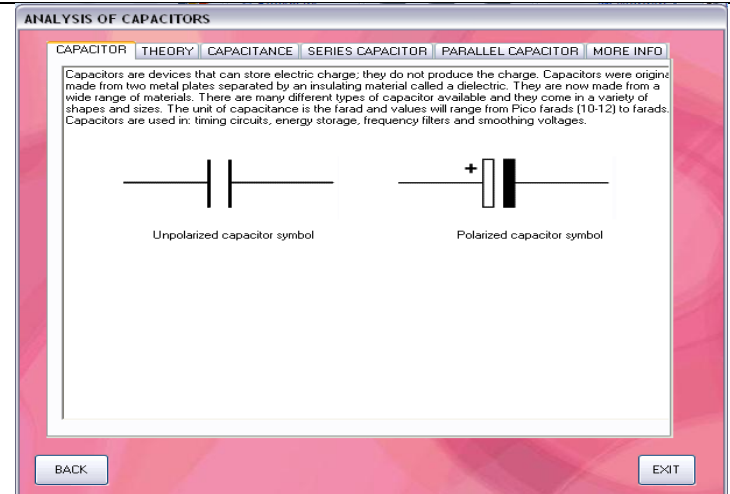
By insert all of the value given, users can get the accurate result of C_{eq} .

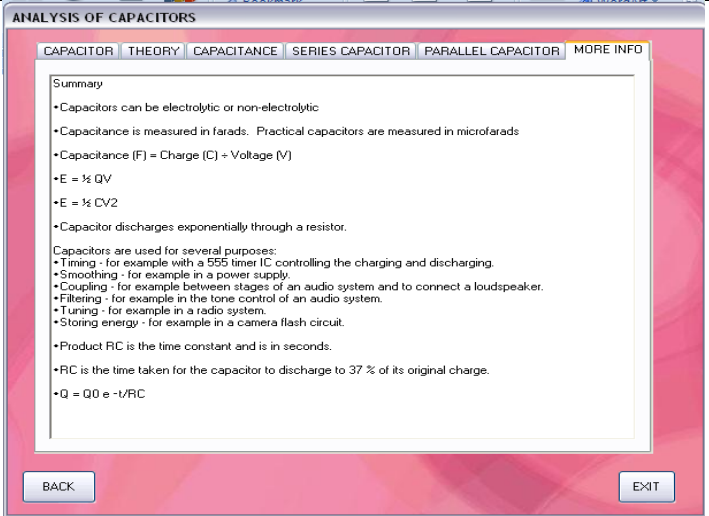
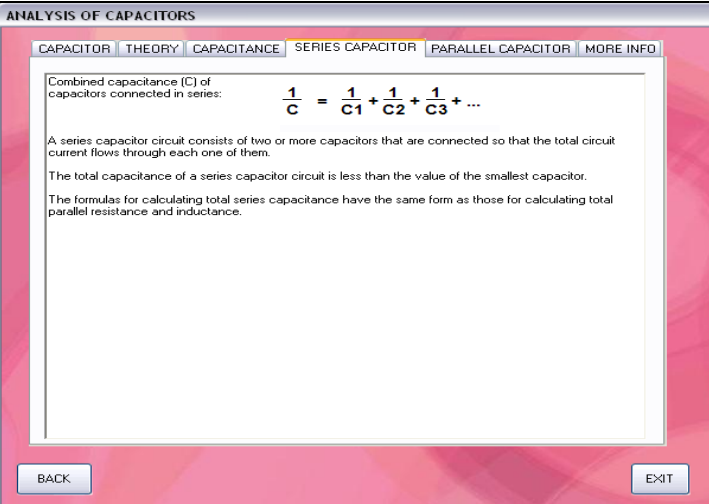



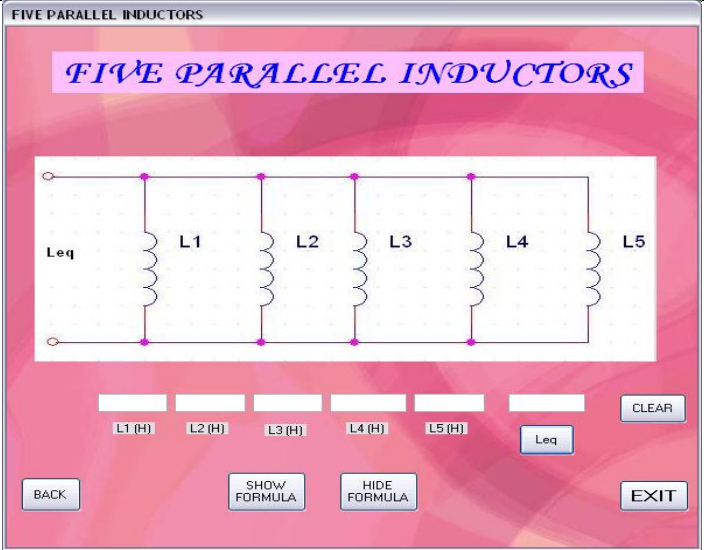
Answer appeared after users click the Ceq button.

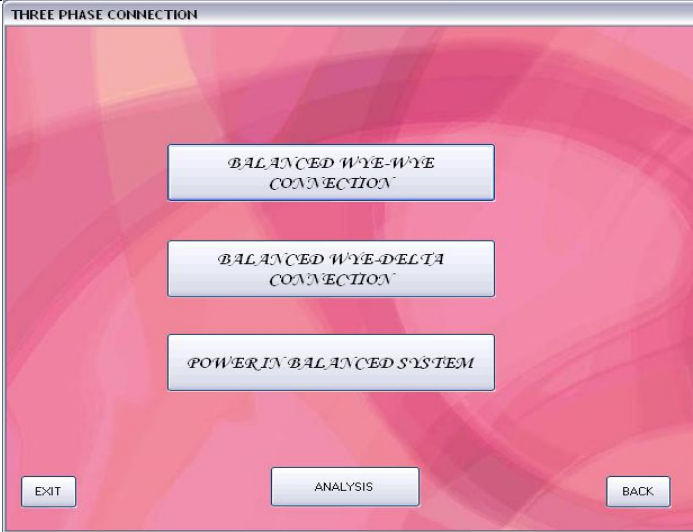


This calculator system also provided some notes as analysis for users. The notes was brief about the related things with the module viewed by users and give users more information as a learning purpose.

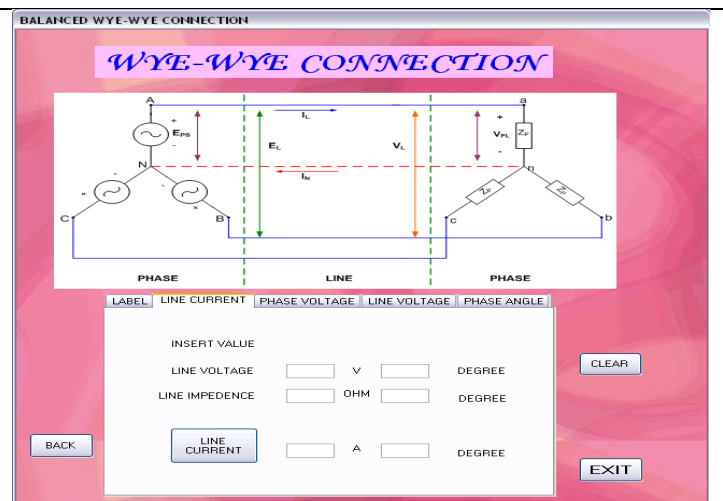


	<p>More information was provided as reference for users in the analysis part. Users may know a lot about the capacitors and its connection in the same time.</p>	
	<p>Series and parallel connection information also provided. Users may compare the different of both connections and may learn more about the connections during do the calculations.</p>	

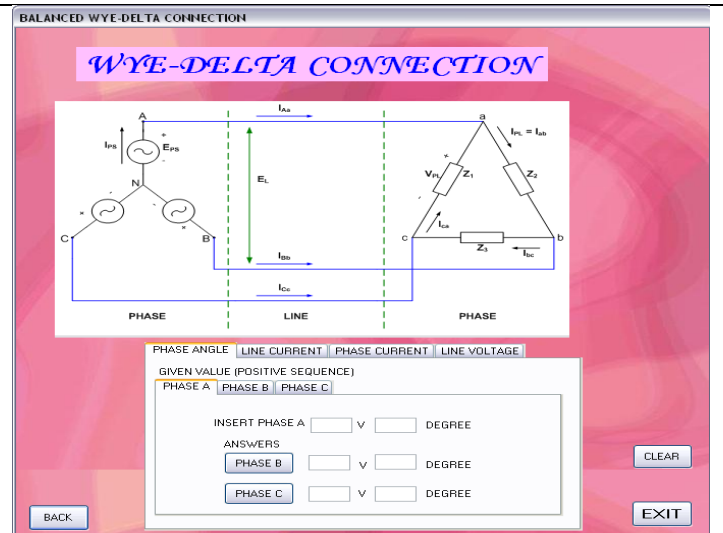
<p>Module 2.2: Inductors</p>	<p>When users select Inductors, this window will appear automatically. So, the users can choose the connection. For inductors connection, the process of the system is almost the same. But, as we know that the way of calculation for parallel inductor same with series capacitor and the series inductor same with parallel capacitors. When users select Inductors, this window will appear automatically. Then users can choose the connection</p>	
	<p>There are an example for five parallel inductors and three series inductors. The way of inductors calculation almost the same with the capacitors. But to make it become users friendly, the system provided the different window for every module of capacitors and inductors.</p>	

<p>Module 3: Three Phase Connection</p>	<p>As we know that three phase connection is the most important topic for an electrical student to know. But there are problems in order to learn and understand for the whole topics. This system provides three phase calculator in order to get the accurate result in only a short time. It is easy for a student to make this system as a learning instrument, so they can check their answer of manual calculation by only use this calculator system. At this stage, there are only three part of this three phase connection provided in this calculator system. All of these three parts was always used by electrical students especially for students who want to master this kind of topic.</p>	
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In wye-wye connection, users may calculate many things such as line current, phase voltage, line voltages and phase angle. So, they can get many answers by only open this window.



In wye-delta connection, users also may calculate many things such as line current, phase current, line voltages and phase angle. So, they can get many answers by only open this window.



Besides wye-wye and wye-delta connection, this calculator system also provided users with the calculation for balanced power in three phase connection. So, users may calculate average power, reactive power apparent power and also the power factor for the three phase connection system for wye and also delta load.

POWER IN BALANCED SYSTEM

PLEASE SELECT THE CONNECTION YOU WANT TO CALCULATE

WYE CONNECTED LOAD

DELTA CONNECTED LOAD

WYE CONNECTED LOAD

INSERT VALUE

LINE VOLTAGE V

LINE CURRENT A

ANGLE DEGREE

AVERAGE POWER WATT

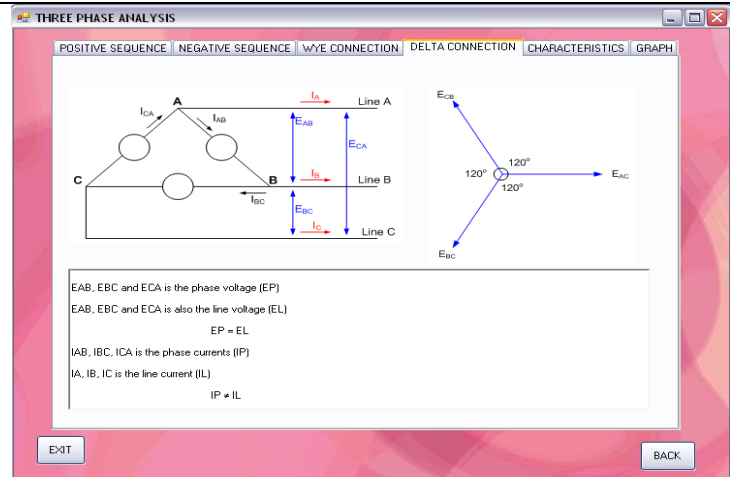
REACTIVE POWER VAR

APPARENT POWER VA

POWER FACTOR

BACK CLEAR EXIT

There are 2 ways of interconnecting separate phase winding to form a 3-phase source; either a wye (Y) or a delta (Δ) connection. In the analysis part, users may see the delta and wye connection and may learn more from the information.



Module 4:
Inverse
Kinematics
Robot

As an electrical student, Automation and Robotics is an obligation subject and Inverse Kinematic Robot is one of the chapters in this subject. To get the value of θ_1 , θ_2 , θ_3 , θ_4 , θ_5 , and θ_6 , a student must derive the formula and all of the calculations was related which others. For an example, students want to calculate θ_5 , so the student must get the accurate result for θ_1 , θ_2 , θ_3 and θ_4 . Failed to get the right answer for the value of θ before, they cannot get the right result for the next value of θ . By using this calculator system, users only need to fulfill both of the table in the window then click to check the answers. It is very easy and accurate. So, as a student, they can check either their answer from the long calculation right or wrong in only a short period. Find θ_1 , θ_2 , θ_3 , θ_4 , θ_5 , and θ_6 . By using this system, we only need to fulfill the blanks to get all of the θ values.

ROBOT

FULL ALL OF THIS BLANK BELOW

Link	Variable	α (°)	a (mm)	d (mm)	range
1	θ_1	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
2	θ_2	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
3	θ_3	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
4	θ_4	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
5	θ_5	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
6	θ_6	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

CLICK HERE AFTER YOU FINISH FULFILL ALL THE BLANKS

${}^0T_6 = \begin{bmatrix} \text{[]} & \text{[]} & \text{[]} & \text{[]} \\ \text{[]} & \text{[]} & \text{[]} & \text{[]} \\ \text{[]} & \text{[]} & \text{[]} & \text{[]} \\ 0 & 0 & 0 & 1 \end{bmatrix}$

Answers

Insert the taken value

θ_1

θ_2

θ_3

θ_4

θ_5

θ_6

ANALYSIS

CLEAR

EXIT

BACK

When both of table was inserted by the given values, users only need to click at the θ button one by one until all of the answers fill the answer textbox.

ROBOT

BELOW

Link	Variable	α (°)	a (mm)	d (mm)	range
1	θ_1	-90	0	0	-160 to 160
2	θ_2	0	432	149.5	-225 to 45
3	θ_3	90	0	0	-45 to 225
4	θ_4	-90	0	432	-110 to 170
5	θ_5	90	0	0	-100 to 100
6	θ_6	0	0	56.5	-266 to 266

CLICK HERE AFTER YOU FINISH FULFILL ALL THE BLANKS

θ_1 θ_2 θ_3 θ_4 θ_5 θ_6

ANSWERS

Insert the taken value

θ_1 θ_2 θ_3 θ_4 θ_5 θ_6

BACK EXIT CLEAR ANALYSIS

$${}^0T_6 = \begin{bmatrix} 0.0476 & -0.7892 & -0.6124 & 400 \\ 0.6597 & 0.4356 & -0.6124 & 300 \\ 0.75 & -0.4330 & 0.5 & 200 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

When users get the answers, for the value of θ_1 and θ_2 must be inserted by users in the answers column. It is because both of the θ value must be inserted according to the range of the θ given in question. Then the other values of θ will inserted automatically when the θ button was clicked.

ROBOT

FULL ALL OF THIS BLANK BELOW

Link	Variable	α (°)	a (mm)	d (mm)	range
1	θ_1	-90	0	0	-160 to 160
2	θ_2	0	432	149.5	-225 to 45
3	θ_3	90	0	0	-45 to 225
4	θ_4	-90	0	432	-110 to 170
5	θ_5	90	0	0	-100 to 100
6	θ_6	0	0	56.5	-266 to 266

CLICK HERE AFTER YOU FINISH FULFILL ALL THE BLANKS

θ_1 16.6603 55.3235

θ_2 35.9232 100.175

θ_3 -25.746

θ_4 26.1165

θ_5 -69.054

θ_6 32.0451

ANSWERS

Insert the taken value

θ_1 16.66

θ_2 35.92

θ_3 -25.746

θ_4 26.1165

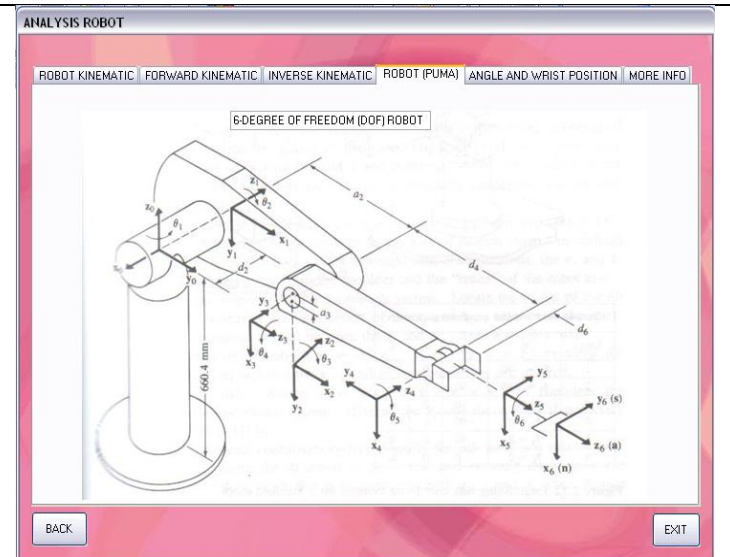
θ_5 -69.054

θ_6 32.0451

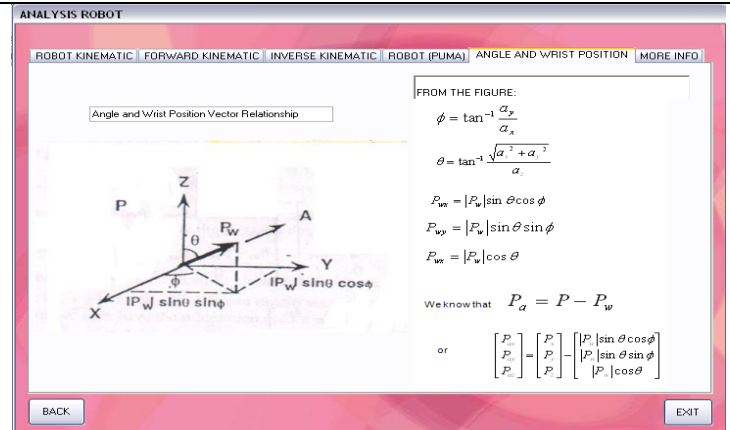
BACK EXIT CLEAR ANALYSIS

$${}^0T_6 = \begin{bmatrix} 0.0476 & -0.7892 & -0.6124 & 400 \\ 0.6597 & 0.4356 & -0.6124 & 300 \\ 0.75 & -0.4330 & 0.5 & 200 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Analysis was provided for users about the robots and the application of the robot. Because of this Inverse Kinematic Calculator System concentrate to 6-degree of freedom robot, the Puma Robot was inserted into the system as users reference.



Because of this calculation have long formula to use, users may refer the formula in the analysis part to get more understanding about the calculation. It is easy for users to understand those of the calculation if they refer to the analysis part in this calculator system.



5.3 PROBLEMS AND SOLUTIONS

PROBLEMS	SOLUTIONS
Get the right formula for each calculation problems	Try one by one, for many times to make sure that the answer is right
To make this system become user friendly	Get others opinion, such as from supervisor and friends
Computer system failed	Save many softcopy backup
Have only a little knowledge about visual basic language	Explore n learn from internet, friends, and old notes
Import many pictures into the system	Arrange all the pictures and make it in one folder

Table 5.1: Problems and solutions

The first problem faced in order to create this Multiuse Expert Calculator System, is to get the right formula for each of the calculation. If the formula was wrong, then users will get the wrong answer. To overcome this kind of problem, a few sample of calculation was taken and this system also tried one by one for many times to make sure that the formula used was right to get the right answers.

To make this system as a user friendly calculator system, other people's opinion was included and the system was repaired step by step until it reach the user's satisfaction. During do this calculator system, some computer's system problems occurred, so it needs to save many same softcopy at another places. In order to finish this calculator system, some problems occur because of lack of knowledge about Visual Basic Language. So, to overcome this problem, Visual Basic Language coding was learned from internet, and explored until get the function that wants to use in the calculator system.

CHAPTER 6

CONCLUSION AND FUTURE DEVELOPMENT

6.1 INTRODUCTION

This chapter discuss about the conclusion and project development in the future. This project has one major part which is software implementation. This software was used to create Multiuse Expert Electrical Calculator System and make it as a learning purpose.

6.2 CONCLUSION

As a conclusion, there are six chapters which are introduction, literature review and methodology, hardware, software implementation, result, discussion and the conclusion that has been discuss in this thesis for the development of Multiuse Expert Electrical Calculator System.

The implementation of this project was successful since the main objective has been achieved. Multiuse Expert Electrical Calculator System ability to perform as an effective learning material in student's world. This system was built successful to calculate the simple and complex equation only by using Visual Basic Language. This system also created to provide some analysis about the calculation and also provide much information about the calculation. Most of the calculation was in Electrical Engineering field.

6.3 FUTURE DEVELOPMENT

For future development, this project may lead to development of Multiuse Expert Electrical Calculator System in Web Based to share the benefit of the calculator system with most of engineering students in all over the world. So, the Multiuse Expert Electrical Calculator System can be use by anyone either by using offline or online with the internet. So the system will be become more effective and user friendly. It also will be easy to use and easy to download by users.

At this level, Multiuse Expert Electrical Calculator System was built to interface with only point numbers such as 0.002, 0.000002 and many more. But in the future, this system may build to interface with calculations which come in μ , n, p, m and many more. So, it will make users easier to type the value of a calculation into a system, and it also may reduce the error during the calculation process.

For future recommendation, this system also can be added more modules such as calculation in controller subject, to make this system become more useful for students. So, day by day we may gain the number of the syllabus, and users will get more benefits only by open this system. Hopefully with future innovations and research, this particular system can become the backbone for other researchers' fields of study.

6.4 COST AND COMMERCIALIZE

This project not includes any cost but only use free Visual Basic Language installing. This kind of language not a big size of file, it just below 500 MB in size. This system can be a commercialize project because it can used as a learning purpose for electrical students. As a commercialize project, this system can be upload in a web based and users need to download the trial first, and need to buy the full version of the calculator system.

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APPENDIX A: OHM'S LAW CODING

```
Public Class OHMSLAW
```

```
    Dim a As Double
    Dim b As Double
    Dim c As Double
    Dim d As Double
    Dim f As Double
    Dim g As Double
    Dim h As Double
    Dim i As Double
    Dim j As Double
    Dim num As Double
    Dim calculation As String
    Dim op As Double
    Dim answer As Double
```

```
    Private Sub Button1_Click_1(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button1.Click
```

```
        'V as an unknown
```

```
        GroupBox1.Show()
        GroupBox2.Hide()
        GroupBox3.Hide()
        PictureBox1.Hide()
        PictureBox2.Show()
        PictureBox3.Hide()
        PictureBox4.Hide()
```

```
    End Sub
```

```
    Private Sub Button4_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button4.Click
```

```
        'R as an unknown
```

```
        GroupBox1.Hide()
        GroupBox2.Hide()
        GroupBox3.Show()
        PictureBox1.Hide()
        PictureBox2.Hide()
        PictureBox3.Hide()
        PictureBox4.Show()
```

```
    End Sub
```

```
    Private Sub Button2_Click_1(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button2.Click
```

'Clear button

```

    TextBox1.Text = ""
    TextBox2.Text = ""
    TextBox3.Text = ""
    TextBox4.Text = ""
    TextBox5.Text = ""
    TextBox6.Text = ""
    TextBox7.Text = ""
    TextBox8.Text = ""
    TextBox9.Text = ""
    calculation = ""
End Sub

```

Private Sub Button3_Click(**ByVal** sender **As** System.Object, **ByVal** e **As** System.EventArgs) **Handles** Button3.Click

'I as an unknown

```

    GroupBox1.Hide()
    GroupBox2.Show()
    GroupBox3.Hide()
    PictureBox1.Hide()
    PictureBox2.Hide()
    PictureBox3.Show()
    PictureBox4.Hide()
End Sub

```

Private Sub Button5_Click(**ByVal** sender **As** System.Object, **ByVal** e **As** System.EventArgs) **Handles** Button5.Click

```

    SYLLABUS.Show()
    Me.Hide()
    PictureBox1.Show()
    PictureBox2.Hide()
    PictureBox3.Hide()
    PictureBox4.Hide()
    GroupBox1.Hide()
    GroupBox2.Hide()
    GroupBox3.Hide()
End Sub

```

Private Sub Button19_Click(**ByVal** sender **As** System.Object, **ByVal** e **As** System.EventArgs) **Handles** Button19.Click

```

    Me.Hide()
End Sub

```

Private Sub Button6_Click(**ByVal** sender **As** System.Object, **ByVal** e **As** System.EventArgs) **Handles** Button6.Click

'To calculate Current

```
c = TextBox3.Text
b = TextBox2.Text
```

```
a = b * c
TextBox1.Text = a
```

End Sub

```
Private Sub Button7_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button7.Click
```

'To calculate Current

```
d = TextBox4.Text
f = TextBox5.Text
```

```
g = d / f
TextBox6.Text = g
```

End Sub

```
Private Sub Button8_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button8.Click
```

'To caculate Resitance

```
h = TextBox7.Text
i = TextBox8.Text
```

```
j = i / h
```

```
TextBox9.Text = j
```

End Sub

```
Private Sub OHMSLAW_Load(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles MyBase.Load
```

```
GroupBox1.Hide()
GroupBox2.Hide()
GroupBox3.Hide()
PictureBox1.Show()
PictureBox2.Hide()
PictureBox3.Hide()
PictureBox4.Hide()
```

End Sub

```
Private Sub Button9_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button9.Click
```

```
        PictureBox1.Show()
        PictureBox2.Hide()
        PictureBox3.Hide()
        PictureBox4.Hide()
    End Sub

    Private Sub Button10_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button10.Click
        ohm_sanalysis.Show()
        Me.Hide()
    End Sub

End Class
```

APPENDIX B: PARALLEL CAPACITORS CODING

```

Public Class pcap4
    Dim a As Double
    Dim b As Double
    Dim c As Double
    Dim d As Double
    Dim f As Double
    Dim calculation As String
    Dim op As Double
    Dim answer As Double

    Private Sub Button1_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button1.Click

        'Ceq calculation

        a = TextBox1.Text
        b = TextBox2.Text
        c = TextBox3.Text
        d = TextBox4.Text

        f = a + b + c + d
        TextBox5.Text = f

    End Sub

    Private Sub Button2_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button2.Click

        'Clear button

        TextBox1.Text = ""
        TextBox2.Text = ""
        TextBox3.Text = ""
        TextBox4.Text = ""
        TextBox5.Text = ""
        calculation = ""

    End Sub

    Private Sub Button3_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button3.Click
        capacitors.Show()
        Me.Hide()
        PictureBox2.Hide()
    
```

```
        PictureBox1.Show()
    End Sub

    Private Sub Button19_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button19.Click
        Me.Hide()
    End Sub

    Private Sub Button4_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button4.Click
        PictureBox1.Hide()
        PictureBox2.Show()
    End Sub

    Private Sub Button5_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button5.Click
        PictureBox2.Hide()
        PictureBox1.Show()
    End Sub

    Private Sub pcap4_Load(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles MyBase.Load
        PictureBox2.Hide()
        PictureBox1.Show()
    End Sub

End Class
```

APPENDIX C: FIVE SERIES CAPACITORS CODING

```

Public Class scap5
    Dim a As Double
    Dim b As Double
    Dim c As Double
    Dim d As Double
    Dim f As Double
    Dim g As Double
    Dim calculation As String
    Dim op As Double
    Dim answer As Double

    Private Sub Button2_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button2.Click

        'Clear button

        TextBox1.Text = ""
        TextBox2.Text = ""
        TextBox3.Text = ""
        TextBox4.Text = ""
        TextBox5.Text = ""
        TextBox6.Text = ""
        calculation = ""

    End Sub

    Private Sub Button1_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button1.Click

        'Ceq calculation

        a = TextBox1.Text
        b = TextBox2.Text
        c = TextBox3.Text
        d = TextBox4.Text
        f = TextBox5.Text

        
$$g = 1 / ((1 / a) + (1 / b) + (1 / c) + (1 / d) + (1 / f))$$

        TextBox6.Text = g

    End Sub

    Private Sub Button3_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button3.Click
        capacitors.Show()
    End Sub

```



```
Me.Hide()  
PictureBox2.Hide()  
PictureBox1.Show()  
End Sub
```

```
Private Sub Button19_Click(ByVal sender As System.Object, ByVal e As  
System.EventArgs) Handles Button19.Click  
Me.Hide()  
End Sub
```

```
Private Sub Button5_Click(ByVal sender As System.Object, ByVal e As  
System.EventArgs) Handles Button5.Click  
PictureBox2.Hide()  
PictureBox1.Show()  
End Sub
```

```
Private Sub Button4_Click(ByVal sender As System.Object, ByVal e As  
System.EventArgs) Handles Button4.Click  
PictureBox1.Hide()  
PictureBox2.Show()  
End Sub
```

```
Private Sub scap5_Load(ByVal sender As System.Object, ByVal e As  
System.EventArgs) Handles MyBase.Load  
PictureBox2.Hide()  
PictureBox1.Show()  
End Sub
```

```
End Class
```

APPENDIX D: THREE PHASE WYE-WYE CONNECTION CODING

```

Public Class wye_wye
    Dim a As Double
    Dim b As Double
    Dim c As Double
    Dim d As Double
    Dim F As Double
    Dim g As Double
    Dim h As Double
    Dim i As Double
    Dim j As Double
    Dim k As Double
    Dim l As Double
    Dim m As Double
    Dim n As Double
    Dim o As Double
    Dim p As Double
    Dim q As Double
    Dim r As Double
    Dim s As Double
    Dim t As Double
    Dim u As Double
    Dim v As Double
    Dim w As Double
    Dim x As Double
    Dim y As Double
    Dim z As Double
    Dim ab As Double
    Dim ac As Double
    Dim ad As Double
    Dim ae As Double
    Dim af As Double
    Dim ag As Double
    Dim ah As Double
    Dim ai As Double
    Dim aj As Double
    Dim calculation As String
    Dim op As Double
    Dim answer As Double

    Private Sub Button19_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button19.Click
        Me.Hide()
    End Sub

    Private Sub Button3_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button3.Click
        Me.Hide()
    End Sub

```

```
THREE_PHASE_CONNECTION.Show()
```

```
End Sub
```

```
Private Sub Button15_Click(ByVal sender As System.Object, ByVal e As  
System.EventArgs) Handles Button15.Click
```

```
'Clear button
```

```
    TextBox1.Text = ""  
    TextBox2.Text = ""  
    TextBox3.Text = ""  
    TextBox4.Text = ""  
    TextBox5.Text = ""  
    TextBox6.Text = ""  
    TextBox7.Text = ""  
    TextBox8.Text = ""  
    TextBox9.Text = ""  
    TextBox10.Text = ""  
    TextBox11.Text = ""  
    TextBox12.Text = ""  
    TextBox13.Text = ""  
    TextBox14.Text = ""  
    TextBox15.Text = ""  
    TextBox16.Text = ""  
    TextBox17.Text = ""  
    TextBox18.Text = ""  
    TextBox19.Text = ""  
    TextBox20.Text = ""  
    TextBox21.Text = ""  
    TextBox22.Text = ""  
    TextBox23.Text = ""  
    TextBox24.Text = ""  
    TextBox25.Text = ""  
    TextBox26.Text = ""  
    TextBox27.Text = ""  
    TextBox28.Text = ""  
    TextBox29.Text = ""  
    TextBox30.Text = ""  
    TextBox31.Text = ""  
    TextBox32.Text = ""  
    TextBox33.Text = ""  
    TextBox34.Text = ""  
    TextBox35.Text = ""  
    calculation = ""
```

```
End Sub
```

Private Sub Button16_Click_1(**ByVal** sender **As** System.Object, **ByVal** e **As** System.EventArgs) **Handles** Button16.Click

'Calculation for line current

```
t = TextBox20.Text
u = TextBox21.Text
v = TextBox22.Text
w = TextBox23.Text
x = t / v
TextBox24.Text = x
y = u - w
TextBox25.Text = y
End Sub
```

Private Sub Button17_Click_1(**ByVal** sender **As** System.Object, **ByVal** e **As** System.EventArgs) **Handles** Button17.Click

'Calculation for phase voltage

```
ae = TextBox30.Text
af = TextBox32.Text
ag = TextBox31.Text
ah = TextBox33.Text
ai = ae * ag
TextBox35.Text = ai
aj = af + ah
TextBox34.Text = aj
End Sub
```

Private Sub Button20_Click_1(**ByVal** sender **As** System.Object, **ByVal** e **As** System.EventArgs) **Handles** Button20.Click

'Calculation for line voltage

```
z = TextBox26.Text
ab = TextBox27.Text
ac = (3 ^ (1 / 2)) * z
TextBox28.Text = ac
ad = 30 + ab
TextBox29.Text = ad
End Sub
```

Private Sub Button11_Click_1(**ByVal** sender **As** System.Object, **ByVal** e **As** System.EventArgs) **Handles** Button11.Click

'Calculation for B phase_A as unknown

```
d = TextBox5.Text
```

```

k = TextBox11.Text
F = d - 120
TextBox6.Text = F
l = k
TextBox12.Text = l
End Sub

```

Private Sub Button12_Click_1(**ByVal** sender **As** System.Object, **ByVal** e **As** System.EventArgs) **Handles** Button12.Click

'Calculation for C phase_A as unknown

```

d = TextBox5.Text
k = TextBox11.Text
g = d + 120
TextBox7.Text = g
m = k
TextBox13.Text = m
End Sub

```

Private Sub Button9_Click_1(**ByVal** sender **As** System.Object, **ByVal** e **As** System.EventArgs) **Handles** Button9.Click

'Calculation for A phase_B as unknown

```

a = TextBox2.Text
n = TextBox14.Text
b = a + 120
TextBox3.Text = b
o = n
TextBox15.Text = o
End Sub

```

Private Sub Button10_Click_1(**ByVal** sender **As** System.Object, **ByVal** e **As** System.EventArgs) **Handles** Button10.Click

'Calculation for C phase_B as unknown

```

a = TextBox2.Text
n = TextBox14.Text
c = a - 120
TextBox4.Text = c
p = n
TextBox16.Text = p
End Sub

```

Private Sub Button13_Click_1(**ByVal** sender **As** System.Object, **ByVal** e **As** System.EventArgs) **Handles** Button13.Click

'Calculation for A phase_C as unknown

```
h = TextBox8.Text
q = TextBox17.Text
i = h - 120
TextBox9.Text = i
r = q
TextBox18.Text = r
End Sub
```

```
Private Sub Button14_Click_1(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button14.Click
```

'Calculation for B phase_C as unknown

```
h = TextBox8.Text
q = TextBox17.Text
j = h + 120
TextBox10.Text = j
s = q
TextBox19.Text = s
End Sub
End Class
```

APPENDIX E: BALANCED POWER THREE PHASE CODING

```

Public Class balancedpower
    Dim a As Double
    Dim b As Double
    Dim c As Double
    Dim d As Double
    Dim g As Double
    Dim h As Double
    Dim i As Double
    Dim j As Double
    Dim k As Double
    Dim l As Double
    Dim m As Double
    Dim o As Double
    Dim p As Double
    Dim q As Double
    Dim r As Double
    Dim s As Double
    Dim t As Double
    Dim u As Double
    Const pi = 3.141592654
    Dim calculation As String
    Dim op As Double
    Dim answer As Double

    Private Sub Button19_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button19.Click
        Me.Hide()
    End Sub

    Private Sub Button3_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button3.Click
        Me.Hide()
        PictureBox1.Hide()
        PictureBox2.Hide()
        PictureBox3.Show()
        Label8.Show()
        GroupBox1.Hide()
        GroupBox2.Hide()
        THREE_PHASE_CONNECTION.Show()
    End Sub

    Private Sub Button8_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button8.Click
        PictureBox1.Show()
        PictureBox2.Hide()
        PictureBox3.Hide()
        Label8.Hide()
        GroupBox1.Show()
        GroupBox2.Hide()
    End Sub

    Private Sub Button9_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button9.Click
        PictureBox1.Hide()
        PictureBox2.Show()

```

```

        PictureBox3.Hide()
        Label8.Hide()
        GroupBox1.Hide()
        GroupBox2.Show()
    End Sub

    Private Sub balancedpower_Load(ByVal sender As System.Object, ByVal e As System.EventArgs) Handles MyBase.Load
        Label8.Show()
        PictureBox3.Show()
        PictureBox1.Hide()
        PictureBox2.Hide()
        GroupBox1.Hide()
        GroupBox2.Hide()
    End Sub

    Private Sub Button1_Click(ByVal sender As System.Object, ByVal e As System.EventArgs) Handles Button1.Click
        a = TextBox1.Text
        b = TextBox2.Text
        c = TextBox3.Text
        r = Math.Cos((c) * pi / 180)

        d = (3 ^ (1 / 2)) * a * b * r
        TextBox4.Text = d

    End Sub

    Private Sub Button2_Click(ByVal sender As System.Object, ByVal e As System.EventArgs) Handles Button2.Click
        TextBox1.Text = ""
        TextBox2.Text = ""
        TextBox3.Text = ""
        TextBox4.Text = ""
        TextBox5.Text = ""
        TextBox6.Text = ""
        TextBox8.Text = ""
        TextBox9.Text = ""
        TextBox10.Text = ""
        TextBox11.Text = ""
        TextBox13.Text = ""
        TextBox14.Text = ""
        TextBox15.Text = ""
        TextBox16.Text = ""
        calculation = ""
    End Sub

    Private Sub Button4_Click(ByVal sender As System.Object, ByVal e As System.EventArgs) Handles Button4.Click
        a = TextBox1.Text
        b = TextBox2.Text
        c = TextBox3.Text
        u = Math.Sin((c) * pi / 180)

        g = (3 ^ (1 / 2)) * a * b * u
        TextBox5.Text = g
    End Sub

```



```

    Private Sub Button5_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button5.Click
        a = TextBox1.Text
        b = TextBox2.Text

        h = (3 ^ (1 / 2)) * a * b
        TextBox6.Text = h
    End Sub

    Private Sub Button6_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button6.Click
        d = TextBox4.Text
        h = TextBox6.Text
        i = d / h
        TextBox8.Text = i

    End Sub

    Private Sub Button7_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button7.Click
        j = TextBox9.Text
        k = TextBox10.Text
        l = TextBox11.Text
        s = Math.Cos((l) * pi / 180)

        m = (3 ^ (1 / 2)) * j * k * s
        TextBox13.Text = m
    End Sub

    Private Sub Button10_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button10.Click
        j = TextBox9.Text
        k = TextBox10.Text
        l = TextBox11.Text
        t = Math.Sin((l) * pi / 180)

        o = Math.Sqrt(3) * j * k * t
        TextBox14.Text = o
    End Sub

    Private Sub Button11_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button11.Click
        j = TextBox9.Text
        k = TextBox10.Text

        p = (3 ^ (1 / 2)) * j * k
        TextBox15.Text = p
    End Sub

    Private Sub Button12_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button12.Click
        m = TextBox13.Text
        p = TextBox15.Text
        q = m / p
        TextBox16.Text = q
    End Sub

End Class

```

APPENDIX F: INVERSE KINEMATICS ROBOT CODING

```

Public Class ROBOT
    Dim al1 As Double
    Dim al2 As Double
    Dim al3 As Double
    Dim al4 As Double
    Dim al5 As Double
    Dim al6 As Double
    Dim a1 As Double
    Dim a2 As Double
    Dim a3 As Double
    Dim a4 As Double
    Dim a5 As Double
    Dim a6 As Double
    Dim d1 As Double
    Dim d2 As Double
    Dim d3 As Double
    Dim d4 As Double
    Dim d5 As Double
    Dim d6 As Double
    Dim nx As Double
    Dim ny As Double
    Dim nz As Double
    Dim ox As Double
    Dim oy As Double
    Dim oz As Double
    Dim ax As Double
    Dim ay As Double
    Dim az As Double
    Dim nwx As Double
    Dim nwy As Double
    Dim nwz As Double
    Dim owx As Double
    Dim owy As Double
    Dim owz As Double
    Dim awx As Double
    Dim awy As Double
    Dim awz As Double
    Dim Px As Double
    Dim Py As Double
    Dim Pz As Double
    Dim Pax As Double
    Dim Pay As Double
    Dim Paz As Double
    Dim Pwx As Double
    Dim Pwy As Double
    Dim Pwz As Double
    Dim sai As Double

```

```
Dim teta As Double
Dim teta1 As Double
Dim teta11 As Double
Dim teta12 As Double
Dim teta2 As Double
Dim teta21 As Double
Dim teta22 As Double
Dim teta3 As Double
Dim teta4 As Double
Dim teta5 As Double
Dim teta6 As Double
Dim a As Double
Dim b As Double
Dim c As Double
Dim d As Double
Dim f As Double
Dim g As Double
Dim h As Double
Dim i As Double
Dim j As Double
Dim k As Double
Dim l As Double
Dim m As Double
Dim n As Double
Dim p As Double
Dim q As Double
Dim r As Double
Dim s As Double
Dim t As Double
Dim u As Double
Dim v1 As Double
Dim v2 As Double
Dim v3 As Double
Dim v4 As Double
Dim tn timer As Double
Dim tny As Double
Dim tnz As Double
Dim tox As Double
Dim toy As Double
Dim toz As Double
Dim tax As Double
Dim tay As Double
Dim taz As Double
Dim alpha As Double
Dim beta As Double
Dim inv0R3 As Double
Const pi = 3.141592654
Dim calculation As String
Dim answer As Double
```

Private Sub Button1_Click(**ByVal** sender **As** System.Object, **ByVal** e **As** System.EventArgs) **Handles** Button1.Click

'Calculation for teta 1

```
ay = TextBox8.Text
ax = TextBox7.Text
az = TextBox9.Text
d2 = TextBox26.Text
d6 = TextBox30.Text
Px = TextBox10.Text
Py = TextBox11.Text
Pz = TextBox12.Text
```

```
sai = (Math.Atan(ay / ax) * (180 / pi))
teta = Math.Atan((((ay ^ 2) + (ax ^ 2)) ^ (1 / 2)) / az) * (180 / pi)
```

```
a = Math.Sin((teta) * pi / 180)
b = Math.Cos((sai) * pi / 180)
c = Math.Sin((sai) * pi / 180)
d = Math.Cos((teta) * pi / 180)
Pwx = (d6) * a * b
Pwy = (d6) * a * c
Pwz = (d6) * d
Pax = Px - Pwx
Pay = Py - Pwy
Paz = Pz - Pwz
f = ((Pax ^ 2) + (Pay ^ 2) - (d2 ^ 2)) ^ (1 / 2)
teta11 = (Math.Atan(Pay / Pax) * (180 / pi)) - (Math.Atan(d2 / f) * (180 / pi))
teta12 = (Math.Atan(Pay / Pax) * (180 / pi)) - (Math.Atan(-d2 / f) * (180 / pi))
```

```
TextBox43.Text = teta12
TextBox37.Text = teta11
```

MsgBox(" please insert the value taken for teta 1 in the answer column")
End Sub

Private Sub Button2_Click(**ByVal** sender **As** System.Object, **ByVal** e **As** System.EventArgs) **Handles** Button2.Click

'Calculation for teta 2

```
teta1 = TextBox45.Text
a2 = TextBox20.Text
d4 = TextBox28.Text
g = Math.Cos((teta1) * pi / 180)
h = Math.Sin((teta1) * pi / 180)
Px = TextBox10.Text
```

```

Py = TextBox11.Text
Pz = TextBox12.Text
a = Math.Sin((teta) * pi / 180)
b = Math.Cos((sai) * pi / 180)
c = Math.Sin((sai) * pi / 180)
d = Math.Cos((teta) * pi / 180)
Pwx = (d6) * a * b
Pwy = (d6) * a * c
Pwz = (d6) * d
Pax = Px - Pwx
Pay = Py - Pwy
Paz = Pz - Pwz
alpha = Pax * g + Pay * h

```

```

j = (alpha ^ 2) + (a2 ^ 2) + (Paz ^ 2) - (d4 ^ 2)
beta = j / (2 * a2)

```

```

k = ((alpha ^ 2) + (Paz ^ 2) - (beta ^ 2)) ^ (1 / 2)
teta21 = (Math.Atan(alpha / Paz) * (180 / pi)) - (Math.Atan(beta / k) * (180 / pi))
teta22 = (Math.Atan(alpha / Paz) * (180 / pi)) - (Math.Atan(-beta / k) * (180 / pi))

```

```

TextBox38.Text = teta21
TextBox44.Text = teta22

```

```

MsgBox(" please insert the value taken for teta 2 in the answer column")
End Sub

```

```

Private Sub Button3_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button3.Click

```

```

'Calculation for teta 3

```

```

a2 = TextBox20.Text
teta2 = TextBox46.Text
Px = TextBox10.Text
Py = TextBox11.Text
Pz = TextBox12.Text
Pwx = (d6) * a * b
Pwy = (d6) * a * c
Pwz = (d6) * d
Pax = Px - Pwx
Pay = Py - Pwy
Paz = Pz - Pwz
m = Math.Cos((teta2) * pi / 180)
n = Math.Sin((teta2) * pi / 180)
i = (alpha - (a2 * m))
l = Paz + (a2 * n)

teta3 = (Math.Atan(i / l) * (180 / pi)) - teta2

```

```

TextBox39.Text = teta3
TextBox47.Text = teta3

```

```

MsgBox(" the value of teta 3 displayed at the taken value box")
End Sub

```

```

Private Sub Button4_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button4.Click

```

```

'Calculation for teta 4

```

```

teta3 = TextBox47.Text
teta2 = TextBox46.Text
teta1 = TextBox45.Text
nx = TextBox1.Text
ny = TextBox2.Text
nz = TextBox3.Text
ox = TextBox4.Text
oy = TextBox5.Text
oz = TextBox6.Text
ax = TextBox7.Text
ay = TextBox8.Text
az = TextBox9.Text

```

```

p = Math.Cos((teta1) * pi / 180)
q = Math.Sin((teta1) * pi / 180)
r = Math.Cos((teta2 + teta3) * pi / 180)
s = Math.Sin((teta2 + teta3) * pi / 180)

```

```

tnx = p * r
tny = (-q)
tnz = p * s
tox = q * r
toy = p
toz = q * s
tax = (-s)
tay = 0
taz = r

```

```

nwx = (tnx * nx) + (tox * ny) + (tax * nz)
nwy = (tny * nx) + (toy * ny) + (tay * nz)
nwz = (tnz * nx) + (toz * ny) + (taz * nz)
owx = (tnx * ox) + (tox * oy) + (tax * oz)
owy = (tny * ox) + (toy * oy) + (tay * oz)
owz = (tnz * ox) + (toz * oy) + (taz * oz)
awx = (tnx * ax) + (tox * ay) + (tax * az)
awy = (tny * ax) + (toy * ay) + (tay * az)
awz = (tnz * ax) + (toz * ay) + (taz * az)

```

```
teta4 = (Math.Atan(awy / awx) * (180 / pi))
```

```
TextBox40.Text = teta4
```

```
TextBox48.Text = teta4
```

```
MsgBox(" the value of teta 4 displayed at the taken value box")
```

```
End Sub
```

```
Private Sub Button5_Click(ByVal sender As System.Object, ByVal e As  
System.EventArgs) Handles Button5.Click
```

```
'Calculation for teta 5
```

```
teta3 = TextBox47.Text
```

```
teta2 = TextBox46.Text
```

```
teta1 = TextBox45.Text
```

```
teta4 = TextBox48.Text
```

```
nx = TextBox1.Text
```

```
ny = TextBox2.Text
```

```
nz = TextBox3.Text
```

```
ox = TextBox4.Text
```

```
oy = TextBox5.Text
```

```
oz = TextBox6.Text
```

```
ax = TextBox7.Text
```

```
ay = TextBox8.Text
```

```
az = TextBox9.Text
```

```
p = Math.Cos((teta1) * pi / 180)
```

```
q = Math.Sin((teta1) * pi / 180)
```

```
t = Math.Cos((teta4) * pi / 180)
```

```
u = Math.Sin((teta4) * pi / 180)
```

```
r = Math.Cos((teta2 + teta3) * pi / 180)
```

```
s = Math.Sin((teta2 + teta3) * pi / 180)
```

```
tnx = p * r
```

```
tny = (-q)
```

```
tnz = p * s
```

```
tox = q * r
```

```
toy = p
```

```
toz = q * s
```

```
tax = (-s)
```

```
tay = 0
```

```
taz = r
```

```
nwx = (tnx * nx) + (tox * ny) + (tax * nz)
```

```
nwy = (tny * nx) + (toy * ny) + (tay * nz)
```

```
nwz = (tnz * nx) + (toz * ny) + (taz * nz)
```

```
owx = (tnx * ox) + (tox * oy) + (tax * oz)
```

```
owy = (tny * ox) + (toy * oy) + (tay * oz)
```

```

owz = (tnz * ox) + (toz * oy) + (taz * oz)
awx = (tnx * ax) + (tox * ay) + (tax * az)
awy = (tny * ax) + (toy * ay) + (tay * az)
awz = (tnz * ax) + (toz * ay) + (taz * az)

```

```

v1 = (t * awx) + (u * awy)
v2 = (awz)
v3 = ((-u) * nwx) + (t * nwy)
v4 = ((-u) * owx) + (t * owy)

```

```
teta5 = (Math.Atan(v1 / v2) * (180 / pi))
```

```
TextBox41.Text = teta5
```

```
TextBox49.Text = teta5
```

```

MsgBox(" the value of teta 5 displayed at the taken value box")
End Sub

```

```

Private Sub Button6_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button6.Click

```

```
'Calculation for teta 6
```

```

teta3 = TextBox47.Text
teta2 = TextBox46.Text
teta1 = TextBox45.Text
teta4 = TextBox48.Text
nx = TextBox1.Text
ny = TextBox2.Text
nz = TextBox3.Text
ox = TextBox4.Text
oy = TextBox5.Text
oz = TextBox6.Text
ax = TextBox7.Text
ay = TextBox8.Text
az = TextBox9.Text

```

```

p = Math.Cos((teta1) * pi / 180)
q = Math.Sin((teta1) * pi / 180)
t = Math.Cos((teta4) * pi / 180)
u = Math.Sin((teta4) * pi / 180)
r = Math.Cos((teta2 + teta3) * pi / 180)
s = Math.Sin((teta2 + teta3) * pi / 180)

```

```

tnx = p * r
tny = (-q)
tnz = p * s
tox = q * r
toy = p

```



```

toz = q * s
tax = (-s)
tay = 0
taz = r

```

```

nwx = (tnx * nx) + (tox * ny) + (tax * nz)
nwy = (tny * nx) + (toy * ny) + (tay * nz)
nwz = (tnz * nx) + (toz * ny) + (taz * nz)
owx = (tnx * ox) + (tox * oy) + (tax * oz)
owy = (tny * ox) + (toy * oy) + (tay * oz)
owz = (tnz * ox) + (toz * oy) + (taz * oz)
awx = (tnx * ax) + (tox * ay) + (tax * az)
awy = (tny * ax) + (toy * ay) + (tay * az)
awz = (tnz * ax) + (toz * ay) + (taz * az)

```

```

v1 = (t * awx) + (u * awy)
v2 = (-awz)
v3 = (-u * nwx) + (t * nwy)
v4 = (-u * owx) + (t * owy)

```

```
teta6 = (Math.Atan(v3 / v4) * (180 / pi))
```

```

TextBox42.Text = teta6
TextBox50.Text = teta6

```

```

MsgBox(" the value of teta 6 displayed at the taken value box")
End Sub

```

```

Private Sub Button7_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button7.Click

```

```
'Clear button
```

```

TextBox1.Text = ""
TextBox2.Text = ""
TextBox3.Text = ""
TextBox4.Text = ""
TextBox5.Text = ""
TextBox6.Text = ""
TextBox7.Text = ""
TextBox8.Text = ""
TextBox9.Text = ""
TextBox10.Text = ""
TextBox11.Text = ""
TextBox12.Text = ""
TextBox13.Text = ""
TextBox14.Text = ""
TextBox15.Text = ""
TextBox16.Text = ""

```

```

TextBox17.Text = ""
TextBox18.Text = ""
TextBox19.Text = ""
TextBox20.Text = ""
TextBox21.Text = ""
TextBox22.Text = ""
TextBox23.Text = ""
TextBox24.Text = ""
TextBox25.Text = ""
TextBox26.Text = ""
TextBox27.Text = ""
TextBox28.Text = ""
TextBox29.Text = ""
TextBox30.Text = ""
TextBox31.Text = ""
TextBox32.Text = ""
TextBox33.Text = ""
TextBox34.Text = ""
TextBox35.Text = ""
TextBox36.Text = ""
TextBox37.Text = ""
TextBox38.Text = ""
TextBox39.Text = ""
TextBox40.Text = ""
TextBox41.Text = ""
TextBox42.Text = ""
TextBox43.Text = ""
TextBox44.Text = ""
TextBox45.Text = ""
TextBox46.Text = ""
TextBox47.Text = ""
TextBox48.Text = ""
TextBox49.Text = ""
TextBox50.Text = ""
calculation = ""

```

End Sub

```

Private Sub Button8_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button8.Click

```

```

    Me.Hide()
    SYLLABUS.Show()

```

End Sub

```

Private Sub Button9_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button9.Click

```

```

    Me.Hide()
    rbtanalysis.Show()

```

End Sub

```
Private Sub Button10_Click(ByVal sender As System.Object, ByVal e As  
System.EventArgs) Handles Button10.Click  
    Me.Hide()  
End Sub  
  
End Class
```