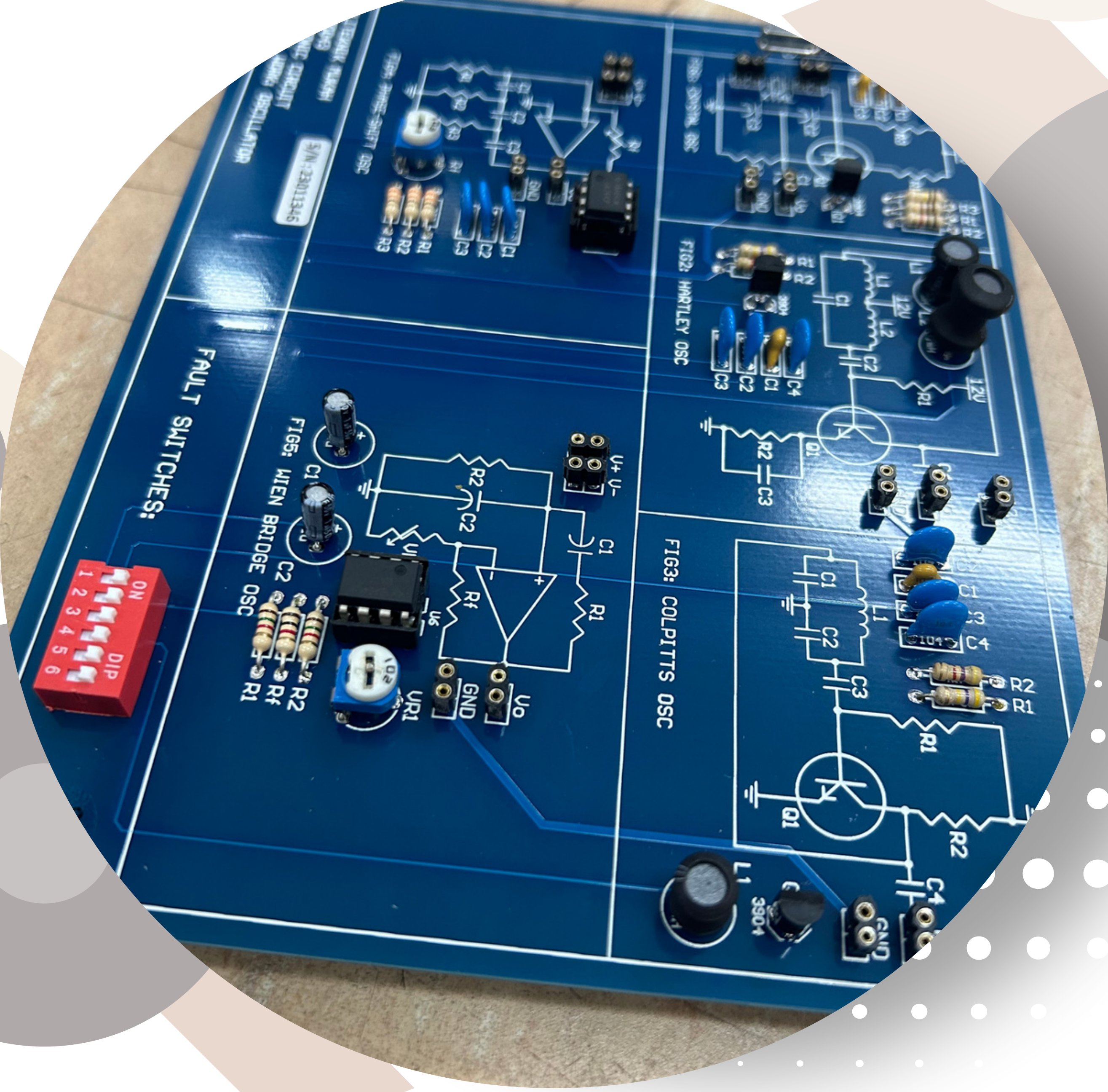
Electronic Circuits
Politeknik Mukah

USER MANUAL

MASTERING OSCILLATOR CIRCUITS



MASTERING OSCILLATOR CIRCUITS

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MASTERING
OSCILLATOR CIRCUITS

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PUBLICATION

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PREFACE

This manual is designed for new users who have little or no experience with the Mastering Oscillator Circuits trainer. The aim of this document is to provide an overview of the main functions of the Mastering Oscillator Circuits and to offer basic instructions for setting up and establishing connections during lab work. The focus of this document is on demonstrating how to interact with the Mastering Oscillator Circuits using this trainer. Every effort has been made to ensure that this document accurately represents the functionality of Mastering Oscillator Circuits. This manual employs the following documentation conventions:

- Introduction
- Layout, Specifications, and Overview
- Mastering Oscillator Circuits in Operation
- Practical Work

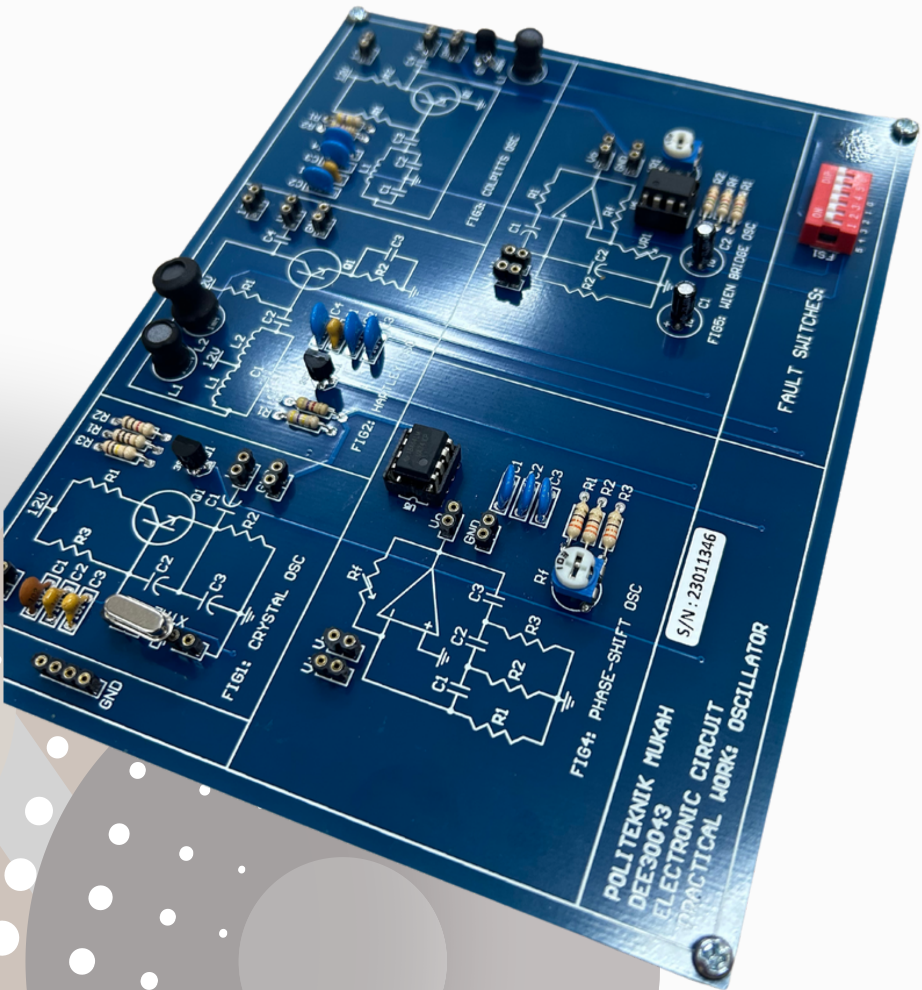
TABLE OF CONTENTS

INTRODUCTION

This manual serves as a basic practical experiment guide to help lecturer to teach oscillator circuit experiments. It had been developed to provide basic laboratory practical and training for users to gain experience in oscillator circuit.It is focus on hands-ontechnique to get these circuitsconstructed and tested.

Students are required to construct the given oscillator circuits and to state their answer at the specific answer column. Tutorials questions are also posted to check their level of understanding and also their depth of knowledge and skills after they have gone through each part of the experiments.

However, users are recommended to do their own research and studies from textbooks or data sheets to obtain more detailinformation about the digital and analog components or integrated circuitused for these experiments.



CAUTIONS & TIPS WHEN CONSTRUCTING EXPERIMENTS CIRCUITS

The following convention applies when using the "Base Unit" as a tool or platform to construct or prototyping the experiment circuits:

- DO NOT switch on the power supply until all portion of the circuits are fully wired and checked. Use a digital multimeter to check for circuit shorting, especially between the positive supply, negative supply and the GND pin.

- Use the built-in DC or AC power supplies to power up your electronics circuits. There are built-in variable DC supply (up to ±12VDC), fixed DC supply (±5VDC) and a fixed AC supply (12VAC) on board to choose from.

- Most of the DC ground points are internally connected but separate from AC ground point. Don't simply connect the DC ground point with AC ground point unless it was the requirement of experiments.

- Never short the positive and negative supply point with the ground (GND) point on the trainer unit to avoid any short-circuit situation from happening.

- Use the built-in connectors (banana sockets)and switches (rotary switch) to assist in constructing your electronics circuits.

CAUTIONS & TIPS WHEN CONSTRUCTING EXPERIMENTS CIRCUITS

The following convention applies when using the “Base Unit” as a tool or platform to construct or prototyping the experiment circuits:

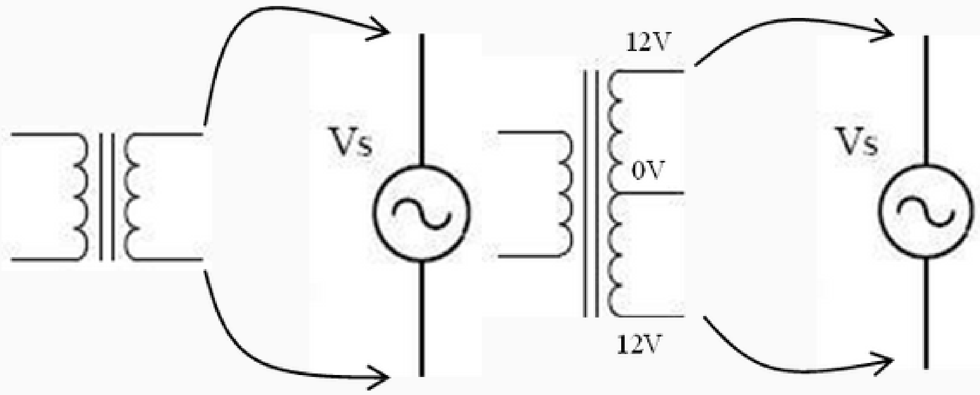
- When a specific AC waveform or pulse signal is required, make use of the “Function Generator” portion to feed in required waveform signals to your circuit. The waveform frequency and amplitude are adjustable via the dedicated control knobs.

- Construct the digital circuit(s) using the solderless prototyping breadboard placed in the middle of the trainer.

- Some of the modules have Faults Switch on board. Pull all the DIP switches to UP position for normal operation.

AC SUPPLY:

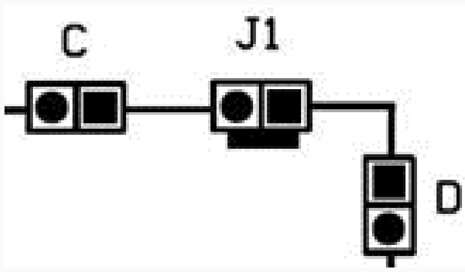
Take note, two terminal of AC power supply do not have polarity. For a center tap AC power supply as shows below, either one side (like 0V-12V) can be used to supply normal AC power. If connect by cross two side (like 12V-12V) then the AC power will be double.



JUMPER:

There are jumpers on each of the module which is as shown in the figurebelow. The function of the jumper is to break the circuit of that point.

For example:
When we remove the jumper, it will result to point C and point D is not connected and vice versa.

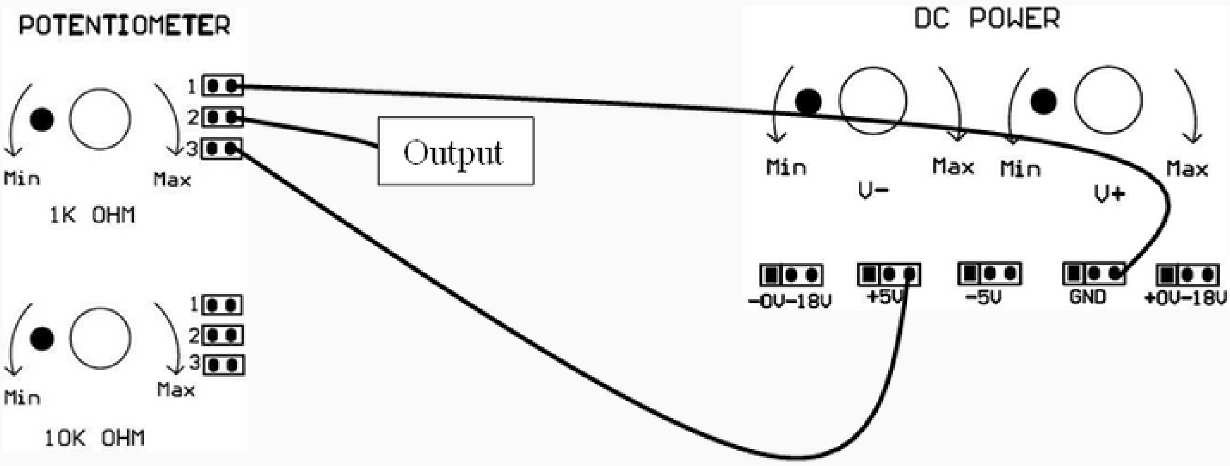


VARIABLE VOLTAGE:

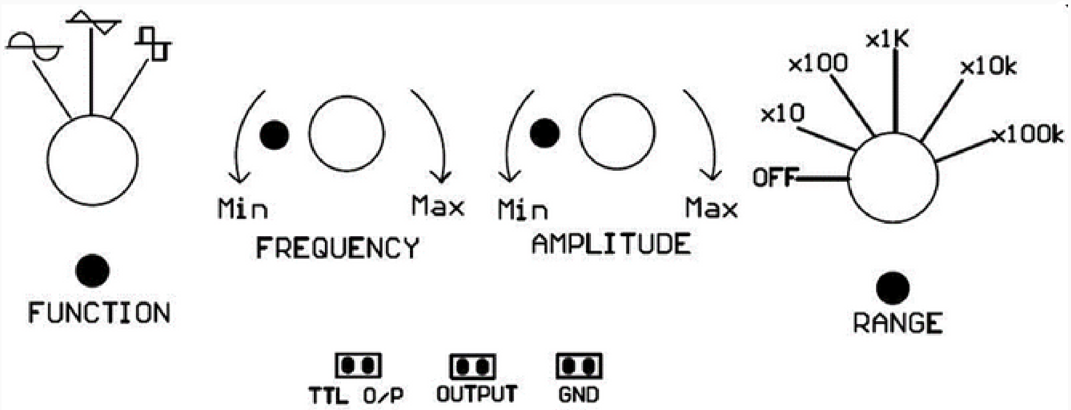
How to connect the connection to have a variable voltage:

Refer to the diagram above we have two potentiometers which is 1kΩ and 10kΩ and also the DC power supply section. User can choose either 1kΩ or 10kΩ potentiometer. Then connect the connection as above to get the desire output voltage.

For example, we want a variable voltage from 0V-5V. Connect the connection as above. Then, vary the potentiometer from min to max to get the desire voltage. If higher voltage is wanted, then change the +5V to +0V-18V point and tune to the desired maximum value.



FUNCTION GENERATOR:



Refer to the above diagram, we have a function generator. Below is the reference and usage of the 4 switches.
Note: Some of the model have DC OFFSET knob.

FUNCTION: to select sine wave, triangle wave and square wave.
FREQUENCY: tune the frequency of the output waveform. AMPLITUDE: tune the amplitude of the output waveform. RANGE: switch between different ranges of frequencies.
x10 : 1Hz~10Hz
x100 : 10Hz~100Hz
x1k : 100Hz~1kHz
x10k : 1kHz~10kHz x100k : 10kHz~100kHz
DC OFFSET (optional): tune the DC level of the output waveform.
*DC OFFSET not applicable to small signal's square wave (Function Generator (2)).

When a specific AC waveform or pulse signal is required, connect the pin labeled OUTPUT to the experiment module. When a clocked pulse signal is required, connect the pin labeled TTL O/P to the experiment module. Request the help and consultancies from the lab assistant when you have doubt about the procedure.

INSTRUMENT:

Electronics Measuring Instrument:

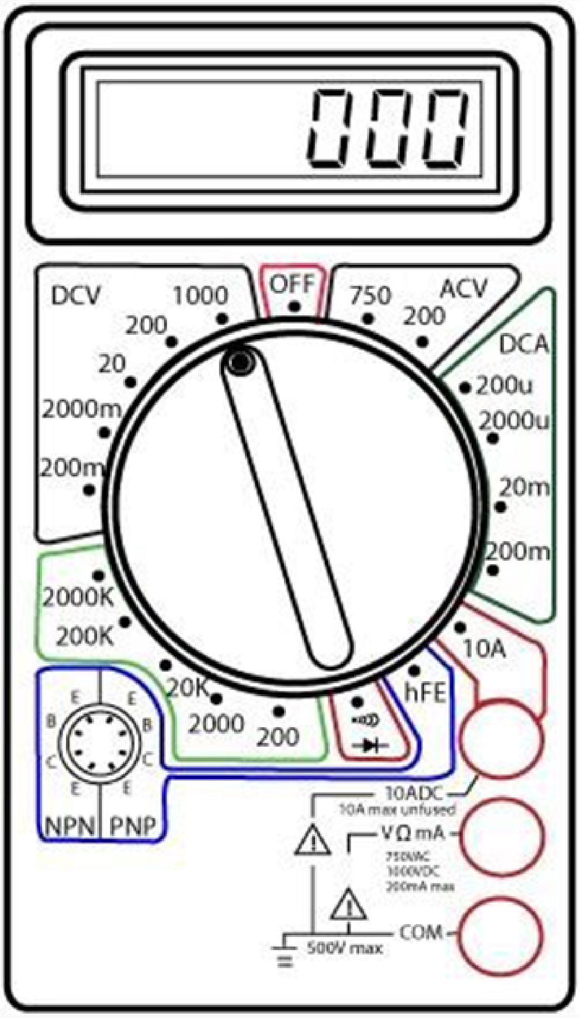
There are various test and measuring instrument in the market that can be used to measure the properties of electronics, such current, voltage, resistance, frequency & etc. They can be used to troubleshoot wide range of electronics equipment, circuit and applications.

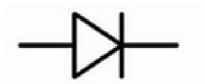
Some of the commonly used test equipments are the ammeter, voltmeter, multimeter, oscilloscope & etc. A multimeter is one of the most common measuring instrument that that integrates various meters into one unit. Its contain multirange voltmeter, multirange ammeter, multirange ohmmeter and other features.

Multimeter can be in the form of analogue type of the digital type. The analogue type has a simple display with a needle that points to the value being measured. The digital ammeter has a display made from 7- segment LEDs or LCDs. Note that, AC (alternative current) and DC (direct current) have different characteristic and should be measure in different settings. Various symbols are use to indicate them.

INSTRUMENT:

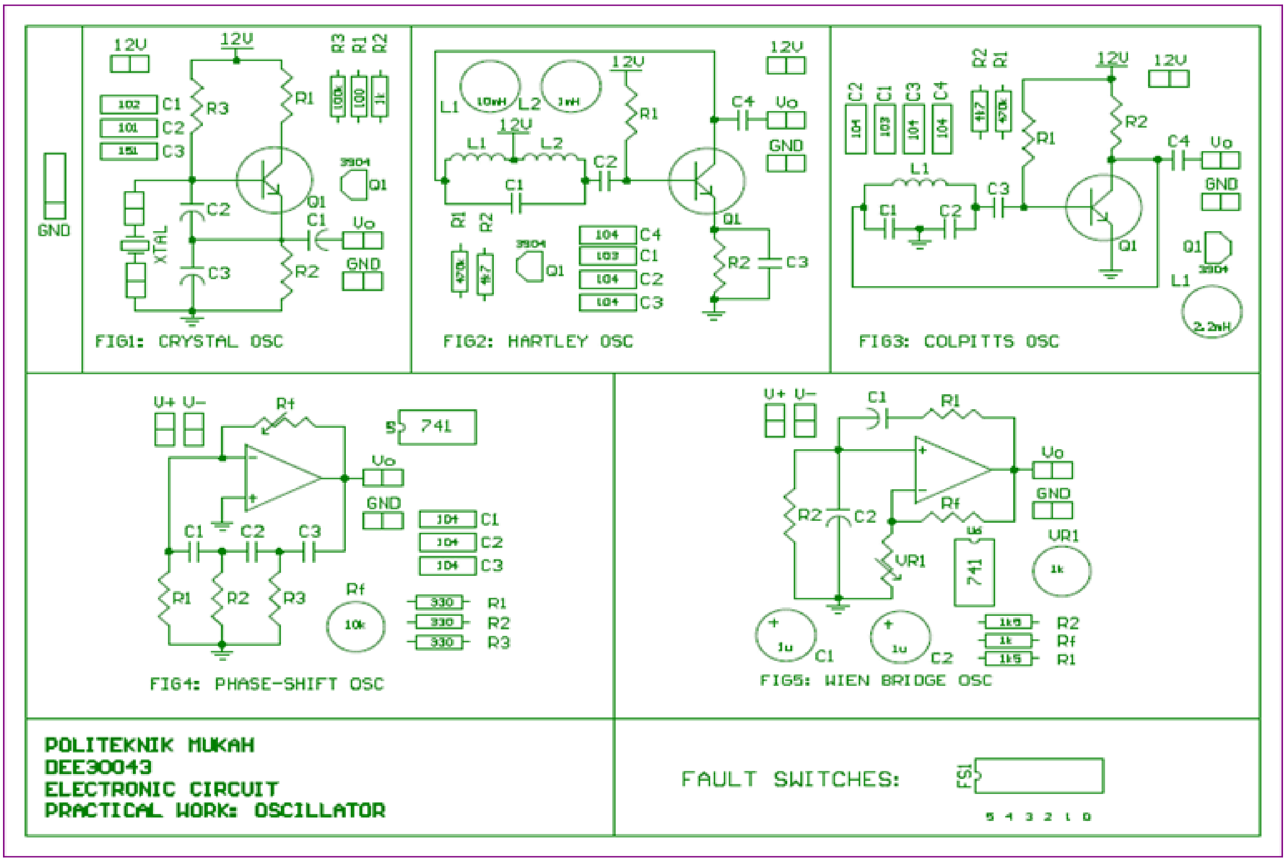
Below is an example of multimeter.



Symbol	Description
V~	AC voltage measurement.
V⎓	DC voltage measurement.
A~	AC current measurement.
A⎓	DC current measurement.
Ω	Resistance measurement.
	Diode measurement
	Continuity tester
hFE	Transistor HFE measurement

OSCILLATOR

PCB BOARD LAYOUT



DEE30043 PCB Board Layout

INTRODUCTION TO OSCILLATOR

The oscillator is used to produce repetitive electronics signal like sine wave, square wave and triangular wave. The oscillator produce sinusoidal output like sine wave is called harmonic oscillator. Another oscillator produce non-sinusoidal output like square wave and triangular wave is called relaxation oscillator. The oscillator could be base on op-amp or transistor and using either RC (resistor-capacitor) feedback or LC (inductor-capacitor) feedback

The following are the oscillator includes in the experiment module.

Relaxation Oscillator:

- The Bistable Multivibrator
- The Monostable Multivibrator
- The Square Wave Oscillator
- The Square Wave Oscillator with variable duty cycle
- The Triangular Wave Oscillator

Harmonic Oscillator:

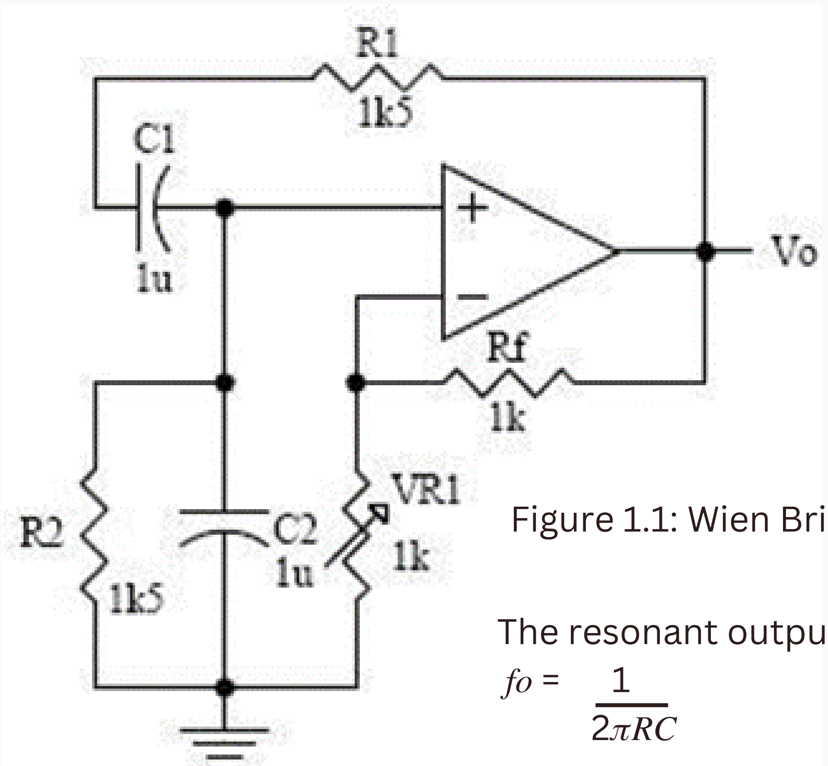
- The Wien Bridge Oscillator
- The Phase Shift Oscillator
- The Twin-T Oscillator
- The Clap Oscillator
- The Colpitt Oscillator
- The Hartley Oscillator
- The Crystal Oscillator

SINE WAVE OSCILLATOR

Sine wave oscillator is a sinusoidal oscillator consists of amplifier with RC or LC feedbackcircuits that can adjust the frequency. It might use a crystal that has a fix oscillation frequency.The sine wave oscillator operates without any external input signal or trigger signal.The RC feedback or LC feedback let the output cycle back and drive the op-amp or transistor to generate pulses continuously.

The Wien Bridge Oscillator

The Wien Bridge oscillator is a type of oscillator with RC feedback circuits that output a sine wave. This oscillator can produce a wide rangeof output frequencies & it is capable to produce low distorted sine wave output. Figure 1.1 shows a Wien Bridge oscillator circuit.



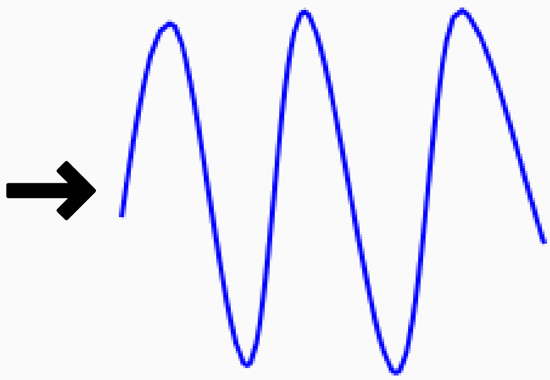


Figure 1.1: Wien Bridge Oscillator circuit

The resonant output frequency fo, is given as:

$$fo = \frac{1}{2\pi RC}$$

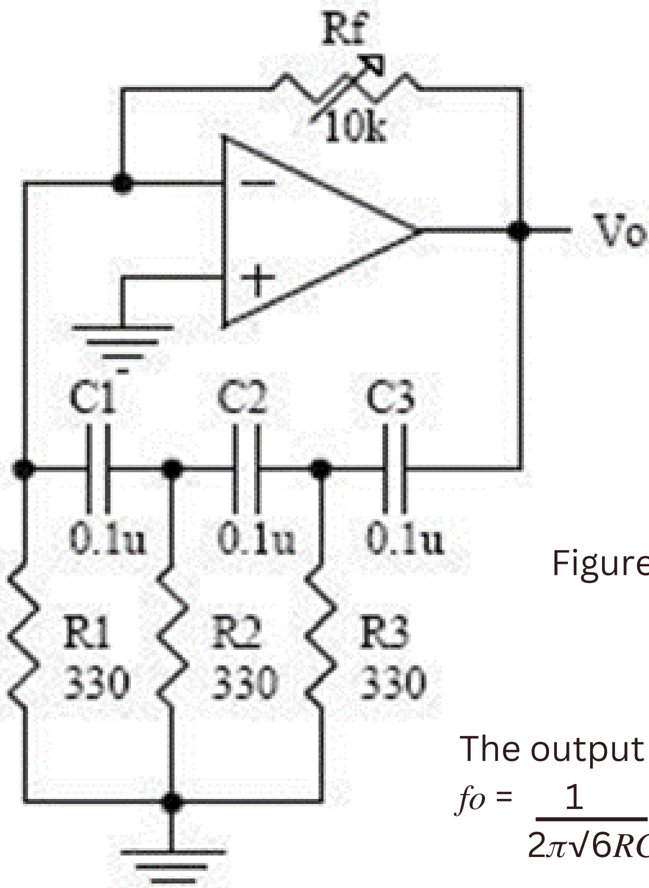
Where R = R1 = R2; C = C1 = C2

The resistors Rf and VR1 is selected to be $Rf/VR1 \approx 2$

SINE WAVE
OSCILLATOR

The Phase Shift Oscillator

The phase shift oscillator is another type of sine wave oscillator. It is made up of an inverting op-amp plus a feedback RC circuit. Figure 1.2 shows the basic circuit diagram. Note that it consists of 3 RC feedback circuits and each RC circuit yields a maximum phase shift of 90 degrees. When the total phase shift from these 3 RC circuits is 180 degree, oscillation will commence and the inverting configuration of the op amp will generate the next cycle of 180 degree to complete a full 360 degree cycle.



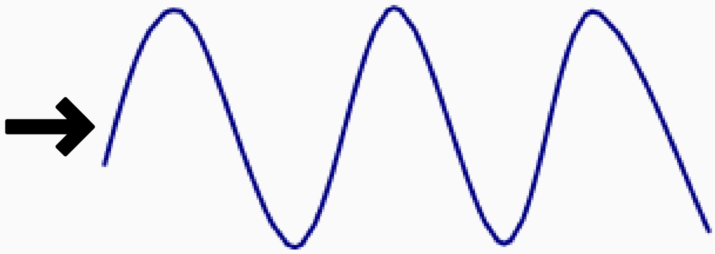


Figure 1.2: Phase Shift Oscillator circuit

The output frequency fo is given as:

$$fo = \frac{1}{2\pi\sqrt{6}RC}$$

Where R = R1 = R2 =R3; C = C1 = C2 = C3

The attenuation is given as:

B = 1/29

Rf = 29R

SINE WAVE
OSCILLATOR

The Crystal Oscillator

Crystal is a device made from quartz component mounted between 2 electrodes and packaged within a metallic can packaging. Internally, it consists of RLC component. These readymade crystals are used to produce an oscillation waveform based on for specific value. A basic circuit is normally used together with the crystal to generate the required resonant frequencies. Figure 1.3 below shows a crystal control oscillator circuit.

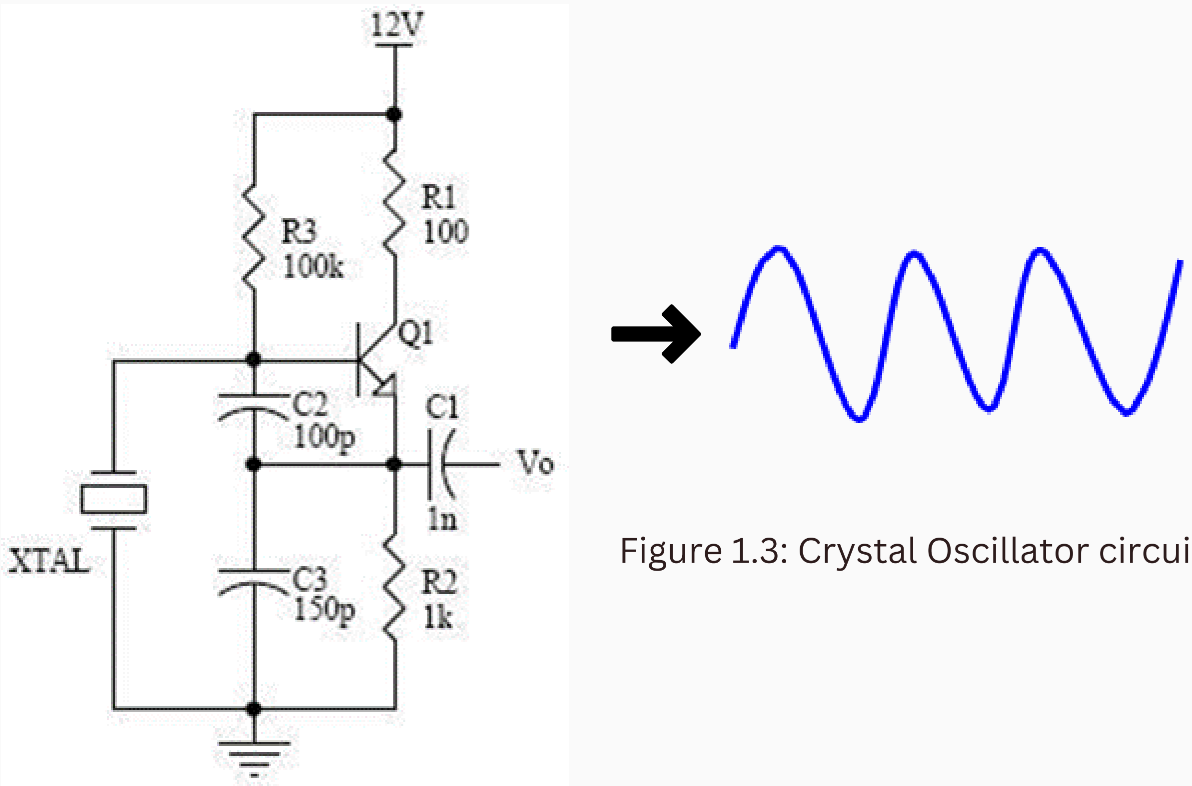


Figure 1.3: Crystal Oscillator circuit

SINE WAVE OSCILLATOR

The Hartley Oscillator

The Hartley oscillator is another type of oscillator that uses LC feedback circuits to operate. It required 2 inductors connected in series and connected in parallel with a capacitor. This oscillator is normally used in broadcasting bands, like the AM & FM. Figure 1.4 shows a basic Hartley oscillator circuit.

It produces an output which is nota pure sine wave. The output is rich in harmonics and is not suitable for certain application. However, the output amplitude is relatively constant over its entire operating range.

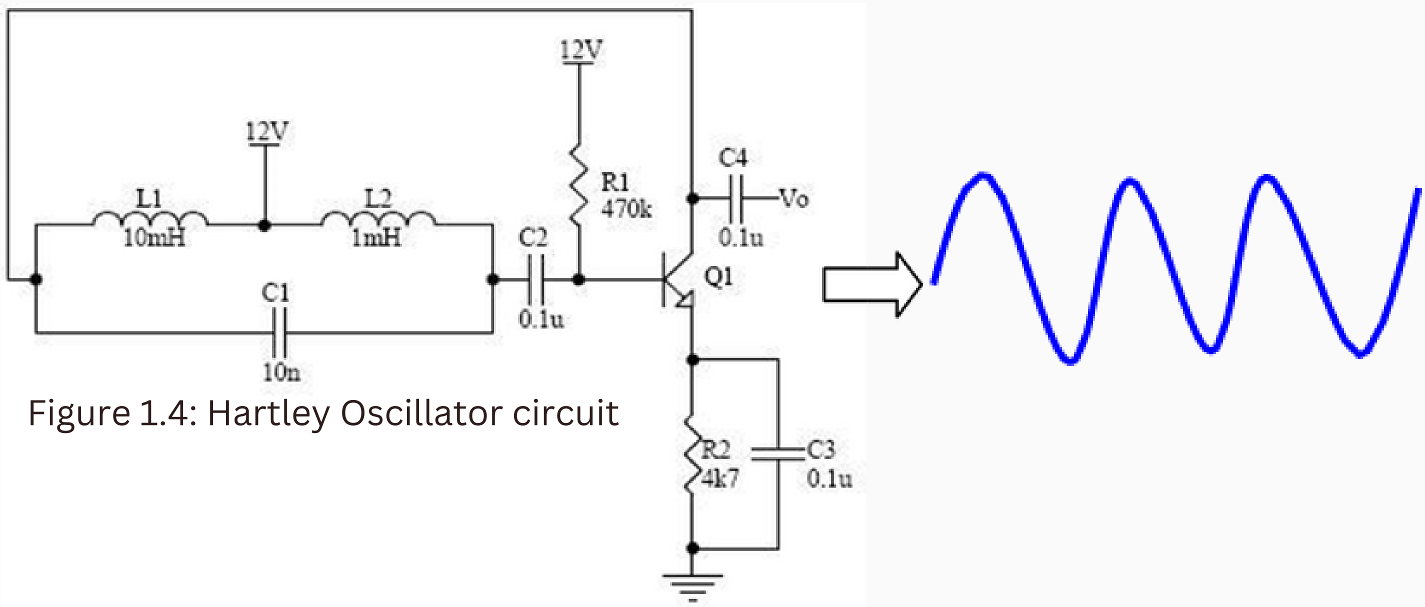


Figure 1.4: Hartley Oscillator circuit

The output frequency is given as:

$$fo = \frac{1}{2\pi\sqrt{LC}}$$

Where L = L1 + L2, C = C1

SINE WAVE OSCILLATOR

The Colpitts Oscillator

A Colpitts oscillator is a type of LC resonant oscillator circuits that similar to Hartley oscillator. However, it uses a split capacitor to provide a feedback signal and onnected in parallel with a inductor. This circuit is rather difficult to be tuned over a wide range of frequencies.
Figure 1.5 shows a basic Colpitts oscillator.

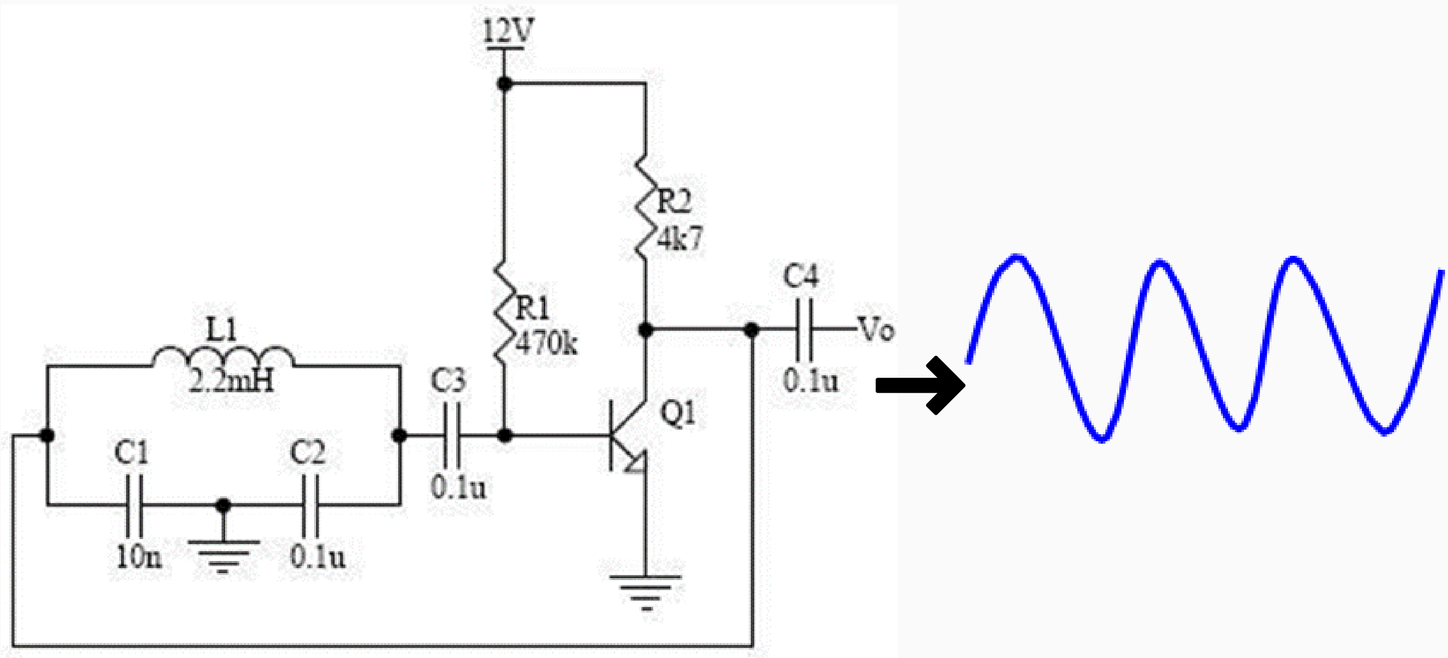


Figure 1.5: Colpitts Oscillator circuit

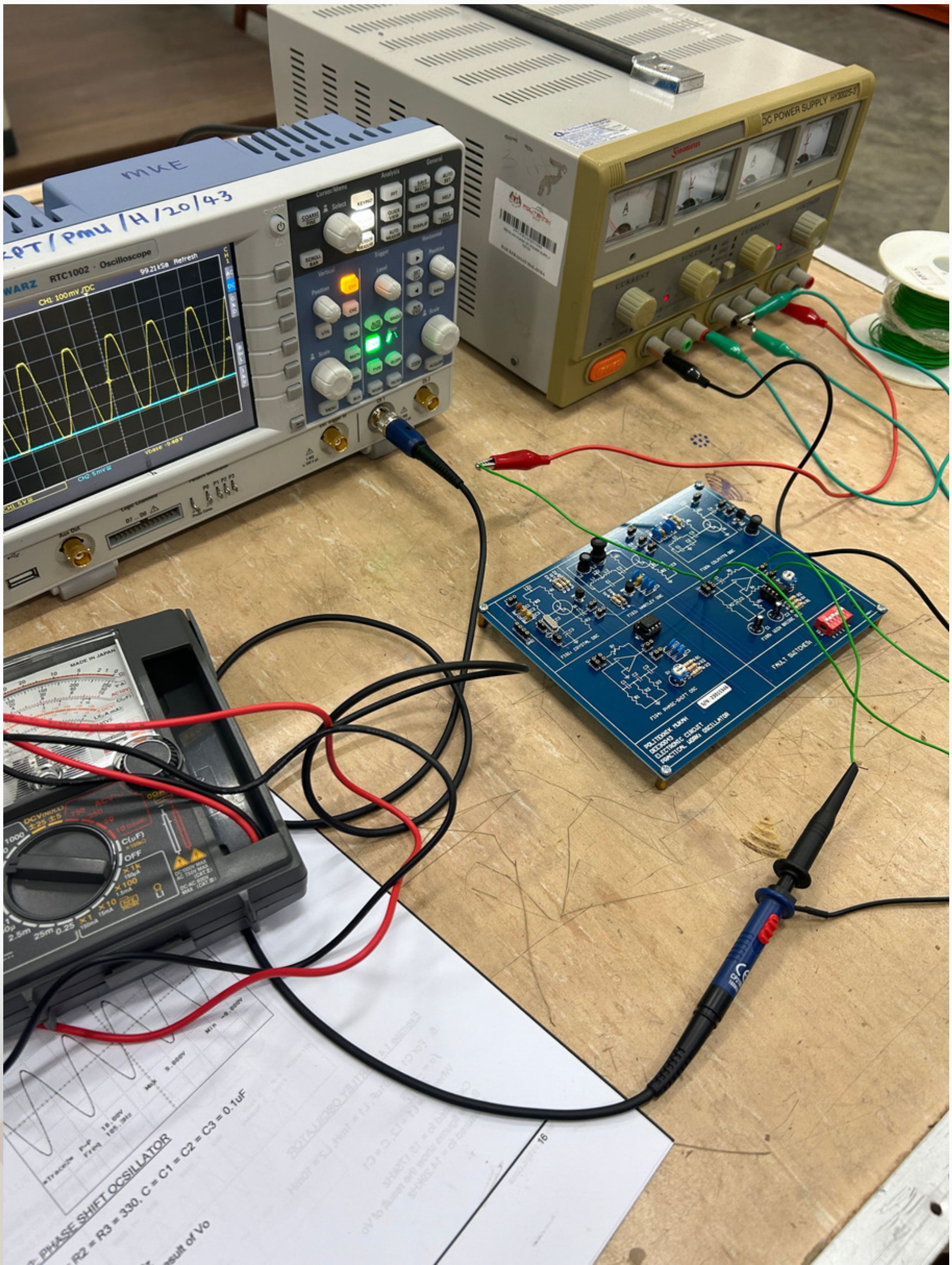
The resonant frequency is given as:

$$fo = \frac{1}{2\pi\sqrt{LC}}$$

Where $L = L1$, $C = \frac{C1C2}{C1+C2}$

EXPERIMENTS

& EXERCISES



DEE30043-ELECTRONIC CIRCUIT

LABORATORY 2:
OSCILLATOR

AIM : To construct and test various electronic circuit application based on the theory and principle operation of the circuit.

OBJECTIVE : At the end of the lab student should be able to:

1. Construct the feedback oscillator circuit
2. Determine the type of feedback oscillator circuit and its characteristics
3. Determine the effect of varying the value of L and C to the oscillator circuit

EQUIPMENT :

1. Lab Experiment Trainer
2. Oscilloscope

INTRODUCTION:

Oscillator is an electronic circuit that produces output of a periodic and oscillating waveform. It converts direct current from supply to alternating current output. Oscillator is widely use in signal broadcasting system such as radio and television transmission system. Figure 1 below shows the block diagram of oscillator.

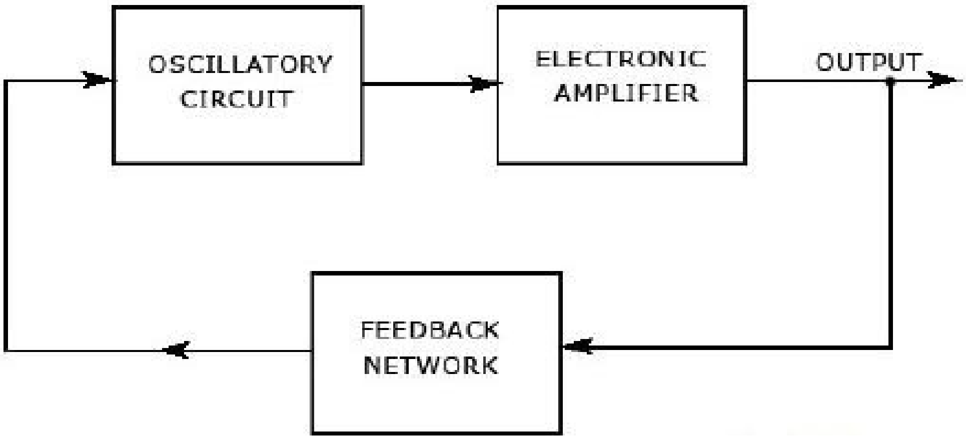


Figure 1: Block Diagram of an oscillator

An oscillator circuit consist of three parts; Transistor Amplifier, Tank Circuit and Feedback Circuit. Transistor Amplifier circuit used to receive direct current source and changes it into alternating signal to provide a supply for tank circuit. Tank circuit is used to produce the output frequency of oscillation. Feedback circuit is used to generate a positive feedback signal for oscillator circuit.

There are two conditions required at the feedback circuit to produce a sustain state of waveform oscillation such as:

a) The phase shift must be 0

b) The closed loop voltage

Figure 2 below show the classification feedback oscillator

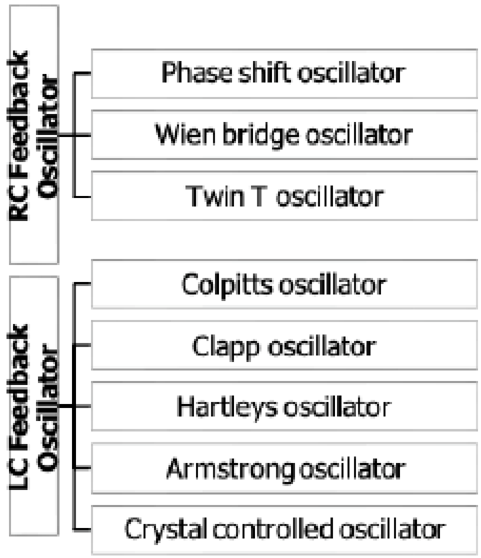


Figure 2 : Feedback oscillator classification

EXPERIMENTAL PROCEDURES:

A. The Wien Bridge Oscillator

1. Refer to FIG5 of the OP-AMP-OSC-01 experiment module.

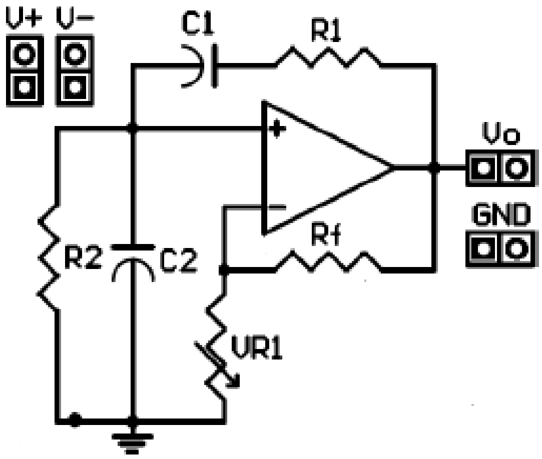


Figure 3a: Wien Bridge Oscillator circuit

2. Connect the required DC power supply to corresponding terminals. V+ to +12V, V- to -12V and GND to GND.
3. Connect the output Vo to oscilloscope to observe output waveform.
4. Turn on power.
5. Adjust the variable resistor VR1 so that Rf/VR1 approx 2.
6. Measure the output waveform using an oscilloscope and deduce your findings in comparison to the calculated answers.

B. Phase Shift Oscillator

1. Refer to FIG4 of the OP-AMP-OSC-01 experiment module.

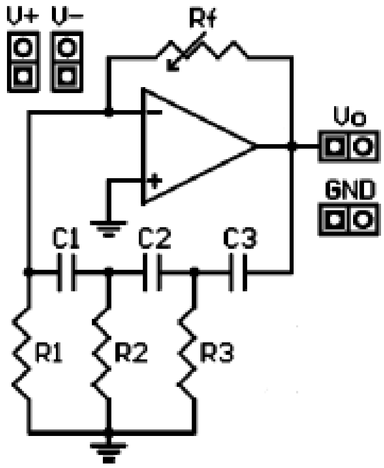


Figure 3b: Phase Shift Oscillator circuit

2. Connect the required DC power supply to corresponding terminals. V+ to +12V, V- to -12V and GND to GND.
3. Connect the output Vo to oscilloscope to observe output waveform.
4. Turn on power.
5. Set Rf to be very close to 29*R.
6. Measure the output waveform using an oscilloscope and deduce your findings in comparison to the calculated answers.

C. The Crystal Oscillator

1. Refer to FIG1 of the OP-AMP-OSC-02 experiment module.

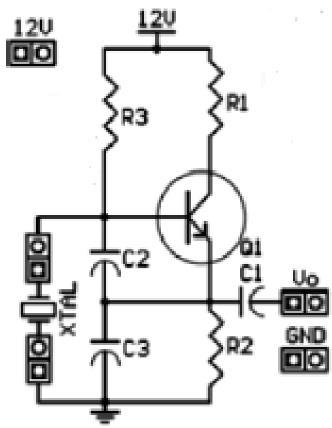


Figure 3c: Crystal Oscillator circuit

2. Connect the required DC power supply to corresponding terminals. 12V to +12V and GND to GND.
3. Connect the output Vo to oscilloscope to observe output waveform.
4. Connect a specific value of a crystal (2 pins), 4MHz to the crystal terminals.
5. Turn on power.
6. Measure the output waveform using an oscilloscope and deduce your findings.Measure the output waveform using an oscilloscope and deduce your findings in comparison to the calculated answers.

D. The Hartley Oscillator

1. Refer to FIG2 of the OP-AMP-OSC-02 experiment module.

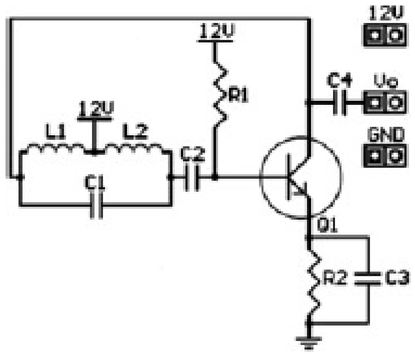


Figure 3d: Hartley Oscillator circuit

2. Connect the required DC power supply to corresponding terminals. 12V to +12V and GND to GND.
3. Connect the output Vo to oscilloscope to observe output waveform.
4. Turn on power.
5. Measure the output waveform using an oscilloscope and deduce your findings in comparison to the calculated answers.

E. The Colpitts Oscillator

1. Refer to FIG3 of the OP-AMP-OSC-02 experiment module.

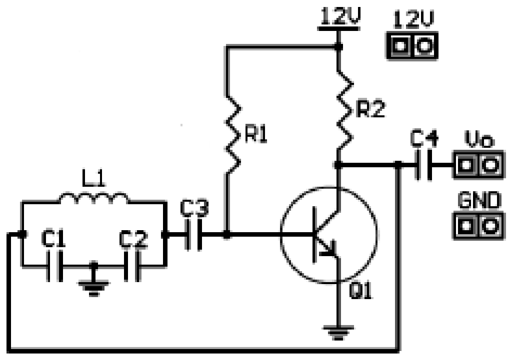


Figure 3e: Colpitts Oscillator circuit

2. Connect the required DC power supply to corresponding terminals. 12V to +12V and GND to GND.
3. Connect the output Vo to oscilloscope to observe output waveform.
4. Turn on power.
5. Measure the output waveform using an oscilloscope and deduce your findings in comparison to the calculated answers.

DATA & OBSERVATION :

Table 1 : Output waveform

No.	Circuit & Calculation	Results

DISCUSSION :

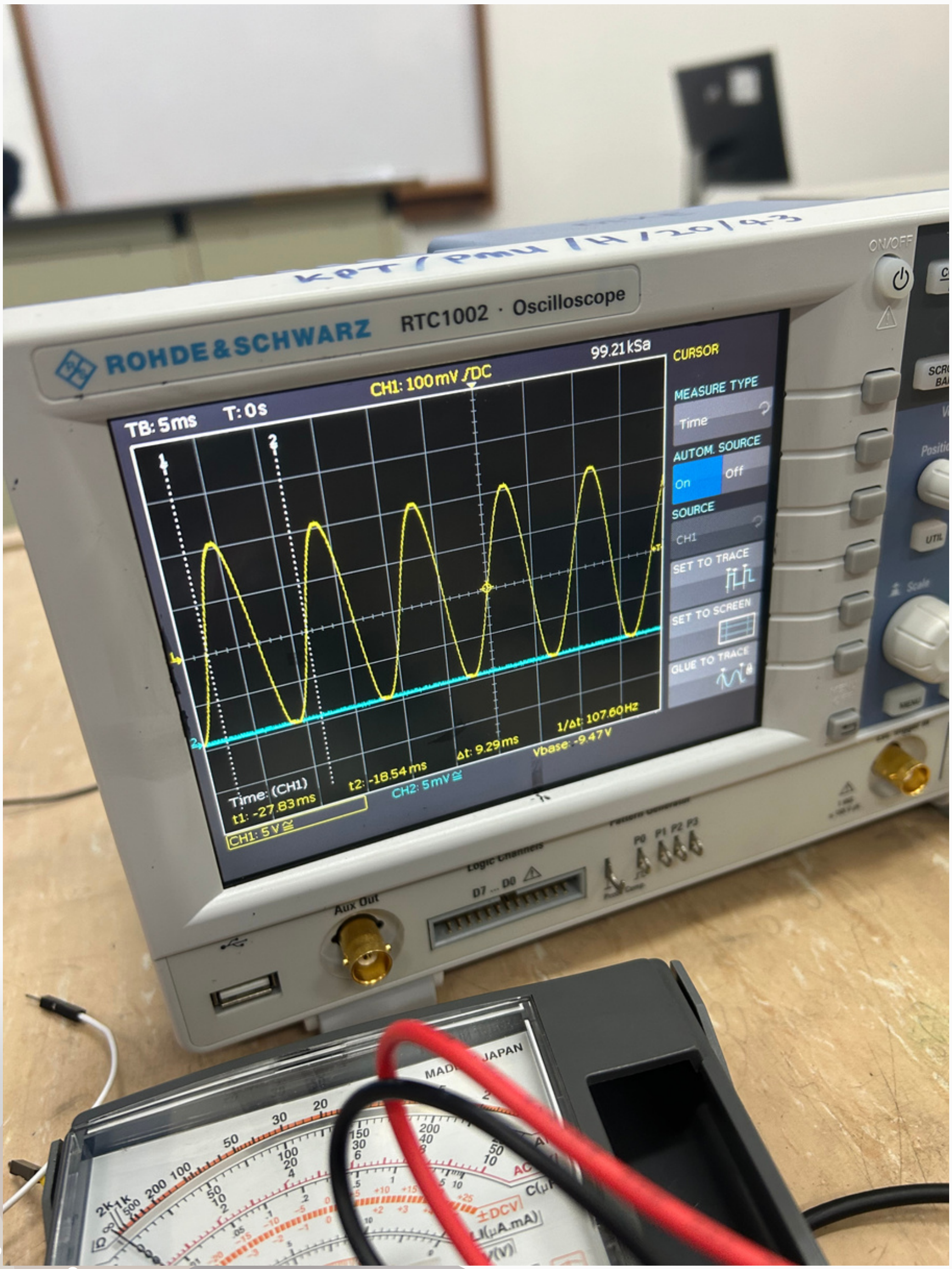
Compare the difference of waveform produced in Table 1. Explain your answer. .

CONCLUSION :

Make a full conclusion from the observation in this practical activities.

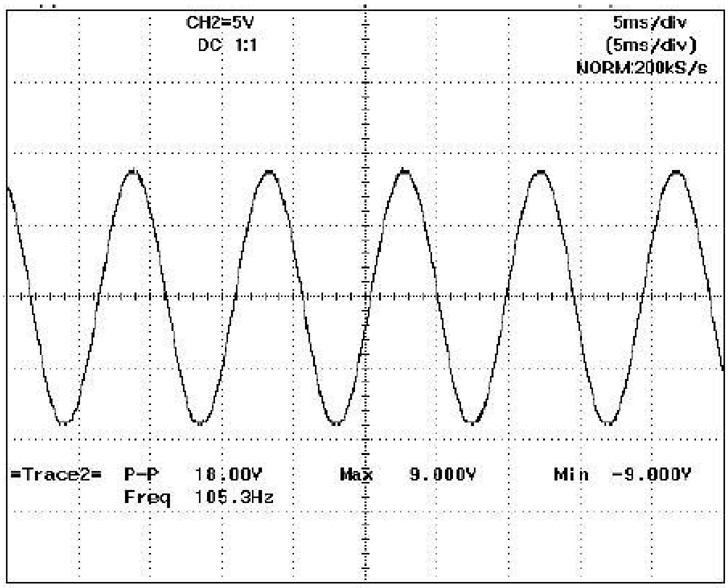
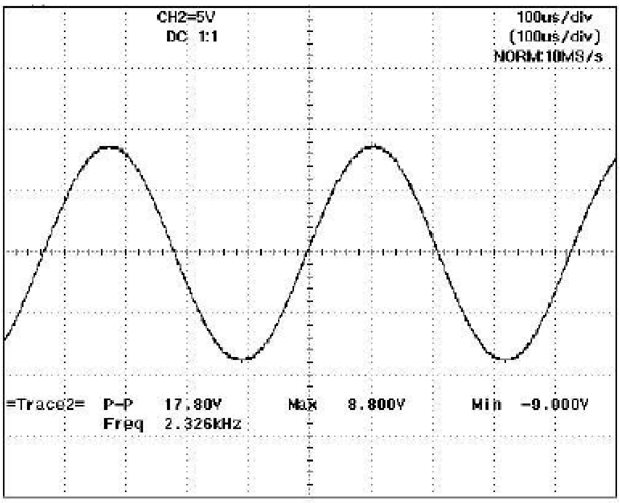
EXPECTED

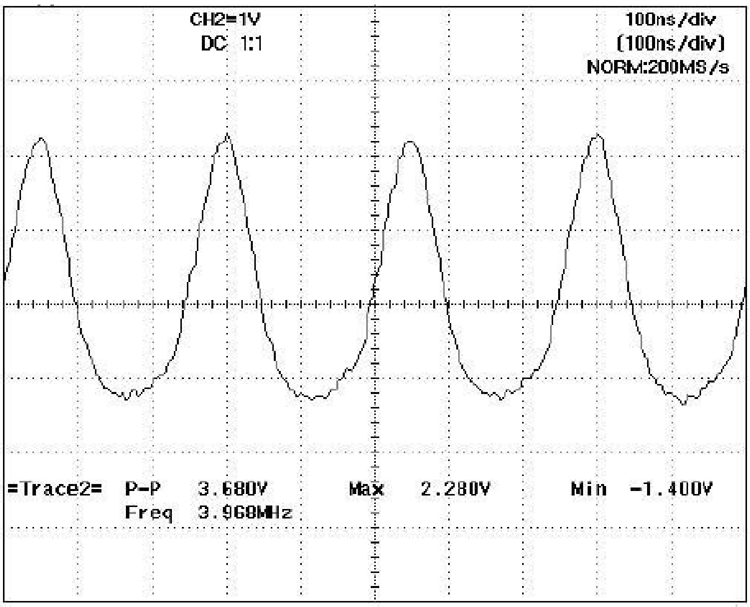
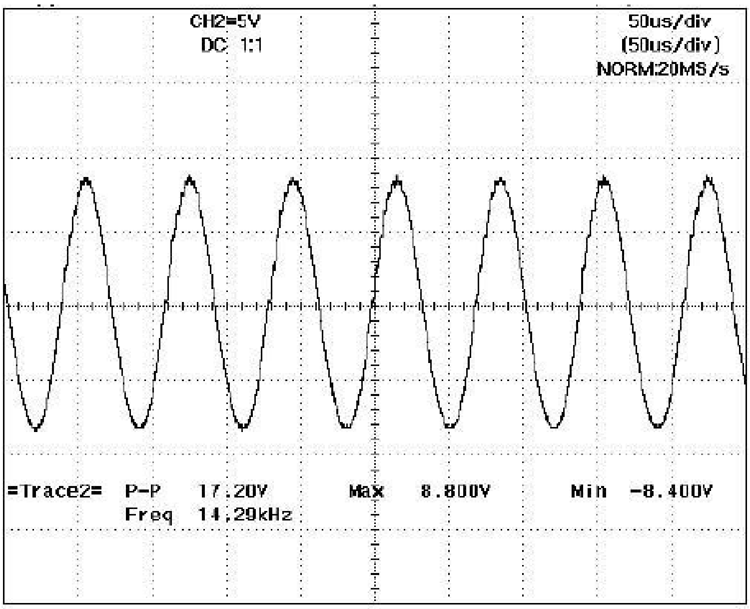
RESULTS

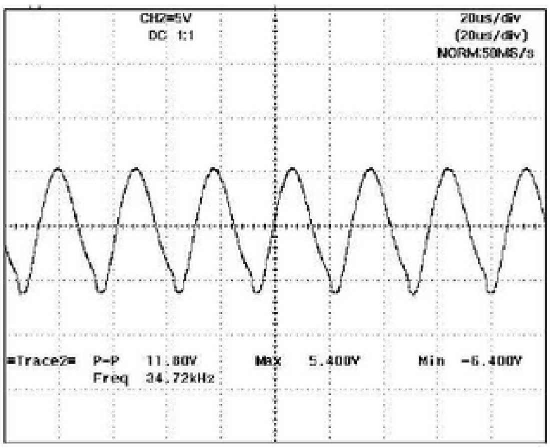


DATA & OBSERVATION :

Table 1 : Output waveform

No.	Circuit & Calculation	Results
1	Wien Bridge Ocsillator For R = R1 = R2 = 1k5, C = C1 = C2 = 1uF $fo = \frac{1}{2\pi RC}$ Calculated fo = 106Hz Figures show the result of Vo Measured fo = 105Hz	
2	Phase Shift Ocsillator For R = R1 = R2 = R3 = 330, C = C1 = C2 = C3 = 0.1uF $fo = \frac{1}{2\pi\sqrt{6}RC}$ Calculated fo = 1968Hz Below figures show the result of Vo Measured fo = 2.32kHz	

3	Crystal Oscillator The result of Vo for 4MHz crystal	
4	Hartley Oscillator For C1 = 0.01uF, L1 = 1mH, L2 = 10mH $fo = \frac{1}{2\pi\sqrt{LC}}$ Where L = L1 + L2, C = C1 Calculated fo = 15.175kHz Below figures show the result of Vo Measured fo = 14.29kHz	

5	Colpitts Oscillator For C1 = 0.01uF, C2 = 0.1uF, L1 = 2.2mH $fo = \frac{1}{2\pi\sqrt{LC}}$ Where L = L1, $C = \frac{C1C2}{C1+C2}$ Calculated fo = 35.588kHz Below figures show the result of Vo Measured fo =34.72kHz	

DISCUSSION :

Compare the difference of waveform produced in Table 1. Explain your answer. .

CONCLUSION :

Make a full conclusion from the observation in this practical activities.

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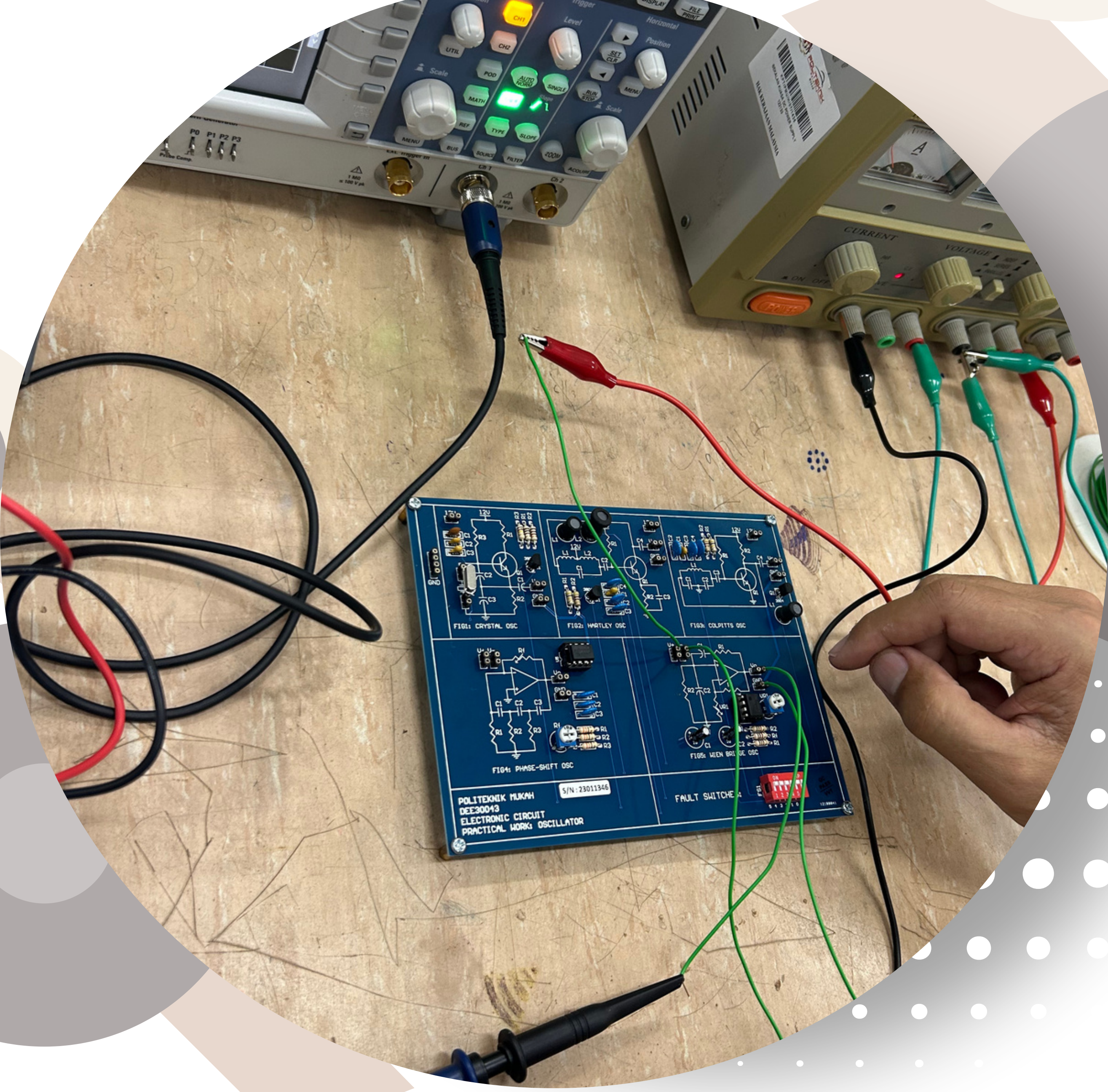

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