PRACTICE GUIDE

BASIC ELECTRONICS

BACHELOR OF PHYSICS PROGRAM
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MODULE I
OHM'S AND KIRCHOFF'S LAWS

Experiment Objectives:

- Be able to understand Ohm and Kirchoff's laws and be able to apply them.

Basic Theory:

A resistor is a two-channel electronic component designed to resist an electric current by producing a decrease in the electrical voltage between the two channels according to the current flowing through it based on Ohm's law.

Ohm's Law is a statement that the magnitude of the electric current flowing through a conductor is always directly proportional to the potential difference applied to it. A conductive object is said to obey Ohm's law if its resistance value does not depend on the magnitude and polarity of the potential difference imposed on it. Although this statement does not always apply to all types of carriers, the term "legal" is still used for historical reasons.

Mathematically Ohm's law is expressed by equations:

$$V = I.R$$

where I is the electric current flowing through a conductor in units of amperes, V is the electrical voltage present at both ends of the conductor in units of volts, and R is the value of electrical resistance (resistance) contained in a conductor in units of ohms.

Kirchoff's Law states that:

1. If various electric currents coincide at a point, then the algebraic sum of the strength of those currents is 0 (zero) at that point of coincidence.
2. In a closed circular electric current the following equation applies : "The algebraic sum of the times the current strength and resistance of each part (of the circular) is equal to the algebraic sum of its electric motion forces".
3. The amount of electric current flowing towards the branching point is equal to the amount of electric current coming out of the branching point.

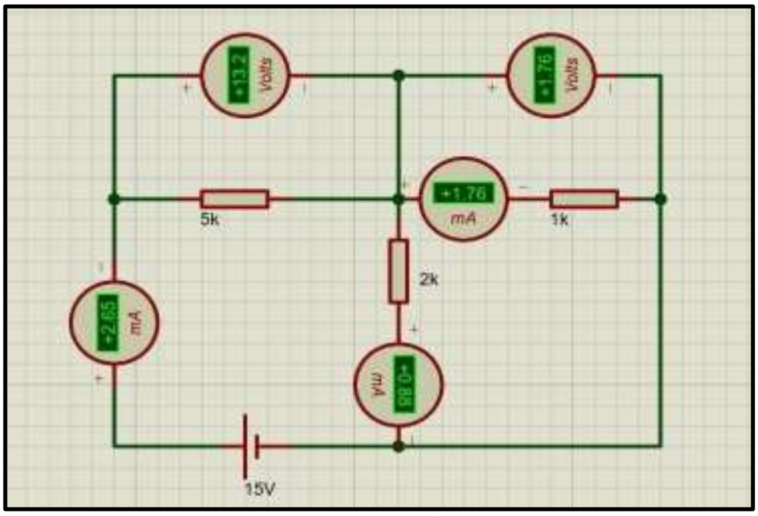
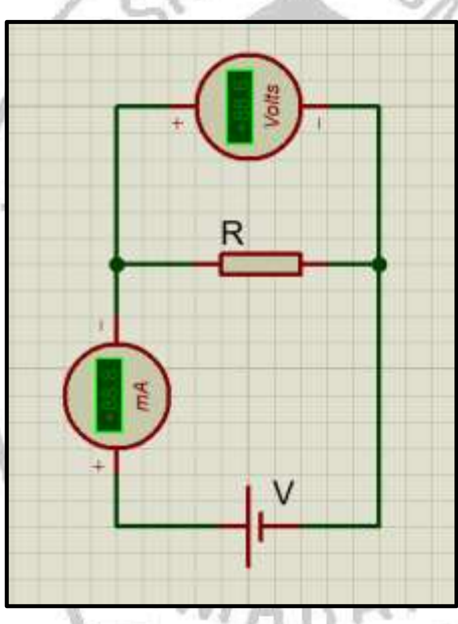


Figure 1. Application of Ohm's Law and Kirchoff's Law

Practice Activities:

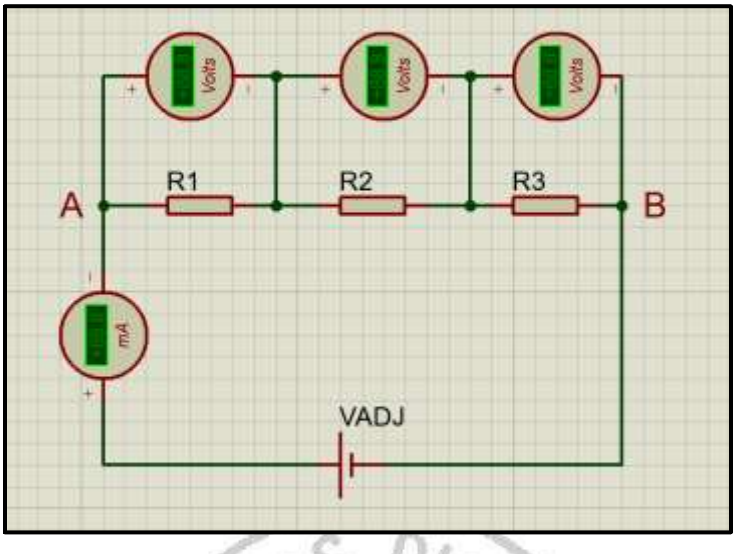
- **Experiment 1 : Ohm's Law Experiment**



Working steps:

1. Make a series like the one shown above (R value ask the assistant). Check the circuit before using it to the support assistant.
2. Turn on the voltage source V starting at 2V.
3. Record the readings on the voltmeter and amperemeter.
4. Slowly raise the voltage source (+2V).
5. Repeat Step 3.
6. Do it up to a rated voltage of 12V or according to the limit specified by the assistant (for the magnitude of the value V can be observed in the value indicated on the power supply)
7. Prove that the test value you obtained corresponds to ohm's law.

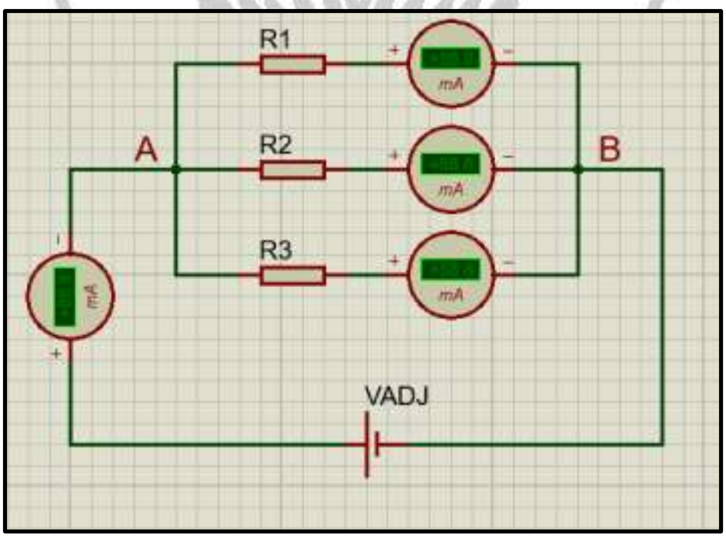
- **Experiment 2 : DC Current Series Circuit**



Working steps:

1. Make Circuit following above picture. Do circuit check before using it to the assistant.
2. Measure the total resistance of point AB using a multimeter.
3. Turn on voltage source and Record Value that appear on the amperemeter and each voltmeter.
4. Measure the voltage at point AB and record the result.
5. Measure and record the voltage present at R1, R2 and R3.
6. Compare the results of measurements and theoretical calculations.

- **Experiment 3 : DC Current Parallel Circuit**

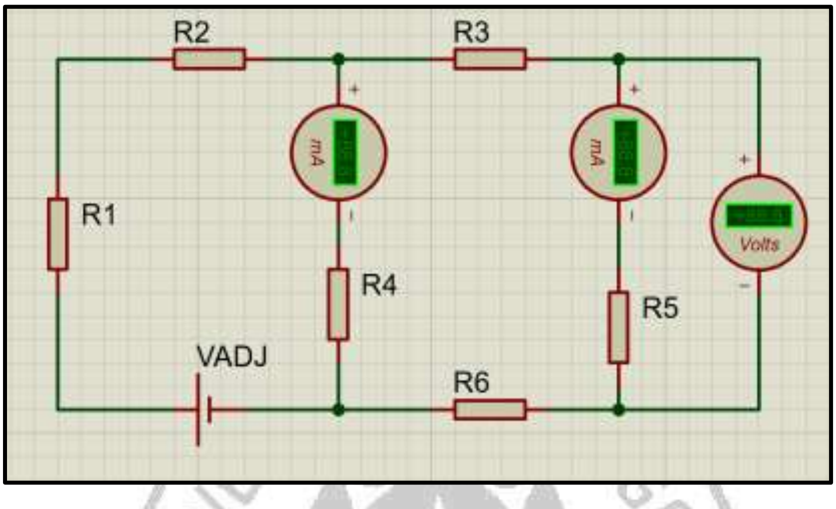


Working steps:

1. Make Circuit following above picture. Do circuit check before using it to the assistant.
2. Measure the total resistance of point AB using a multimeter.

3. Turn on the voltage source and record the values that appear on each ampermeter.
4. Measure the voltage at point AB and record the result.
5. Compare the results of measurements and theoretical calculations.

- **Experiment 4 : Combined Series**



Working Steps
1. Create a circuit like the one pictured above. Check the circuit before using it to the support assistant. The R value is determined by the Assistant.
2. Measure and record the value of the total resistance on the circuit.
3. Turn on the voltage source. Note the values that appear on the voltmeter and ampermeter.
4. Also measure the current and voltage values at R4 and R2.
5. Repeat Steps 2 – 4 with different voltage values. Ask the assistant for voltage value variations.
6. Compare the results of measurements and theoretical calculations

Information:
- For all experiments it is expected **to use caution** in the installation of measuring instruments and components, as misfitting may cause **damage** to the measuring instruments and components.
- Before turning on the voltage source on the circuit, ask **the practice assistant for approval and checking**. If the assistant has declared it feasible, the practitioner **can** turn on the voltage source and can start taking data.
- For all equipment damage caused by the practice's negligence that **does not** receive the assistant's prior approval, the **practice will be fully borne by the** practice for repair or replacement of damaged equipment components during the practice.

MODULE II
WHEATSTONE BRIDGE

Experiment Objectives:

- Knowing the wheatstone bridge circuit.
- Knowing the process of changing the delta to wye series and vice versa.

Basic Theory:

The wheatstone bridge is a measuring instrument invented in 1833 by Samuel Hunter Christie. The Wheatstone Bridge Series is a series used to simplify the arrangement of resistorss that originally could not be simplified in a parallel series to be simplified in a series of parallels. A set of resistorss can be calculated with the Wheatstone bridge principle if the result of two resistorss facing each other is equally great.

Wheatstone circuits are nothing more than 2 simple parallel circuit parallel arrangements connected between the voltage supply terminals and the ground resulting in a zero voltage difference between two parallel branches if balanced. The Wheatstone bridge circuit has 2 input terminals and 2 output terminals consisting of 4 resistors configured in a circuit.

Consider Figure 2. The Wheatstone Bridge series is a series with R1, R2, R3, R4 and R5 (ignore Ra, Rb and Rc first). This series can be solved simply if the result of multiplying R4 and R2 with R1 and R3 is of the same value. Thus, the value of R5 can be ignored because the voltage at R5 is value 0. When R5 is ignored, then the series is solved easily using the series and parallel series equations.

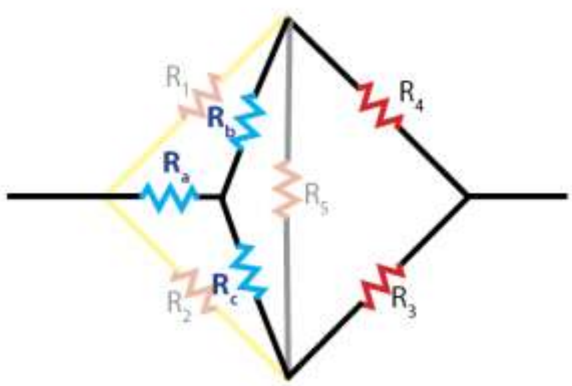


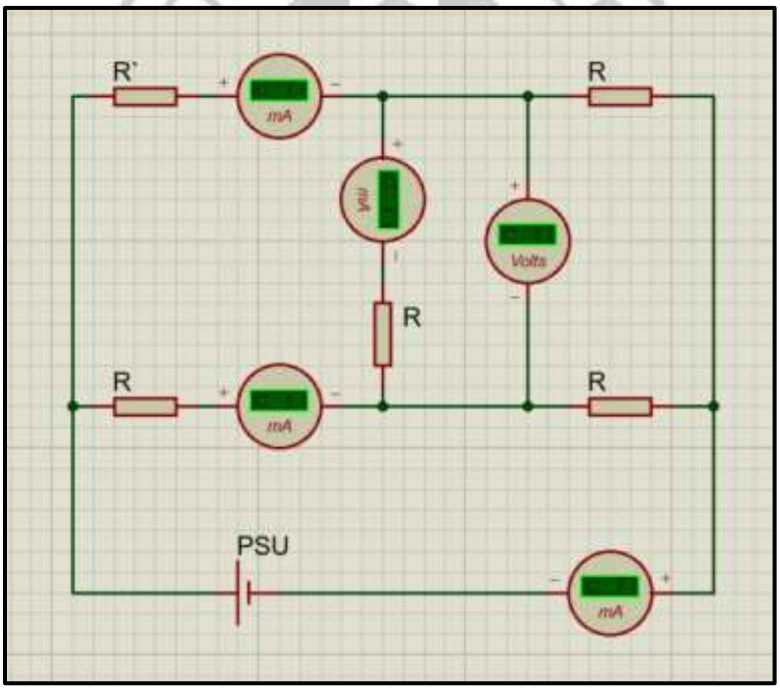
Figure 2. Wheatstone Bridge Circuit

If these conditions are not met, then the completion of the Wheatstone Bridge series must use the delta to Y transformation method. Now pay attention to R1, R2 and R5, the arrangement of these resistors forms a triangle or delta with the sides consisting of R1, R2 and R5. Then, this circuit is converted to the wye form with the value R1 changing to Ra, R2 changing to Rb and R5 changing to Rc. After being changed to this shape, then the solution can use a simple parallel series circuit equation. The equations of Ra, Rb and Rc are as follows.

$$\mathrm{Ra} = \frac{\mathrm{R1.R2}}{\mathrm{R1 + R2 + R3}}$$
$$\mathrm{Rb} = \frac{\mathrm{R1.R5}}{\mathrm{R1 + R2 + R3}}$$
$$\mathrm{Ra} = \frac{\mathrm{R2.R5}}{\mathrm{R1 + R2 + R3}}$$

Practice Activities:

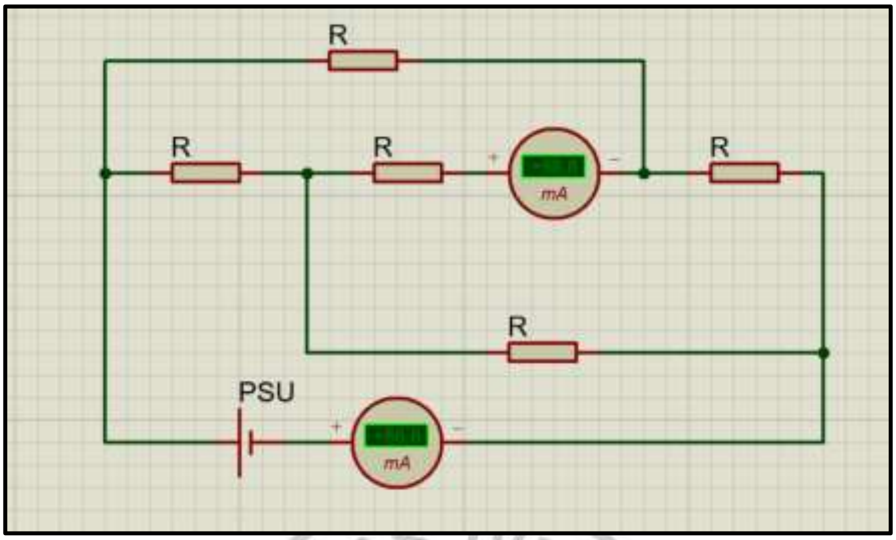
- **Experiment 1 : Wheatstone Bridge Series**



Working steps:

1. Make Circuit following above picture. Do circuit check before using it to the teaching assistant.
2. Measure the total resistance using a multimeter.
3. Turn on the voltage source, then measure and record the voltage and current at each resistance.
4. Vary the value of the resistance and the voltage source according to the assistant's direction.
5. Repeat steps 2 – 4.
6. Compare result Measurement and account of theory.

- **Experiment 2 : Delta to Wye Transformation Series**



Working steps:

1. Make a series like the picture above. Change the value of the resistors according to the assistant's direction. Check the circuit before using it to the support assistant.
2. Measure the total resistance using a multimeter.
3. Turn on the voltage source, then measure and record the voltage and current at each resistance.
4. Vary the value of the resistance and the voltage source according to the assistant's direction.
5. Repeat steps 2 – 4.
6. Compare result Measurement and account of the theory by transforming Delta to Wye and Wye to Delta.

Information:

- For all experiments it is expected **to use caution** in the installation of measuring instruments and components, as misfitting may cause **damage** to the measuring instruments and components.
- Before turning on the voltage source on the circuit, ask **the practice assistant for approval and checking**. If the assistant has declared it feasible, the practitioner **can** turn on the voltage source and can start taking data.
- For all equipment damage caused by the practice's negligence that **does not** receive the assistant's prior approval, the **practice will be fully borne by the** practice for repair or replacement of damaged equipment components during the practice.

MODULE III
CAPACITORS AND PASSIVE FILTERS

Experiment Objectives:

- Know the process of charging and discharging capacitors.
- Knowing the difference between a pastive filter and a capacitor

Basic Theory:

A capacitor is a device that can store energy in an electric field, by collecting an internal imbalance of the electric charge. The unit of capacitor is Farad (F). However Farad is a large a unit, so it is used:

- Pikofarad (*pF*) = $1x10^{-12}$
- Nanofarad (*nF*) = $1x10^{-9}$
- Microfarad (*μF*) = $1x10^{-6}$

Capacitance is defined as the ability of a capacitor to be able to accommodate an electron charge. The formula for capacitor as a charge storage can be written:

$$Q = C.V$$

- Q = electron charge in C (*coulombs*)
- C = capacitance value in F (*farads*)
- V = large voltage in V (*volts*)

The capacitance of the capacitor can be determined by the formula:

$$C = \mathcal{E}0\mathcal{E}r\frac{A}{d}$$

C : Capacitance
$\mathcal{E}0$: Vacuum permitivity
$\mathcal{E}r$: relative permitivity
A : Plate area
d : distance between plates/dielectric thickness

As for how to enlarge the capacitance of a capacitor or capacitor by way:

1. Arrange it in layers.
2. Expanding the variable surface.
3. Uses materials with great potency. Based on their usefulness, the capacitor is divided into:
   a) Fixed capacitor (the capacity value remains unchanged)
   b) Kondensator elektrolit (*Electrolite Condenser* = Elco)
   c) Variable capacitors (their capacity values are variable) Capacitors are of several types, depending on their dielectric material.

To make it simpler, it can be divided into 3 parts, namely capacitors *electrostatic*, *electrolytic* dan *electrochemical*.

Electrostatic Capacitor

Electrostatic capacitors are a group: capacitors made with dielectric materials from ceramics, films and mica. Ceramics and mica are popular as well as inexpensive materials for making capacitors with small capacitances. Available from pF to several uF, which is typically for high-frequency circuit applications. Generally, capacitors of this group are non-polar.

Electrolytic Capacitor

The electrolytic capacitor group consists of capacitors whose dielectric material is a metal-oxide layer. Generally, capacitors that belong to this group are polar capacitors with + and - signs on their bodies. This capacitor can have polarity because the manufacturing process uses electrolysis so that a positive anode and a negative cathode are formed.

Electrochemical Capacitor

Another type of capacitor is electrochemical capacitors. Included in this type of capacitor are batteries and accus. In fact, batteries and *accus* are excellent capacitors, because they have a large capacitance and *a very small* leakage current.

One of the uses of capacitors is as a filter. A filter is a circuit for forwarding or transmitting signals over a specific frequency region. Filters can be designed with reactive circuits (R, C). On the basis of their frequency region, filters are divided into:

1. *Low pass filter* (skip low frequencies below the limit value)
2. *High pass filter* (passes high frequencies above the limit value)
3. *Band pass filter* (skipping frequencies between low and high limits)
4. *Band rejection filter* (skipping frequencies below the low limit and above the high)

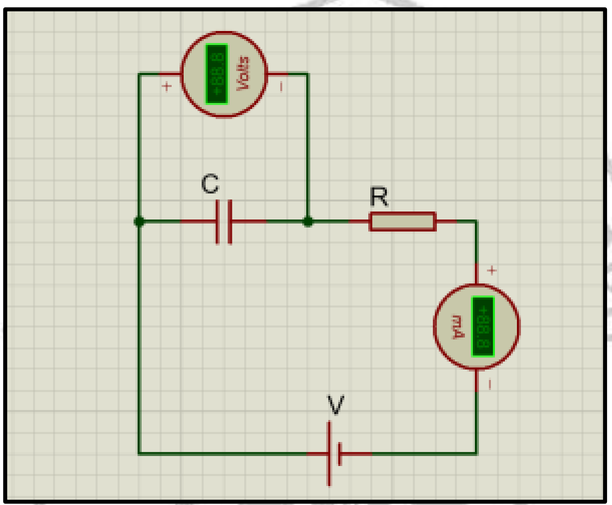
The frequency limit between a signal that can be forwarded and that is muffled or retained is called the cut-off frequency. The cut-off frequency can be determined by the following calculations:

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

Where:
R : Resistance value
C : Capacitor value

Practice Activities:

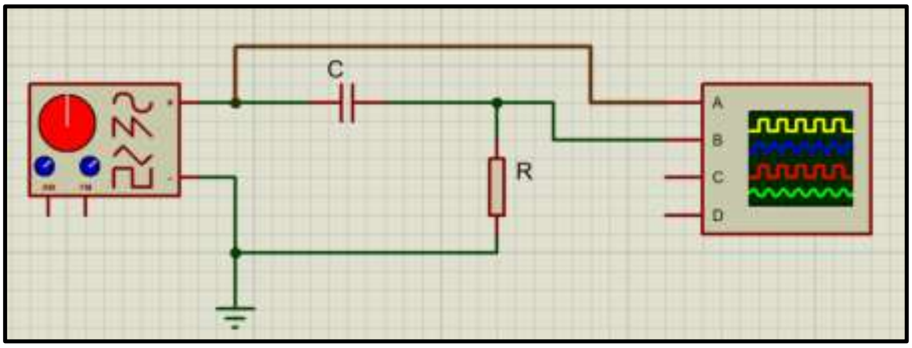
- **Experiment 1 : Capacitor Discharge Charging**



Working steps:

1. Make a series circuit like the picture above. Adjust the value of the component quantity according to the instructions from the assistant. Check the circuit before using it to the support assistant.
2. Prepare *the Stopwatch*, turn on the voltage source at the same time as *stopwatch*.
3. Record the current and voltage values that are read every few seconds.
4. Disconnect the cable towards the power supply then short connect the two cables.
5. Record the current and voltage values that are read every few seconds.
6. Vary the capacitor values and repeat steps 2 – 5.
7. Create a graph from the Experiment Results. Analyze the results obtained.

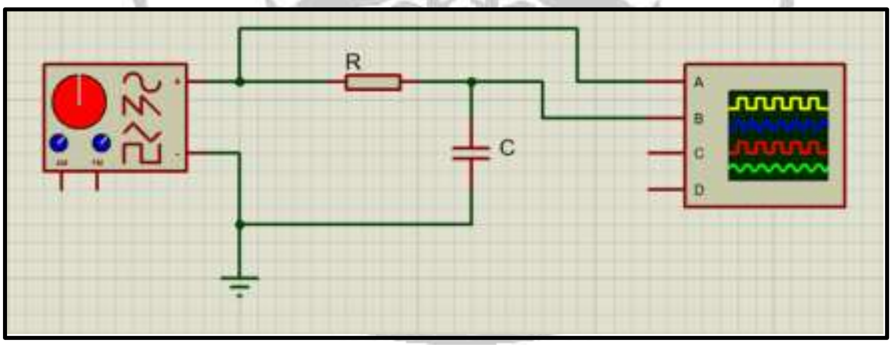
- **Experiment 2 : High Pass Filter**



Working Steps:

1. Make a series like the picture above. Adjust the value of the component quantity according to the instructions from the assistant. Check the circuit before using it to the support assistant.
2. Turn on the Signal generator, setting the amplitude and frequency according to the instructions of the assistant.
3. Set the signal display on the oscilloscope then save/photograph the Oscilloscope Graph for Data Analysis.
4. Vary the signal generator's frequency values according to the assistant's directions.
5. Calculate the *cut-off* frequency (fc) using the formula.
6. Determine the *cut-off* frequency area (fc).

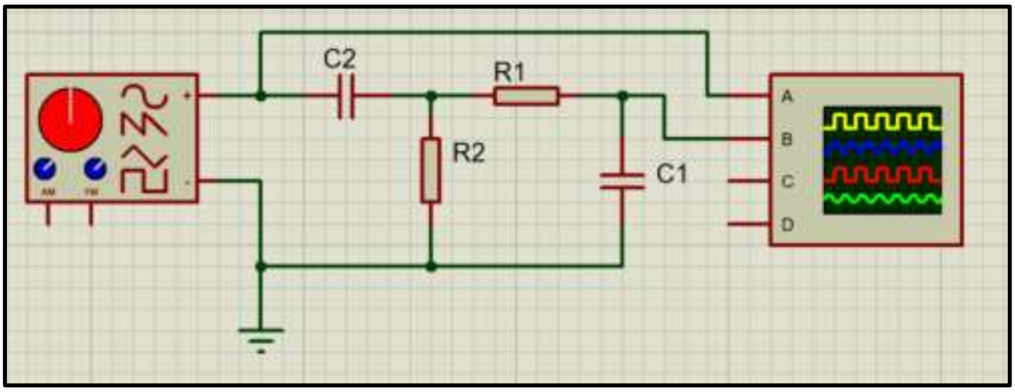
- **Experiment 3 : Low Pass Filter**



Working Steps:

1. Make a series like the picture above. Adjust the value of the component quantity according to the instructions from the assistant. Check the circuit before using it to the support assistant.
2. Turn on the Signal generator, setting the amplitude and frequency according to the instructions of the assistant.
3. Set the signal display on the oscilloscope then save/photograph the Oscilloscope Graph for Data Analysis.
4. Vary the signal generator's frequency values according to the assistant's directions.
5. Calculate the *cut-off* frequency (fc) using the formula.
6. Determine the *cut-off* frequency area (fc).

- **Experiment 4 : Band Pass Filter**



Working Steps:

1. Make a series like the picture above. Adjust the value of the component quantity according to the instructions from the assistant. Check the circuit before using it to the support assistant.
2. Turn on the Signal generator, setting the amplitude and frequency according to the instructions of the assistant.
3. Set the signal display on the oscilloscope then save/photograph the Oscilloscope Graph for Data Analysis.
4. Vary the signal generator's frequency values according to the assistant's directions.
5. Calculate the *cut-off* frequency (fc) using the formula.
6. Determine the *cut-off* frequency area (fc).

Information:

- For all experiments it is expected **to use caution** in the installation of measuring instruments and components, as misfitting may cause **damage** to the measuring instruments and components.
- Before turning on the voltage source on the circuit, ask **the practice assistant for approval and checking**. If the assistant has declared it feasible, the practitioner **can** turn on the voltage source and can start taking data.
- For all equipment damage caused by the practice's negligence that **does not** receive the assistant's prior approval, the **practice will be fully borne by the** practice for repair or replacement of damaged equipment components during the practice.

MODULE IV
AC CURRENT RLC CIRCUIT

Experiment Objectives:

- Knowing the effect of AC current on the RL, RC, and RLC circuits.
- To know the phenomenon of resonance frequencies in the RLC circuit of AC current.

Basic Theory:

Resistors (R), inductors (L), and capacitors can be assembled in an electrical circuit in series, parallel, or combination. An electrical circuit that contains resistors, inductors, and capacitors is known as an RLC circuit. Resistors are electrical components that have a function to inhibit electric current. While inductors and capacitors are devices that can store energy for a while. The difference between an inductor and a capacitor lies in the type of energy stored in the form of a magnetic field (inductor) or an electrical charge (capacitor).

In the RLC series AC circuit, the magnitude of the electric current in each component is equal (IR = IL = IC) and meets the equation I = Imax · without ωt. The effective current value (Ief) is the root of the mean value of the current square or rms (root mean square) that meets the equation Imax = Ief√2. The electric current will pass through all three components so that VR (on the resistor), VL (on the inductor), and VC (on the capacitor) voltage. The difference in potential or source voltage on the RLC series AC circuit meets the equation V = Vmax · sin (ωt
+ φ) with an effective voltage meets the equation Vmax = Vef√2. Where the source voltage (V) is not equal to the sum of the voltages of the three components (V ≠ VR + VL + VC). The form of a series RLC circuit connected to an AC (Alternating Current) voltage source or alternating current is appropriate in the following example.

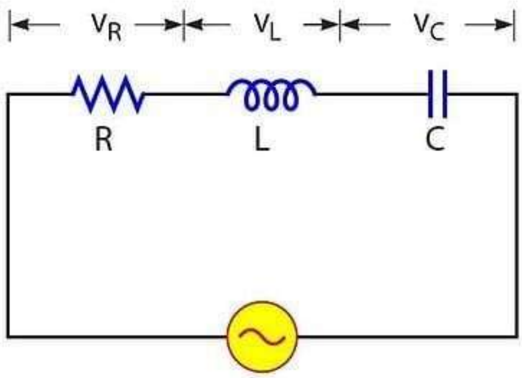
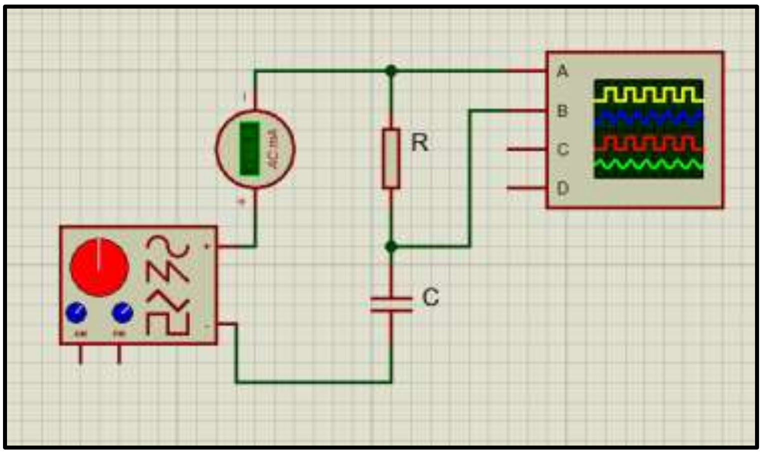


Figure 3. AC Current RLC Circuit

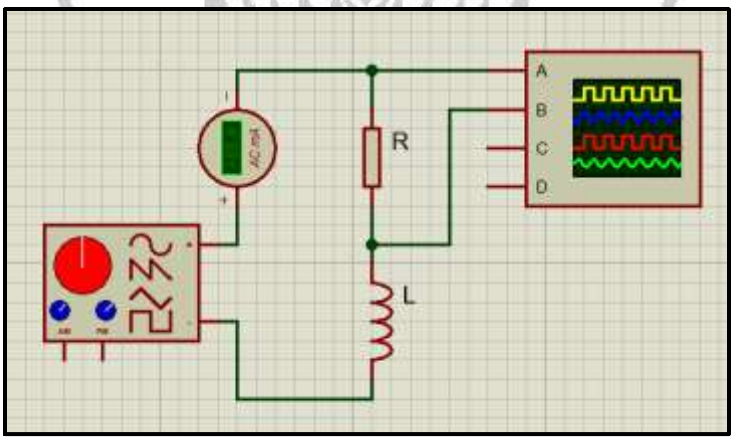
- **Experiment 1 : Series R-C Series**



Working Steps:

1. Make a series like the picture above. Adjust the value of the component quantity according to the instructions from the assistant. Check the circuit before using it to the support assistant.
2. Turn on the Signal generator, setting the amplitude and frequency according to the instructions of the assistant.
3. Set the signal display on the oscilloscope according to the assistant's direction then save/photograph the Oscilloscope Graph for Data Analysis.
4. Vary the signal generator's frequency values according to the assistant's directions.
5. Explain the difference in signals before and after passing through the RC series in Data analysis.

- **Experiment 2: R-L series**

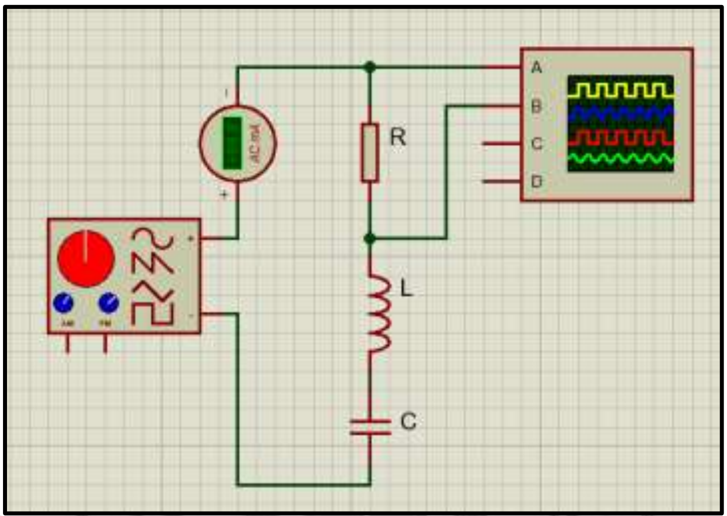


Working Steps:

1. Make a series like the picture above. Adjust the value of the component quantity according to the instructions from the assistant. Check the circuit before using it to the support assistant.
2. Turn on the Signal generator, setting the amplitude and frequency according to the instructions of the assistant.
3. Set the signal display on the oscilloscope according to the assistant's

instructions then save/photo Oscilloscope Graph for Data Analysis.
4. Vary the signal generator's frequency values according to the assistant's directions.
5. Explain the difference in signals before and after passing the RL series in Data analysis.

- **Experiment 3: Series R-L-C series**



Working Steps:
1. Make a series like the picture above. Adjust the value of the component quantity according to the instructions from the assistant. Check the circuit before using it to the support assistant.
2. Turn on the Signal generator, setting the amplitude and frequency according to the instructions of the assistant.
3. Set the signal display on the oscilloscope according to the assistant's direction then save/photograph the Oscilloscope Graph for Data Analysis.
4. Vary the signal generator's frequency values according to the assistant's directions.
5. Explain the difference in signals before and after passing the RL series in Data analysis.
6. Determine the value of its resonant frequency.

Information:
- For all experiments it is expected **to use caution** in the installation of measuring instruments and components, as misfitting may cause **damage** to the measuring instruments and components.
- Before turning on the voltage source on the circuit, ask **the practice assistant for approval and checking**. If the assistant has declared it feasible, the practitioner **can** turn on the voltage source and can start taking data.
- For all equipment damage caused by the practice's negligence that **does not** receive the assistant's prior approval, the **practice will be fully borne by the** practice for repair or replacement of damaged equipment components during the practice.

MODULE V
DIODE CHARACTHERISTICS

Experiment Objectives:

- Can determine the anode pole and diode cathode
- Can know the characteristics of the diode
- Can know the function of the diode

Theoretical basis:

Diodes are active components made of semiconductors. Active components are components that can only work if they get an initial voltage. If a part of a P-type semiconductor is connected to an N-type semiconductor part, it turns out that the formed connection will flow direct current easily in one direction, but will provide considerable resistance in the opposite direction. A two-electrode semiconductor device of P-type and N-type is called a diode. So the diode only conducts current easily in one direction, forward direction (forward bias).

Figure 1. Diode symbols and poles

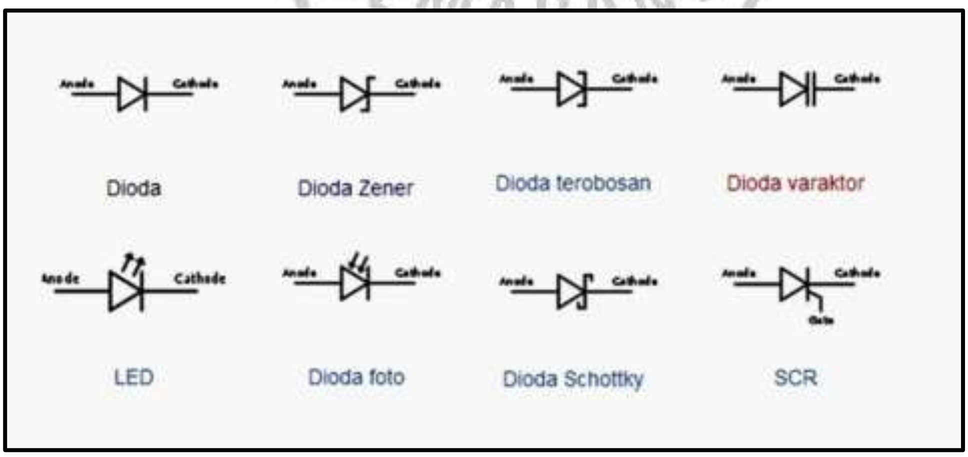


Figure 2. Various diodes

Diodes on the market are silicon or germanium diodes with currents from a few milliamps to several hundred amperes and voltages up to thousands of volts. The characteristics of the diode can be shown in the following figure.

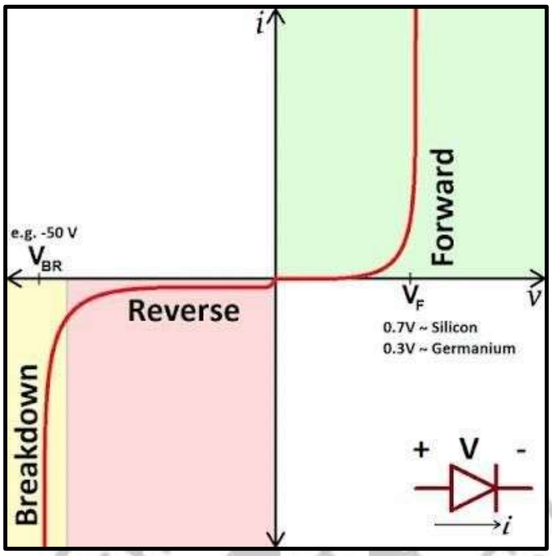
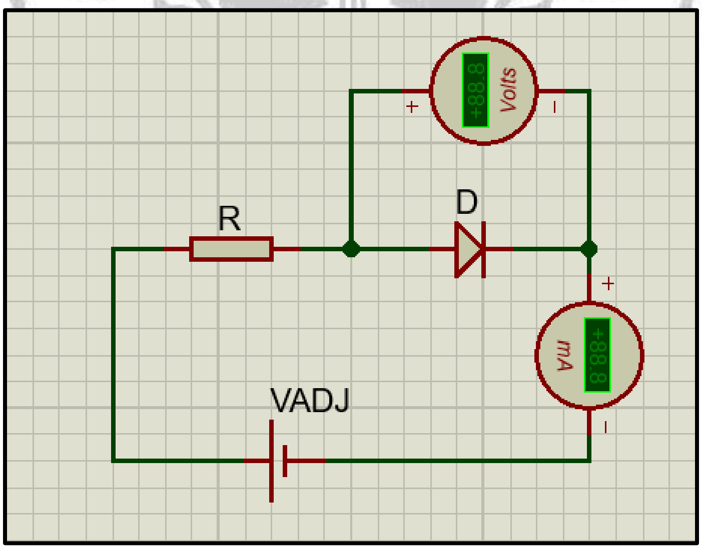


Figure 4. Characteristics of forward bias and diode backward bias.

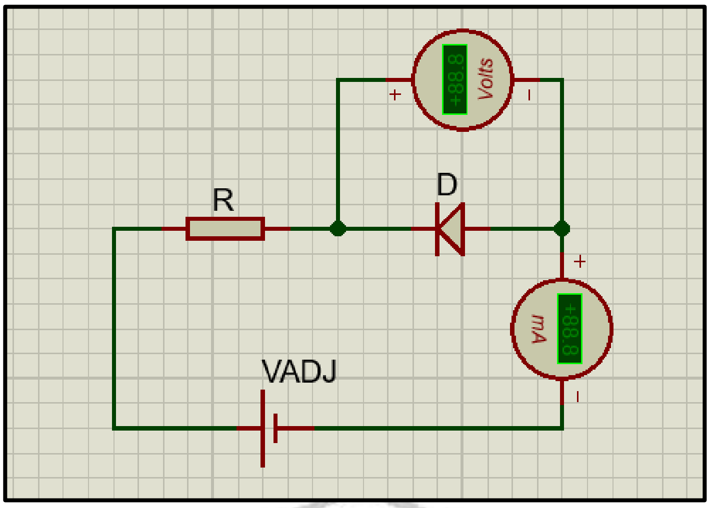
Practicum Activities:

- **Experiment 1: Forward Bias Rectifier**



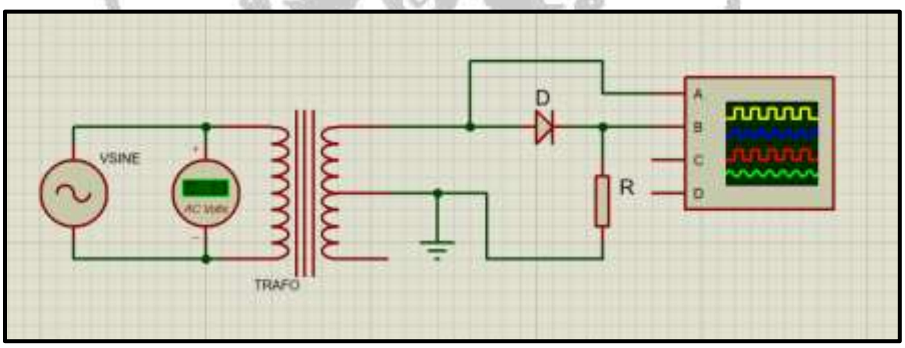
1. Make a series like the picture above. Adjust the value of the component quantity according to the instructions from the assistant. Check the circuit before using it to the support assistant.
2. Set the power source to 1VDC and then turn it on.
3. Record the change in voltage and current on the voltmeter and amperemeter for each increase in the Vadj.
4. Vary the voltage value according to the assistant's directions.
5. Make a graph from the data obtained, then explain the data obtained in the Data Analysis.

- **Experiment 2: Reverse Bias Rectifier**



1. Make a series like the picture above. Adjust the value of the component quantity according to the instructions from the assistant. Check the circuit before using it to the support assistant.
2. Set the power source to 1VDC and then turn it on.
3. Record changes in voltage and current on the voltmeter and amperemeter.
4. Vary the voltage value according to the assistant's directions.
5. Make a graph from the data obtained, then explain the data obtained in the Data Analysis.

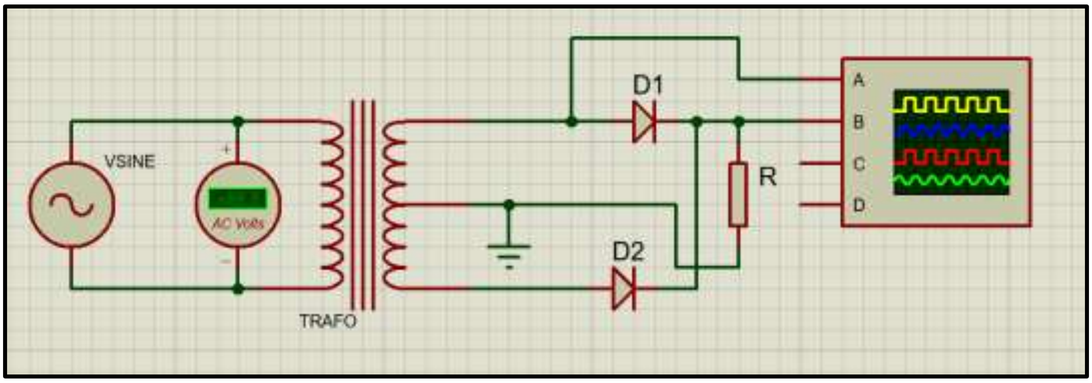
- **Experiment 3: Single Rectifier.**



Working steps:

1. Make a series like the picture above. Adjust the value of the component quantity according to the instructions from the assistant. Check the circuit before using it to the support assistant.
2. Turn on the voltage source of the transformer and oscilloscope.
3. Observe the waveform and save the graphic image.
4. Measure the voltage before and after the diode using a digital multimeter and record the results.
5. Compare it to the direct waveform of the transformer without using a diode rectifier (pure AC wave).

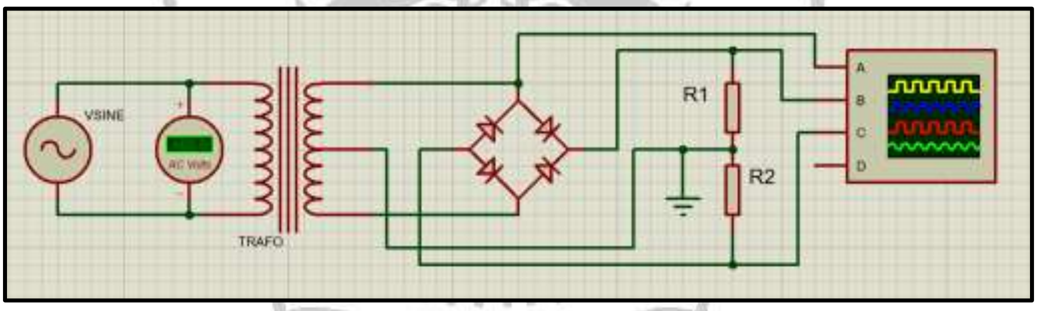
- **Experiment 4: Dual Rectifier**



Working steps:

1. Make a series like the picture above. Adjust the value of the component quantity according to the instructions from the assistant. Check the circuit before using it to the support assistant.
2. Turn on the voltage source of the transformer and oscilloscope.
3. Observe the waveform and save the graphic image.
4. Measure the voltage before and after the diode using a digital multimeter and record the results.
5. Compare it to the direct waveform of the transformer without using a diode rectifier (pure AC wave).

- **Experiment 5: Bridge Diode**



Working steps:

1. Make a series like the picture above. Adjust the value of the component quantity according to the instructions from the assistant. Check the circuit before using it to the support assistant.
2. Turn on the voltage source of the transformer and oscilloscope.
3. Observe the waveform and save the graphic image.
4. Measure the voltage before and after the diode using a digital multimeter and record the results.
5. Compare it to the direct waveform of the transformer without using a diode rectifier (pure AC wave).

Information:

- For all experiments it is expected **to use caution** in the installation of measuring instruments and components, as misfitting may cause **damage** to the measuring instruments and components.
- Before turning on the voltage source on the circuit, ask **the practice assistant for approval and checking**. If the assistant has declared it feasible, the practitioner **can** turn on the voltage source and can start taking data.
- For all equipment damage caused by the practice's negligence that **does not** receive the assistant's prior approval, the **practice will be fully borne by the** practice for repair or replacement of damaged equipment components during the practice.

MODULE VI
TRANSISTOR BIPOLAR NPN

Experiment Objectives:

- Can know the characteristics of the transistor
- Can know the function of the transistor

Basic Theory:

The transistor is one of the components of active electronics and has three legs named Base (B), Collector (C) and Emitter (E) respectively. Transistors can serve as current and voltage amplifiers. Transistors can also function as electronic switches. There are two types of transistors, namely NPN transistors and PNP transistors.

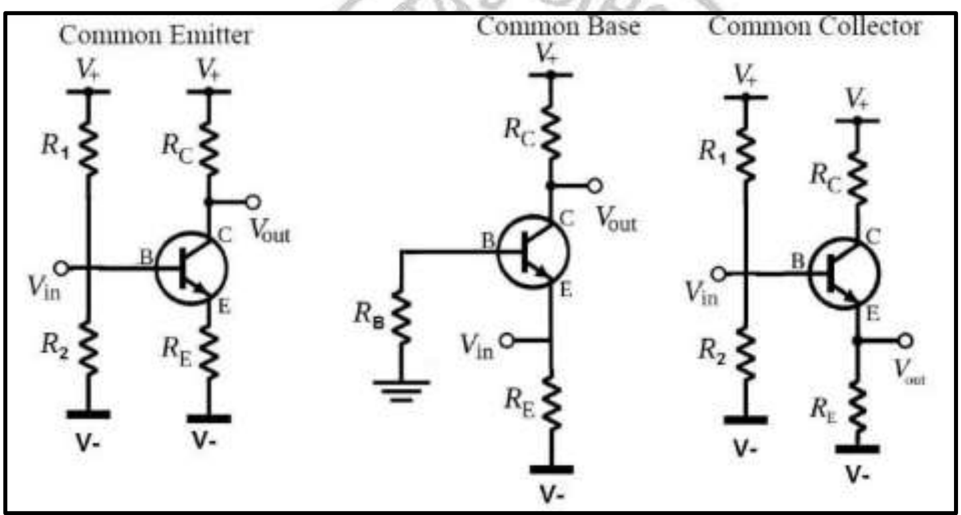


Figure 1. NPN Transistor Configuration

In its use, transistors can be assembled in three configurations, namely: common emitter, common basis, and common collector. Transistors have several characteristics including input characteristics, transmission characteristics and transfer characteristics. Transistors are usually often used as amplifiers, in general the use of transistors as amplifiers can be grouped into several systems, including class A amplifiers, class B amplifiers, class AB amplifiers and class C amplifiers. Transistors can not only function as amplifiers, but also function as electronic switches using the Darlington Circuit.

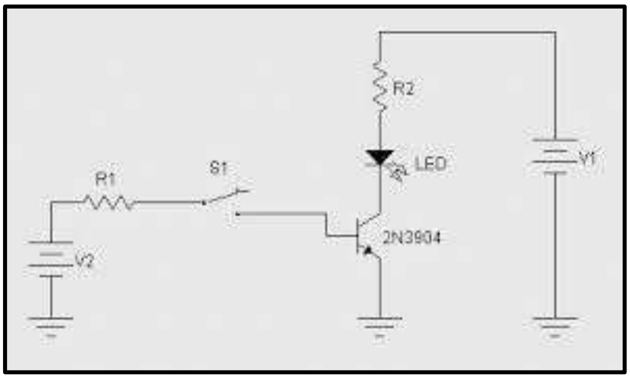
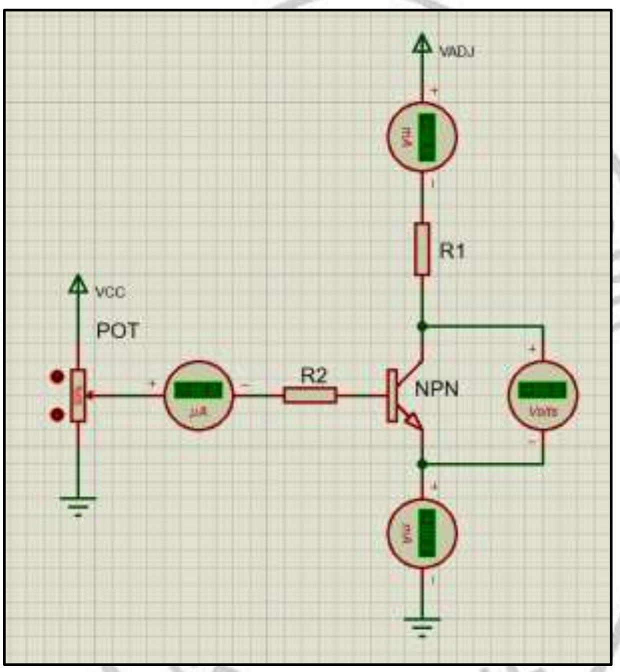


Figure 2. Transistor as a Switch

Practicum Activities:

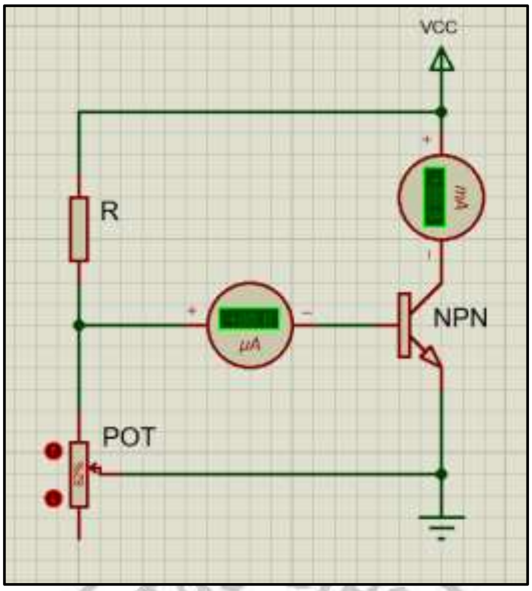
- **Experiment 1: Characteristics of NPN Transistors**



Working steps:

1. Make a series like the picture above. Adjust the value of the component quantity according to the instructions from the assistant. Check the circuit before using it to the support assistant.
2. Set the Constant VCC value as directed by the assistant.
3. Rotate the POT Potentiometer until the ampermeter on the base or IB shows a value of ±50μA.
4. Set the voltage of the VAdj according to the instructions of the assistant.
5. Measure the IC Value, and V_{CE}, then record the results in a table.
6. Increase the voltage on the VAdj according to the table provided by the assistant assistant.
7. Repeat Steps 2 – 6 with the corresponding IB variations in the table.
8. Make a Graph from the results that have been obtained and draw conclusions from this experiment.

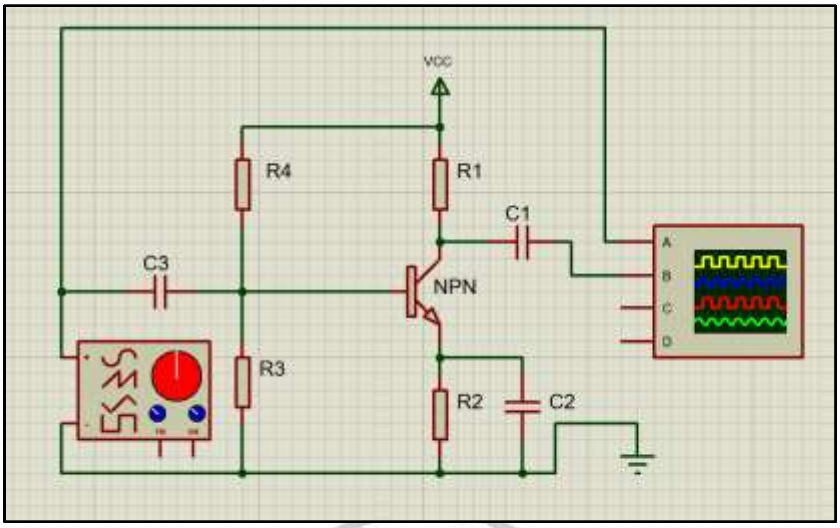
- **Experiment 2: NPN Transistor as a Current Amplifier**



Working steps:

1. Make a series like the picture above. Adjust the value of the component quantity according to the instructions from the assistant. Check the circuit before using it to the support assistant.
2. Set the VCC Constant value, adjust the value according to the assistant direction.
3. Turn the POT Potentiometer position ±0k.
4. Read and record the Current values on the base and the Colector into the table.
5. Do the same for variations in the potentiometer values according to the table that has been given.
6. Calculate the value of the Current gain that occurs in the circuit.

- **Experiment 3: NPN Transistor as a Voltage Amplifier**



Working steps:

1. Make a series like the picture above. Adjust the value of the component quantity according to the instructions from the assistant. Check the circuit before using it to the support assistant.
2. Set the Constant VCC value to as per the assistant's direction.
3. Calibration of the Oscilloscope to be used.
4. Turn on the Signal Generator, Oscilloscope, and Source of Cooling. Set the signal display on the oscilloscope, then take a photo and save the signal image.
5. Repeat Steps 3 – 4 with the amplitude value variation on the signal generator according to the table provided.
6. Observe the experiment to see if the increase in amplitude affects the output signal from the transistor. What is the value of the reinforcement that occurs in this series.

Information:

- For all experiments it is expected **to use caution** in the installation of measuring instruments and components, as misfitting may cause **damage** to the measuring instruments and components.
- Before turning on the voltage source on the circuit, ask **the practice assistant for approval and checking**. If the assistant has declared it feasible, the practitioner **can** turn on the voltage source and can start taking data.
- For all equipment damage caused by the practice's negligence that **does not** receive the assistant's prior approval, the **practice will be fully borne by the** practice for repair or replacement of damaged equipment components during the practice.

MODULE VII
OP-AMP

Experiment Objectives:

- Knowing the characteristics of the op-amp
- Know the function of the op-amp as an inverting, non-inverting, and buffer amplifier

Basic Theory:

An operational amplifier *or commonly called* an *op-amp is a type of electronic amplifier with* a direct current coupling *that has a very large beam (gain factor*) with two inputs and one output. Operational amplifiers are generally available in the form of integrated circuits and the most widely used is the 741 series. Operational boosters are highly efficient and versatile devices. Examples of the use of operational amplifiers are for simple mathematical operations such as addition and subtraction of electrical voltage until they are developed for applicative use such as comparators and oscillators with low distortion.

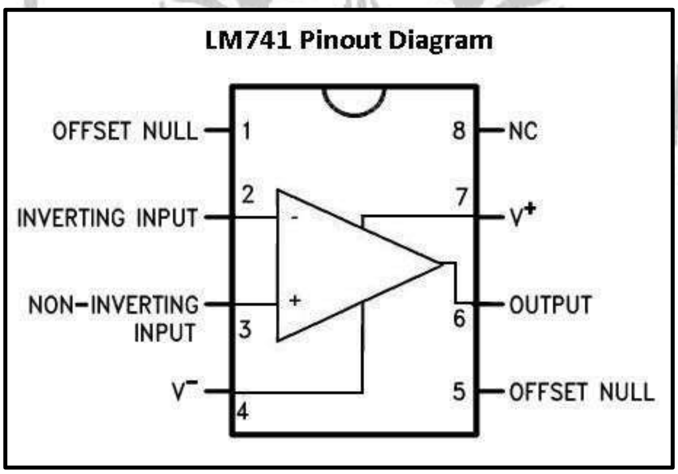


Figure 1. IC 741Configuration

Operational amplifiers in the form of integrated circuits have characteristics that are close to the characteristics of an ideal operational amplifier without the need to pay attention to what is contained in them. The characteristics of the ideal operational amplifier are:

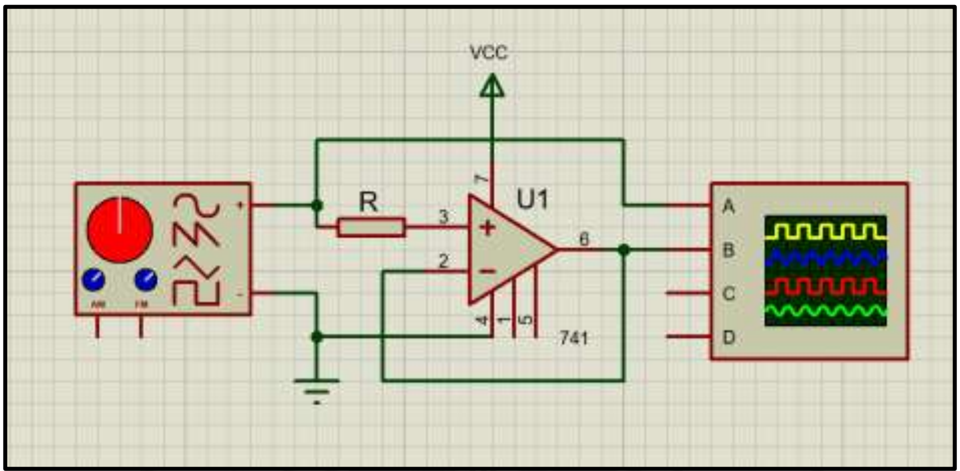
1. Infinite voltage.
2. Unlimited input Impedan.
3. Zero output impedance.
4. Unlimited bandwidth.
5. Zero offset voltage (output will be zero if input is zero.

In general, an op-amp circuit can be assembled into several circuits:

1. Penguat *inverting*
2. Penguat *non inverting*
3. Voltage follower
4. Mixing
5. Differensiator
6. Integrator

Practicum Activities.

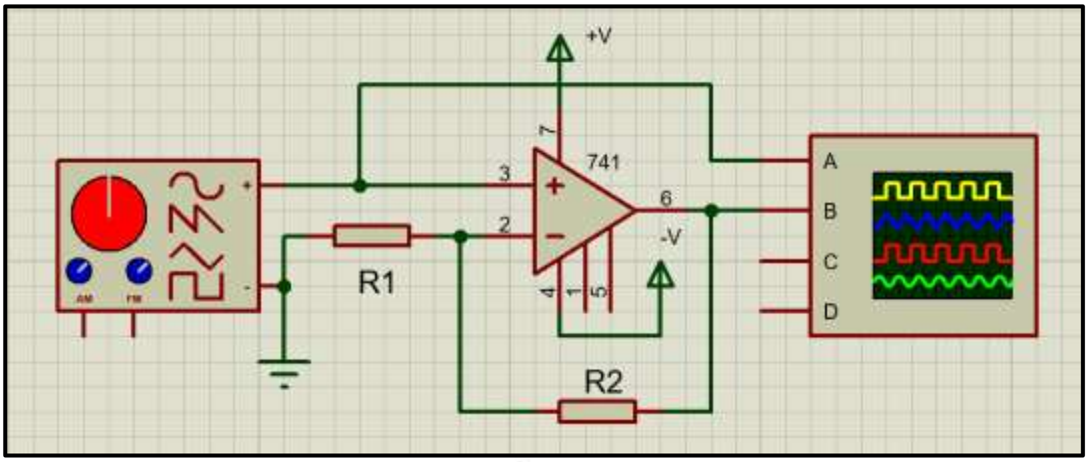
- **Experiment 1: Buffer Array**



Working steps:

1. Make a series like the picture above. Adjust the value of the component quantity according to the instructions from the assistant. Check the circuit before using it to the support assistant.
2. Set the oscilloscope so that *channel* 1 is used to analyze the input waves from the op-amp and *channel* 2 is used to analyze the *output waves* from the op-amp.
3. Save the image of the output of the op-amp input wave and *the op-amp* output.
4. Calculate the voltage value of *the op-amp input and the output of the op-amp.*
5. Calculate the frequency *of the* op-amp input wave and *the op-amp* output.
6. Analyze and evaluate the data obtained.
7. Repeat by changing the signal generator frequency values with different frequencies by 3X (low, medium and high frequencies as per the assistant's instructions).

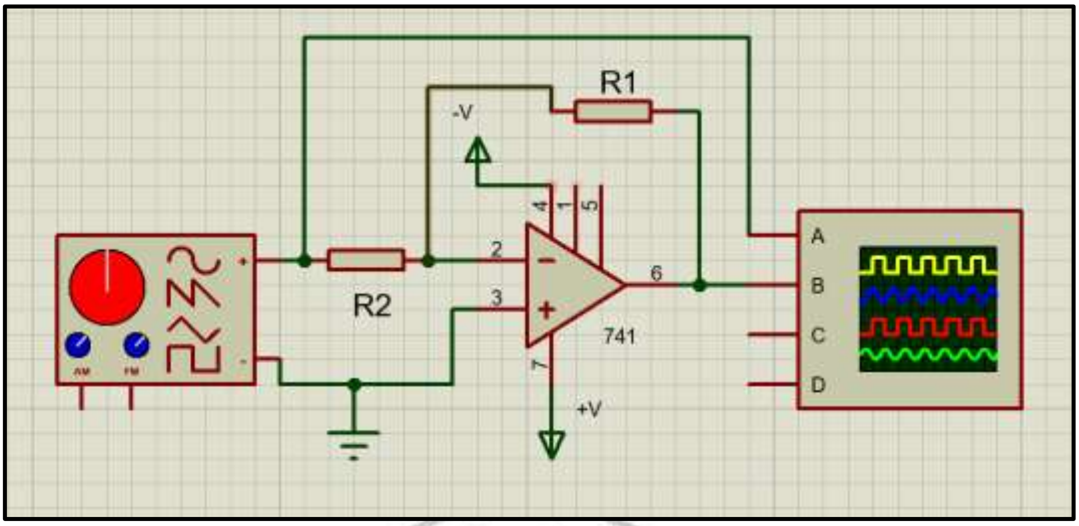
- **Experiment 2: Non-Inverting Amplifier**



Working steps:

1. Make a series like the picture above. Adjust the value of the component quantity according to the instructions from the assistant. Check the circuit before using it to the support assistant.
2. Set the oscilloscope so that *channel* 1 is used to analyze the input waves from the op-amp and *channel* 2 is used to analyze the *output waves* from the op-amp.
3. Save the image of the output of the op-amp input wave and *the op-amp* output.
4. Calculate the voltage value of *the op-amp input and the output of the op-amp.*
5. Calculate the frequency *of the* op-amp input wave and *the op-amp* output.
6. Analyze and evaluate the data obtained.
7. Repeat by replacing the signal generator frequency value with a different frequency by 2X (low and high frequencies as per the assistant's instructions).

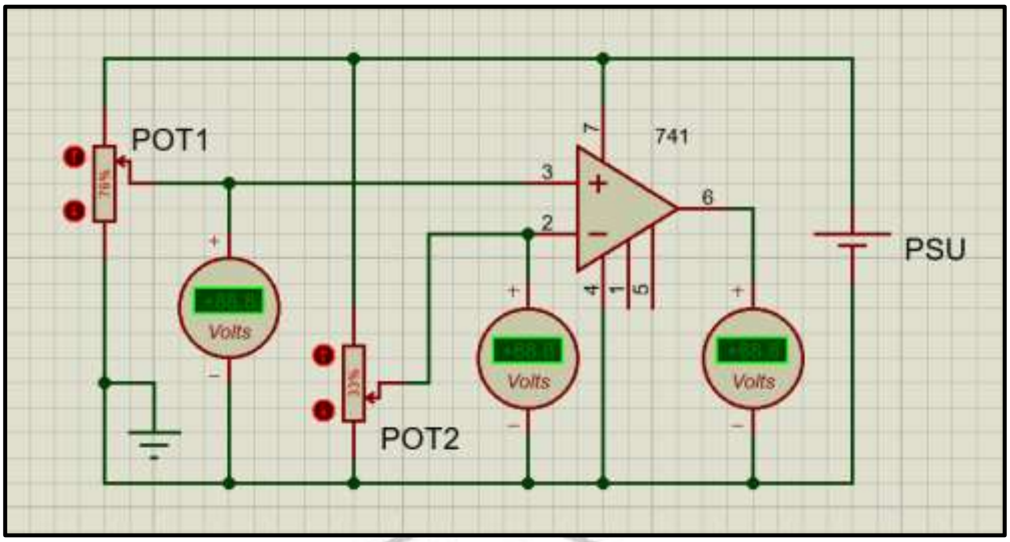
- **Experiment 3: Inverting Amplifier**



Working steps:

1. Make a series like the picture above. Adjust the value of the component quantity according to the instructions from the assistant. Check the circuit before using it to the support assistant.
2. Set the oscilloscope so that *channel* 1 is used to analyze the *input waves* from the op-amp and *channel* 2 is used to analyze the *output waves* from the op-amp.
3. Save the image of *the output of* the op-amp input wave and *the op-amp* output.
4. Calculate the voltage value of *the op-amp input and the output of the op-amp.*
5. Calculate the frequency *of the* op-amp input wave and *the op-amp* output.
6. Analyze and evaluate the data obtained.
7. Repeat by replacing the signal generator frequency value with a different frequency by 2X (low and high frequencies as per the assistant's instructions).

- **Experiment 4: Comparator**



Working steps:

1. Make a series like the picture above. Adjust the value of the component quantity according to the instructions from the assistant. Check the circuit before using it to the support assistant.
2. Set the POT1 and POT2 Potentiometers at 0 Ohms or 0%. Raise the POT2 potentiometer in increments of 10% later and save the readings on the voltmeter. Repeat this until the POT2 potentiometer resistance value reaches 100%.
3. Repeat the same by increasing the resistance on the POT1 potentiometer by an increase of 10%. Enter all the observations into the table.
4. Analyze the data that has been obtained and make conclusions.

Information:

- For all experiments it is expected **to use caution** in the installation of measuring instruments and components, as misfitting may cause **damage** to the measuring instruments and components.
- Before turning on the voltage source on the circuit, ask **the practice assistant for approval and checking**. If the assistant has declared it feasible, the practitioner **can** turn on the voltage source and can start taking data.
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MODULE VIII
BASIC LOGIC GATES

Experiment Objectives:

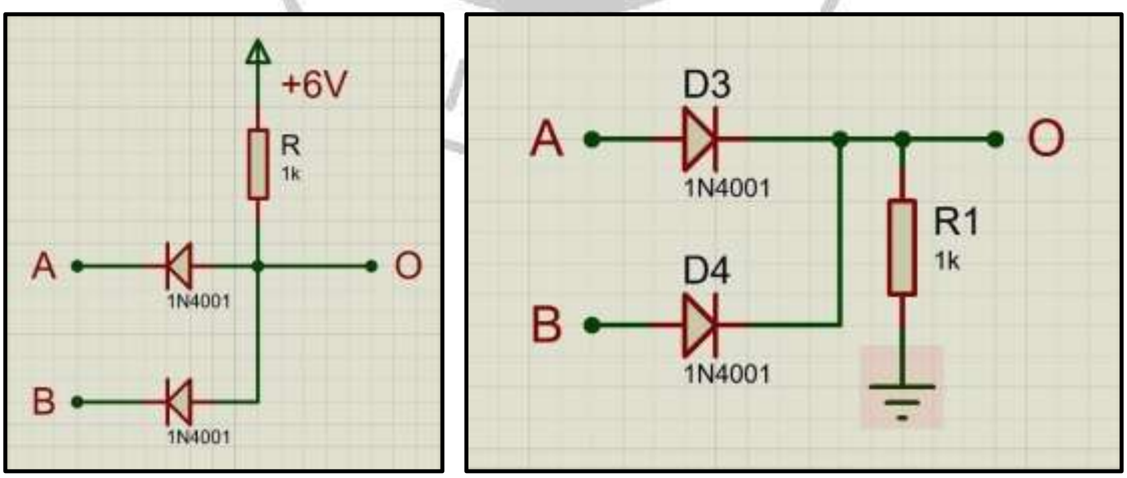
- Be able to know the basic logic gates
- Can be able to create combinations of basic logic qebang

Basic Theory:

A logic gate or logic gate is an entity in Boolean electronics and mathematics that converts one or more logical inputs into a logical output signal. Logic gates are mainly implemented electronically using diodes or transistors, but can also be built using an array of components that utilize the electromagnetic properties (relay) of liquids, optics and even mechanics.

The commonly used basic logic gates are the AND, OR and NOT gates. These three gates are basic gates that can be combined back into NAND (AND NOT) and NOR (OR NOT) gates, as well as other gate gates such as XOR and XNOR.

Logic gates in addition to using TTL ICs (74xx and CMUS 40xx) can also be made using basic components of electronics such as resistors, diodes and transistors. Logic gates that use basic components of electronics between Iain such as: DRL (Logic Resistor Diode), RTL (Logic Transistor Resistor) and DTL (Logic Transistor Diode). In the DRL (Optical Resistor Diode) series, two logic gates can be formed, including AND and OR gates.

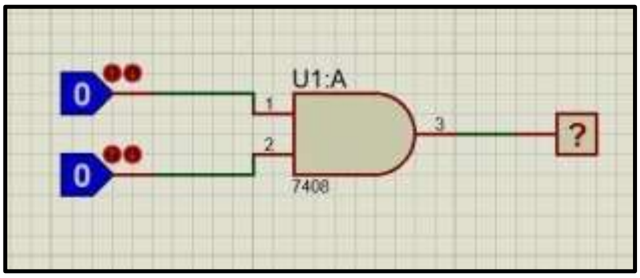


(a) AND (b) OR

Figure 1. Logic gates using DRLs

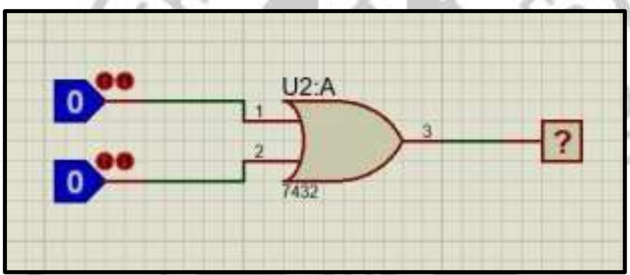
Practicum Activities.

- **Experiment 1: Logic Gate AND**



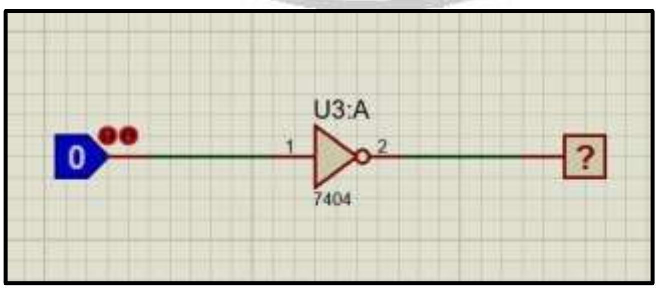
Working steps:
1. Make a circuit according to the image above (IC 7408).
2. Test the IC by changing the input logic (0 and 1).
3. Make a table of truths and analyze them.

- **Experiment 2: OR Logic Gate**



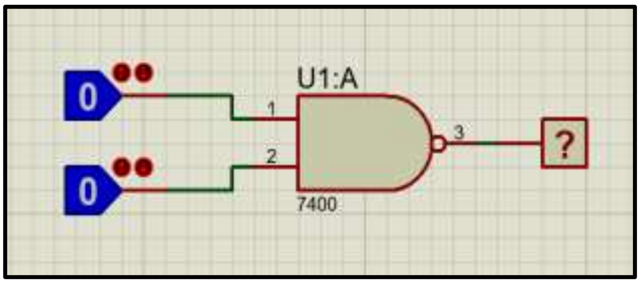
Working steps:
1. Make a circuit according to the image above (IC 7432).
2. Test the IC by changing the input logic (0 and 1).
3. Make a table of truths and analyze them.

- **Experiment 3: NOT Logic Gate**



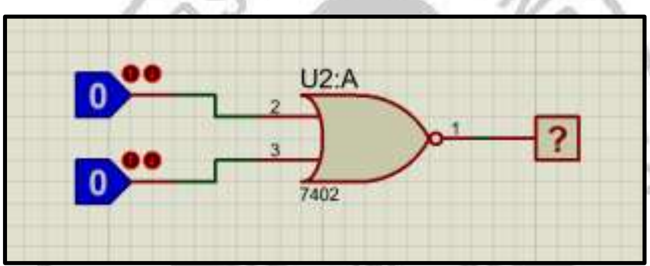
Working steps:
1. Make a circuit according to the image above (IC 7404).
2. Test the IC by changing the input logic (0 and 1).
3. Make a table of truths and analyze them.

- **Experiment 4: NAND Logic Gates**



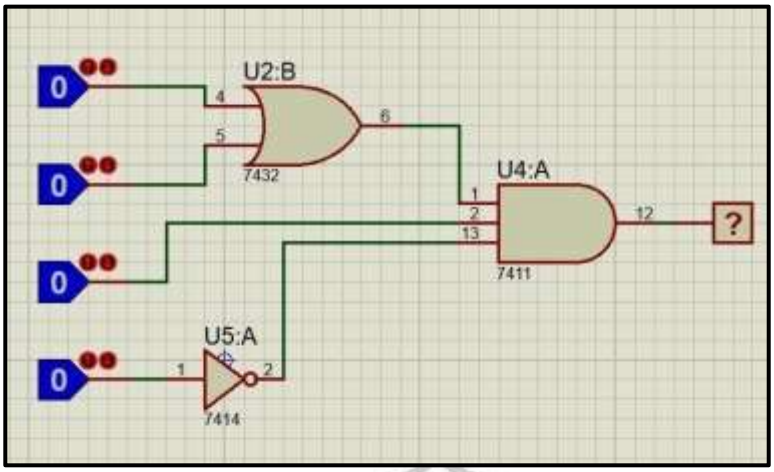
Working steps:
4. Make a circuit according to the image above (IC 7400).
5. Test the IC by changing the input logic (0 and 1).
6. Make a table of truths and analyze them.

- **Experiment 5: NOR Logic Gate**



Working steps:
4. Make a circuit according to the picture above (IC 7402).
5. Test the IC by changing the input logic (0 and 1).
6. Make a table of truths and analyze them.

- **Experiment 6: Combination Logic Gates**



Working steps:
1. Make a series according to the picture above.
2. Test the IC by changing the input logic (0 and 1).
3. Make a table of truths and analyze them.

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