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Development of a Student-Centered Lecture Manual for Electrical Circuits 2

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Abstract. The aim of this research is to design a manual in with reference to the objectives given and required by the Commission on Higher Education (CHED) to all engineering schools in the Philippines offering Bachelor of Science in Electrical Engineering (BSEE) pertaining to the course Electrical Circuits 2. The absence of standardized lecture manuals for Electrical Circuits 2 in most schools in the Western Visayas region indicates a significant gap in instructional resources. This gap may contribute to inconsistencies in teaching methods, difficulty in meeting diverse student needs, and a lack of structured learning materials. Considering the lack of existing manuals for Electrical Circuits 2, a comprehensive lecture manual is developed to address the instructional needs of educators in the Western Visayas region.

Key words: Electrical Circuits 2, Manual, Commission on Higher Education, Western Visayas

Introduction

This study aims to develop a lecture manual in Electrical Circuits 2 in compliance by the Commission on Higher Education (CHED) thru CHED CMO No. 88 series of 2017 to all engineering schools in the Philippines offering Bachelor of Science in Electrical Engineering (BSEE). Pertaining to the course Electrical Circuits 2, the following are the minimum expected outcomes but may not be limited to CHED CMO No. 88 series of 2017 in relation to Electrical Circuits 2 Course Competencies.

Engineering is a crucial activity that serves the needs of society, drives economic growth, and provides essential services. It combines mathematical and scientific principles with a body of knowledge, technology, and techniques to develop solutions that can be accurately predicted and implemented in uncertain situations (Merin, 2022). Electrical Engineering is a profession that encompasses the creation, design, and implementation of safe, sustainable, and cost-effective systems for generating, transmitting, distributing, and utilizing electrical energy. This field draws upon a broad range of mathematical, scientific, and technological knowledge to address a wide variety of problems and ensure the well-being of society and the environment (Merin, 2021).

The Electrical Circuits 2 manual provides a comprehensive framework for understanding the behavior and analysis of electrical circuits. The manual's emphasis on advanced circuit analysis techniques, such as mesh analysis, nodal analysis, and Thevenin and Norton equivalent circuits, underscores the importance of these methods in designing and troubleshooting complex electrical systems. Furthermore, the manual's exploration of transient circuit analysis and frequency domain analysis highlights the significance of understanding the dynamic and frequency-dependent behavior of circuits. This conceptual framework is supported by the work of Alexander and Sadiku (2012), who emphasize the importance of advanced circuit analysis techniques in electrical engineering education. Similarly, Hayt, Kemmerly, and Durbin (2018) stress the significance of frequency domain analysis in understanding the behavior of electrical circuits. By integrating these concepts, the Electrical Circuits 2 manual offers a robust foundation for electrical engineering students to develop a deep understanding of electrical circuits and their applications. The laboratory manual should provide a comprehensive set of experiments that bridge the gap between theory and application. It should include variations between measured and calculated values, and questions/problems to explore the theory in greater depth. Proper procedures for conducting experiments and writing lab reports are crucial, including designating a group leader, obtaining measurements immediately, verifying data, and including all results and calculations (Merin, 2021). Pre-tests and post-tests can be used to assess students' understanding and skills in electrical measurements like voltage and current before and after the lab activities. Both hands-on and simulation-based labs can positively impact students' learning of electrical measurement concepts and skills, though hands-on may better develop skills like selecting the correct ammeter range (Kapadia, 2020). The lab manual should cover a wide range of AC circuit topics like wave concepts, RLC circuits, power, and three-phase systems, with detailed theory, equipment, and procedure information for each experiment (Mohamad, 2022). Alam and Hossain (2020) provide valuable insights into the design and development of an effective laboratory manual for electrical circuits courses. The authors emphasize that the manual should provide a comprehensive set of experiments that bridge the gap between theory and application. It should include variations between measured and calculated values, as well as questions and problems to explore the theory in greater depth. Proper procedures for conducting experiments and writing lab reports are also crucial, such as designating a group leader, obtaining measurements immediately, verifying data, and including all results and calculations. The researchers found that pre-tests and post-tests can be used to assess students' understanding and skills in electrical measurements before and after the lab activities. Additionally, both hands-on and simulation-based labs were shown to positively impact students' learning of electrical measurement concepts and skills, though hands-on labs may better develop skills like selecting the correct ammeter range.

One significant gap in creating an Electrical Circuits 2 laboratory manual is the lack of coverage for advanced circuit analysis techniques beyond the basics. The manual should delve into methods such as mesh analysis, nodal analysis, Norton, Thevenin method, superposition theorem, and maximum power transfer theorem, which enable the analysis of more complex circuits with multiple voltage and current sources, resistors, capacitors, and inductors in intricate configurations. Additionally, the manual should include transient circuit analysis, examining the behavior of circuits as they transition from one steady state to another, encompassing topics. This understanding of transient response is crucial for designing circuits that operate reliably under dynamic conditions. Furthermore, the manual should provide insights into frequency domain analysis, which involves representing circuits in terms of their response to sinusoidal inputs of different frequencies, covering concepts such as phasors and phasor diagrams, impedance and admittance, series and parallel resonance, and filters. Frequency domain analysis is essential for designing circuits that operate with AC signals, such as in communication systems and power electronics.

The creation of an Electrical Circuits 2 laboratory manual is motivated by the need to require electrical engineering students with a comprehensive resource that addresses the United Nations' Sustainable Development Goals (SDGs). Specifically, the manual aims to contribute to SDG 9, "Industry, Innovation, and Infrastructure," by equipping students with the knowledge and skills necessary to design and develop innovative electrical systems that support sustainable development. The manual's focus on advanced circuit analysis techniques, transient response, and frequency domain analysis will enable students to develop a deep understanding of electrical circuits and their applications, ultimately leading to the creation of more efficient and sustainable electrical systems. By addressing the gaps in existing resources, the manual will also support SDG 4, "Quality Education," by providing students with a high-quality educational experience that prepares them for the challenges of the 21st century. Furthermore, the manual's emphasis on practical applications and simulations will help students develop problem-solving skills and critical thinking, aligning with SDG 4's goal of promoting lifelong learning and skills development.

Objectives

With reference to the objectives given and required by the Commission on Higher Education (CHED) to all engineering schools in the Philippines offering Bachelor of Science in Electrical Engineering (BSEE) pertaining to the course Electrical Circuits II, the following are the minimum expected outcomes but may not be limited to (Commission on Higher Education 2017) in relation to Electrical Circuits 2 Course Competencies.

1. Assessment of the availability of Electrical Circuits 2 Manual in schools offering BSEE Program in Western Visayas.
2. Design a manual for Electrical Circuits 2.

Materials and Methods

For the descriptive study conducted, the research design focused on examining the status of lecture manuals for Electrical Circuits 2 among State Universities and Colleges (SUCs) and Private Universities and Colleges (PUCs) in the Western Visayas region. The participants of the study comprised Department Heads or Deans of the Colleges within these institutions. With the total number of respondents being less than 10, a researcher-made questionnaire was developed to gather data. Prior to distribution, the questionnaire underwent a validation process by three educational experts to ensure its reliability and validity.

The data gathering procedure commenced with the identification and selection of potential participants from various SUCs and PUCs. Contact was established with the Department Heads or Deans through email or phone, wherein the purpose of the study was explained, and their participation was requested. Following the receipt of necessary permissions, the validated questionnaire was digitally disseminated to the chosen participants or mailed to them via postal services, accompanied by clear guidelines on how to complete and return the survey. Subsequently, follow-up measures were taken to encourage participation and ensure a high response rate. Upon the completion of the stipulated timeframe, the collected questionnaires were retrieved from the respondents.

Upon the conclusion of the data collection phase, the responses to the questionnaire were subjected to analysis. Utilizing frequency distribution and percentage calculation methods, the prevalence of certain patterns or trends among the respondents was determined. The findings were summarized descriptively, highlighting key insights and observations. Furthermore, cross-tabulation of responses was conducted to discern any significant differences between SUCs and PUCs, where applicable. This methodological approach allowed for a comprehensive examination of the status of lecture manuals for Electrical Circuits 2 across institutions in the Western Visayas region.

Results and Discussion

Upon analysis of the data gathered from the respondents, it was found that the majority of the statements in the questionnaire received poor responses. This suggests a lack of standardized lecture manuals for Electrical Circuits 2 among State Universities and Colleges (SUCs) and Private Universities and Colleges (PUCs) in the Western Visayas region. Respondents indicated challenges in delivering effective lectures, integrating practical applications, catering to diverse learning needs, and promoting active student engagement as shown in Table 1.

QUESTIONS	YES	NO
Do you currently have a standardized lecture manual for Electrical Circuits 2?	28.57 %	71.43%
Have you faced challenges in delivering effective lectures for Electrical Circuits 2?	100%	0%
Are there specific topics or concepts that you find challenging to teach in Electrical Circuits 2?	100%	0%
Do you integrate practical applications or real-world examples into your lectures for Electrical Circuits 2?	100%	0%
Do you ensure that your lectures cater to the diverse learning needs of students in Electrical Circuits 2?	100%	0%
Do you use resources other than a lecture manual for lecture preparation in Electrical Circuits 2?	28.57 %	71.43%
Would you require support or resources to effectively implement a student-centered lecture manual for Electrical Circuits 2 in your institution?	100%	0%
Do you promote active student engagement and participation during lectures for Electrical Circuits 2?	100%	0%
Are there key components you believe should be included in a student-centered lecture manual for Electrical Circuits 2?	100%	0%
Do you believe a student-centered lecture manual would enhance teaching effectiveness in Electrical Circuits 2?	100%	0%

71.43 % of the schools in Western Visayas don't have even lecture manual for Electrical Circuits 2 and not using other resources other that manuals in preparing Electrical Circuits 2. Mostly all the faced challenges in delivering effective lectures and hard to teach the subject. But in the bright side, practical applications, student engagement, varied learning need are integrated in a student-centered manual that will enhance teaching effectiveness in Electrical Circuits 2.

Development of Lecture Manual for Circuits 2

Considering the lack of existing manuals for Electrical Circuits 2, a comprehensive lecture manual is developed to address the instructional needs of educators in the Western Visayas region. The manual includes the following components:

EXPERIMENT NO. 1: AC VOLTAGE AND CURRENT

Objectives

1. To determine the root-mean-square (RMS) value of an alternating current (AC) voltage
2. To gain practical experience using AC voltmeters and ammeters
3. To validate V = IR in an Alternating Current circuit
4. To solve the power consumed in an AC circuit

Instruments and Components

Power Supply
Resistance Module
AC Metering Module (2.5 A)
AC Metering Module (250 V)
DC Metering Module (200 V, 2.5 A)
Synchronizing Switch Module
Connection Leads

Procedure

1. Investigate the internal structure of the synchronizing module EMS 8621, focusing on the circuit diagram printed on the module's surface.
    a. The module is divided into three sections and each section has a bulb positioned between terminals, in connection with the wires and circuit breakers. By toggling the switch to the open position, the circuit breaker in each lamp circuit is electrically disconnected. (The module's use as a synchronizing switch will be explored in a subsequent laboratory experiment.)
    b. Set the switch to the off/open position and maintain this during the simulation of the abovementioned laboratory experiment.
2. To set up the circuit shown in Figure 1.1, make the following connections using the power supply, AC metering module, and DC metering module:
    a. Connect the lamp across the fixed AC power source.
    b. Connect the nearby lamp across the varying DC power source.

    Ensure that the lamps are properly connected to the respective AC and DC power sources as depicted in Figure 1.1.

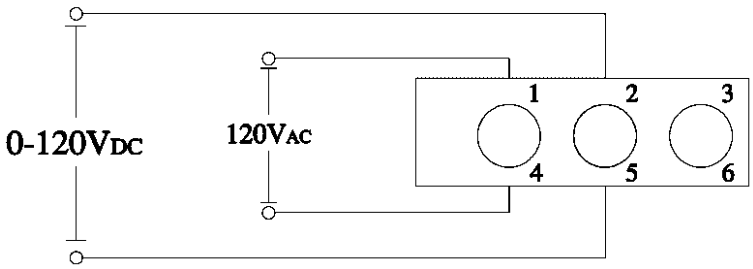

Figure 1.1 The Synchronizing Switch Module

3. ON the power supply and adjust the DC voltage until both bulbs are lit to the same intensity. Record the DC voltage at this point.

    V_{DC} = ______________________ Volts

    Since both bulbs are equally illuminated, they consume the same supply of power. Consequently, the DC voltage across one lamp that is measured must be equal to the effective value of the AC voltage across the other bulb. Once this point is reached, put the DC voltage back to zero and off the power supply.
4.
    a. Connect the voltmeter across the fixed AC voltage source. This can be done by connecting the voltmeter to terminal 1 and N of the power supply, or to terminals 1 and 4 of the lamp module.
    b. On the power supply and adjust the DC voltage until both lamps are equally bright. Record the AC and DC voltages in Table 1.1. Repeat this process at least three times, starting from zero DC volts for each trial. Record all your measurements in Table 1.1.

Table 1.1 Comparing DC and AC Voltage

Data	1	2	3	4
V_{AC}				
V_{DC}				

c. Are your measured AC and DC voltage values significantly similar?
d. Set the voltage back to zero and turn off the power supply.
e. Remove the synchronized switch module and using the Resistor Module, set up the circuit as shown in Figure 1.2. This circuit should be connected to the variable AC power source of your power supply. Ensure all resistors and resistor sections in the module are connected in parallel to achieve a maximum load of approximately 600 ohms for your circuit.

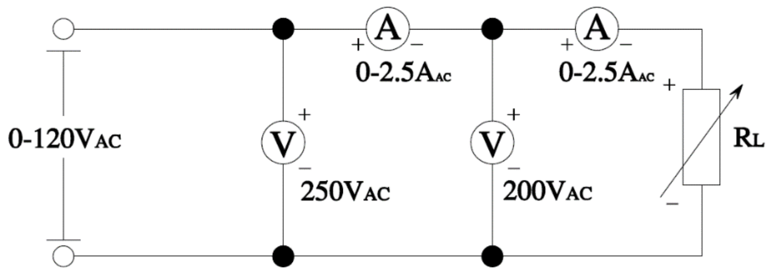

Figure 1.2 Circuit Using AC/DC Metering and Resistance Module

5. ON the power supply and set it to 120 VDC. Take measurements. V_{AC} = __________ Volts V_{DC} = _________ Volts
   I_{AC} = __________ Amperes I_{DC} = _________ Amperes

6. Set up the circuit as depicted in Figure 1.2. Adjust the resistances so that the total resistance is first 50 ohms, and then 100 ohms.
   a. ON the power supply and set it to 100 V_{AC}.
   b. Take the measured value of current (I_{AC}) with a resistance of 50 ohms. Record this measurement in Table 1.2.
   c. Add the power supply voltage to 120 V_{AC}. Repeat steps (a) and (b) to measure I_{AC} at this new voltage level.
   d. Set the voltage to zero and OFF the power supply
7.
   a. Calculate the resistance (R) for each measurement using the formula E/I, where E is the voltage, and I is the current. Record the calculated resistance in Table 1.2.
   b. Calculate the power (P) for each condition using the formula E x I. Record the calculated power in Table 1.2.

Table 1.2 Ohm's Law in AC Resistive Circuit

R_L	50 Ω	100 Ω	50 Ω	100 Ω
E_{AC}				
I_{AC}				
E/I				
E x I				

   e. Does your calculated resistance (R) match the known resistance value (R_L) for each condition?
   f. Is V= IR apply to the AC resistive circuit?
   g. Do you think that the product of each effective AC voltage (E_{AC}) and effective AC current (I_{AC}) equates with the power in watts dispersed in the load?

EXPERIMENT NO. 2: INDUCTIVE REACTANCE

Objectives

1. Investigate the behavior of inductance in AC circuits.
2. Gain understanding of the concept of inductive power.

Instruments and Components

Power Supply
Resistance Module
AC Metering Module (250 V)
Single-Phase Wattmeter Module (750)
AC Metering Module (2.5A)
Connections Leads

Procedure

1. Study the internal structure of the inductance module EMS 8821, focusing on the inductors, switches, connection terminals, and wiring.
2. The module is equally distributed in three sections containing three inductors with values of 3.2 H, 1.6 H, and 0.8 H.
3. When the switches are closed, any pair or all three inductors can be connected in parallel, resulting in inductance values of 1.07 H, 0.64 H, 0.5 H, and 0.46 H.
4. If the inductance is divided into two, the reactance is also divided. Select the actual switches and the 60 Hz (120 V) current can be controlled in steps of 0.1 ampere up to a total of 2.1 amperes.
5. Use the EMS inductance, AC metering, wattmeter, and power supply, set the circuit as shown in Figure 2.2.

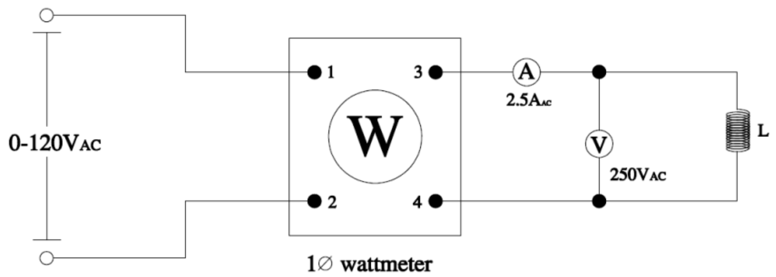

Figure 2.2 AC Power Using Ammeter, Voltmeter and Wattmeter

Measure and record the current and power readings.

I =__________________AAC
P=__________________Watts

Note: The wattmeter indication is due to the copper wire and iron losses in the inductor and in the losses in the voltmeter and ammeter. In an ideal coil, the copper losses indicate zero. Set the voltage to zero and OFF the power.

6. Solve the value of the inductive reactance (X_l) and the corresponding inductance in Henry. Additionally, evaluate the apparent power and reactive power

Reactance	: ________	Ohms
Inductance	: ________	Henrys
Apparent Power	: ________	Volt-Ampere
Reactive Power	: _________	Vars

EXPERIMENT NO. 3: CAPACITIVE REACTANCE

Objectives

1. Investigate the behavior of inductance in AC circuits.
2. Gain understanding of the concept of inductive reactive power.

Instruments and Components

Power Supply
Capacitance Module
AC Metering Module
AC Metering Module
Single Phase Module
Connections Leads

Procedure

1. Study the internal structure of the inductance module EMS 8831, focusing on the inductors, switches, connections, terminals, and wiring.
2. The module is equally distributed in three sections containing three identical capacitance elements with a value of 8.8µf. The reactance and current values for each capacitor at 60 Hz are marked on the module's surface.
3. When the swithes are closed, any pair or all three capacitors can be connected in parallel, resulting in capacitance values of 6.6µf, 11.0µf, 13.2µf, and 1.5µf. These parallel capacitance values can be further reduced by connecting sections in parallel.
4. When the capacitance is multiplied by 2, the reactance is divided into half. Select the actual switches and the 60 Hz (120 V) line current can be controlled in steps of 0.1 ampere up to a total of 2.1 amperes.
5. Using the inductance, AC metering, wattmeter, and power supply modules, set up the circuit as shown in Figure 3.2.

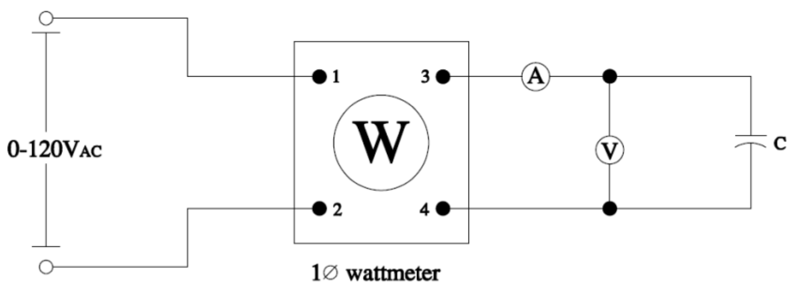

Figure 3.2 AC Power Using Ammeter, Voltmeter, and Wattmeter

6.
   a. Connect all the capacitance sections in parallel.
   b. ON the power supply to 120 V_{ac}, as indicated in the ammeter and wattmeter.

      I= Amperes
      P= Watts

7. Calculate the value of the capacitive reactance (Xc). Determine the corresponding capacitance in microfarads. Evaluate the apparent power and reactive power.

   Reactance__________________Ohms
   Capacitance_________________Farad
   Apparent Power______________Volt-Amperes
   Reactive Power_______________Vars

8. The circuit voltage and current waveforms along with the resultant power are found in Figure 3.2.

Note: The instantaneous power curve oscillates twice during one complete cycle (360°) of voltage or current.

The power curve has equal positive and negative loops. This means that during the negative portion of the power cycle, energy is being returned to the source. For the remaining portion of the cycle, the net (total) power absorbed by the circuit is zero. Inductive loads share this characteristic with capacitive loads.

EXPERIMENT NO. 4: RESISTANCE, INDUCTANCE, AND CAPACITANCE IN SERIES

Objectives

1. Learn how to connect resistance, inductance, and capacitance in series.
2. Determine the values of resistance, inductance, and capacitance using the voltmeter-ammeter method.
3. Validate that the impedance (Z) of a series RLC circuit.

Instruments and components

Power Supply
Capacitance Module
AC Metering Module
Frequency Meter
Inductance Module
Resistance Module
Connections Leads

Procedure

1. Using the circuit shown in Figure 5, measure the frequency of the source using a frequency meter. Open the switch and set the output voltage of the source to 120 volts.
2. Close the circuit and measure the voltage (E), resistance (E_R), inductive reactance (E_L), capacitive reactance (E_C), and current (I). Record these values in Table 5.1.
3. Repeat step 2 by adjusting the output voltage. Perform at least three trials.
4. Turn off the power supply. Compute respective reactances, and resistance (R) using the measured values.
5. Compare the computed values of inductance and capacitance with their rated values.
6. Compute and record the inductance and capacitance and compare them with the rated values.
7. Compute the impedance of the circuit using the formula: $Z = \frac{E}{I}$
8. Compute the impedance of the circuit using the formula:

$$Z=\sqrt{R^2 + (X_L + X_c)^2}$$

Show that

$$I = \sqrt{I_R^2 + (I_C + I_L)^2} \; ; \; E = \sqrt{E_R^2 + (E_L - E_C)^2}$$

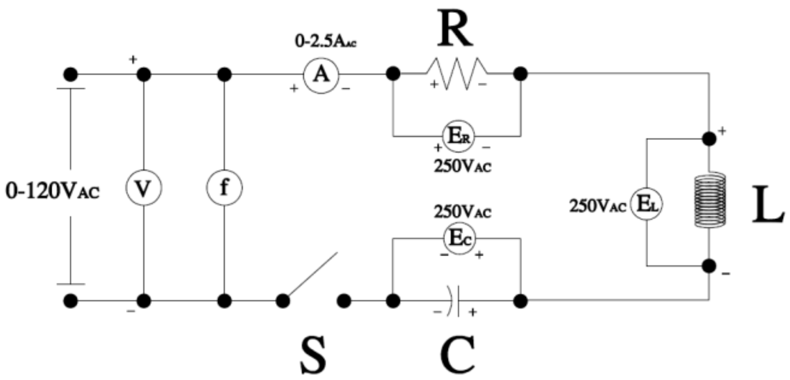

Figure 4.1 RLC Circuit

Table 4.1 Voltage across R, L and C of Series Circuit

Trial	MEASURED VALUES						COMPUTED VALUES						
	E (V)	E_R (V)	E_L (V)	E_c (v)	F (Hz)	I_T (Amp)	X_L (Ω)	X_C (Ω)	R (Ω)	L (Henry)	C (μF)	Z (Ω)	Θ (Deg)
1													
2													
3													

EXPERIMENT NO. 5: RESISTANCE, INDUCTANCE, AND CAPACITANCE IN PARALLEL

Objectives

1. Learn how to connect resistance, inductance, and capacitance in parallel.
2. Determine the values of resistance, inductance, and capacitance using the voltmeter-ammeter method.
3. Experimentally verify that the impedance of a parallel connected RLC circuit is given by the formula:

$$I_T = \sqrt{I_R^2 + (I_C - I_L)^2}$$

Instruments and Components

Power Supply
Capacitance Module
AC Metering Module
Frequency Meter
Inductance Module
Resistance Module
Connections Leads

Procedure

1. Using the circuit shown in Figure 5.1, measure the frequency of the source using a frequency meter. Open the switch and set the output voltage of the source to 120 volts.
2. Close the circuit and measure the voltage (E) and currents (I_L, I_R, I_C, I_T). Record these values in Table 5.1.
3. Repeat step 2 by adjusting the output voltage. Perform at least three trials.
4. Turn off the power supply. Compute respective reactances, and resistance (R) using the measured values.
5. Compare the computed values of inductance and capacitance with their rated values.
6. Compute the current (I) using the formula: $I_T = \sqrt{I_R^2 + (I_c - I_L)^2}$
7. Compute the impedance of the circuit using the formula: $Z = \frac{E}{I}$
8. Compute the impedance of the RLC circuit using the formula

$$\frac{E}{I} = \sqrt{(\frac{1}{R})^2 + (\frac{1}{X_C} - \frac{1}{X_L})^2}$$

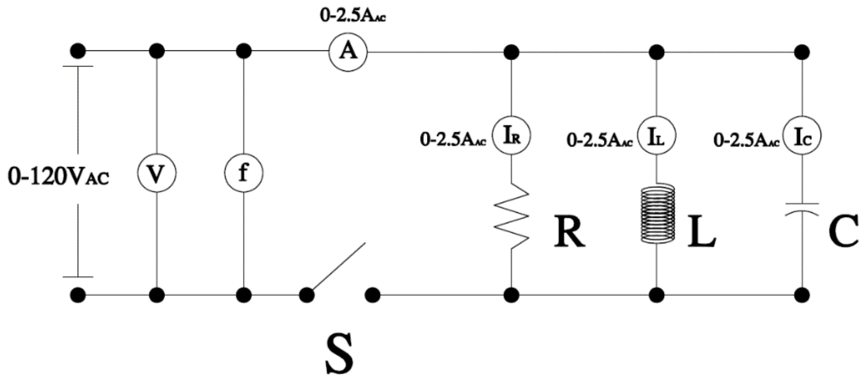

Figure 5.1 Parallel Connection of RLC

Table 5.1 Current Across R, L and C of Parallel Circuit

Trial	MEASURED VALUES						COMPUTED VALUES						
	E (V)	E_R (V)	E_L (V)	E_c (v)	F (Hz)	I_T (Amp)	X_L (Ω)	X_C (Ω)	R (Ω)	L (Henry)	C (μF)	Z (Ω)	Θ (Deg)
1													
2													
3													

EXPERIMENT NO. 6: WATT, VAR, VOLT-AMPERE, AND POWER FACTOR

Objectives

1. Determine and evaluate the power (real, reactive, apparent).
2. Determine the p.f.

Instruments and Components

Power Supply Module
Split-Phase/Capacitor Start Motor Module
AC Metering Module (2.5 A)
AC Metering Module (250 Volts)
2 Capacitance Module
Connections Leads

Procedure

1. Using the components, connect the circuit as shown in Figure 6.1. This configuration sets up the motor for Split-Phase Operation

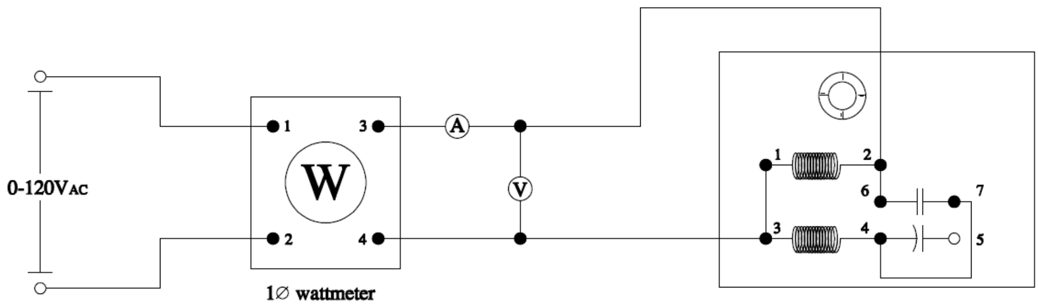

Figure 6.1 The Split-Phase/ Capacitor-Start Motor Circuit

<u>DO NOT TURN ON THE POWER AT THIS STAGE</u>

2. Make sure your connections are correct.
3. ON the power supply and modify it to 120VAC as indicated. Make sure the motor is running.
    a. Record the line current:
       I_L = ______________A_{AC}
    b. Record the real power:
       P = ______________W
4.
    a. Make sure the voltage is zero then OFF the power supply.
    b. Solve the apparent power:
       S = ______________VA
    c. Solve the power factor.
       p.f = ______________
    d. Solve the reactive power.
       Q= _______________ VAR
5. Using the components, connect the circuit as shown in Figure 6.2.

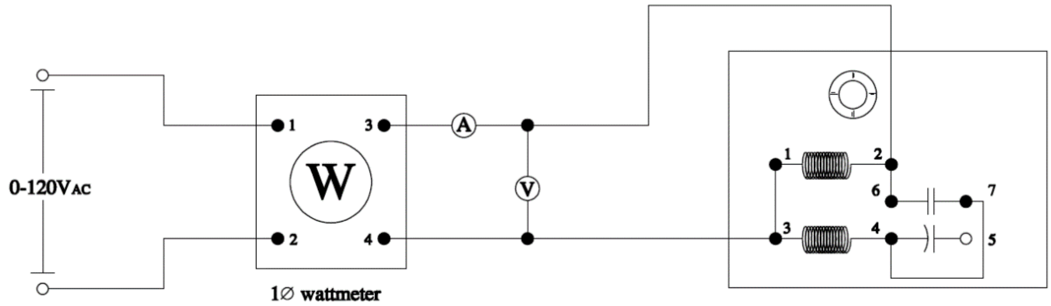

Figure 6.2 AC Circuit Using Ammeter, Voltmeter, and Wattmeter

6.
   a. ON the power supply and modify it to 120 V_{AC}, as in Procedure 3. The motor should be running.
   b. Add capacitance to the connected circuit by closing the switches one at a time.
   c. The capacitance must be in minimum line current.
   d. Record the line current:
      I_L = ____________A_{AC}
   e. Record the real power:
      P = _______________W
7.
   a. Make sure the voltage is zero then OFF the power supply.
   b. Calculate the apparent power (S) in VA:
      S = _______________VA
   c. Determine the power factor by analyzing the relationship between real and reactive power:
      Pf = _______________
   d. Calculate the reactive power (Q) in VA:
      Q = _______________VA
8. ON power supply and adjust it to 120 V_{AC}, as previously done.
   a. OFF the capacitance switches to achieve the minimum current.
   b. Adjust the capacitance switches to maintain exactly 120 V_{AC} across the motor, while ensuring the line current remains at its minimum value. Determine the reactance value that corresponds to the lowest current:
      X_C = __________________ohms
   c. Make sure the voltage is zero then OFF the power supply

EXPERIMENT NO. 7: 3 - PHASE CIRCUITS

Objectives

1. Determine the relationship of the voltage and current in three-phase circuits to gain a deeper understanding of the interactions between these fundamental circuit parameters.
2. Learn to make both delta and wye connections in three-phase circuits, which are crucial for designing and analyzing these complex systems.
3. Develop the ability to calculate various parameters in three-phase circuits, including voltage, current, power, and impedance, to accurately analyze and design these circuits.

Instruments and Components

Power Supply Module (0-120/208V/3Ø)
AC Metering Module (250/250/250V)

AC Metering Module (0.5/.05/0.5A)
Resistance Module
Connections Leads

Procedure:

1.
   a. Connect the circuit as shown in Figure 7.1.

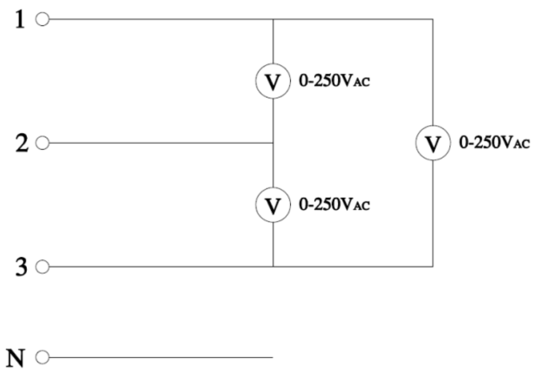

Figure 7.1 Line to Line Voltage Configuration of a 3-Phase Power Supply

   b. ON the power supply and adjust the line-to-neutral voltage to exactly 120 V_{AC} at the output terminals of your power supply.

E_{1to2} = ________________ V_{AC}
E_{1to3} = ________________ V_{AC}
E_{2to3} = ________________ V_{AC}

   c. Record all the line-to-line voltage to accurately capture the voltage levels in the three-phase system.

E_{4to5} = ________________ V_{AC}
E_{5to6} = ________________ V_{AC}
E_{4to6} = ________________ V_{AC}

2.
   a. Redo the connection of the three voltmeters to measure the voltages from each line to neutral.
   b. ON the power supply and adjust the line-to-neutral to exactly 120 V_{AC}.
   c. Record each line-to-neutral voltage:

E_{4toN} = ________________ V_{AC}
E_{5toN} = ________________ V_{AC}
E_{4toN} = ________________ V_{AC}

   d. Make sure the voltage is zero then OFF the power supply

3. Repeat the procedures for measuring line-to-neutral voltages, measure the voltages from the fixed points:

E_{2toN} = ________________ V_{AC}
E_{1toN} = ________________ V_{AC}
E_{3toN} = ________________ V_{AC}

4.

a. Connect the wye circuit as shown in Figure 7.2. Dessignate a section of resistances for each load (R_1, R_2, and R_3). Make sure the neutral of the resistance module is not connected to the neutral of the power supply.
b. Each resistance is set to 400 ohms.
c. ON the power supply and adjust it to 200 V_{AC}.

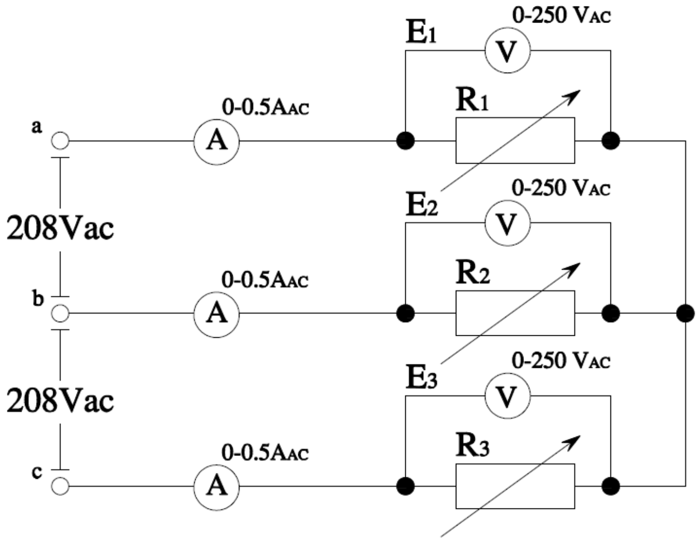

Figure 7.2 Wye-Connected Resistive Load

d. Measure and record the following parameters for each load resistance (R1, R2, and R3):
E_1=________________V_{AC}

I_1=__________________V_{AC}
E_2=________________V_{AC}
I_2=__________________V_{AC}
E_3=________________V_{AC}
I_3=__________________V_{AC}

5.

a. Connect the circuit as shown in Figure 7.3.
b. Set each resistance section to 300 ohms.
c. ON the power supply and adjust it to 120 V_{AC} line-to-line.
d. Record the following parameters for each load resistance (R_1, R_2, and R_3):.
E_1=________________V_{AC} I_1=__________________V_{AC}
E_2=________________V_{AC} I_2=__________________V_{AC}
E_3=________________V_{AC} I_3=__________________V_{AC}

e. Make sure the voltage is zero then OFF the power supply
f. Series the three current meters with power supply terminals 4, 5, and 6. Put the removed current meters with connection leads as shown in Figure 7.4.
g. ON the power supply and adjust it to 100 V_{AC}.

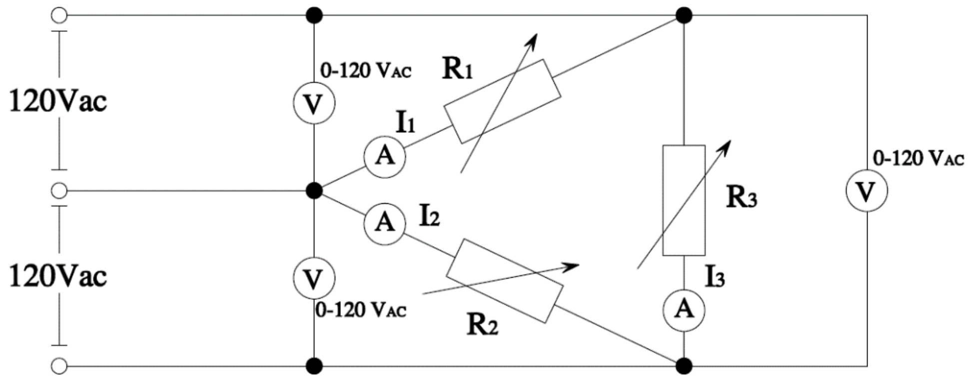

Figure 7.3 Delta-connected Resistive Load

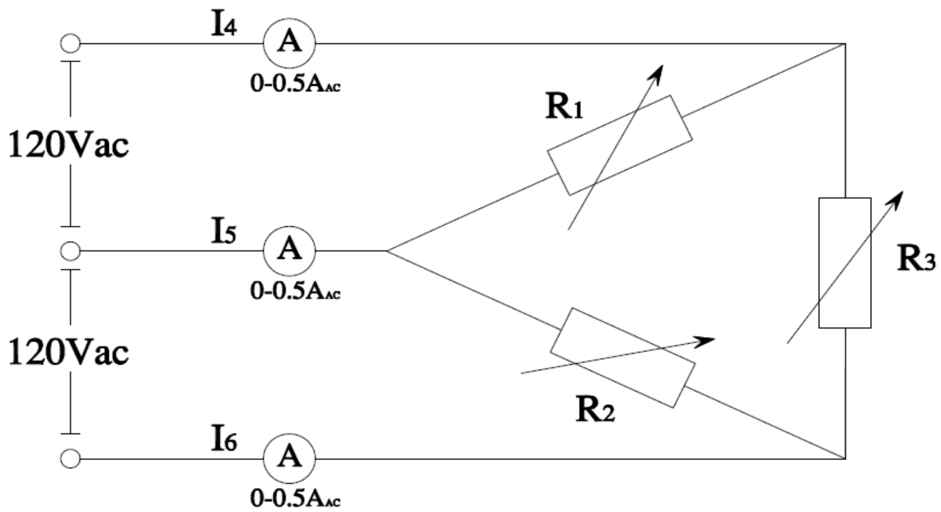

Figure 7.4 Line Currents of Delta-connected Load

e. Record the three line currents.

I_4 = ___________________ V_{AC}
I_5 = ___________________ V_{AC}
I_6 = ___________________ V_{AC}

f. Return the voltage to zero and turn off the power supply Make sure the voltage is zero then OFF the power supply

The absence of standardized lecture manuals for Electrical Circuits 2 in most schools in the Western Visayas region indicates a significant gap in instructional resources. This gap may contribute to inconsistencies in teaching methods, difficulty in meeting diverse student needs, and a lack of structured learning materials. Without comprehensive lecture manuals, educators may face challenges in delivering high-quality instruction and engaging students effectively

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