



## LABORATORY MANUAL

**B.Tech. Semester- I/ II**

**BASICS OF ELECTRICAL AND ELECTRONICS  
ENGINEERING LAB**

**Subject code: EEE-101P**

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**DEPARTMENT OF APPLIED SCIENCE & HUMANITIES  
DRONACHARYA COLLEGE OF ENGINEERING  
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## **Vision and Mission of the Institute**

**Vision:**

Empowering human values and advanced technical education to navigate and address global challenges with excellence.

**Mission:**

- **M1** - Seamlessly integrate human values with advanced technical education.
- **M2** - Supporting the cultivation of a new generation of innovators who are not only skilled but also ethically responsible.
- **M3** - Inspire global citizens who are equipped to create positive and sustainable impact, driving progress towards a more inclusive and harmonious world.

## **Vision and Mission of the Department**

### **Vision**

- To establish a strong foundation for first-year engineering students, aiming to equip them with the skills to innovate and devise engineering solutions.

### **Mission**

- **M1:** To develop a solid foundation of knowledge and hands on experience in budding technocrats, empowering them to apply scientific principles to address complex engineering challenges.
- **M2:** To provide education that fosters comprehension and collaboration between engineering and other core field of Applied Sciences.
- **M3:** To inculcate values and ethics in students and make them responsible citizens of India.

## **Programme Educational Objectives (PEOs)**

- **PEO1:** PEO1: To instill the basic principles of Applied Sciences to enable students learn technical subjects effectively.
- **PEO2:** To equip students with innovative skills that improve their practical understanding enabling them to solve real-world challenges effectively.
- **PEO3:** To enhance students' team-building skills and leadership qualities continuously through social, cultural, and environmental activities.

## Programme Outcomes (POs)

**Engineering Graduates will be able to:**

- PO1: Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- PO2: Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- PO3: Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
- PO4: Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
- PO5: Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and software tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
- PO6: The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
- PO7: Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- PO8: Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- PO9: Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- PO10: Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
- PO11: Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
- PO12: Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

## **University Syllabus**

1. Verify that resistance of conductor is directly proportional to resistivity and length and inversely proportional to cross-sectional area of the conductor.
2. Verification of Ohm's Law, Kirchhoff current and voltage laws
3. Verification of temperature coefficient of resistance:
  - (i) Positive for Tungsten and Nichrome and
  - (ii) Negative for carbon.
4. To measure DC voltage and current, AC voltage and current with multi-meter
5. To observe waveforms on oscilloscope, measure basic parameters amplitude and frequency of sine wave and square wave.
6. Obtain VI characteristics of semiconductor rectifier diode, LED, Photo-diode
7. To observe waveform at the output of half wave rectifier with and without filter capacitor.
8. To observe waveform at the output of full wave rectifier with and without filter capacitor.
9. To experimentally plot the input and output characteristics of a given BJT transistor in CE configuration and calculate its various parameters.
10. To experimentally plot the input and output characteristics of a given BJT transistor in CB configuration and calculate its various parameters.
11. To study the transfer and drain characteristics of JFET and calculate its various parameters.
12. To study the transfer and drain characteristics of MOSFET and calculate its various parameters.

## Course Outcomes (COs)

Upon successful completion of the course, the students will be able to:

C101.1: To study multimeter and oscilloscope.

C101.2: To study all network theorems & laws.

C101.3: To observe waveforms of diode and rectifier.

C101.4: To study input and output characteristics of a BJT transistor

C101.5: To study the transfer and drain characteristics of JFET, MOSFET.

## CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C101.1		3			3			2	2	2	2	2
C101.2			2		3			2	2	2	2	2
C101.3				2	3			2	2	2	2	2
C101.4				2	3			2	2	2	2	2
C101.5				2	3			2	2	2	2	2
<b>C101</b>		<b>3</b>	<b>2</b>	<b>2</b>	<b>3</b>			<b>2</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>2</b>

## CO-PSO Mapping

	PSO1	PSO2	PSO3
C101.1	2	2	
C101.2		2	
C101.3		2	
C101.4		2	
C101.5		2	
<b>C101</b>	<b>2</b>	<b>2</b>	



## **Course Overview**

This laboratory provides students with hands-on experience on the basic electrical and electronic system. This laboratory has played a role in on-going development of the circuit's curriculum at institute. This laboratory is to provide students with experience on various electrical system operating and planning functions, a set of experiments have been designed and are under design for use with breadboard and basic circuits.

## List of Experiments mapped with COs

Sl No.	List of Experiments	Course Outcome	Page no.
1.	Introduction of Electrical Elements, sources, measuring devices.	C101.1	1-6
2.	To measure DC voltage and current, AC voltage and current with multi-meter	C101.1	7-10
3.	To observe waveforms on oscilloscope, measure basic parameters amplitude and frequency of sine wave and square wave.	C101.1	11-16
4.	A. Verification of Ohm's Law	C101.2	17-22
	B. Verification of Kirchhoff voltage laws	C101.2	
	C. Verification of Kirchhoff current laws	C101.2	
5.	Obtain VI characteristics of semiconductor rectifier diode	C101.3	23-25
6.	To observe waveform at the output of half wave rectifier.	C101.3	26-28
7.	To observe waveform at the output of full wave rectifier.	C101.3	29-31
8.	To experimentally plot the input and output characteristics of a given BJT transistor in CE configuration and calculate its various parameters.	C101.4	32-35
9.	To experimentally plot the input and output characteristics of a given BJT transistor in CB configuration and calculate its various parameters.	C101.4	36-38
10.	To study the transfer and drain characteristics of JFET.	C101.5	39-41
11.	To study the transfer and drain characteristics of MOSFET.	C101.5	42-45

## **DOs and DON'Ts**

### **DOs**

1. Enter the lab on time and leave at proper time.
2. Keep the bags outside in the racks.
3. Utilize lab hours in the corresponding experiment.
4. Make the Supply off the Kits/Equipments after completion of Experiments.
5. Maintain the decorum of the lab.

### **DON'Ts**

1. Don't bring any external material in the lab.
2. Don't make noise in the lab.
3. Don't bring the mobile in the lab.
4. Don't enter in Faculty room without permission.
5. Don't litter in the lab.
6. Don't carry any lab equipments outside the lab

## **General Safety Precautions**

### **Precautions (In case of Injury or Electric Shock)**

1. To break the victim with live electric source, use an insulator such as fire wood or plastic to break the contact. Do not touch the victim with bare hands to avoid the risk of electrifying yourself.
2. Unplug the risk of faulty equipment. If main circuit breaker is accessible, turn the circuit off.
3. If the victim is unconscious, start resuscitation immediately, use your hands to press the chest in and out to continue breathing function. Use mouth-to-mouth resuscitation if necessary.
4. Immediately call medical emergency and security. Remember! Time is critical; be best.

### **Precautions (In case of Fire)**

1. Turn the equipment off. If power switch is not immediately accessible, take plug off.
2. If fire continues, try to curb the fire, if possible, by using the fire extinguisher or by covering it with a heavy cloth, if possible, isolate the burning equipment from the other surrounding equipment.
3. Sound the fire alarm by activating the nearest alarm switch located in the hallway.
4. Call security and emergency department immediately:

**Emergency           :           Reception**  
**Security             :           Main Gate**

## **Guidelines to students for report preparation**

All students are required to maintain a record of the experiments conducted by them.

Guidelines for its preparation are as follows: -

- 1) All files must contain a title page followed by an index page. *The files will not be signed by the faculty without an entry in the index page.*
- 2) Student's Name, Roll number and date of conduction of experiment must be written on all pages.
- 3) For each experiment, the record must contain the following
  - (i) Aim/Objective of the experiment
  - (ii) Pre-experiment work (as given by the faculty)
  - (iii) Lab assignment questions and their solutions
  - (iv) Test Cases (if applicable to the course)
  - (v) Results/ output

**Note:**

1. Students must bring their lab record along with them whenever they come for the lab.
2. Students must ensure that their lab record is regularly evaluated.

## Lab Assessment Criteria

An estimated 10 lab classes are conducted in a semester for each lab course. These lab classes are assessed continuously. Each lab experiment is evaluated based on 5 assessment criteria as shown in following table. Assessed performance in each experiment is used to compute CO attainment as well as internal marks in the lab course.

<b>Grading Criteria</b>	<b>Exemplary (4)</b>	<b>Competent (3)</b>	<b>Needs Improvement (2)</b>	<b>Poor (1)</b>
<b>AC1: Pre-Lab written work (this may be assessed through viva)</b>	Complete procedure with underlined concept is properly written	Underlined concept is written but procedure is incomplete	Not able to write concept and procedure	Underlined concept is not clearly understood
<b>AC2: Program Writing/ Modeling</b>	Assigned problem is properly analyzed, correct solution designed, appropriate language constructs/ tools are applied, Program/solution written is readable	Assigned problem is properly analyzed, correct solution designed, appropriate language constructs/ tools are applied	Assigned problem is properly analyzed & correct solution designed	Assigned problem is properly analyzed
<b>AC3: Identification &amp; Removal of errors/ bugs</b>	Able to identify errors/ bugs and remove them	Able to identify errors/ bugs and remove them with little bit of guidance	Is dependent totally on someone for identification of errors/ bugs and their removal	Unable to understand the reason for errors/ bugs even after they are explicitly pointed out
<b>AC4: Execution &amp; Demonstration</b>	All variants of input /output are tested, Solution is well demonstrated and implemented concept is clearly explained	All variants of input /output are not tested, However, solution is well demonstrated and implemented concept is clearly explained	Only few variants of input /output are tested, Solution is well demonstrated but implemented concept is not clearly explained	Solution is not well demonstrated and implemented concept is not clearly explained
<b>AC5: Lab Record Assessment</b>	All assigned problems are well recorded with objective, design constructs and solution along with Performance analysis using all variants of input and output	More than 70 % of the assigned problems are well recorded with objective, design constructs and solution along with Performance analysis is done with all variants of input and output	Less than 70 % of the assigned problems are well recorded with objective, design constructs and solution along with Performance analysis is done with all variants of input and output	

# LAB EXPERIMENTS

## EXPERIMENT No. 1

**AIM:** Introduction of Electrical Elements, sources, measuring devices.

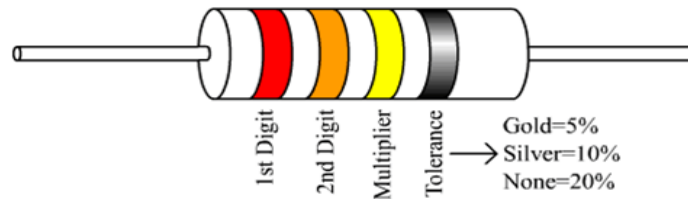
**APPARATUS REQUIRED:** Electrical elements, sources, measuring devices

**THEORY:**

**Resistor :**

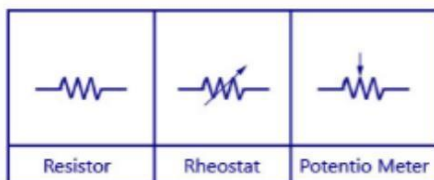
Resistor is an electronic component whose function is to limit the flow of current in an electric circuit. It is measured in units called ohms. The symbol for ohm is  $\Omega$ (ohm).

They are available in different values, shapes and sizes. Every material has some resistance. Some materials such as Rubber, Glass and air have very high opposition to current to flow These materials are called insulators. Other materials such as Copper, Silver and Aluminum etc, has very low resistance, they are called Conductors.



Color	Digit	Multiplier	Tolerance (%)
	Black	0	$10^0$ (1)
	Brown	1	$10^1$
	Red	2	$10^2$
	Orange	3	$10^3$
	Yellow	4	$10^4$
	Green	5	$10^5$
	Blue	6	$10^6$
	Violet	7	$10^7$
	Grey	8	$10^8$
	White	9	$10^9$
	Gold		$10^{-1}$
	Silver		$10^{-2}$
	(none)		

Resistor symbols:





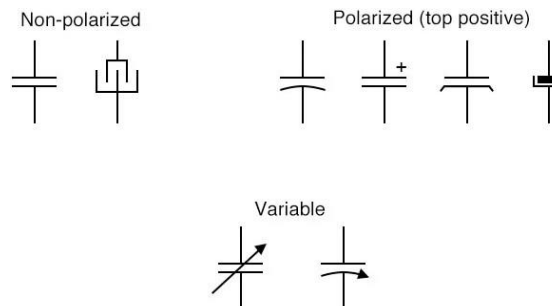
Different types of resistors:



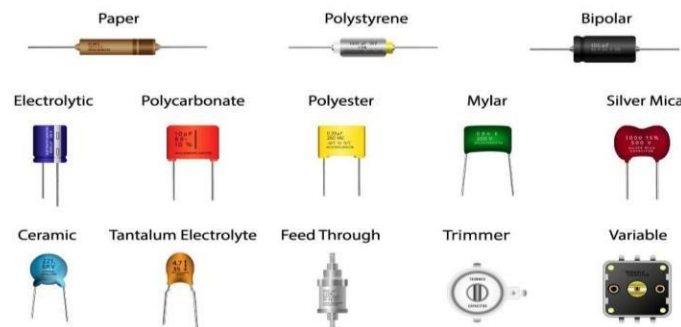
## Capacitor:

A capacitor (originally known as a condenser) is a passive two-terminal electrical component used to store energy electrostatically in an electric field. By contrast, batteries store energy via chemical reactions. The forms of practical capacitors vary widely, but all contain at least two electrical conductors separated by a dielectric (insulator); for example, one common construction consists of metal foils separated by a thin layer of insulating film. Capacitors are widely used as parts of electrical circuits in many common electrical devices. Capacitors are also very commonly used. A lot have their values printed on them, some are marked with 3-digit codes, and a few are color coded. The same resources listed above for resistors can also help you identify capacitor values. They are typically marked with an “C” on a circuit board.

## Capacitor Symbol



## Types of Capacitors

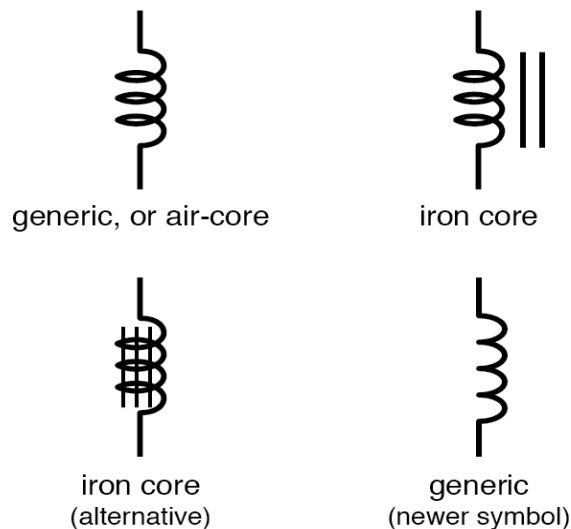


## Inductor:

An inductor, also called a coil or reactor, is a passive two-terminal electrical component which resists changes in electric current passing through it. It consists of a conductor such as a wire, usually wound into a coil. When a current flows through it, energy is stored in a magnetic field in the coil. When the current flowing through an inductor change, the time varying magnetic field induces a voltage in the conductor, according to Faraday's law of electromagnetic induction, which by Lenz's law opposes the change in current that created it. Inductors, also called coils, can be a bit harder to figure out their values. If they are color coded, the resources listed for resistors can help, otherwise a good meter that can measure inductance will be needed.

They are typically marked with an "L" on a circuit board

Inductor Symbol:



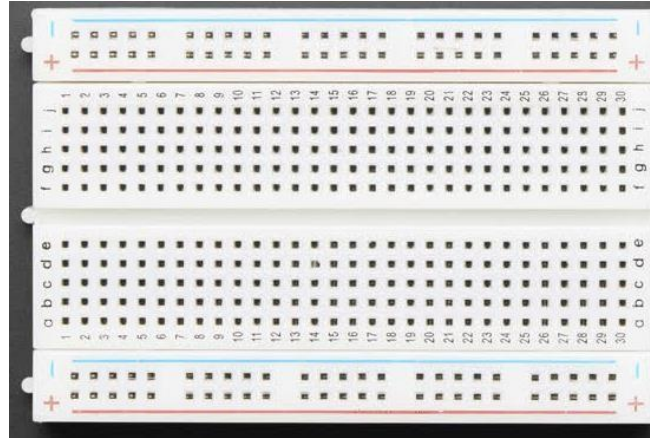
Types of inductors:



## Bread Boards:

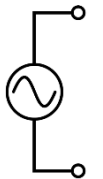
This is the platform (or chasis) on which any circuit can be ringed up to provide inter connections between electronics components and devices. The advantage of bread board is, the components can be connected (or) disconnected easily. It has holes both horizontally and vertically as shown in the figure. The horizontal holes at the top and bottom are having internal shorts where as in the remaining part vertical holes are shorted internally.

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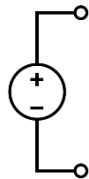


## Voltage Source:

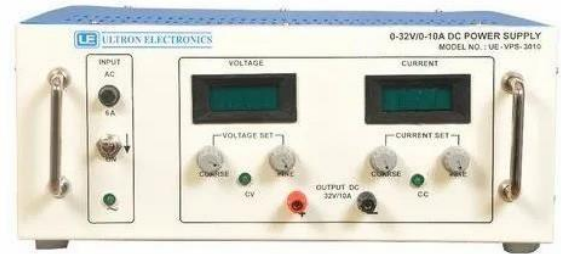
A Voltage Source is a two-terminal device whose voltage at any instant of time is constant and is independent of the current drawn from it.



AC VOLTAGE SOURCE



DC VOLTAGE SOURCE



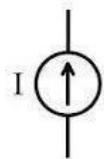
Variable Power supply available in lab:-

## Current Source:

A current source is a two-terminal circuit element which supplies the same current to any load resistance connected across its terminals.

## Voltmeter:

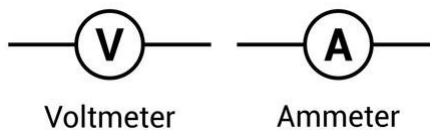
Voltmeter is parallelly connected with the electric circuit in order to measure the potential.



## Ammeter:

The ammeter is used for measuring a small amount of current and the result is displayed in milliamperes when it is kept in series with the circuit to be measured so that the entire current in the circuit is passing through it.

Voltmeter and ammeter symbol:



Voltmeter

Ammeter

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Difference Between Ammeter and Voltmeter	
Ammeter	Voltmeter
It is used to measure current.	It is used to measure the voltage across two points.
Resistance is low.	Resistance is high.
It is connected in series with the circuit and its accuracy is more.	It is connected in parallel with the circuit and its accuracy is less.
Changing the range is not possible.	Changing the range is possible.
For ideal ammeter, the value of resistance is 0.	For an ideal voltmeter, the value of resistance is approximately infinity.
It is denoted by a symbol A.	It is denoted by a symbol V.



## RESULT:

Study of Electrical Elements, sources, measuring devices is done.

## VIVA QUESTIONS:

1. What are the fundamental components of electrical circuits?

Ans: In general, a circuit has the following components:

- A cell or battery: source of electricity
- Connecting wires: Act as conductor to flow electric current
- Key or switch to control the circuit
- Bulb or electric device act as a load to the circuit

Metal wires are used in electric circuits because the metals are good conductors of electricity and allow current to pass through them

2. What are insulators?

Ans: Insulators are those substances through which electricity cannot flow are called insulators. Some common insulators are glass, plastic, rubber, and wood.

3. What are conductors?

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Ans: Conductors are those substances through which electricity can flow are called conductors. Some common conductors are copper, aluminum, gold, and silver.

4. What is AC and DC?

Ans: Electric current flows in two ways as an alternating current (AC) or direct current (DC). The main difference between AC and DC lies in the direction in which the electrons flow. In DC, the electrons flow steadily in a single direction, while electrons keep switching directions, going forward and then backwards in AC.

5. What is active and passive elements?

Ans: An electric circuit element which can supply electric power to the circuit or power gain in the circuit, is known as an active element. The circuit element which can only absorb electrical energy and dissipates it in the form of heat or stores in either magnetic field or electric field is known as passive elements.

6. Explain R L and C.

Ans: R is a resistive component; L is Inductive and C is Capacitive.

In a R component, the current and Voltage vectors are in phase with each other i.e. the phase angle between the two is ZERO

In a L component, the phase angle between the current and Voltage vector is  $-90$  deg i.e. the current vector lags the voltage vector by  $90$  deg

and in a C component, the phase angle between the current and voltage vectors is  $+90$  deg i.e. the current vector leads the voltage vector by  $90$  deg.

## EXPERIMENT No. 2

**AIM:** To measure DC voltage and current, AC voltage and current with multi-meter

**APPARATUS REQUIRED:** Breadboard, Voltage source, Multimeter, Resistor, Ammeter, Voltmeter, Connecting wires

### **THEORY:**

The DMM is an instrument which can be used to measure DC (non-time-varying) voltages and currents, AC (time-varying) voltages and currents, and resistance values. The signal is input to the DMM through two leads (wires), and the value measured is displayed. The DMM uses an A/D (analog-to-digital) converter, which converts DC voltages to a digital code. Therefore, internally the meter can read only DC voltages. Thus, to measure current or resistance, the signal must be converted into a voltage value. For current, this is easily done by placing a (very small) precision resistor in the circuit and measuring the voltage across the resistor, which will be linearly proportional to the current (remember Ohm's Law:  $V=IR$ ).



Resistance measurements require more circuitry because a resistor is a passive element, thus a source must be provided in the DMM. In the DMM there is a current source to force a current through the resistor and the voltage is then measured. From this information the resistance value may be determined by Ohm's Law:

$$R = V/I$$

Additional circuitry is necessary to allow variable ranges. For voltage and resistance measurements this consists of various voltage-divider networks which are switched in. For current measurements it consists of different resistors to be switched in. Also, an RMS (root mean square) circuit is used to convert the AC

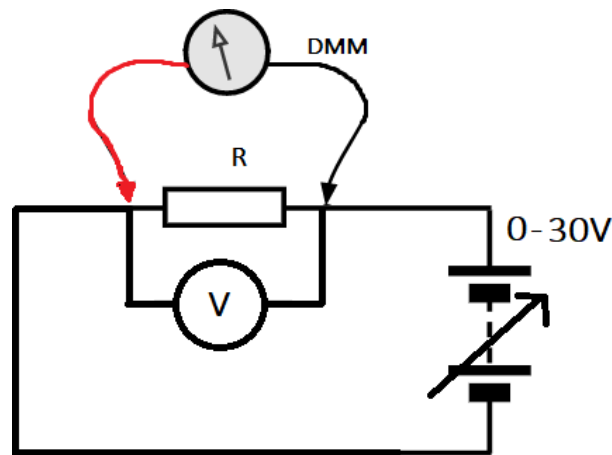
# BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING LAB (EEE-101P)

voltages to DC voltages. The DC voltage given is the square root of the average value of the input voltage squared.

The DC voltage is converted into a digital code by the A/D converter. This digital code is decoded using the range of information and displayed. Since a voltmeter measures the voltage across itself, it should be connected in parallel with the device to guarantee that the voltage across the device under test (DUT) is the same as the voltage across the voltmeter. An ammeter measures the current through itself, so it should be connected in series with the DUT in order to ensure that the current through the ammeter is the same as the current through the DUT. An ohmmeter sends out a current and measures the voltage produced across the DUT. Because the ohmmeter is ultimately measuring a voltage, it should be connected in parallel with the DUT. When measuring a resistance, one end of the resistor should be disconnected from the circuit so that all of the current from the DMM's current source is passing through the resistor to be measured. Otherwise, one is not measuring the resistance value of the resistor because the current going through the resistor is unknown.

## A. To measure voltage using DMM

Circuit Diagram:



measure voltage using DMM

Observation Table:

S. No.	Applied Voltage	Voltmeter Reading	DMM Reading	Error
1.				
2.				
3.				
4.				
5.				

## B. To measure current using DMM



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Circuit Diagram:

Observation

Table:

S. No.	Applied Voltage	Ammeter Reading	DMM Reading	Error
1.				
2.				
3.				
4.				
5.				

**RESULT:** DC voltage and current with multi-meter is measured.

### PRECAUTIONS:

- 1) All the connection should be tight.
- 2) Ammeter is always connected in series in the circuit while voltmeter is parallel to the conductor.
- 3) The electrical current should not flow the circuit for long time, otherwise its temperature will increase and the result will be affected.
- 4) Maximum reading of voltmeter should be greater than the electromotive force of the cell.
- 5) It should be care that the values of the components of the circuit is does not exceed to their ratings (maximum value).
- 6) Before the circuit connection it should be check out working condition of all the components.

### VIVA QUESTIONS:

1. What are applications of multimeter?

Ans: The applications of a multimeter are mentioned as follows below:

- It is used to measure AC and DC voltage and current.
- It is also used to measure resistance.
- It is also used to check the diodes.
- It is also used to measure the frequency as well as the capacitance of an electronic device.
- It is also used to test batteries, switches, light bulbs, and outlets.



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- It is also used to determine any faults present in the electric circuit.
- It is used to measure the time and frequency of the electronic device.
- It is also used to check the temperature of the electronic device.

2. What quantities are measured using multimeter?

Ans: A typical multimeter can measure voltage, resistance, and current.

3. What are different types of probes used in multimeter?

Ans: A multimeter can use many different test probes to connect to the circuit or device under test. Crocodile clips, retractable hook clips, and pointed probes are the three most common types. Tweezer probes are used for closely spaced test points, as for instance surface-mount devices.

4. Current is converted to voltage \_\_\_\_\_.

Ans: through a low shunt resistance.

5. For resistance measurement, meter contains \_\_\_\_\_.

Ans: a precision low current source applied across an unknown resistance which gives a d.c. voltage.

6. Output of a digital multimeter is \_\_\_\_\_.

Ans: the digital display by which it shows results and the beeper

## EXPERIMENT No. 3

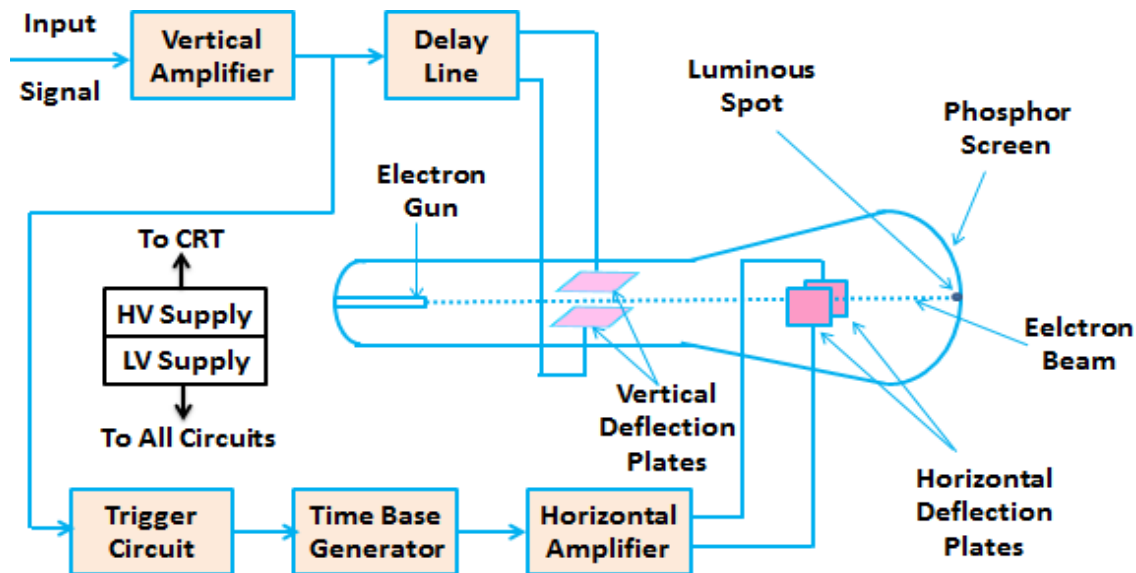
**AIM:** To observe waveforms on oscilloscope, measure basic parameters amplitude and frequency of sine wave and square wave.

**APPARATUS REQUIRED:** oscilloscope, cables and function generator

### **THEORY:**

The oscilloscope is a valuable tool for both design and troubleshooting. Knowledge of the instrument's theory of operation aids in the correct application of the instrument in the laboratory. This knowledge will lead to correct measurements and the safe use of the instrument. The oscilloscope is a device for displaying repetitive events in terms of a voltage on the vertical axis and time on the horizontal axis. Any response that can be converted to a time varying electric signal can be displayed on the oscilloscope. The most common use of the instrument in electrical/electronic design is to display time varying waves.

Block Diagram of Typical Oscilloscope:

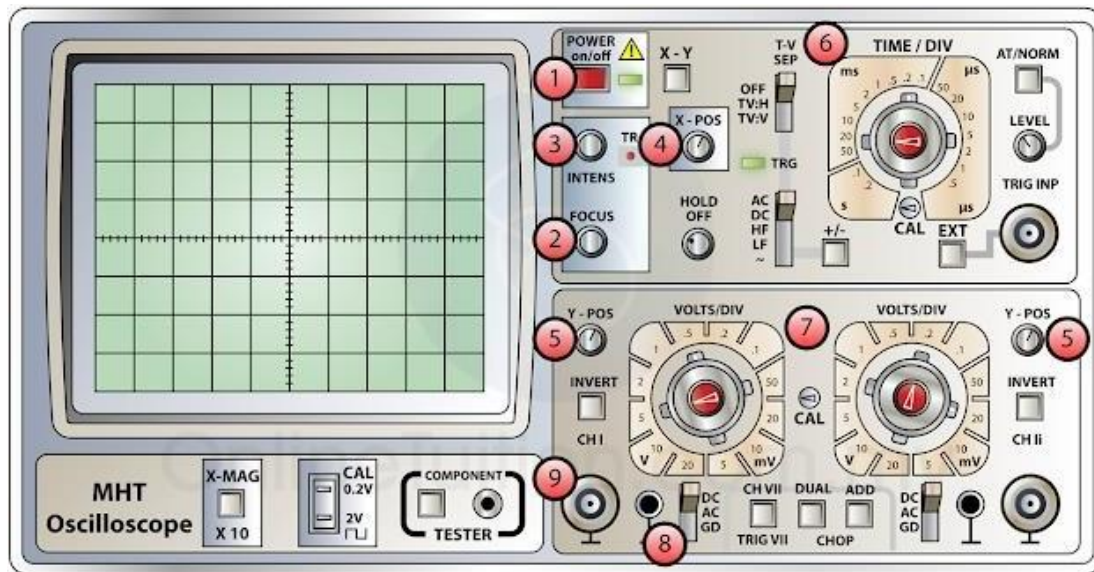


Signals enter the oscilloscope through the channel I and 2 inputs. The vertical preamplifiers are accurate, wide-band amplifiers connected to a voltage divider attenuator network. The incoming signals are routed through the input coupling switch to the preamplifier/attenuator. At this point, a portion of the signal is diverted to the Sweep Generator by the trigger circuits. The vertical signal is then sent on the delay line. The delay line provides a short time delay so the leading edge of the desired signal can be viewed. From the delay circuit, the vertical signal is routed to the vertical amplifier. The vertical amplifier provides a voltage to the plates inside the C.R.T. that direct the electron beam vertically onto the face of the scope. The heart of the horizontal deflection circuit is the sweep generator. The sweep generator produces a ramp wave that is synchronized to the input channels by the trigger circuit. The time base control determines the time required for the ramp wave to reach its maximum value, which controls the time it takes for the C.R.T. trace to traverse the scope face. The sweep generator drives the horizontal deflection amplifiers. These amplifiers connect to plates inside the C.R.T. that direct the electron beam horizontally onto the

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face of the scope.

The high voltage power supply supplies the potential that produces the electron beam in the C.R.T. The low voltage power supply powers all other sub-circuits in the instrument.



S. No.	Switch	Functions
1.	Power switch	To switch on and off of the oscilloscope
2.	Focus control	To control the focus of the spot on the screen.
3.	Intensity control	To control the brightness of the spot on the screen.
4.	X-offset	Y-offset moves the whole trace vertically up and down on the screen, while X-offset moves the whole trace from side to side on the screen.
5.	Y-offset	
6.	Time base control	Whenever we switch on the time-base, we are actually applying a sawtooth voltage to the X-plates * This makes the electron beam sweep across the screen at a constant speed. * By knowing the period of each cycle, T, we can then know how fast the beam is sweeping across the screen. The time-base is thus a measure of time for the oscilloscope.
7.	Y gain control	The “Volts/Div.” wheels amplify an input signal so that for a division a given voltage level is invalid. A “division” is a segment, a square on the screen of the oscilloscope. A setting of “.5” i.e., means, that the height of a single square equals a voltage of 0.5 V. An amplitude of 1 V would have a size of two divisions vertical to the abscissa.
8.	d.c./a.c. switch	d.c. – d.c. and a.c. voltage displayed. a.c. – only a.c. voltage displayed.
9.	X-input and Y-input	Electric input connects to the X-plate and Y-plate.

## Applications

- The CRO's are used in huge applications like radio stations for observing the transmitting & receiving the properties of the signal.
- The CRO is used to measure the voltage, current, frequency, inductance, admittance, resistance, and power factor.
- This device is also used to check the AM and FM circuits characteristics
- This device is used to monitor the signal properties as well as characteristics and also controls the analog signals.
- The CRO is used through the resonance circuit to view the shape of the signal, bandwidth, etc.
- The shape of voltage and current waveform can be observed by CRO which helps to take the necessary decision in a radio station or communication station.
- It is used in laboratories for the purpose of research. Once researchers design a new circuit, then they use CRO to verify the waveforms of voltage and current of every element of the circuit.
- Used for comparing phase & frequency
- It is used in TV, Radar, and analysis of engine pressure
- To check the reactions of nervous and heartbeat.
- In the hysteresis loop, it is used to find BH curves
- Transistor curves can be traced.

## Advantages

The advantages of CRO include the following.

- Cost and Timeline
- Training requirements
- Consistency & quality
- Time efficiency
- Hassle-free
- Expertise & experience
- Capacity for problem-solving
- Assurance for regulatory compliance
- Voltage measurement
- Current measurement
- Examination of waveform
- Measurement of phase and frequency

## Disadvantages

The disadvantages of CRO include the following.

- These oscilloscopes are expensive as compared with other measuring devices like multimeters.
- They are complicated to repair once it gets damaged.
- These devices need complete isolation
- These are huge, heavy and uses more power
- A lot of control terminals

## Use of CRO(Cathode Ray Oscilloscope)

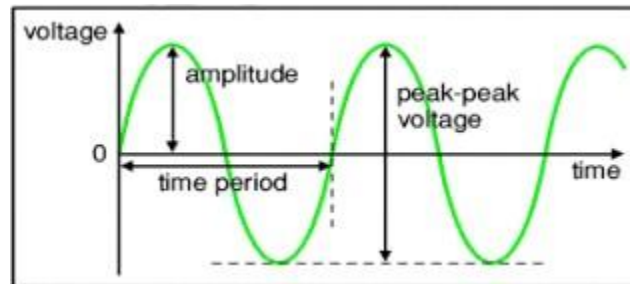
**Current Measurement:** We can measure the value of current or magnitude and direction of current using CRO. By calculating the amplitude variation, horizontal and vertical cells in the CRO screen we can measure the current. We can measure both AC and DC in CRO.

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**Voltage Measurement:** We can measure AC voltage as well as DC voltage in CRO. Here also the same procedure should be followed to measure the voltage that is calculating horizontal and vertical cells in the CRO screen.

**Frequency Measurement:** We not only measure voltage and current using CRO, but we can also measure the frequency of a signal by calculating the time period. Once we measure the time period of a signal then we can easily measure the frequency. The measurement of the time period using CRO also very easy.

**Phase Difference Measurement:** Most of the CROs has two channels. We can apply two different signals at a time on the CRO. And we can measure easily the phase difference between the two different signals. Lissajous figures in the CRO screen helps us to measure the phase difference between two signals. Using this method, we can also measure the frequency of two signals at a time.



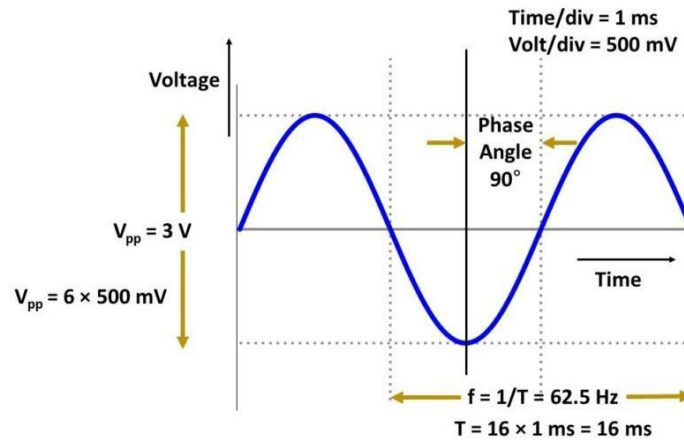
### PROCEDURE:

1. Set the oscilloscope with the volt/cm control at 1, the time base control at 1 ms/cm and the AC-DC switch to AC.
2. Set the signal generator to 2 V, 50 Hz, sinusoidal output. Connect the high-impedance output terminals to the input of the CRO.
3. Show the effects of varying the output voltage of the signal generator (amplitude changes) and the frequency (period changes).
4. Switch between the different output waveforms (sinusoidal, square and triangular) to show these.

### OBSERVATION TABLE:

S. No.	Observed waveform	Measured Voltage $V_{pp}$	Time Period $T$	Frequency $f$
1.				

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**RESULT:** Waveforms on oscilloscope, basic parameters amplitude and frequency of sine wave is observed and measured.

### VIVA QUESTIONS:

1. How is CRO superior to ordinary measuring instruments?

Ans: CRO is an electronic device that gives graphical representation of alternating quantities under examination. The CRO gives very accurate measurements and is free from the errors introduced by the moving parts.

2. Name main components of a cathode ray tube (CRT).

Ans: The three main parts of a cathode ray tube are:

- (i) Electron gun: It gives out a fine beam of electrons.
- (ii) Deflecting system: It deflects the electron beam.
- (iii) Fluorescent screen: It is the part of the cathode ray tube on which the visual pattern of electron beam is obtained.

3. Enlist the applications of CRO.

- radio stations for observing the transmitting & receiving the properties of the signal.
- measure the voltage, current, frequency, inductance, admittance, resistance, and power factor.
- This device is also used to check the AM and FM circuits characteristics
- monitor the signal properties as well as characteristics and also controls the analog signals.
- The CRO is used through the resonance circuit to view the shape of the signal, bandwidth, etc.
- The shape of voltage and current waveform can be observed by CRO which helps to take the necessary decision in a radio station or communication station.
- It is used in laboratories for the purpose of research.
- Used for comparing phase & frequency
- It is used in TV, Radar, and analysis of engine pressure
- To check the reactions of nervous and heartbeat.
- In the hysteresis loop, it is used to find BH curves
- Transistor curves can be traced.

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4. What is difference between analog storage oscilloscope and digital storage oscilloscope?

Ans: Digital storage allows you to store information in a way that is more efficient and compact than analog storage methods. The advantage of digital storage is that it can hold much more information, take up less space, and be created in a shorter amount of time than analog methods.

5. What electron gun assembly is provided in CRT?

Ans: The electron gun assembly of CRT consists of an indirectly heated cathode, a control grid surrounding the cathode, a focusing anode and an accelerating anode. The sole function of the electron gun assembly is to provide a focused electron beam which is accelerated towards the phosphor screen.

6. Deflection system of a CRT consists of \_\_\_\_\_

Ans: The cathode-ray-tube deflection system is made up of two pairs of parallel plates known as the vertical and horizontal deflection plates.

## EXPERIMENT No. 4 (A)

**AIM:** Verification of Ohm's law

**APPARATUS REQUIRED:** Breadboard, Voltage source, Resistor, Ammeter, Voltmeter, Connecting wires

### **THEORY:**

Ohm's Law states that "If the physical conditions such as temperature, pressure, etc., remain the same during the experiment, then the current (I) flowing is directly proportional to the potential difference (V) across the ends of the circuit"

$$V = I \times R \quad I = \frac{V}{R} \quad R = \frac{V}{I}$$

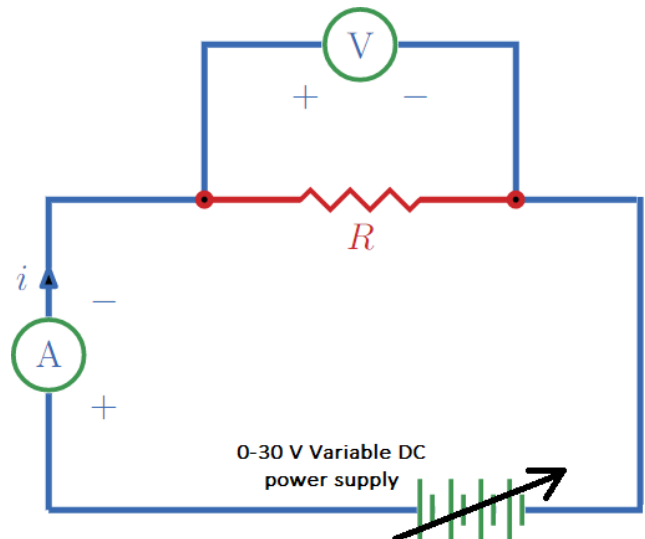
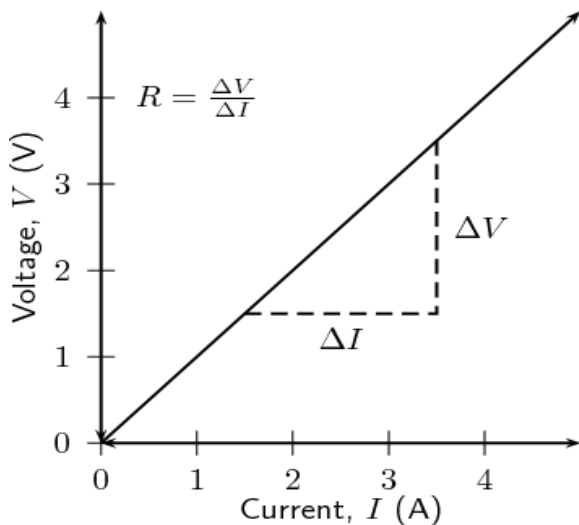
V = volts , I = current in amperes , R = resistance in ohms

Where,

1. The resistance(R) is the characteristic property of the conductor which resist the flow of electric current through it
2. The potential difference (V) is the is the potential difference across the ends of a conductor.
3. The electric current (I) is the amount of charge flowing through a particular area in a unit time.

Ohm's law only holds true if the provided temperature and the other physical factors remain constant. In certain components, increasing the current raises the temperature. An example of this is the filament of a light bulb, in which the temperature rises as the current is increased. In this case, Ohm's law cannot be applied. The lightbulb filament violates Ohm's Law.

If we plot a graph between the current (I) and the applied potential difference(V) between its ends, for an ideal resistance it will be a straight line as shown:





## BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING LAB (EEE-101P)

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### PROCEDURE:

1. Connect the battery, ammeter and resistance in series.
2. The voltmeter is connected in parallel connection across the given coil. The circuit is closed.
3. Note down the ammeter reading  $I$  and the corresponding potential difference across the coil in the voltmeter as  $V$ .
4. Use the formula to calculate the resistance of the resistance.
5. The experiment is repeated for different values of current and the corresponding potential difference is noted.
6. These values will be found to be a constant. Thus, verifying Ohm's law.

### OBSERVATION TABLE:

S. No.	Applied Voltage	Ammeter Reading	Voltmeter Reading	Resistance of coil $R = V/I$ (ohm)
1.				
2.				
3.				
4.				
5.				

The mean value of Resistance is calculated as:

$$R = \frac{R_1 + R_2 + R_3 + R_4 + R_5}{5}$$

For the V-I graph, The slope of Line AB

$$R = \frac{V_2 - V_1}{I_2 - I_1}$$

**RESULT:** Ohm's law is verified.

### PRECAUTIONS:

1. All the connection should be tight.
2. Ammeter is always connected in series in the circuit while voltmeter is parallel to the conductor.
3. The electrical current should not flow the circuit for long time, otherwise its temperature will increase and the result will be affected.
4. Maximum reading of voltmeter should be greater than the electromotive force of the cell.
5. It should be care that the values of the components of the circuit is does not exceed to their ratings (maximum value).
6. Before the circuit connection it should be check out working condition of all the components.

## EXPERIMENT No. 4 (B)

**AIM:** Verification of KVL

**APPARATUS REQUIRED:** Breadboard, Voltage source, Resistor, Voltmeter, Connecting wires

### **THEORY:**

Kirchhoff's Voltage Law (KVL):

Kirchhoff's Voltage Law (KVL) in a DC circuit states that, "the algebraic sum of the Voltage drop around any closed path is equal to the algebraic sum of the Voltage rises".

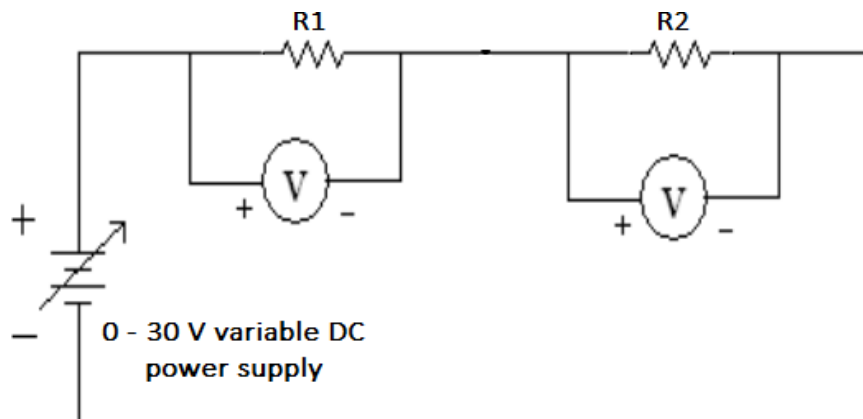
In other words, "the algebraic sum of the Voltage rises and drops around any closed path is equal to zero". A plus (+) sign is assigned for the potential rises (- to +) and minus sign (-) is assigned to a potential drop (+ to -). In symbolic form, Kirchhoff's Voltage Law (KVL) can be expressed as  $\sum V=0$ , Where C is used for closed loop and V is used for the potential rises and drops.

In any closed path / mesh, the algebraic sum of EMF and voltage drops is zero.

The sum of all the voltages around a loop is equal to zero i.e.,  $v_1 + v_2 + v_3 + v_4 = 0$ .

Kirchhoff's Voltage Law (KVL) is Kirchhoff's second law that deals with the conservation of energy around a closed-circuit path.

### **CRICUT DIAGRAM:**



### **PROCEDURE:**

1. Connect the battery and resistance in series.
2. The voltmeters are connected in parallel connection across the resistances. The circuit is closed.
3. Note down the voltmeters reading.
4. Use the formula to calculate the total voltage  $V = V_1 + V_2$ .

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5. The experiment is repeated for different values of supply voltage and the corresponding potential differences are noted.
6. Also find the errors between calculated and measured values.

### OBSERVATION TABLE:

S. No.	Applied Voltage V	$V_1$	$V_2$	$V_m = V_1 + V_2$	Error $V - V_m$
1.					
2.					
3.					
4.					
5.					

**RESULT:** KVL is verified.

### PRECAUTIONS:

1. All the connection should be tight.
2. Ammeter is always connected in series in the circuit while voltmeter is parallel to the conductor.
3. The electrical current should not flow the circuit for long time, otherwise its temperature will increase and the result will be affected.
4. Maximum reading of voltmeter should be greater than the electromotive force of the cell.
5. It should be care that the values of the components of the circuit is does not exceed to their ratings (maximum value).
6. Before the circuit connection it should be check out working condition of all the components.

## EXPERIMENT No. 4 (C)

**AIM:** Verification of KCL

**APPARATUS REQUIRED:** Breadboard, Voltage source, Resistor, Ammeter, Connecting wires

### **THEORY:**

Kirchhoff's Current Law (KCL):

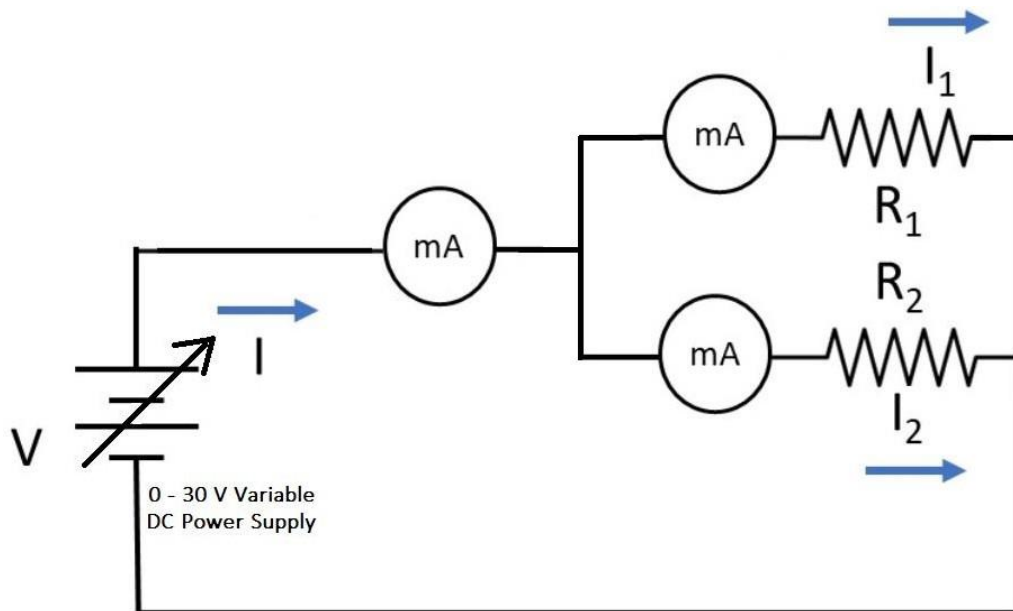
It States that the algebraic sum of currents meeting at a junction is zero. In other words, the sum of the currents flowing away from a junction is equal to the sum of current entering in to the junction.

For example-

There are six currents  $I_1, I_2, I_3, I_4, I_5$  and  $I_6$  meeting at a junction. Assuming that the currents entering into the junction, are positive and current leaving the junction, are negative.

According to KCL  $I_1 + I_2 + I_3 + I_4 + I_5 + I_6 = 0$

### **CRICUT DIAGRAM:**



### **PROCEDURE:**

1. Connect the battery in series with a parallel combination of resistances.
2. The ammeters are connected in series of the resistances. The circuit is closed.
3. Note down the ammeters reading.
4. Use the formula to calculate the total current  $I = I_1 + I_2$ .
5. The experiment is repeated for different values of supply voltage and the corresponding current

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readings are noted.

6. Also find the errors between calculated and measured values.

### OBSERVATION TABLE:

S. No.	Applied Voltage V	I	$I_1$	$I_2$	$I_m = I_1 + I_2$	Error $I - I_m$
1.						
2.						
3.						
4.						
5.						

**RESULT:** KCL is verified.

### PRECAUTIONS:

1. All the connection should be tight.
2. Ammeter is always connected in series in the circuit while voltmeter is parallel to the conductor.
3. The electrical current should not flow the circuit for long time, otherwise its temperature will increase and the result will be affected.
4. Maximum reading of voltmeter should be greater than the electromotive force of the cell.
5. It should be care that the values of the components of the circuit is does not exceed to their ratings (maximum value).
6. Before the circuit connection it should be check out working condition of all the components.

### VIVA QUESTIONS:

1. Explain Ohm's Law.  
Ans: Ohm's law states that the voltage across a conductor is directly proportional to the current flowing through it, provided all physical conditions and temperatures remain constant.
2. What is another name for KCL & KVL?  
Ans: Nodal Analysis and Mesh Analysis
3. Define network and circuit?  
Ans: An electrical circuit is a network consisting of a closed loop, giving a return path for the current. Thus, all circuits are networks, but not all networks are circuits (although networks without a closed loop are often imprecisely referred to as "circuits").
4. What is the difference between mesh and loop?  
Ans: Loop and mesh both are a part of a circuit. A loop is any closed path through a circuit where no node quite once is encountered. A mesh is a closed path during a circuit with no other paths inside it.
5. What is the difference between node and junction?

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Ans: A node has at least two connecting elements, but a junction has at least three connecting elements

## EXPERIMENT No. 5

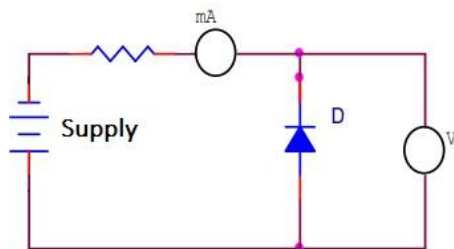
**AIM:** Obtain VI characteristics of semiconductor rectifier diode

**APPARATUS REQUIRED:** Diode Characteristics Kit, Power Supply, Ammeter (0-20mA), Voltmeter (0-20V), Connecting Leads.

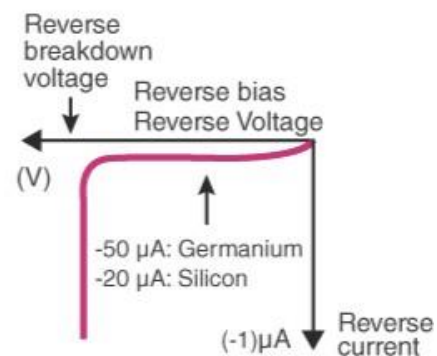
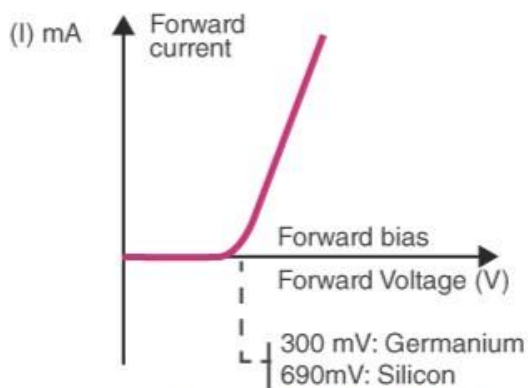
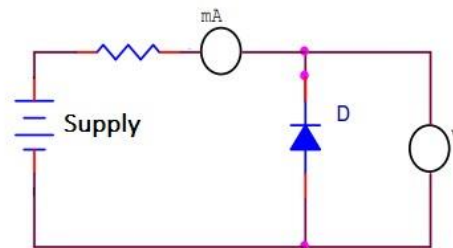
### **THEORY:**

A P-N junction is known as Semiconductor diode or Crystal diode. It is the combination of P-type & N-type Semiconductor. This offers nearly zero resistance to current on forward biasing & nearly infinite Resistance to the flow of current when in reverse biased. Forward biasing: When P-type semiconductor is connected to the +ve terminal and N-type to -ve terminal of voltage source. Nearly zero resistance is offered to the flow of current. Reverse biasing: When P-type semiconductor is connected to the -ve terminal and N-type to +ve terminal. Nearly zero current flow in this condition.

(1) When diode is forward biased



(2) When diode is reverse biased



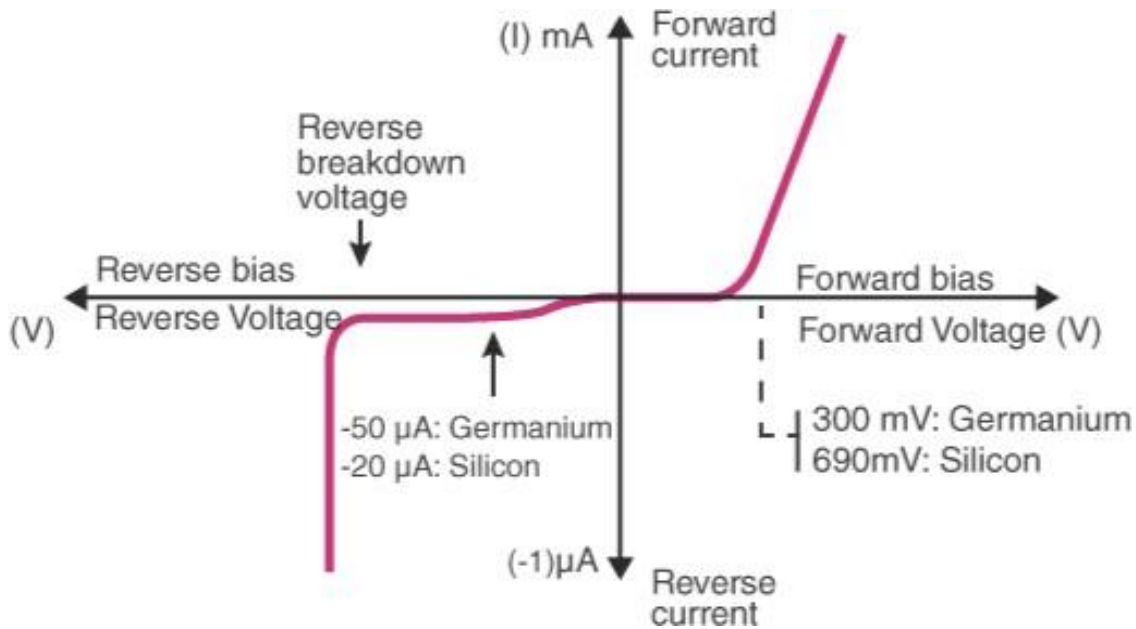
### **PROCEDURE:**

1. Connect the circuit as shown in fig.
2. Switch on the power supply.
3. Vary the value of input dc supply in steps.
4. Note down the ammeter & voltmeter readings for each step.
5. Plot the graph of Voltage Vs Current.

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## OBSERVATION TABLE:

S. No.	Forward Biased		Reverse Biased	
	V	I (mA)	V	I ( $\mu$ A)
1.				
2.				
.				
..				
...				



**RESULT:** VI characteristics of semiconductor rectifier diode has been plotted.

## PRECAUTIONS:

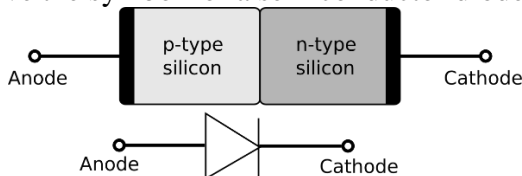
1. All the connection should be tight.
2. Ammeter is always connected in series in the circuit while voltmeter is parallel to the conductor.
3. The electrical current should not flow the circuit for long time, otherwise its temperature will increase and the result will be affected.
4. Maximum reading of voltmeter should be greater than the electromotive force of the cell.
5. It should be care that the values of the components of the circuit is does not exceed to their ratings (maximum value).
6. Before the circuit connection it should be check out working condition of all the components.

### VIVA QUESTIONS:

1. What is a PN junction?

Ans: A P-N junction is an interface or a boundary between two semiconductor material types, namely the p-type and the n-type, inside a semiconductor. In a semiconductor, the P-N junction is created by the method of doping.

2. Give the symbol for a semiconductor diode.



3. What is meant by forward biasing of a PN junction?

Ans: Forward bias or biasing is where the external voltage is delivered across the P-N junction diode. In a forward bias setup, the P-side of the diode is attached to the positive terminal, and N-side is fixed to the negative side of the battery. Here, the applied voltage is opposite to the junction barrier potential.

4. What is meant by reverse biasing of a PN junction?

Ans: When the p-type is connected to the battery's negative terminal and the n-type is connected to the positive side, the P-N junction is reverse biased. In this case, the built-in electric field and the applied electric field are in the same direction. When the two fields are added, the resultant electric field is in the same direction as the built-in electric field, creating a more resistive, thicker depletion region. The depletion region becomes more resistive and thicker if the applied voltage becomes larger.

5. What is forward resistance of a diode?

Ans: Forward resistance is a resistance offered by the p-n junction diode when it is forward biased. In a forward biased p-n junction diode, two type of resistance takes place based on the voltage applied. The two types of resistance take place in forward biased diode are

- Static resistance or DC resistance
- Dynamic resistance or AC resistance

6. What is doping?

Ans: Doping is the process of adding some impurity atoms in a pure or (intrinsic) semiconductor so as to increase the conductivity of a semiconductor.



**EXPERIMENT No. 6**

**AIM:** To observe waveform at the output of half wave rectifier.

**APPARATUS REQUIRED:** Power supply, rectifier kit, CRO, Connecting leads.

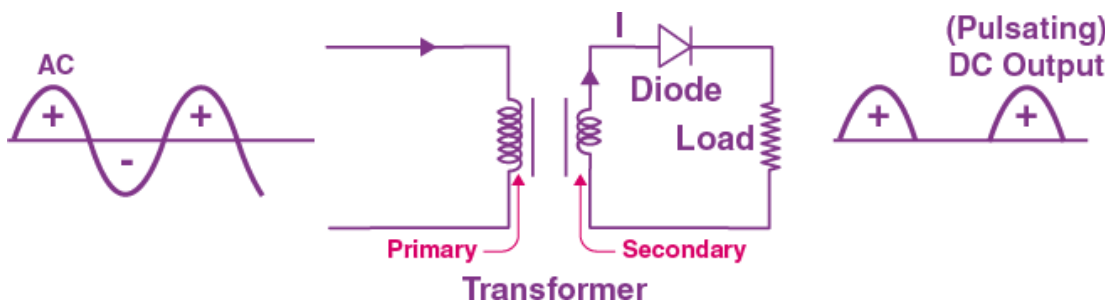
**THEORY:**

Rectification is a process of conversion of AC to DC.

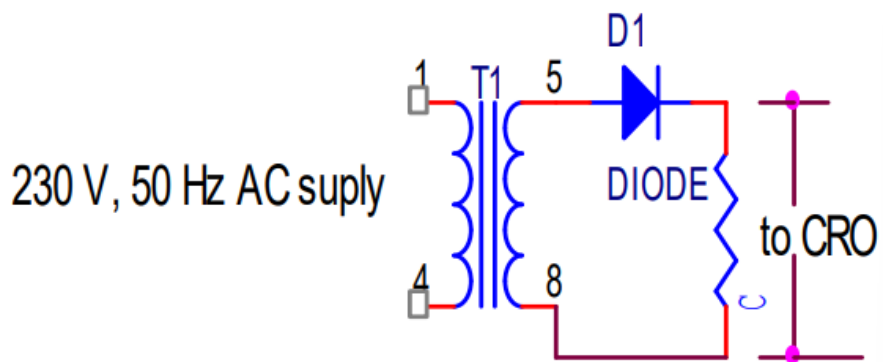
A halfwave rectifier circuit consists of three main components as follows:

- A diode
- A transformer
- A resistive load

In half-wave rectifier, only one diode is used. During +ve half cycle the diode is forward biased & it conducts current through the load resistor R. During -ve half cycle diode is reverse biased. Hence, no current flow through the circuit. Only +ve half cycle appears across the load, whereas, the -ve half cycle is suppressed.



**CRICUT DIAGRAM:**



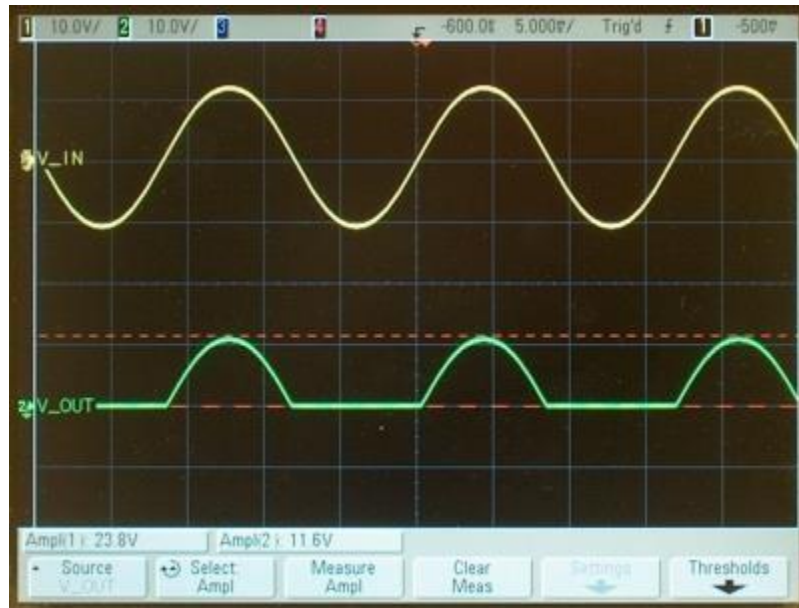
**PROCEDURE:**

1. Connect the circuit as per the circuit diagram
2. A high AC voltage is applied to the primary side of the step-down transformer. The obtained secondary low voltage is applied to the diode.
3. The diode is forward biased during the positive half cycle of the AC voltage and reverse biased during the negative half cycle.
4. The output is noted down on CRO.

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5. Graph is drawn by noting down peak to peak amplitude of input and output voltage.



**RESULT:** Waveform of half wave rectifier is observed.

### PRECAUTIONS:

1. All the connection should be tight.
2. Handle the equipment's with care.
3. The electrical current should not flow the circuit for long time, otherwise its temperature will increase and the result will be affected.
4. It should be care that the values of the components of the circuit is does not exceed to their ratings (maximum value).
5. Before the circuit connection it should be check out working condition of all the components.

### VIVA QUESTIONS:

1. In a simplified half wave circuit, when the diode is forward biased, it acts as \_\_\_\_\_.  
Ans: Short circuit
2. Which is the simplest form of the rectifier?  
Ans: Half Wave Rectifier
3. How many diodes are used by a half wave rectifier circuit for the transformation?  
Ans: 1
4. Filters in half wave rectifiers are used to transform the pulsating waveform into constant\_\_\_\_\_.

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Ans: DC waveform

5. What is a half wave rectifier?

Ans: A halfwave rectifier is defined as a type of rectifier that allows only one-half cycle of an AC voltage waveform to pass while blocking the other half cycle.

6. Give one application of a half wave rectifier.

Ans: A half-wave rectifier is used in soldering iron types of circuits and is also used in mosquito repellent to drive the lead for the fumes. In electric welding, bridge rectifier circuits are used to supply steady and polarized DC voltage.

## EXPERIMENT No. 7

**AIM:** To observe waveform at the output of full wave rectifier.

**APPARATUS REQUIRED:** Power supply, rectifier kit, CRO, Connecting leads.

### **THEORY:**

Rectification is a process of conversion of AC to DC.

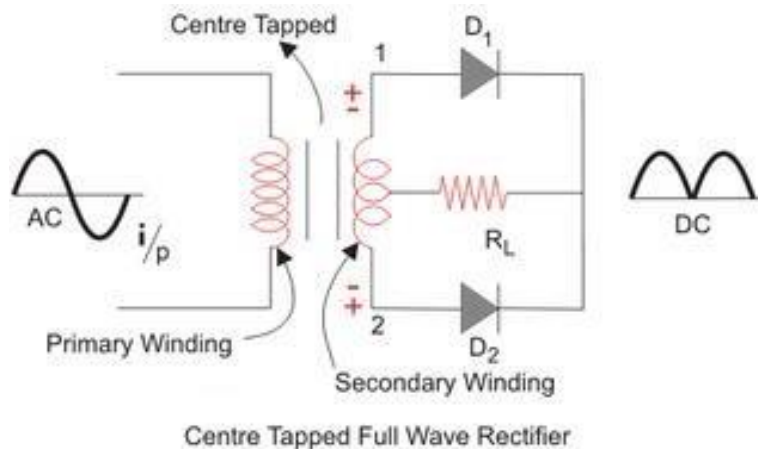
A full wave rectifier circuit consists of three main components as follows:

- 2 diodes
- A transformer
- A resistive load

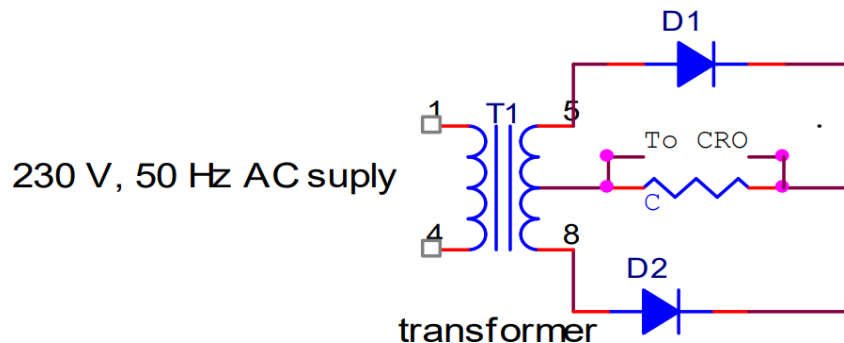
In full-wave rectifier, when a.c supplied at the input, both the half cycle current flows through the load in the same direction. The following two circuits are commonly employed.

**Centre-tap full-wave Rectifier:** In this rectifier, two diode & a center-tap transformer is used. During +ve half cycle the diode D1 is forward biased & D2 is reverse biased. Output will be obtained across load resistor R. During -ve half cycle diode D1 is reverse biased & D2 is forward biased. Output will be obtained across load resistor R & the direction of output is same i.e., DC output is obtained.

**Bridge Rectifier:** The circuit Contains four diodes connected to form a bridge. In this an ordinary transformer is used. During +ve half cycle of secondary voltage, diodes D1 & D3 are forward Biased & diodes D2& D4 are reverse biased & vice versa.

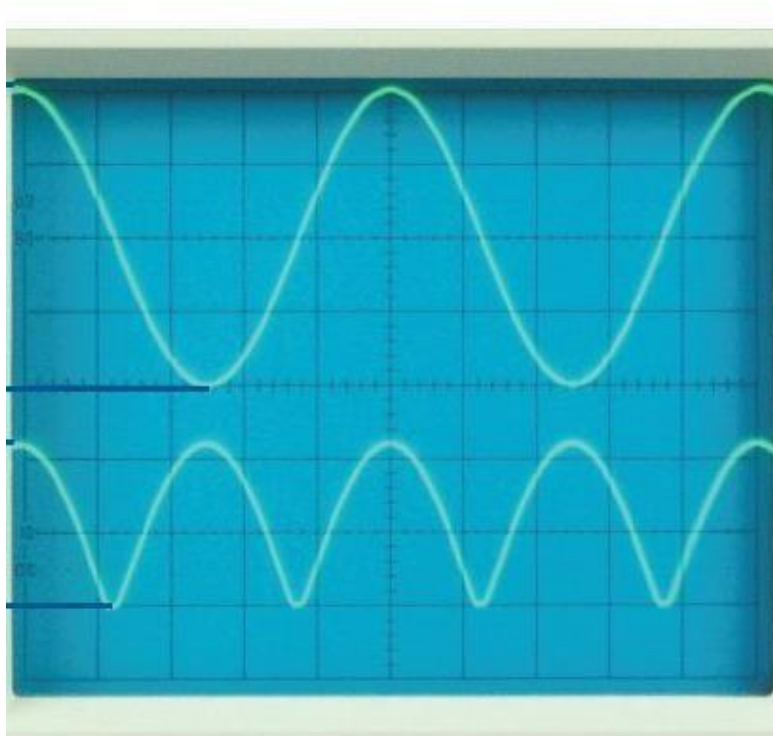


### **CRICUT DIAGRAM:**



### PROCEDURE:

1. Connect the circuit as per the circuit diagram
2. A high AC voltage is applied to the primary side of the step-down transformer. The obtained secondary low voltage is applied to the diode.
3. The diodes are forward biased during the positive half cycle of the AC voltage and reverse biased during the negative half cycle.
4. The output is noted down on CRO.
5. Graph is drawn by noting down peak to peak amplitude of input and output voltage.



**RESULT:** Waveform of full wave rectifier is observed.

### PRECAUTIONS:

1. All the connection should be tight.
2. Handle the equipment's with care.
3. The electrical current should not flow the circuit for long time, otherwise its temperature will increase and the result will be affected.
4. It should be care that the values of the components of the circuit is does not exceed to their ratings (maximum value).
5. Before the circuit connection it should be check out working condition of all the components

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### **VIVA QUESTIONS:**

1. How many diodes are used by a full wave rectifier circuit for the transformation?

Ans: 2 or 4

2. What is full wave rectifier?

Ans: A full wave rectifier is defined as a rectifier that converts the complete cycle of alternating current into pulsating DC. Unlike halfwave rectifiers that utilize only the halfwave of the input AC cycle, full wave rectifiers utilize the full cycle.

3. Give one application of a full wave rectifier.

Ans: Mobile phones, laptops, charger circuits. Uninterruptible Power Supply (UPS) circuits to convert AC to DC.

4. What is the difference between Half Wave and Full Wave Rectifier?

Ans: A Half-Wave rectifier is an electronic circuit which converts only one-half of the AC cycle into pulsating DC. It utilizes only half of AC cycle for the conversion process. On the other hand, Full wave rectifier is an electronic circuit which converts entire cycle of AC into Pulsating DC.

5. Name the basic types of rectifiers?

- Single Phase Rectifiers.
- Three Phase Rectifiers.
- Controlled Rectifiers.
- Uncontrolled Rectifiers.
- Half Wave Rectifiers.
- Full Wave Rectifiers.
- Bridge Rectifiers.
- Center-Tapped Rectifiers.

6. What is the PIV of full wave center tapped rectifier and why?

Ans: The peak inverse voltage (PIV) of the diode in the center tapped full wave rectifier is twice the transformer secondary terminal voltage. Peak inverse voltage PIV of the diode is equal to the transformer secondary voltage. The other diode has +V in its cathode, but the other end of the winding is at -V, so the maximum reverse voltage across the non conducting diode is +2V. It is twice as much only if the center tap to one side is the same value of voltage as the full wave bridge transformer.

## EXPERIMENT No. 8

**AIM:** To experimentally plot the input and output characteristics of a given BJT transistor in CE configuration and calculate its various parameters.

**APPARATUS REQUIRED:** Transistor Characteristic kit, Multimeter, Connecting leads and Power Supply.

### **THEORY:**

In a bipolar junction transistor, the Emitter (E), Base (B) and Collector (C) are the only three terminals available. Hence, in any circuit, one of these terminals has to be common to both input and output connections. Therefore, the junction transistor can be connected in either of these configurations:

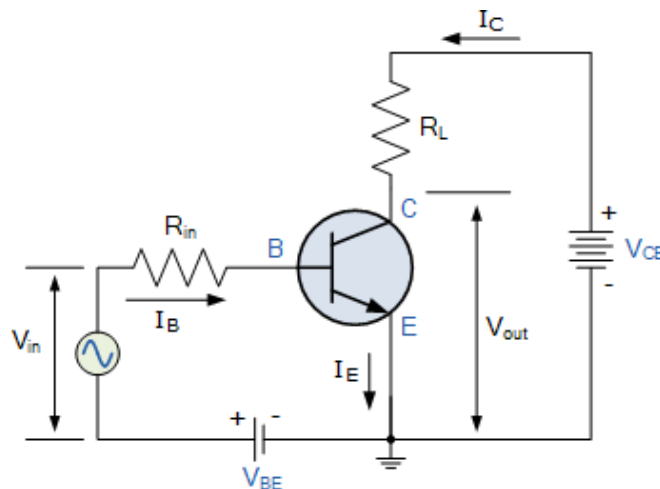
- CE or Common Emitter
- CB or Common Base
- CC or Common Collector

Among these, the junction transistor is most widely used in the Common Emitter configuration. Also, the n-p-n Silicon transistors are used more commonly than the p-n-p transistors. Hence, we will look at the characteristics and configurations of an n-p-n Silicon Junction Transistor in a CE configuration. In common Emitter configuration input is applied between base and emitter while the output is taken across emitter and collector. Thus, the emitter forms the terminal common to both input and output circuits. The load resistance is connected at collector. In Common Emitter (CE) configuration, the emitter is the common terminal. Hence, the input is between the base and the emitter while the output is between the collector and the emitter. Two terms that you must remember:

Input characteristic – the variation of the base current ( $I_B$ ) with the base-emitter voltage ( $V_{BE}$ )

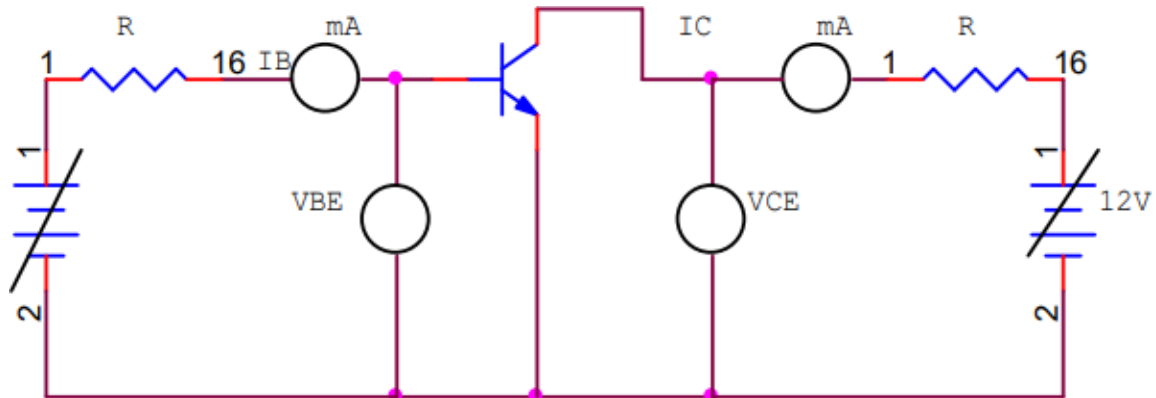
Output characteristic – the variation of the collector current ( $I_C$ ) with the collector-emitter voltage ( $V_{CE}$ )

It is observed that the output characteristics are controlled by the input characteristics. Hence, the collector current changes with the base current.



# BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING LAB (EEE-101P)

## CRICUT DIAGRAM:



## PROCEDURE:

1. Connect the circuit as per the circuit diagram

### Input characteristics

- Keep emitter - collector voltage constant.
- Vary emitter-base voltage in steps and note down base current reading.
- Readings are tabulated and graph is drawn.

### Output characteristics

- Keep base current constant.
- Vary collector-emitter voltage in steps and note down emitter current.
- Readings are tabulated and graph is drawn.

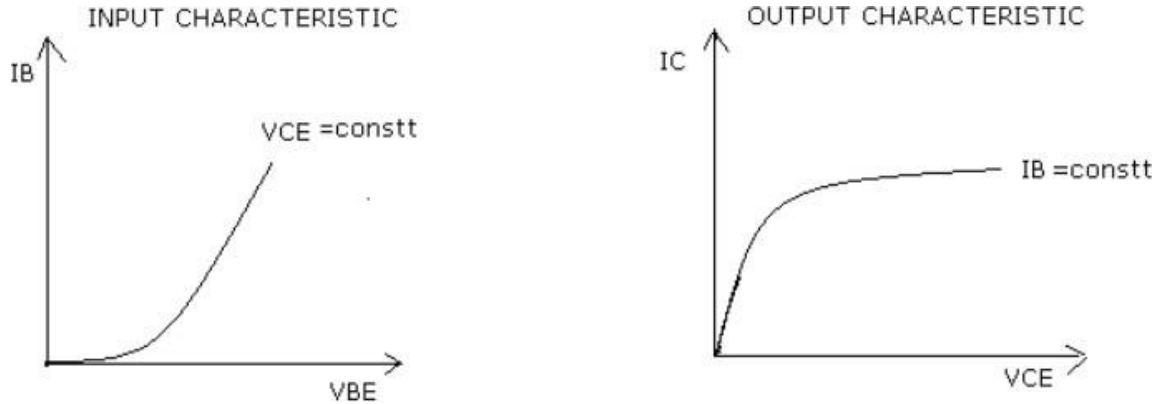
## OBSERVATION TABLE:

S. No.	Input charact.(Vce=Cons.)		Output charact. (Ib = Const.)	
	Vbe(Volts)	Ib(mA)	Vce(Volts)	Ic(mA)
1.				
2.				
3.				
4.				
5.				



## BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING LAB (EEE-101P)

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**RESULT:** -The input and output characteristic of transistor in common emitter configuration has been plotted.

### PRECAUTIONS:

1. All the connection should be tight.
2. Handle the equipment's with care.
3. The electrical current should not flow the circuit for long time, otherwise its temperature will increase and the result will be affected.
4. It should be care that the values of the components of the circuit is does not exceed to their ratings (maximum value).
5. Before the circuit connection it should be check out working condition of all the components.

### VIVA QUESTIONS:

1. What is the equation for voltage gain?

Ans: The voltage gain in a common emitter amplifier is given as  $v = \beta R_L / R_i$

Here  $v$  is the voltage gain,  $\beta$  is the current gain,  $R_L$  is the load resistance and  $R_i$  is the input resistance.

2. What is cut off frequency?

Ans: In electronics, cutoff frequency or corner frequency is the frequency either above or below which the power output of a circuit, such as a line, amplifier, or electronic filter has fallen to a given proportion of the power in the passband.

3. What are the applications of CE amplifier?

Ans: The applications of this CE amplifier are as follows

- These amplifiers are preferably used as the current amplifier than a voltage amplifier as it has more current gain than the voltage gain.
- In the radio frequency circuitry this configuration is preferred.
- For the lower values of noise and its amplification this configuration is preferred.

4. What is active region?

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Ans: The region between cut off and saturation is known as active region. In the active region, collector-base junction remains reverse biased while base-emitter junction remains forward biased. Consequently, the transistor will function normally in this region.

5. What is Bandwidth of an amplifier?

Ans: The Bandwidth (BW) of an amplifier is defined as the difference between the frequency limits of the amplifier. The range of frequencies within a band is known as bandwidth.

6. What is the importance of gain bandwidth product?

Ans: The gain bandwidth product, GBW, is defined as the product of the open loop voltage gain and the frequency at which it is measured. GBW is expressed in units of hertz.

## EXPERIMENT No. 9

**AIM:** To experimentally plot the input and output characteristics of a given BJT transistor in CB configuration and calculate its various parameters.

**APPARATUS REQUIRED:** Transistor Characteristic kit, Multimeter, Connecting leads and Power Supply.

### **THEORY:**

In a bipolar junction transistor, the Emitter (E), Base (B) and Collector (C) are the only three terminals available. Hence, in any circuit, one of these terminals has to be common to both input and output connections. Therefore, the junction transistor can be connected in either of these configurations:

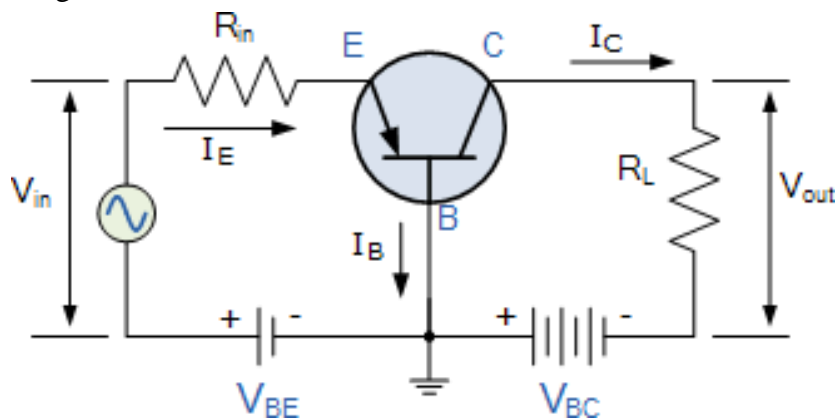
- CE or Common Emitter
- CB or Common Base
- CC or Common Collector

Also, the n-p-n Silicon transistors are used more commonly than the p-n-p transistors. Hence, we will look at the characteristics and configurations of an n-p-n Silicon Junction Transistor in a CB configuration. In common base configuration, base terminal of transistor is common between the input and output circuits. Thus, the base forms the terminal common to both input and output circuits. The load resistance is connected at collector. In Common Base (CE) configuration, the base is the common terminal. Hence, the input is between the base and the emitter while the output is between the collector and the base. Two terms that you must remember:

**Input characteristic** – The graph showing the variation of emitter current ( $I_E$ ) with the variation of emitter-base voltage ( $V_{EB}$ ) when a collector-base voltage ( $V_{CB}$ ) is kept constant is known as input characteristics of a transistor.

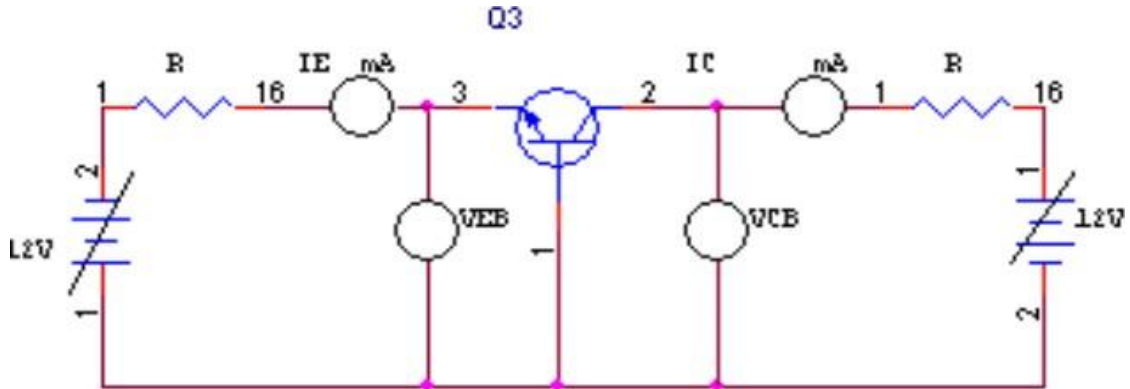
**Output characteristic** – The variation of collector current  $I_C$  with the collector-base voltage ( $V_{CB}$ ) at constant emitter current ( $I_E$ ) is called output characteristics of the transistor in the common base configuration.

It is observed that the output characteristics are controlled by the input characteristics. Hence, the collector current changes with the base current.



# BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING LAB (EEE-101P)

## CRICUT DIAGRAM:



## PROCEDURE:

1. Connect the circuit as per the circuit diagram

### Input characteristics

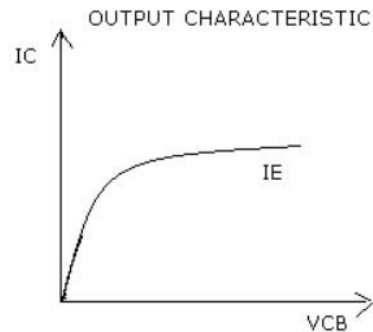
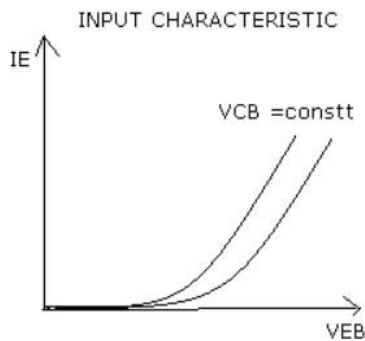
- a) Keep collector - base voltage constant.
- b) Vary emitter-base voltage in steps and note down emitter current reading.
- c) Readings are tabulated and graph is drawn.

### Output characteristics

- a) Keep emitter current constant.
- b) Vary collector-base voltage in steps and note down collector current.
- c) Readings are tabulated and graph is drawn.

## OBSERVATION TABLE:

S. No.	Input charact.(Vcb=Cons.)		Output charact. (Ie = Const.)	
	Veb (Volts)	Ie(mA)	Vcb(Volts)	Ic(mA)
1.				
2.				
3.				
4.				
5.				



## BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING LAB (EEE-101P)

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**RESULT:** -The input and output characteristic of transistor in common base configuration has been plotted.

### PRECAUTIONS:

1. All the connection should be tight.
2. Handle the equipment's with care.
3. The electrical current should not flow the circuit for long time, otherwise its temperature will increase and the result will be affected.
4. It should be care that the values of the components of the circuit is does not exceed to their ratings (maximum value).
5. Before the circuit connection it should be check out working condition of all the components.

### VIVA QUESTIONS:

1. What is the equation for voltage gain?

Ans: The voltage gain for the common base amplifier is the ratio of  $V_{OUT}/V_{IN}$ ,  $A_V = \alpha \frac{R_C}{R_E} = A_i \left[ \frac{R_C}{R_E} \right]$

2. What is meant by small signal amplifier?

Ans: Small signal amplifiers are designed to amplify very small signal voltage levels of only a few micro-volts ( $\mu V$ ) from sensors or audio signals.

3. What are the applications of CB amplifier?

Ans: It is commonly used for amplifiers than requires low input impedance, such as microphones. It is used in very high and ultra-high frequency amplifiers because it performs better at high frequencies.

4. What is the effect of source resistance on voltage gain of a common base transistor amplifier?

Ans: The input impedance of a CB stage is much smaller than that of a CE stage. With the inclusion of a source resistance, the input signal is attenuated before it reaches the emitter of the amplifier; therefore, the voltage gain is lowered.

5. What is BJT and explain about its terminals?

Ans: A bipolar junction transistor is a three-terminal semiconductor device that consists of two p-n junctions which are able to amplify or magnify a signal. It is a current controlled device. The three terminals of the BJT are the base, the collector, and the emitter.

6. What are BJT types, and which type is better, why?

Ans: A BJT can be configured into three types, they are a common collector configuration, common base configuration and common emitter configuration. Common emitter configuration is providing the maximum power gain. The power gain is the product of voltage and current gain. Since the voltage and current gain of the CE configuration are high, hence the power gain is also maximum.

## EXPERIMENT No. 10

**AIM:** To study the transfer and drain characteristics of JFET.

**APPARATUS REQUIRED:** Power supply, JFET characteristic Kit, connecting leads, two Multimeters.

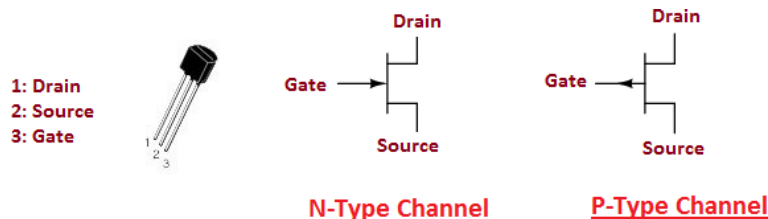
### **THEORY:**

A FET is a three terminal semiconductor device in which current conduction is by one type of carries & is controlled by the effect of electric field. Different types of FETs are available to design different circuits. They are Junction field effect transistors (JFET), Metal Oxide Silicon FET (MOSFET), VFET and more. These all are based on the same basic technology. In all these FETs electric field alters the flow of current through a semiconductor channel. The Field Effect Transistor consists of three terminals such as source, drain and gate.

**Source:** The Source (S) is the electrode of the transistor, which the charge carriers enter the channel, then it acts as the source of carriers for the device, current flowing through the source to the channel is chosen by  $I_S$ .

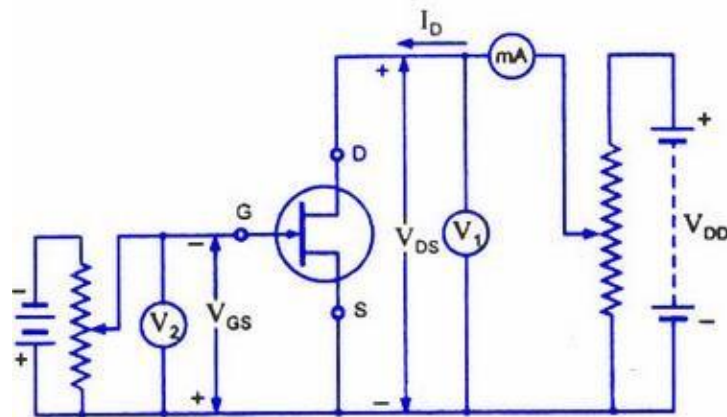
**Drain:** The Drain (D) is the electrode of the transistor, through which the majority charge carriers leave the channel, i.e., they are exhausted from the channel. Conventional current entering the channel at the drain is chosen by  $I_D$ . Also Drain to Source voltage is frequently chosen by the  $V_{DS}$

**Gate:** The Gate terminal (G) controls the conductivity of the channel. By applying voltage to gate terminal one can control the  $I_D$ .



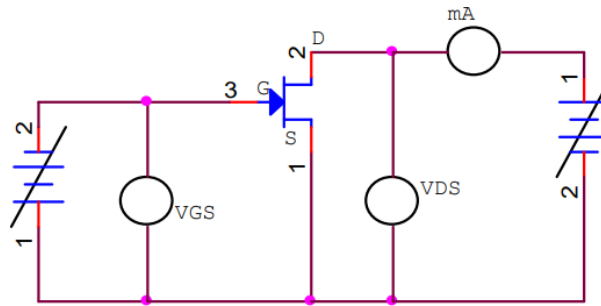
There are two types of FET namely JFET & MOSFET. Again, a JFET can either have N-channel or P-channel. A N-channel JFET has a N-type semiconductor bar, the two ends of which make the Drain & source terminal. On the two sides of this bar, P-N junction is made. This P region makes gate. Usually, these two gates are connected Together to form a single gate. The gate is given a -ve bias w.r.t source. The Drain is given +ve potential w.r.t source.

### **CRICUT DIAGRAM:**



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**PROCEDURE:**

1. Connect the circuit as per the circuit diagram

**Input characteristics**

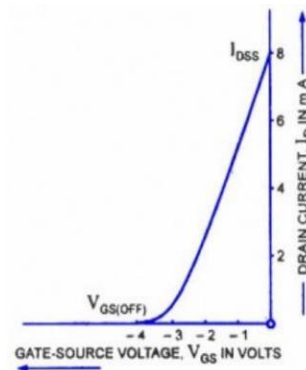
- a) Keep drain-source voltage constant
- b) Vary gate-source voltage in steps and note down drain current
- c) Readings are tabulated and graph is drawn

**Output characteristics**

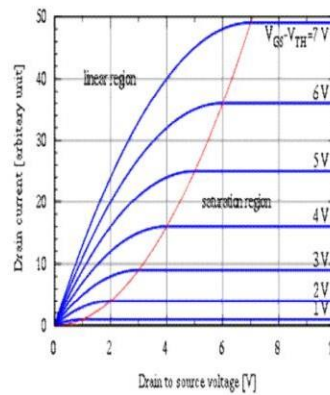
- a) Keep gate-source voltage constant.
- b) Vary drain-source voltage in steps and note down drain current.
- c) Readings are tabulated and graph is drawn.

**OBSERVATION TABLE:**

S. No.	Transfer charact. ( $V_{DS} = \text{Cons.}$ )		Drain charact. ( $V_{GS} = \text{Const.}$ )	
	$V_{GS}$ (Volts)	$I_D$ (mA)	$V_{DS}$ (Volts)	$I_D$ (mA)
1.				
2.				
3.				
4.				
5.				



**INPUT CHARACTERISTIC**



**OUTPUT CHARACTERISTIC**

## **BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING LAB (EEE-101P)**

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**RESULT:** - Transfer and drain characteristics of JFET has been plotted.

### **PRECAUTIONS:**

1. All the connection should be tight.
2. Handle the equipment's with care.
3. The electrical current should not flow the circuit for long time, otherwise its temperature will increase and the result will be affected.
4. It should be care that the values of the components of the circuit is does not exceed to their ratings (maximum value).
5. Before the circuit connection it should be check out working condition of all the components.

### **VIVA QUESTIONS:**

1. What is a junction field-effect transistor (JFET)?

Ans: JFET or Junction Field Effect Transistor is a unipolar current-controlled semiconductor device with three terminals: source, drain, and gate. JFETs are commonly used as switches and amplifiers.

2. What is the depletion region in JFET?

Ans: The depletion regions are wedge-shaped, being larger at the drain end than at the source end. This is because the gate-to-channel reverse bias at the drain end of the gate is larger than the reverse bias at the source end of the gate.

3. What is the pinch-off region?

Ans: "pinch-off" refers to the threshold voltage below which the transistor turns off. the pinch off voltage is the value of  $V_{ds}$  when drain current reaches constant saturation value.

4. Define breakdown region for JFET.

Ans: Breakdown Region – The voltage between the Drain and the Source, ( $V_{DS}$ ) is high enough to causes the JFET's resistive channel to break down and pass uncontrolled maximum current.

5. Why are field-effect transistors called unipolar transistors?

Ans: FETs are also known as unipolar transistors since they involve single-carrier-type operation. That is, FETs use either electrons (n-channel) or holes (p-channel) as charge carriers in their operation, but not both.

6. Why the channel of a JFET is never completely closed at the drain end?

Ans: The reason for this is that the electrostatic forces between the electrons cause them to spread out, giving a counter effect to the increase in thickness of the depletion layer.



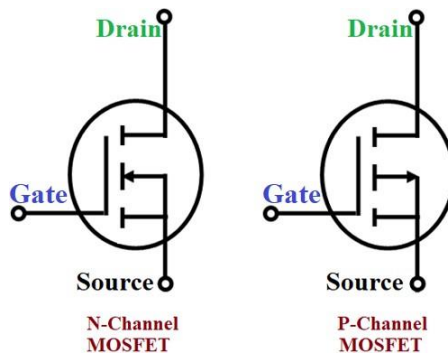
## EXPERIMENT No. 11

**AIM:** To study the transfer and drain characteristics of MOSFET.

**APPARATUS REQUIRED:** Power supply, JFET characteristic Kit, connecting leads, two Multimeters.

### **THEORY:**

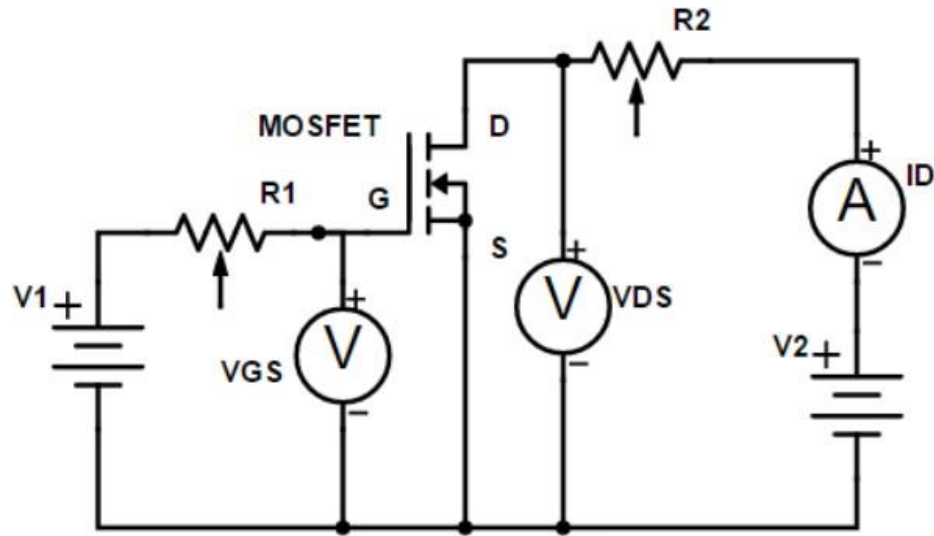
A FET is a three terminal semiconductor device in which current conduction is by one type of carries & is controlled by the effect of electric field. Different types of FETs are available to design different circuits. They are Junction field effect transistors (JFET), Metal Oxide Silicon FET (MOSFET), VFET and more. These all are based on the same basic technology. In all these FETs electric field alters the flow of current through a semiconductor channel. The Field Effect Transistor consists of three terminals such as source, drain and gate.



**Source:** The Source (S) is the electrode of the transistor, which the charge carriers enter the channel, then it acts as the source of carriers for the device, current flowing through the source to the channel is chosen by  $I_S$ .

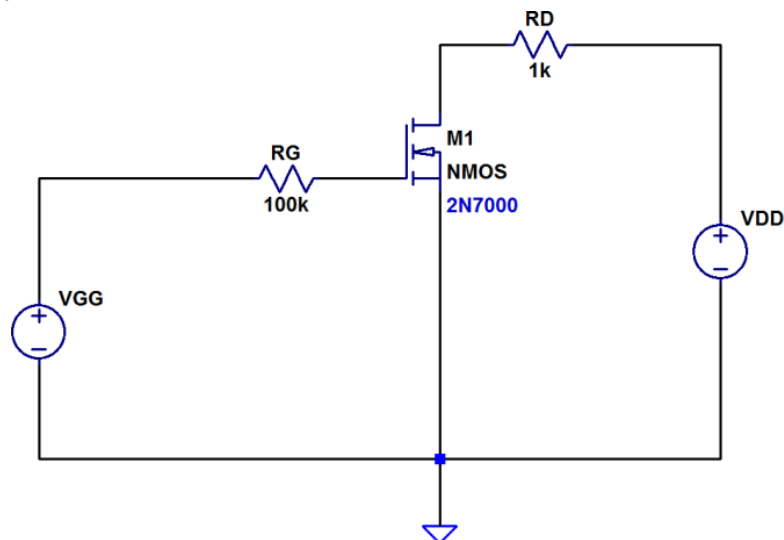
**Drain:** The Drain (D) is the electrode of the transistor, through which the majority charge carriers leave the channel, i.e., they are exhausted from the channel. Conventional current entering the channel at the drain is chosen by  $I_D$ . Also Drain to Source voltage is frequently chosen by the  $V_{DS}$

**Gate:** The Gate terminal (G) controls the conductivity of the channel. By applying voltage to gate terminal one can control the  $I_D$ .



There are two types of FET namely JFET & MOSFET. The p-type semiconductor forms the base of the MOSFET. The two types of the base are highly doped with an n-type impurity. From the heavily doped regions of the base, the terminals source and drain originate. The layer of the substrate is coated with a layer of silicon dioxide for insulation. A thin insulated metallic plate is kept on top of the silicon dioxide and it acts as a capacitor. The gate terminal is brought out from the thin metallic plate. A DC circuit is then formed by connecting a voltage source between these two n-type regions.

## CRICUT DIAGRAM:



## PROCEDURE:

1. Connect the circuit as per the circuit diagram

### Input characteristics

- a) Keep drain-source voltage constant
- b) Vary gate-source voltage in steps and note down drain current
- c) Readings are tabulated and graph is drawn

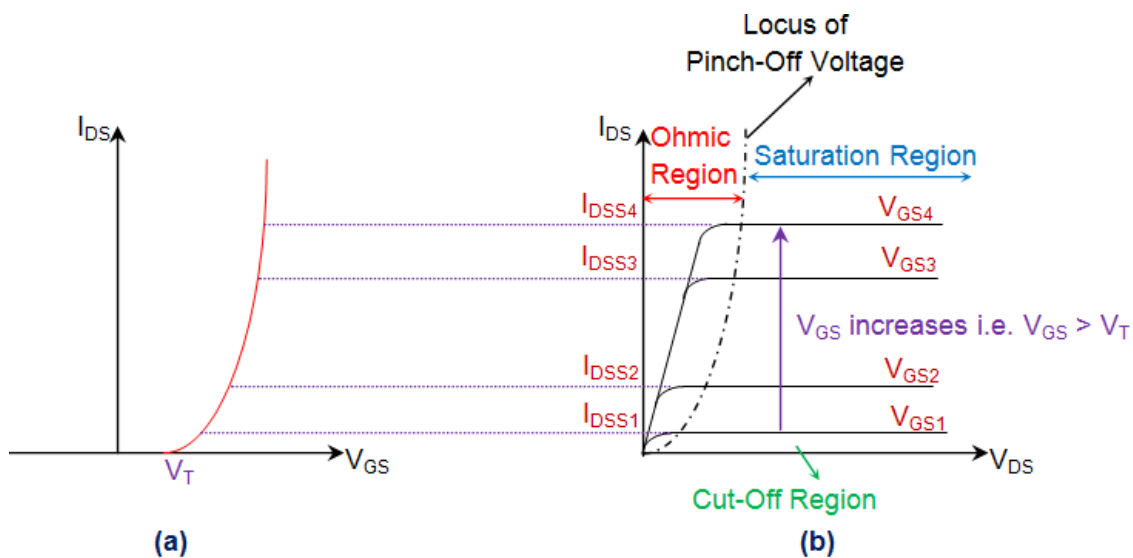
### Output characteristics

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- Keep gate-source voltage constant.
- Vary drain-source voltage in steps and note down drain current.
- Readings are tabulated and graph is drawn.

## OBSERVATION TABLE:

S. No.	Transfer charact. ( $V_{DS} = \text{Cons.}$ )		Drain charact. ( $V_{GS} = \text{Const.}$ )	
	$V_{GS}$ (Volts)	$I_D$ (mA)	$V_{DS}$ (Volts)	$I_D$ (mA)
1.				
2.				
3.				
4.				
5.				



**n-Channel Enhancement type MOSFET (a) Transfer Characteristics (b) Output Characteristics**

**RESULT:** - Transfer and drain characteristics of MOSFET has been plotted.

## PRECAUTIONS:

- All the connection should be tight.
- Handle the equipment's with care.
- The electrical current should not flow the circuit for long time, otherwise its temperature will increase and the result will be affected.
- It should be care that the values of the components of the circuit is does not exceed to their ratings (maximum value).
- Before the circuit connection it should be check out working condition of all the components.

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### **VIVA QUESTIONS:**

1. What is a MOSFET?

Ans: The metal-oxide-semiconductor field-effect transistor (MOSFET, MOS-FET, or MOS FET) is a type of field-effect transistor (FET), most commonly fabricated by the controlled oxidation of silicon. It has an insulated gate, the voltage of which determines the conductivity of the device.

2. What is the depletion region in MOSFET?

Ans: This region of uncovered positive and negative ions is called the depletion region due to the depletion of carriers in this region. The depletion region is so named because it is formed from a conducting region by removal of all free charge carriers, leaving none to carry a current.

3. What is the significant difference between the construction of an enhancement type MOSFET and a depletion type MOSFET?

Ans: Enhancement MOSFET does not conduct at 0 volt, as there is no channel in this type to conduct. Depletion MOSFET conducts at 0 volt. Moreover, when positive cut-off gate voltage is applied to depletion MOSFET, hence it is less preferred.

4. Define breakdown region for MOSFET.

Ans: The Breakdown Region of a transistor is the region where the collector voltage,  $V_{cc}$ , is so large that the collector-base diode breaks down, causing a large, undesired collector current to flow.

5. What is meant by the transfer characteristic of FETs?

Ans: The transfer characteristic indicates that the drain current  $I_D$  decreases with the gate-source voltage  $V_{GS}$  at constant  $V_{DS}$

6. What is meant by drain characteristics of FETs?

Ans: The variation of drain current ( $I_D$ ) with drain-source voltage ( $V_{DS}$ ) at constant gate source voltage ( $V_{GS}$ ) provides the drain characteristic

This lab manual has been updated by

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Crosschecked By  
HOD Applied  
Science

Please spare some time to provide your valuable feedback.