FACULTY OF ENGINEERING AND TECHNOLOGY

BACHELOR OF TECHNOLOGY

ELECTRICAL AND ELECTRONICS ENGINEERING

(03010601ES02)

1ST SEMESTER

ELECTRICAL ENGINEERING DEPARTMENT

Laboratory Manual

PREFACE

Electrical and Electronics Engineering theory and laboratory course at **PARUL UNIVERSITY, WAGHODIA, VADODARA** is designed in such a way that students develop a basic understanding of the subject in the theory classes and then try their hands on the experiments to realize the various concepts learned during the theoretical sessions. The main objective of the Electrical and Electronics Engineering laboratory course is: To get Hands-on experience of the concepts they have learned in theory classes. All the experiments are designed to understand the interfacing of various elements of Electrical and Electronics Engineering and also to expose the students to their uses.

This Electrical and Electronics Engineering Practical Book aims to provide a comprehensive source for all the experiments included in the Electrical and Electronics Engineering laboratory course. It explains all the aspects related to every experiment such as: safety, basic elements of electrical engineering, types of power, analysis and simplification circuits, details of the instruments, how to use these instruments for the desired purpose, the theoretical formalism & formulae, the procedure of experimenting and how to calculate the desired electrical quantities from the observations, etc. It also gives sufficient information on interpreting and discussing the results.

INSTRUCTIONS TO STUDENTS

1. Be prompt in arriving at the laboratory and always come well-prepared for the experiment.
2. Be careful while working on the equipment operated with high voltage power supply.
3. Work quietly and carefully. Give equal opportunity to all your fellow students to work on the instruments.
4. Every student should have his/her copy of the Electrical and Electronics Engineering Practical Record Book and Lab Manual.
5. Every student have to prepare the notebooks specifically reserved for the Electrical and Electronics Engineering practical work: "Electrical and Electronics Engineering Practical Lab Manual".
6. Record your observations honestly. Never makeup reading them either to get a better fit on the graph or to produce the correct result. Display all your observations on the graph (if applicable)
7. All the observations have to be neatly recorded in the Electrical and Electronics Engineering Practical Record Book (as explained in the Electrical and Electronics Engineering Practical Lab Manual) and verified by the instructor before leaving the laboratory.
8. If some of the readings appear to be wrong then repeat the set of observations carefully.
9. Do not share your readings with your fellow students. Every student has to produce his/her own set of readings by experimenting separately.
10. After verification of the recorded observations, do the calculation in the Electrical and Electronics Engineering Practical Record Book (as explained in the Electrical and Electronics Engineering Practical Lab Manual) produce the desired results, and get them verified by the instructor.
11. Never forget to mention the units of the observed quantities in the observation table. After calculations, represent the results with appropriate units.
12. Calculate the percentage error in the results obtained by you if the standard results are available and also try to point out the sources of errors in the experiment.
13. Find the answers to all the questions mentioned under the section 'Find the Answers' at the end of each experiment in the Electrical and Electronics Engineering Practical Lab Manual.
14. Finally, record the verified observations, calculations, and results in the Electrical and Electronics Engineering Record Book.
15. The grades for the Electrical and Electronics Engineering Practical course work will be awarded based on your performance in the laboratory, regularity, recording of experiments in the Electrical and Electronics Engineering Practical Lab Manual, lab quiz, regular viva-voce, and end-term examination.

CERTIFICATE

This is to certify that,

Mr./Ms...

with enrolment no. .... has successfully completed his/her laboratory experiments in the Electrical and Electronics Engineering (03010601ES02) B.Tech. 1st Year from the department of .... Engineering during the academic year ....

Date of Submission: .... *Staff In charge: ....*

Head of Department: ....

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Sr. No.	Experiment Title	Page No		Date of Performance	Date of Assessment	Marks (out of 20)	Sign
		From	To				
1	To study about various electrical and electronics symbols and demonstrate various measuring instruments used in electrical & electronics laboratories.						
2	Verification of superposition theorem with DC source.						
3	Verification of thevenin's theorem with DC source.						
4	To experimentally investigate the behaviour of a series RLC circuit under AC excitation.						
5	Verification of current and voltage relations in three-phase balanced star and delta-connected loads.						
6	To Plot V-I characteristics of the P-N junction diode.						
7	To perform half wave rectifier with and without filter.						
8	To perform full wave rectifier with and without filter						
9	To plot and study input-output characteristics of the Common Emitter (CE) configuration of the transistor						
10	To perform and observe the response of voltage regulator IC 7805.						

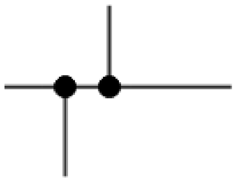
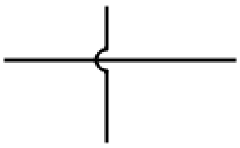
EXPERIMENT NO. 1

AIM: To study about various electrical and electronics symbols and demonstrate various measuring instruments used in electrical & electronics laboratory.

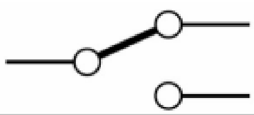
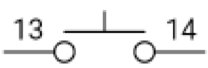
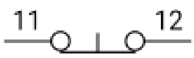
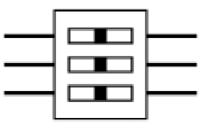
THEORY:

Electrical and Electronics Symbols

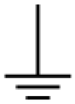
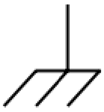
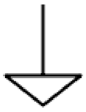
Wires Symbols

Symbol	Name	Description
	Electrical Wire	It is the symbol that is used to represent a wire.
	Connected Wires	This Symbol represents the wire-connected crossing.
	Not Connect Wires	This Symbol shows that wires are not connected on the crossing.

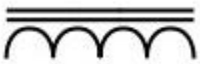
Switches Symbols

Symbol	Name	Description
	SPST Toggle Switch	It is the symbol of a switch that disconnects current when open.
	SPDT Toggle Switch	This Symbol of switch selects between two connections.
	Push Button (N.O)	It is a symbol that denotes Momentary switch - normally open.
	Push Button Switch (N.C)	This denotes the symbol of a Momentary switch - Normally closed.
	DIP Switch	It is the symbol of the DIP switch which is used for onboard configuration.

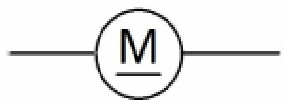
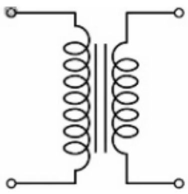
Earthing

Symbol	Name	Description
	Earth Ground	This Symbol is used for zero potential reference and electrical shock protection.
	Chassis Ground	This symbol shows the wire Connected to the chassis of the circuit.
	Digital Ground	It refers to the reference voltage of digital-analog if.

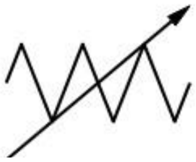
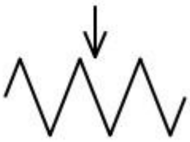
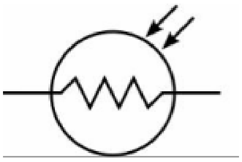
Inductors

Symbol	Name	Description
	Inductor	Symbol of a Coil / solenoid that generates a magnetic field.
	Iron Core Inductor	It is the symbol of the iron core Inductor Which Includes iron.
	Variable Inductor	It is the coil or solenoid that has a Variable magnetic field.

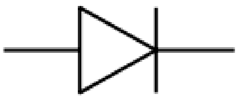
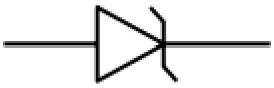
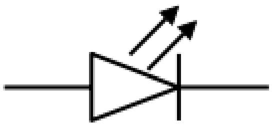
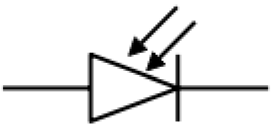
Motor and Transformer

Symbol	Name	Description
	Motor	Symbol of motor, which changes electric energy to kinetic energy.
	AC Transformer	Transformer changes AC voltage from high to low or low to high.

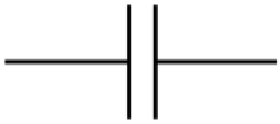
Resistance

Symbol	Name	Description
	Variable Resistance	It is the symbol of an adjustable resistor which has 2 terminals.
	Potentiometer	It is the symbol of an adjustable resistor that has 3 terminals.
	Thermistor	It is the symbol of a Thermal resistor that changes the resistance when temperature changes.
	Photo-resistor / LDR	It is the symbol of Photo-resistor (Light Dependent Resistor - LDR) - change resistance with light intensity change.

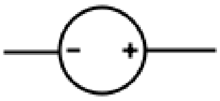
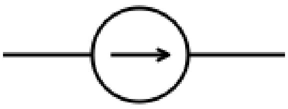
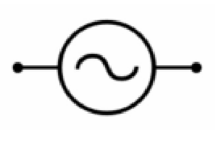
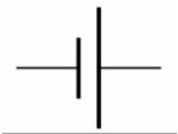
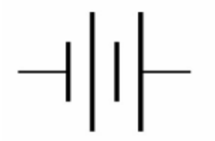
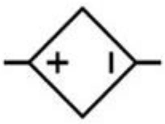
Diode

Symbol	Name	Description
	Diode	Diode allows current flow in one direction only - left (anode) to the right (cathode).
	Zener Diode	It allows current flow in one direction, but also can flow in the reverse direction when above breakdown volt.
	Light Emitting Diode	LED emits light when current flows through it.
	Photodiode	This is the symbol of Photodiode that allows current flow when exposed to light.

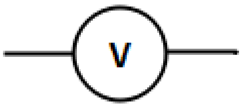
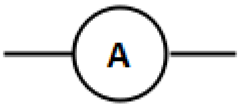
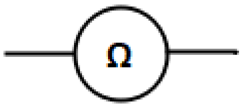
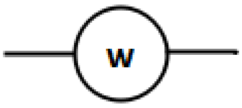
Capacitor

Symbol	Name	Description
	Capacitor	Capacitor is used to store electric charge. It acts as a short circuit with AC and an open circuit with DC.
	Variable Capacitor	The Symbol represent the adjustable capacitance.

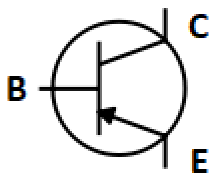
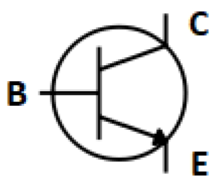
Sources

Symbol	Name	Description
	Voltage Source	It is the symbol of a voltage Source which generates constant voltage.
	Current Source	It is the symbol of a current Source which generates constant current.
	AC Voltage Source	This symbol shows the AC Voltage Source.
	Battery Cell	It is the symbol of single cell use to generate constant volt.
	Battery	It is the symbol of a battery which is the combination of two or more cells.
	Controlled Voltage Source	It is the symbol of a constant voltage Source that gives controllable voltage at the output.
	Controlled Current Source	It represents the controlled Current source which gives controllable current at the output.

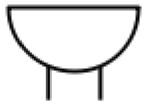
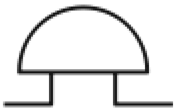
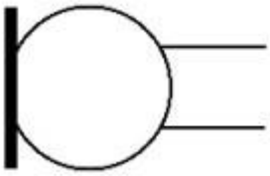
Meter Symbols

Symbol	Name	Description
	Voltmeter	It is the symbol that shows Voltmeter which is used to measure the voltage.
	Ammeter	It represents the ammeter whose work is to measure the current in the circuit.
	Ohmmeter	It is the symbol of the ohmmeter which is needed to measure the value of a resistor.
	Wattmeter	This represents the power meter which shows the power consumption.

Transistors Symbols

Symbol	Name	Description
	NPN Bipolar Transistor	It allows current flow when the high potential is at the base (middle).
	PNP Bipolar Transistor	It allows current flow when the low potential is at the base (middle) of the symbol.

Utility Symbols

Symbol	Name	Description
	BUZZER	Produce a buzzing sound when current flows through it.
	Electric Bell	This is the symbol of Bell which Rings when activated.
	Fuse	The fuse disconnects when the current is above the threshold---used to protect a circuit from high currents.
	Bus	The bus symbol contains several wires. Usually for data/address.
	Loudspeaker	Convert electrical signals to sound waves.
	Microphone	Microphone Converts sound waves to the electrical signal.
	Lamp/Light Bulb	This is the symbol of a lamp that glows when current flows through it.

Measuring Instruments

1. Ammeter

An ammeter (from Ampere Meter) is a measuring instrument used to measure the current in a circuit. Electric currents are measured in amperes (A), hence the name. Instruments used to measure smaller currents, in the milliampere or microampere range, are designated as milliammeters or micro ammeters. Early ammeters were laboratory instruments which relied on the Earth's magnetic field for operation. By the late 19th century, improved instruments were designed which could be mounted in any position and allowed accurate measurements in electric power systems.

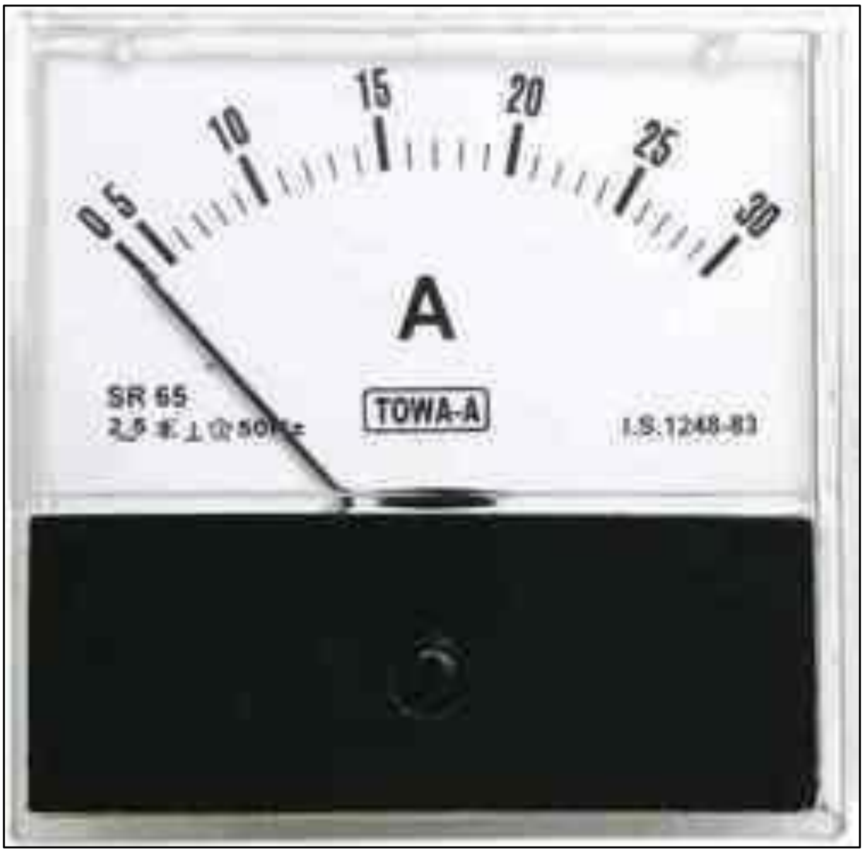


Fig 1.1 Ammeter

2. Capacitance Meter

A capacitance meter is a piece of electronic test equipment used to measure capacitance, mainly of discrete capacitors. Depending on the sophistication of the meter, it may display the capacitance only, or it may also measure a number of other parameters such as leakage, equivalent series resistance (ESR), and inductance. For most purposes and in most cases the capacitor must be disconnected from circuit; ESR can usually be measured in circuit.

Fig 1.2 Capacitance meter

3. Current Clamp

In electrical and electronic engineering, a current clamp or current probe is an electrical device having jaws which open to allow clamping around an electrical conductor. This allows measurement of the current in a conductor without the need to make physical contact with it, or to disconnect it for insertion through the probe. Current clamps are typically used to read the magnitude of alternating current (AC) and, with additional instrumentation, the phase and waveform can also be measured. Some clamps meters can measure currents of 1000 A and more. Hall Effect and vane type clamps can also measure direct current (DC).

Fig 1.3 Clamp Meter

4. Electricity Meter

An electricity meter, electric meter, electrical meter, or energy meter is a device that measures the amount of electric energy consumed by a residence, a business, or an electrically powered device. Electric utilities use electric meters installed at customers' premises to measure electric energy delivered to their customers for billing purposes. They are typically calibrated in billing units, the most common one being the kilowatt hour [kWh]. They are usually read once each billing period.

Fig 1.4 Electric Meter

5. LCR Meter

An LCR meter is a type of electronic test equipment used to measure the inductance (L), capacitance (C), and resistance (R) of an electronic component. In the simpler versions of this instrument the impedance was measured internally and converted for display to the corresponding capacitance or inductance value. Readings should be reasonably accurate if the capacitor or inductor device under test does not have a significant resistive component of impedance. More advanced designs measure true inductance or capacitance, as well as the equivalent series resistance of capacitors and the Q factor of inductive components.

Fig1.5 LCR Meter

6. Multimeter

A multimeter or a multitester, also known as a VOM (Volt-Ohm-Millimeter), is an electronic measuring instrument that combines several measurement functions in one unit. A typical multimeter can measure voltage, current, and resistance. Analog multimeters use a micrometer with a moving pointer to display readings. Digital multimeters (DMM, DVOM) have a numeric display, and may also show a graphical bar representing the measured value. Digital multimeters are now far more common due to their cost and precision, but analog multimeters are still preferable in some cases, for example when monitoring a rapidly varying value.

Fig 1.6 Multimeter

7. OHM Meter

An ohmmeter is an electrical instrument that measures electrical resistance, the opposition to an electric current. Micro-ohmmeters (microhmmeter or microohmmeter) make low resistance measurements. Megohmmeters (also a trademarked device Megger) measure large values of resistance. The unit of measurement for resistance is ohms (Ω).

Fig1.7 Ohm meter

8. Wattmeter

The wattmeter is an instrument for measuring the electric power (or the supply rate of electrical energy) in watts of any given circuit. Electromagnetic wattmeters are used for measurement of utility frequency and audio frequency power; other types are required for radio frequency measurements. The traditional analog wattmeter is an electrodynamic instrument. The device consists of a pair of fixed coils, known as current coils, and a movable coil known as the potential coil. The current coils are connected in series with the circuit, while the potential coil is connected in parallel. Also, on analog wattmeters, the potential coil carries a needle that moves over a scale to indicate the measurement. A current flowing through the current coil generates an electromagnetic field around the coil. The strength of this field is proportional to the line current and in phase with it. The potential coil has, as a general rule, a high-value resistor connected in series with it to reduce the current that flows through it. The result of this arrangement is that on a dc circuit, the deflection of the needle is proportional to both the current (I) and the voltage (V), thus conforming to the equation P=VI. For AC power, current and voltage may not be in phase, owing to the delaying effects of circuit inductance or capacitance. On an ac circuit the deflection is proportional to the average instantaneous product of voltage and current, thus measuring true power, P=VI cosφ. Here, cosφ represents the power factor which shows that the power transmitted may be less than the apparent power obtained by multiplying the readings of a voltmeter and ammeter in the same circuit.

Fig 1.8 Wattmeter

9. Voltmeter

A voltmeter is an instrument used for measuring electrical potential difference between two points in an electric circuit. Analog voltmeters move a pointer across a scale in proportion to the voltage of the circuit; digital voltmeters give a numerical display of voltage by use of an analog to digital converter. A voltmeter in a circuit diagram is represented by the letter *V* in a circle.

Fig 1.9 Voltmeter

CONCLUSION:

Date: **Signature of Faculty**

EXPERIMENT NO. 2

AIM: Verification of superposition theorem with DC source

APPARATUS:

Sr. No.	Equipment Name	Range	Quantity

CIRCUIT DIAGRAM:

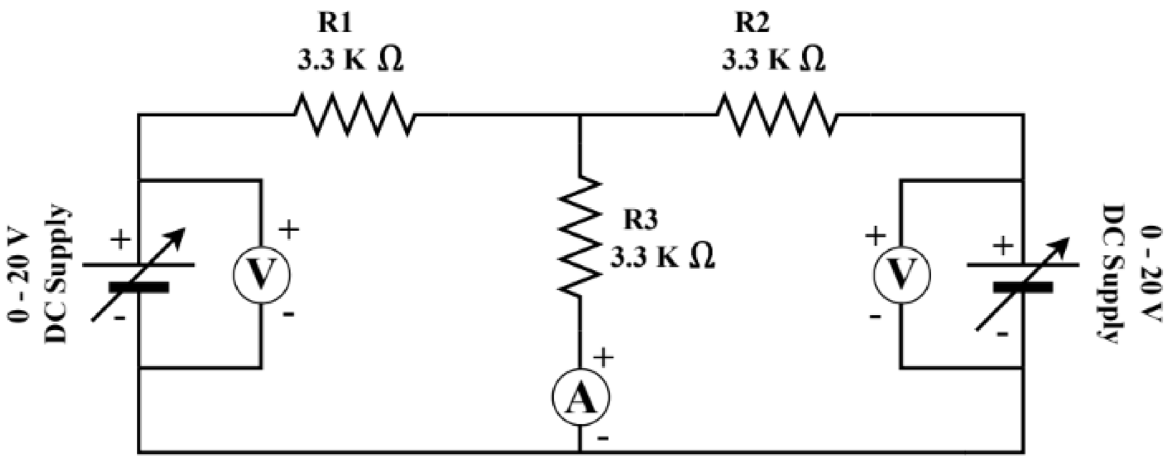


Fig 2.1 Superposition Theorem

THEORY:

❖ **SUPERPOSITION THEOREM**

The total current in any part of a linear circuit equals the algebraic sum of the currents produced by each source separately. To evaluate the separate currents to be combined, replace all other voltage sources by short circuits and all other current sources by open circuits. kΩ

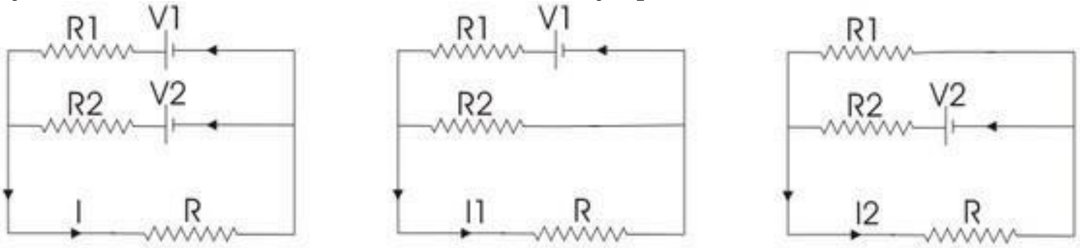


Fig 2.2 Superposition Theorem

Suppose there are two voltage sources V_1 and V_2 acting simultaneously on the circuit. Because of these two voltage sources, say current I flows through the resistance R. Now replace V_2 by short circuit, keeping V_1 at its position and measure current through the resistance, R. Say it is I_1. Then replace, V_1 by short circuit, reconnect V_2 to its original position and measure current through the same resistance R and say it is I_2. Now if we add these two currents, I_1 and I_2 we will get the current which is equal to the current - was actually flowing through R, when both voltage sources V_1 and V_2 were acting on the circuit simultaneously. That is $I_1 + I_2 = I$.

PROCEDURE:

OBSERVATION TABLE:

Case 1: Supply voltage (V_1= 10v), Case 2: Supply Voltage (V_2 = 12v)

R_1= **R_2=** **R_3=**

Sr. No.	Current through R_3 in Case 1 I_1 (A)	Current through R_3 in Case 2 I_2 (A)	Current through R_3 in Case 3 I (A)	$I=I_1+I_2$ (A)	%Error
1.					
2.					

CALCULATIONS:

CONCLUSION:

Date: **Signature of Faculty**

EXPERIMENT – 03

AIM: Verification of thevenin's theorem with DC source.

APPARATUS:

Sr. No.	Equipment Name	Range	Quantity

CIRCUIT DIAGRAM:

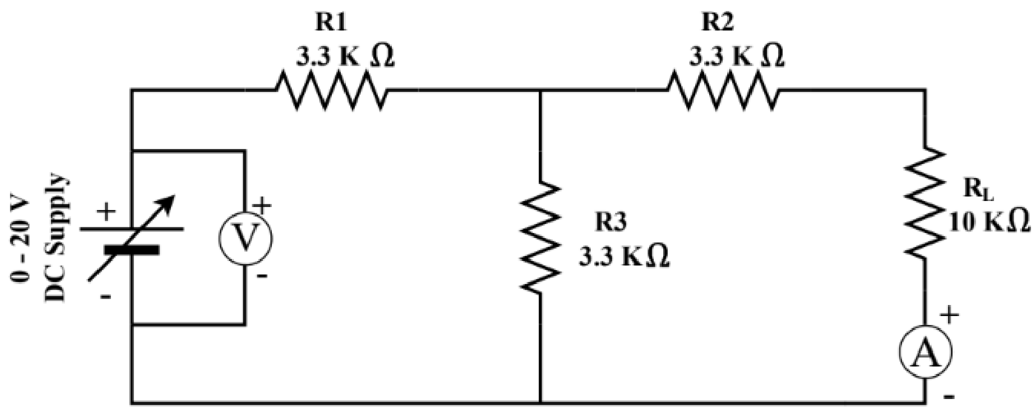


Fig 3.1 Thevenin's Theorem

THEORY:

❖ **THEVENIN'S THEOREM:**

Thevenin's theorem can be stated as; "An active bilateral linear network containing energy sources (generators) and impedances can be replaced by an equivalent circuit containing a voltage source (E_{Th} or V_{Th}) in series with an impedance (Z_{Th}), where the E_{Th} or $V_{Th}$is the open circuit voltage between terminals of the network and $Z_{Th}$is the impedance measured between the terminals of this network with all energy sources eliminated".

In other words, "when a particular branch is removed from a circuit, the open circuit voltage appears across the terminals of the circuit, is Thevenin's equivalent voltage and the equivalent resistance of the circuit network looking back into the terminal is Thevenin's equivalent resistance". If we replace the rest of the circuit network by a single voltage source, then the voltage of the source would be Thevenin's equivalent voltage and internal resistance of the voltage source would be Thevenin's equivalent resistance which would be connected in series with the source as shown in the figure.

PROCEDURE:

OBSERVATION TABLE:

Sr. No.	Supply Voltage V (V)	Load Current I_L (mA)	Thevenin's Voltage V_{th} (V)		Thevenin's Resistance R_{th} (Ω)		Thevenin's Equivalent circuit Load Current (mA)	
			Theoretical	Practical	Theoretical	Practical	Theoretical	Practical

CALCULATIONS:

CONCLUSION:

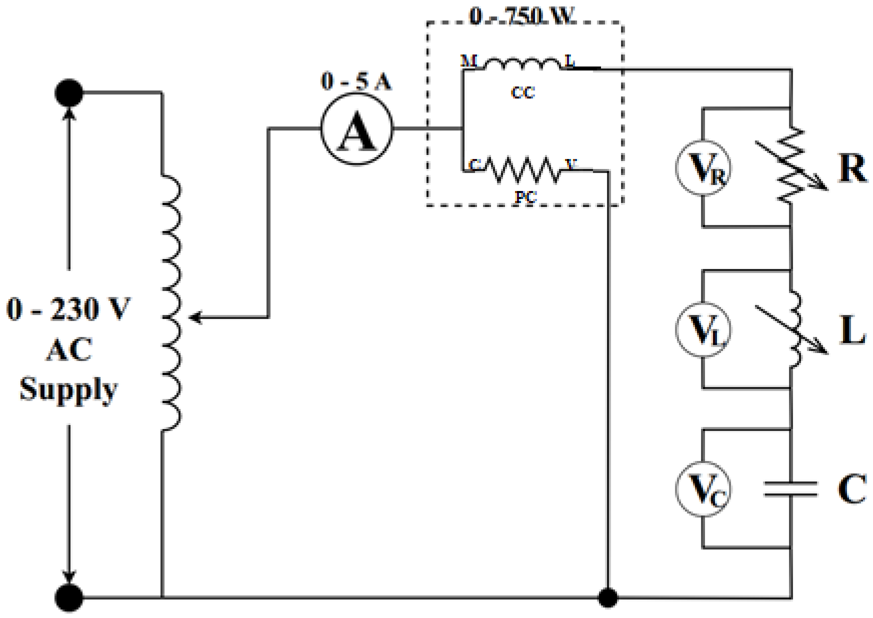
EXPERIMENT NO. 4

AIM: To experimentally investigate the behavior of RLC circuit under AC excitation.

APPARATUS:

Sr. No.	Equipment Name	Range	Quantity

CIRCUIT DIAGRAM:



THEORY:

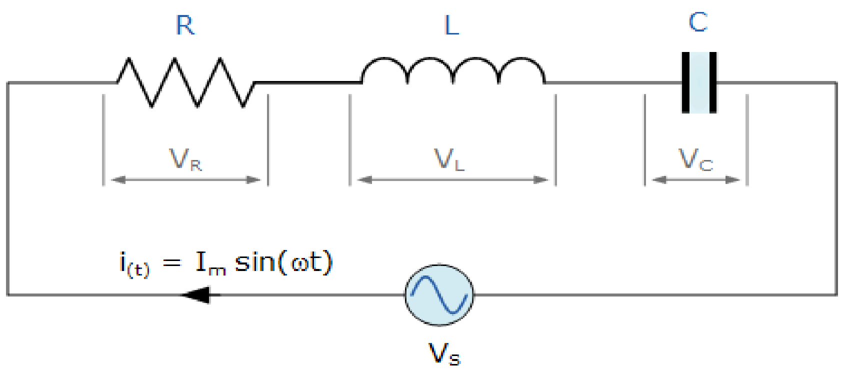


Fig 4.1 Series R-L-C Circuit

Consider Circuit Consisting of Resistor of Resistance R ohms and a pure inductance L Henry and a pure capacitor of capacitance c farads in series as in the fig. 4.1

Series RLC circuits are classed as second-order circuits because they contain two energy storage elements, an inductance L and a capacitance C. Consider the RLC circuit below. The phasor diagram for a series RLC circuit is produced by combining the three individual phasors above and adding these voltages vectorially. Since the current flowing through the circuit is common to all three circuit elements, we can use this as the reference vector with the three voltage vectors drawn relative to this at their corresponding angles.

The resulting vector V_S is obtained by adding together two of the vectors, V_L and V_C and then adding this sum to the remaining vector V_R. The resulting angle obtained between VS and I will be the circuits phase angle as shown below.

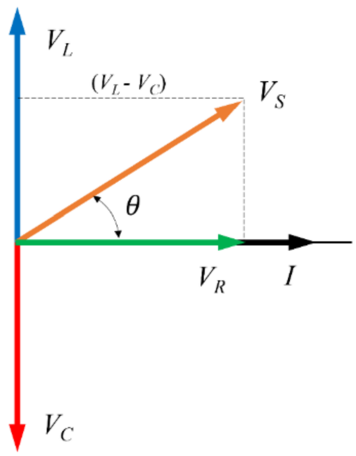


Fig. Vector diagram of Series RLC circuit

PROCEDURE:

OBSERVATION TABLE:

Sr. No.	Supplied Voltage Vs (V)	Total Current I (A)	Power (W)	Voltage Across R, L, C		
				V_R (V)	V_L (V)	V_C (V)
1.						
2.						
3.						

CALCULATION TABLE:

Sr. No.	R=V_R / I (Ω)	$L = \frac{X_L}{2\pi f}$ (mH)	$C = \frac{1}{2\pi f X_c}$ (µF)	X_L= V_L/ I (Ω)	X_C =V_C/I (Ω)	Z = Vs/I ()	Cos Φ = R/Z	Phase Angle Φ (Deg)	P = VIcosΦ (Watt)
1.									
2.									
3.									

CALCULATION:

CONCLUSION:

EXPERIMENT NO. 5

AIM: Verification of current and voltage relations in three-phase balanced star and delta-connected loads.

APPARATUS:

Sr. No	Equipment Name	Range	Quantity

CIRCUIT DIAGRAM:

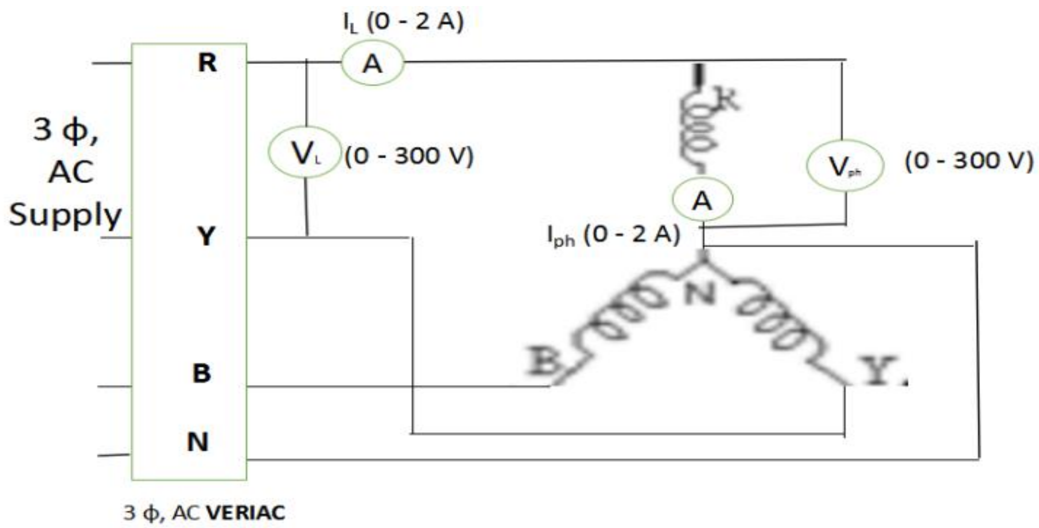


Fig.1 Circuit diagram of Star connection

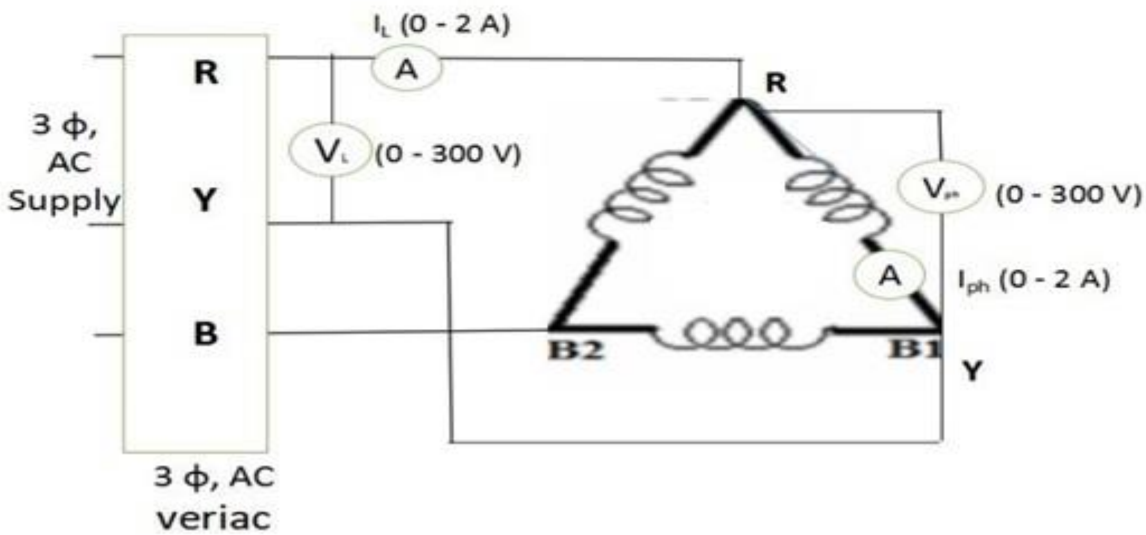
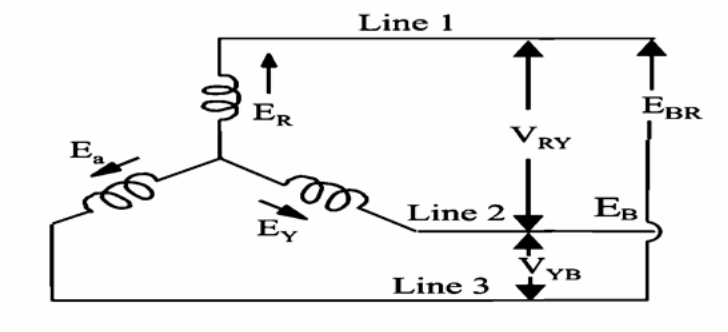


Fig. 2 Circuit diagram of Delta connection

THEORY:



- **STAR CONNECTION**

Fig 5.1 Star Connection

- **Voltages Relationship in Star Connection:**

Emf induced in each phase is called phase voltage available between the line and neutral terminals denoted by E_R, E_Y, E_B In general it is expressed as EP the phase voltage. The voltage between any two terminals is called the line voltage and denoted by E_{RY}, E_{BR}, E_{RB}

Line voltage $E_L = V_{RY}$=OC = 2OB = 2 OA COS (30) = $2E_P$ X √3/2
E_L =√3E_P
Hence in star connection **Line Voltage =√3 Phase voltage Currents Relationship in Star Connection**
Observing the star connection, it is seen that the current which passes through the phase the same current pass through the line. Hence in star connection,

Line Current = Phase current
$I_L=I_P$

- **DELTA CONNECTION**

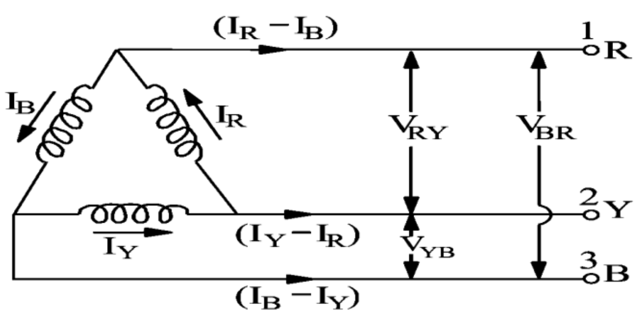


Fig 5.2 Delta Connection

- **Voltages Relationship in Delta Connection:**

It can be seen that the line voltage and the phase voltage are the same as the two line wires come out from the phase terminal

Line voltage = Phase voltage E_L=E_P

- **Currents Relationship in Star Connection**

In delta connection

Line Current = √3 Phase Current

PROCEDURE:

Star Connection

Delta Connection

OBSERVATION TABLE:

Star Connection

Sr. No.	Line Voltage V_L (V)	Phase Voltage V_P (V)	Line Current I_L (A)	Phase Current I_P (A)	I_L/I_P	V_L/V_P
1						
2						
3						

Delta Connection

Sr. No.	Line Voltage V_L (V)	Phase Voltage V_P (V)	Line Current I_L (A)	Phase Current I_P (A)	I_L/I_P	V_L/V_P
1						
2						
3						

CONCLUSION:

Date: **Signature of Faculty**

EXPERIMENT NO: 6

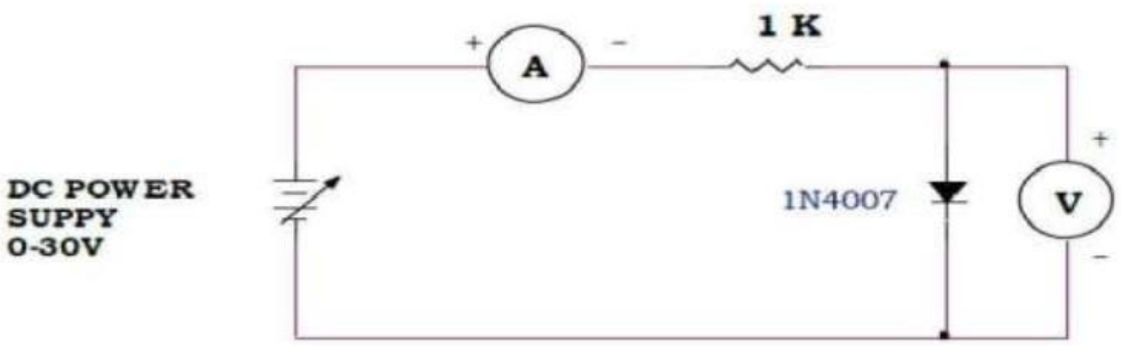
AIM: To Plot V-I characteristics of the P-N junction diode.

APPARATUS:

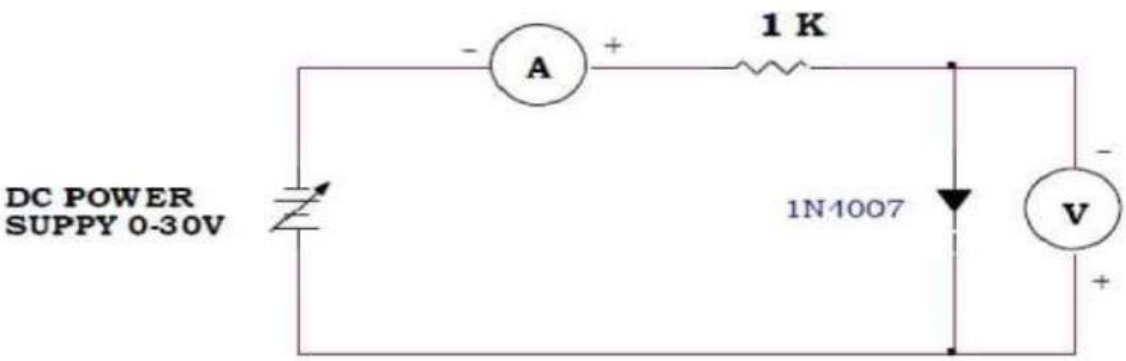
Sr. No	Equipment Name	Range	Quantity

CIRCUIT DIAGRAM:

Circuit diagram (forward bias):



Circuit diagram (reverse bias):



THEORY:

PN JUNCTION DIODE CHARACTERISTIC

The most important characteristic of PN junction is its ability to conduct current in one direction only. In other direction, it offers very high resistance. This information is obtained by performing this experiment. The circuit is as shown in the fig. the P- region is called the anode, and the N-region is called the cathode.

- **Forward biased: -**

The positive terminal of the battery is connected to anode and negative terminal of the battery is connected to cathode of the diode. Hence, the diode acts as short circuit. In this condition, the resistance of the diode is very small.

Fig 6.1 Forward Bias

- **Reverse biased-**

The positive terminal of the battery is connected to cathode and negative terminal of the battery is connected to anode of the diode. Hence, the diode acts as open circuit. In this condition the resistance of the diode is very high.

Fig 6.2 Reverse Bias

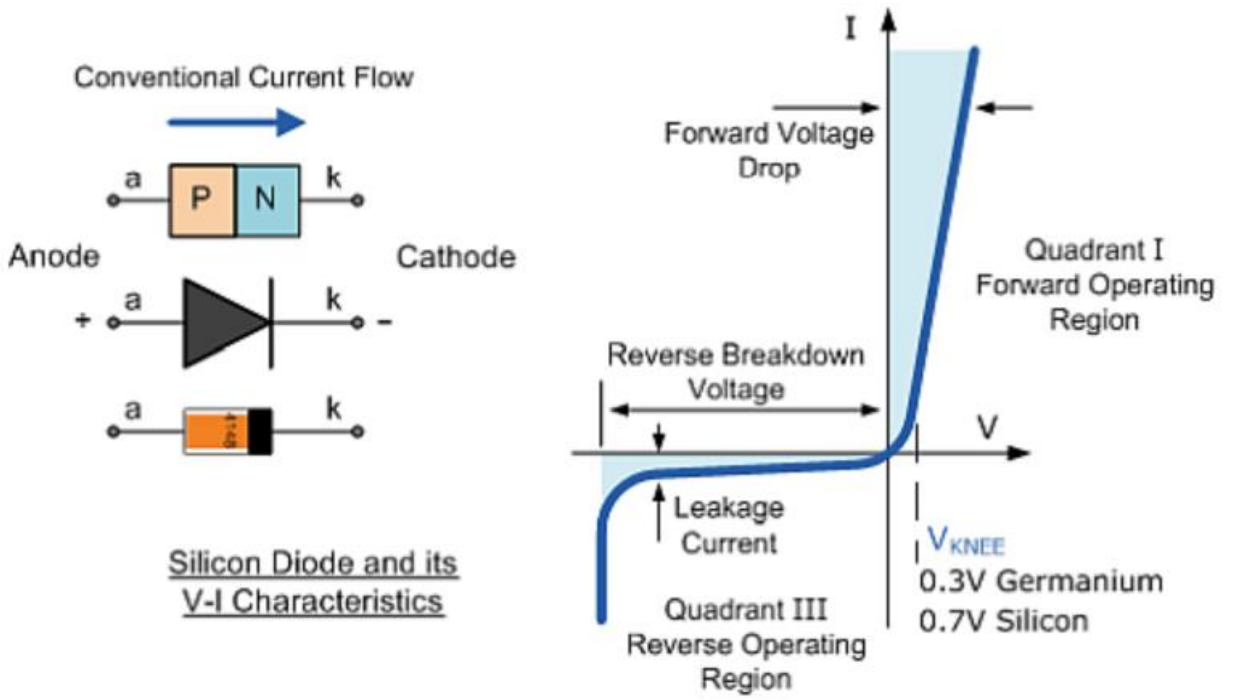


Fig 6.3 V-I Characteristics of PN Junction Diode

PROCEDURE:

OBSERVATION TABLE:

- **Forward Bias**

Sr. No.	Supply Voltage	Diode Voltage (V_D)	Diode Current (I_D)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

- **Reverse Bias**

Sr. No.	Supply Voltage	Diode Voltage (VD)	Diode Current (ID)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

CONCLUSION:

Date: **Signature of Faculty**

EXPERIMENT NO. 7

AIM: To perform half wave rectifier with and without filter.

APPARATUS:

Sr. No.	Apparatus	Range	Quantity
1.	Experiment Kit	0-230 Vac	01
2.	Centre tap Transformer (in built)	230 V / 12 V -0- 230 V	01
3.	PN Junction Diode	1N4007	01
4.	Capacitor	47µF	01
5.	Load Resistors	100E, 200E, 300E	01 each
6.	DC Ammeter	0-50 mA	01
7.	Digital Multimeter	Auto Range	02
8.	DSO / CRO	--	01
9.	Connecting Probes	--	As Required

THEORY:

One of the very important applications of diode is in DC power supply as a rectifier to convert AC into DC. The conversion of AC into DC is called Rectification.

- **Half Wave Rectifier without Filter**

During the positive half cycle, the diode is forward biased and it conducts and hence a current flows through the load resistor. During the negative half cycle, the diode is reverse biased and it is equivalent to an open circuit, hence the current through the load resistance is zero. Thus the diode conducts only for one half cycle and results in a half wave rectified output. Below Figure 1 shows the theoretical circuit diagram and the input and output waveforms of half wave rectifier without filter. Input is the sinusoidal wave form and the output is pulsating dc.

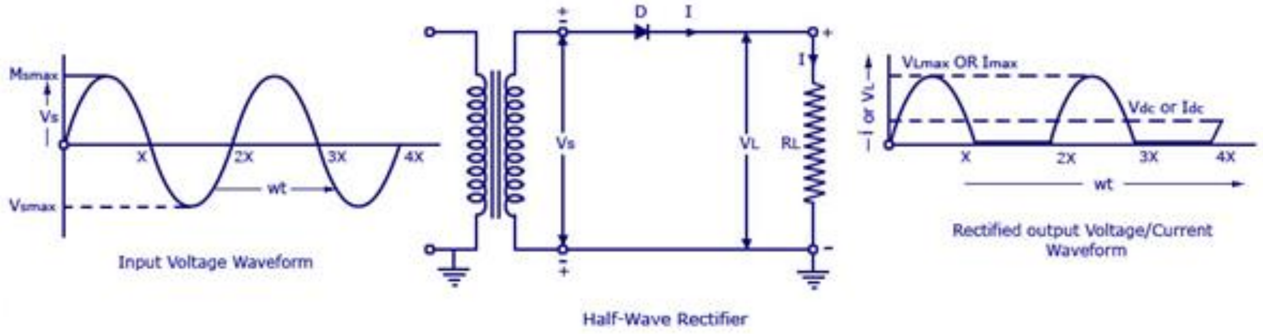


Figure 7.1: Half Wave Rectifier without Filter

- **Half Wave Rectifier with Filter**

The output of rectifier without filter is pulsating dc. So we require filters to smoothen the pulsating dc waveform to a constant dc waveform. Below Figure 2 shows a half wave rectifier with filter. The capacitor C blocks the dc components and by passes the unwanted ac components to ground. Hence in the output we get only dc components. Below figure also shows the output waveform with and without capacitor.

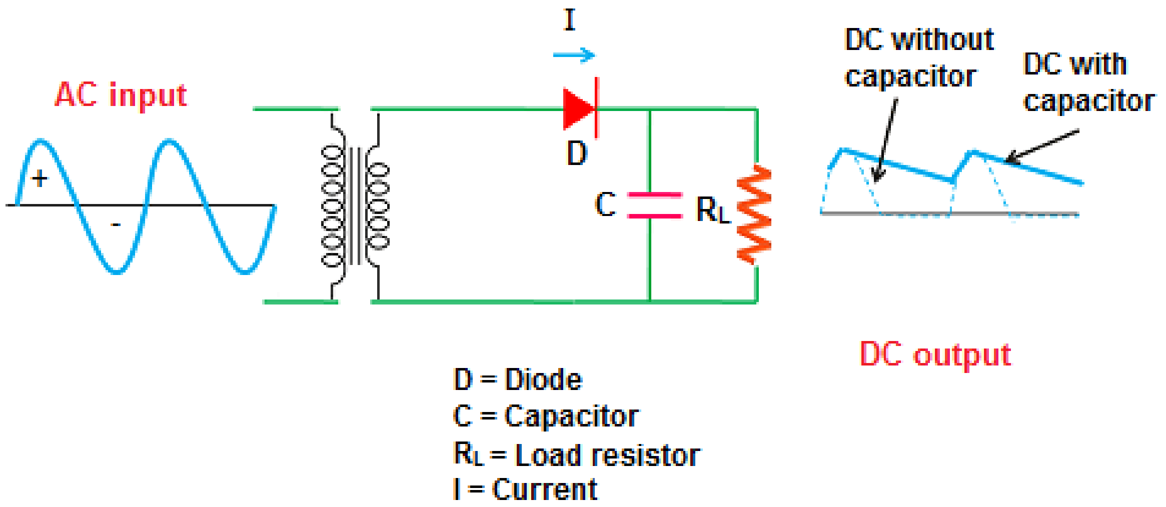


Figure 7.2: Half Wave Rectifier with Filter

- **Major Equations of Half wave rectifier:**

Average or DC value of output current is given by

$\mathbf{I_{dc}}$ **or** $\mathbf{I_{avg} = I_m / \pi}$

Where I_m is the maximum value of current

Average or DC value of output voltage is given by

$\mathbf{V_{dc}}$ **or** $\mathbf{V_{avg} = V_m / \pi}$

Where V_m is the maximum value of voltage

RMS value of output current is given by

$\mathbf{I_{rms} = I_m / 2}$

Theoretical ripple factor of half-wave rectifier is 1.21 and theoretical rectification ratio is 40.6%

PROCEDURE

1. Make connections as per Figure 7.3.
2. Measure AC output of transformer secondary Vin, this voltage is the input to the diode.
3. Measure rectified dc voltage (V_{dc}) and ac voltage (V_{ac}) across R_L.
4. Measure output current I_{dc}
5. Now connect circuit as per Figure 7.4.
6. Now repeat above steps 2 to 4.
7. Observe waveforms across the load for both cases (i.e. without filter and with filter)

PRACTICAL CIRCUIT DIAGRAM

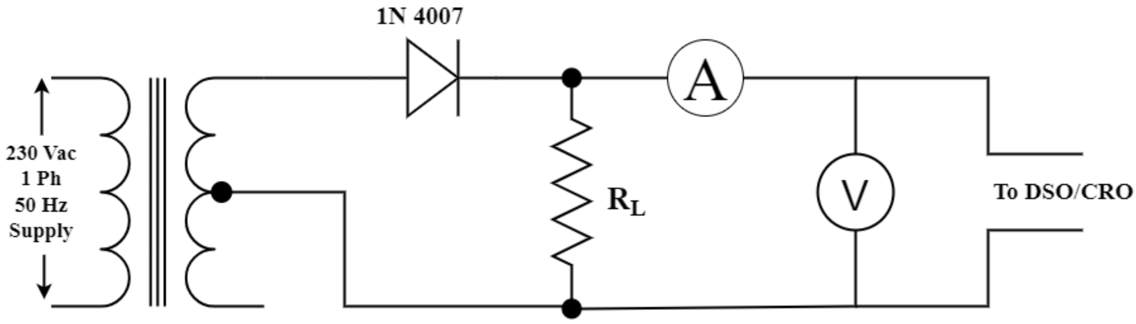


Figure: 7.3 Half Wave Rectifier without Filter

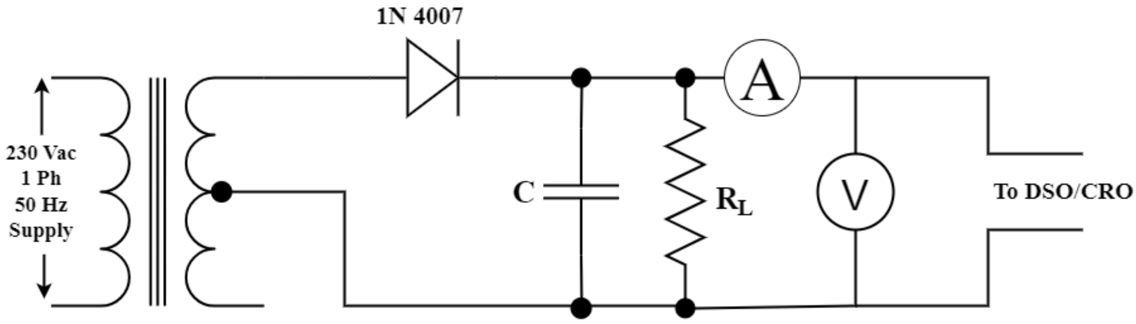


Figure: 7.4 Half Wave Rectifier with Filter

OBSERVATION TABLE

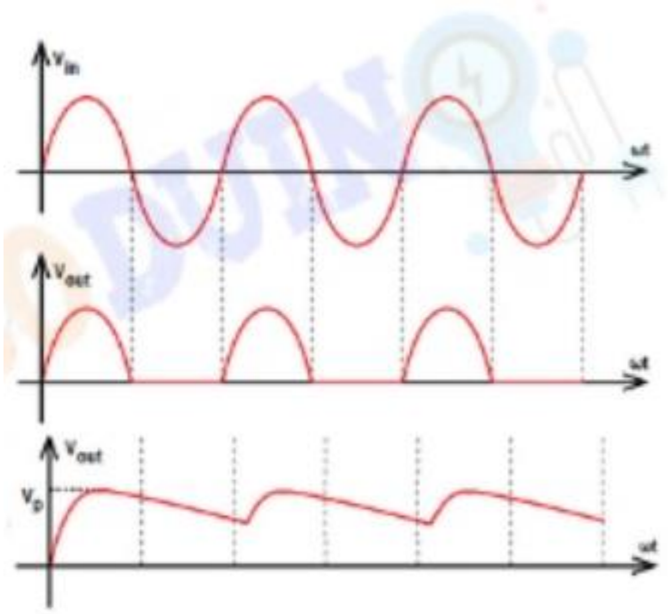
- **Without Filter**

Sr. No.	V_{in} (volts)	V_{dc} (volts)	V_{ac} (volts)	I_{dc} (mA)	R_L (ohms)
1.					100
2.					200
3.					300

- **With Filter**

Sr. No.	V_{in} (volts)	V_{dc} (volts)	V_{ac} (volts)	I_{dc} (mA)	R_L (ohms)
1.					100
2.					200
3.					300

Expected Waveforms:



CONCLUSION:

Date: **Signature of Faculty**

EXPERIMENT NO. 8

AIM: To perform full wave rectifier with and without filter.

APPARATUS:

Sr. No.	Apparatus	Range	Quantity
1.	Experiment Kit	0-230 Vac	01
2.	Centre tap Transformer (in built)	230 V / 12 V -0- 230 V	01
3.	PN Junction Diode	1N4007	02
4.	Capacitor	47µF	01
5.	Load Resistors	100E, 200E, 300E	01 each
6.	DC Ammeter	0-50 mA	01
7.	Digital Multimeter	Auto Range	02
8.	DSO / CRO	--	01
9.	Connecting Probes	--	As Required

THEORY:

One of the very important applications of diode is in DC power supply as a rectifier to convert AC into DC. The conversion of AC into DC is called Rectification.

- **Full Wave Rectifier without Filter**

The full-wave rectifier consists of a center-tap transformer, which results in equal voltages above and below the center-tap. During the positive half cycle, a positive voltage appears at the anode of D1 while a negative voltage appears at the anode of D2. Due to this diode D1 is forward biased it results in a current I_{dc} through the load R_L. During the negative half cycle, a positive voltage appears at the anode of D2 and hence it is forward biased. Resulting in a current I_{dc} through the load R_L at the same instant a negative voltage appears at the anode of D1 thus reverse biasing it and hence it doesn't conduct. Below Figure 1 shows the theoretical circuit diagram and the input and output waveforms of full wave rectifier without filter. Input is the sinusoidal wave form and the output is pulsating dc in each half cycle. In full wave rectifier we get the dc output in both the half cycles. During both half cycles each diode will conduct current through load resistance R_L. Diode D_1 conducts in positive half cycle and diode D_2 conducts during negative half cycle.

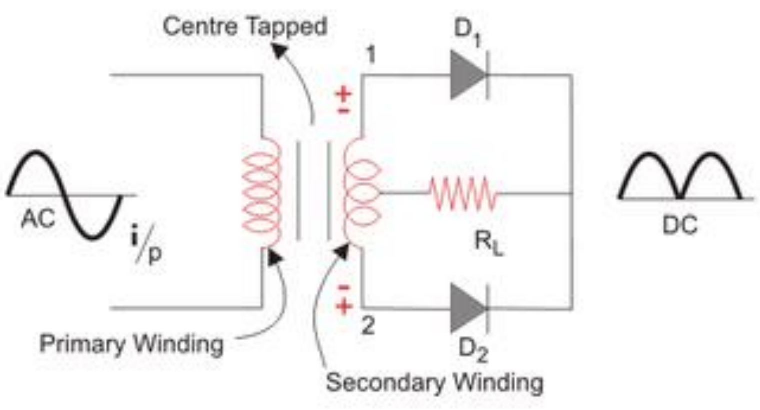


Figure: 8.1 Centre Tap Type Full Wave Rectifier without Filter

- **<u>Full Wave Rectifier with Filter</u>**

The output of rectifier without filter is pulsating dc. So we require filters to smoothen the pulsating dc waveform to a constant dc waveform. Below Figure 2 shows a center tap full wave rectifier with filter. The capacitor C blocks the dc components and by passes the unwanted ac components to ground. Hence in the output we get only dc components. Below Figure 2 also shows the output waveform with and without capacitor.

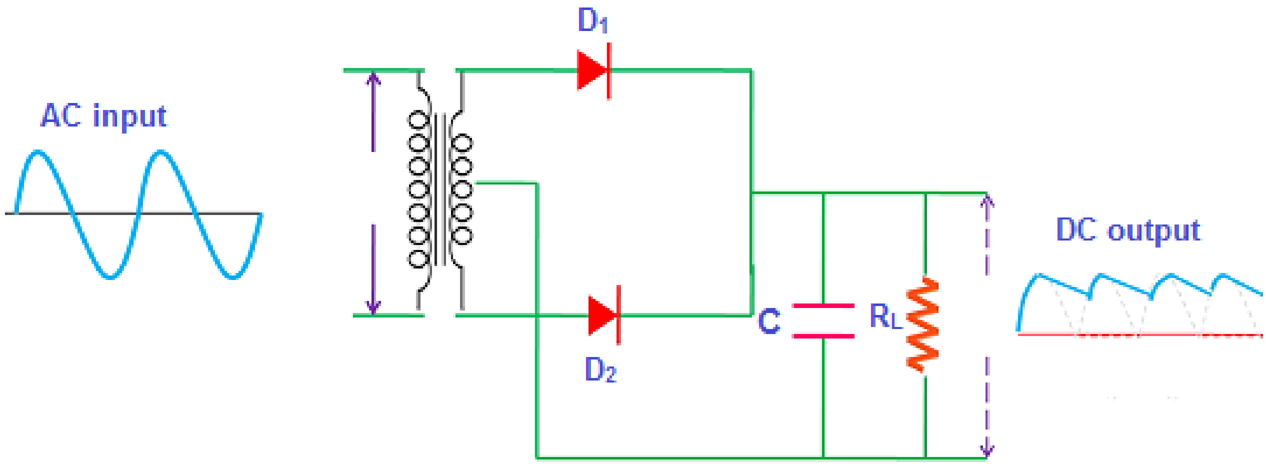


Figure: 8.2 Centre Tap Type Full Wave Rectifier with Filter

<u>Major Equations of Full wave rectifier:</u>
Average or DC value of output current is given by
$\mathbf{I_{dc}}$ **or** $\mathbf{I_{avg} = 2 I_m / \pi}$
Where I_m is the maximum value of current
Average or DC value of output voltage is given by
$\mathbf{V_{dc}}$ **or** $\mathbf{V_{avg} = 2 V_m / \pi}$
Where V_m is the maximum value of voltage
RMS value of output current is given by
$\mathbf{I_{rms} = I_m / \sqrt{2}}$

Theoretical ripple factor of full-wave rectifier is 0.48 and theoretical rectification ratio is 81.2%

<u>PROCEDURE:</u>

1. Make connections as per Figure 8.3.
2. Measure AC output of transformer secondary Vin, this voltage is the input to the diode.
3. Measure rectified dc voltage (V_{dc}) and ac voltage (V_{ac}) across R_L.
4. Measure output current I_{dc}
5. Now connect circuit as per Figure 8.4.
6. Now repeat above steps 2 to 4.
7. Observe waveforms across the load in both the cases (i.e. with filter and without filter)

- **Practical Circuit Diagram**

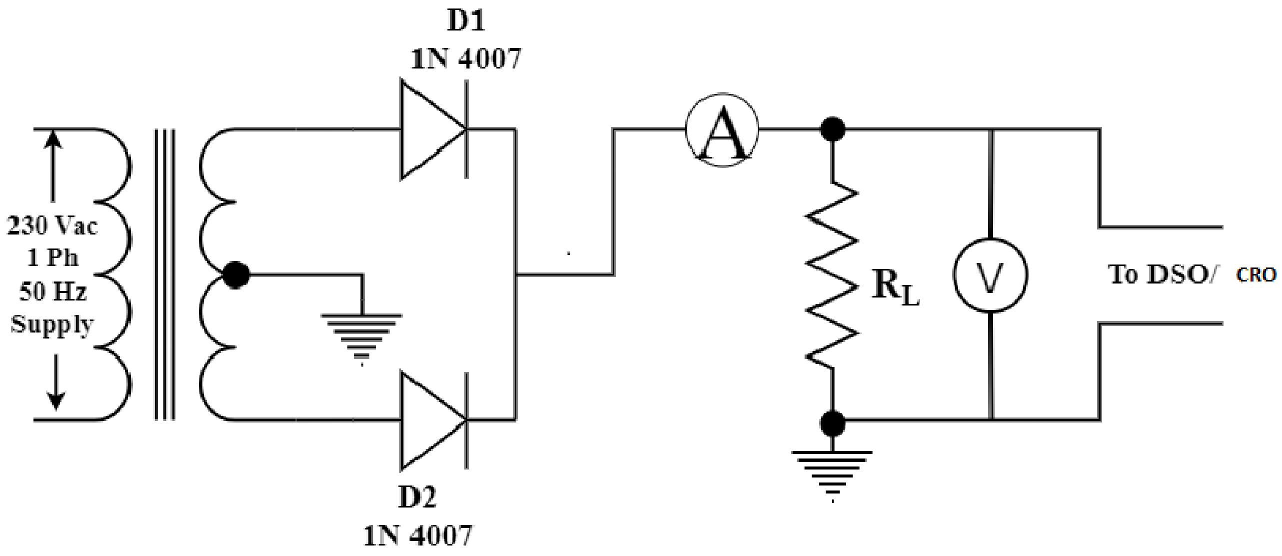


Figure 8.3: Full Wave Rectifier without Filter

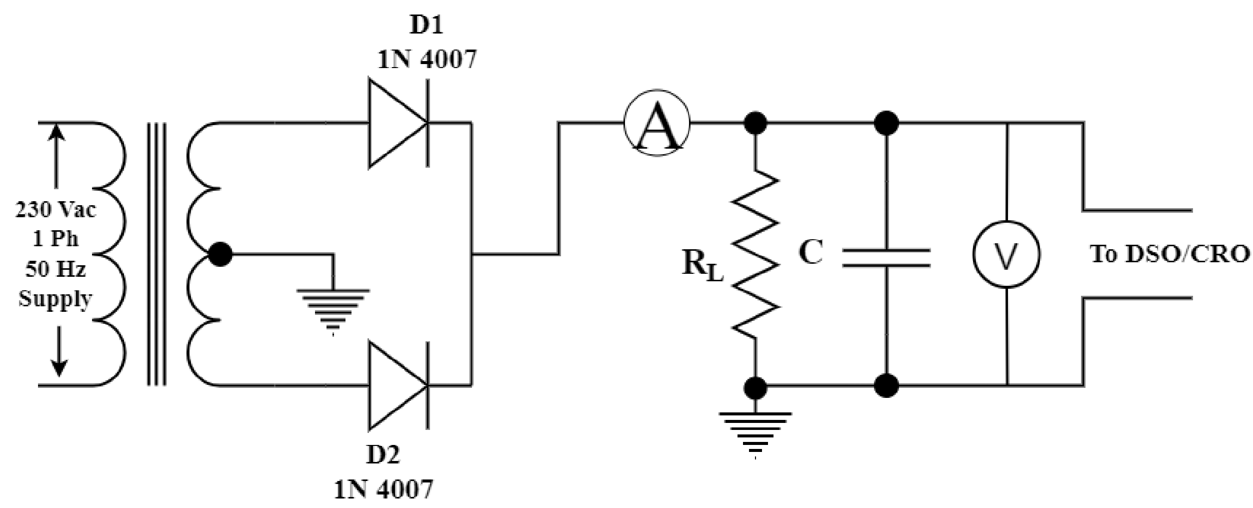


Figure: 8.4 Full Wave Rectifier with Filter

OBSERVATION TABLE

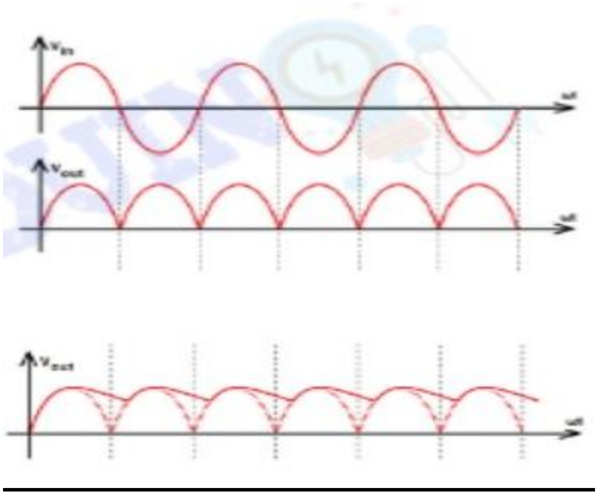
- **Without Filter**

Sr. No.	V_{in} (volts)	V_{dc} (volts)	V_{ac} (volts)	I_{dc} (mA)	R_L (ohms)
1.					100
2.					200
3.					300

- **With Filter**

Sr. No.	V_{in} (V)	V_{dc} (V)	V_{ac} (V)	I_{dc} (mA)	R_L (Ω)
1.					100
2.					200
3.					300

Expected Waveforms



CONCLUSION:

Date: **Signature of Faculty**

EXPERIMENT NO. 9

AIM: To plot and study input-output characteristics of the Common Emitter (CE) configuration of the transistor.

APPARATUS:

Sr. No	Equipment Name	Range	Quantity

CIRCUIT DIAGRAM:

THEORY:

Transistor is three terminal active device having terminals collector, base and emitter. To understand operation of the transistor, we use three configurations common emitter, common base and common collector. In this practical, we will understand common emitter configuration. As the name suggest, emitter is common between input and output. Input is applied to base and output is taken from collector. We will obtain input characteristics and output characteristics of common emitter (CE) configuration. We will connect variable DC power supply at V_{BB} and V_{CC} to obtain characteristics. Input voltage in CE configuration is base-emitter voltage V_{BE} and input current is base current Ib. Output voltage in CE configuration is collector to emitter voltage V_{CE} and output current is collector current I_C. We will use multi-meter to measure these voltages and currents for different characteristics. Collector to emitter junction is reverse biased and base to emitter junction is forward biased.

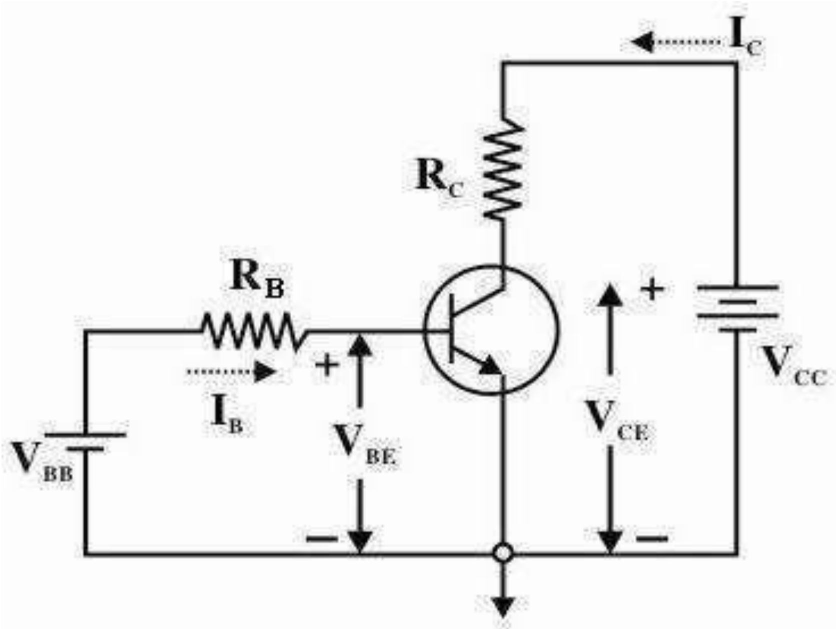


Fig 9.1 Circuit Diagram for CE Configuration**)**

The CE configuration is widely used in amplifier circuits because it provides voltage gain as well as current gain. In CB configuration current gain is less than unity. In CC configuration voltage gain is less than unity. Input resistance of CE configuration is less than CC configuration and more than CB configuration. Output resistance of CE configuration is more than CC configuration and less than CB configuration.

PROCEDURE:

OBSERVATION TABLE:

- **For Input characteristics**

Sr. No.	V_{CE} =		V_{CE}=	
	V_{BE} (V)	I_B(μA)	V_{BE} (V)	I_B(μA)
1.				
2.				
3.				
4.				
5.				
6.				
7.				

- **For Output characteristics**

Sr. No.	I_B =		I_B =	
	V_{CE} (V)	I_C(mA)	V_{CE} (V)	I_C(mA)
1.				
2.				
3.				
4.				
5.				
6.				
7.				

CONCLUSION:

Date: **Signature of Faculty**

EXPERIMENT NO. 10

AIM: To perform and observe the response of voltage regulator IC 7805.

APPARATUS:

Sr. No	Equipment Name	Range	Quantity

CIRCUIT DIAGRAM:

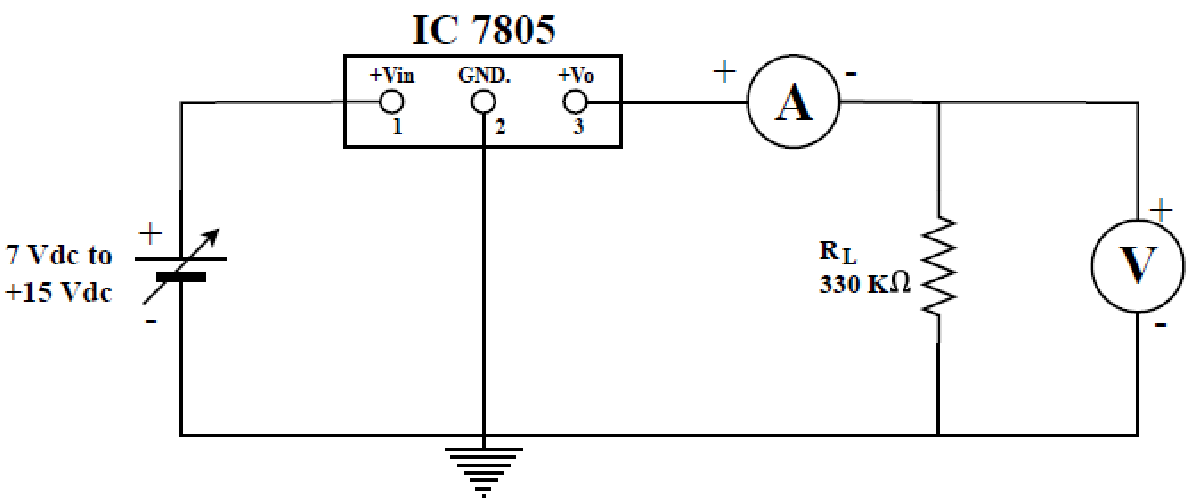


Fig. 1. Line Regulation

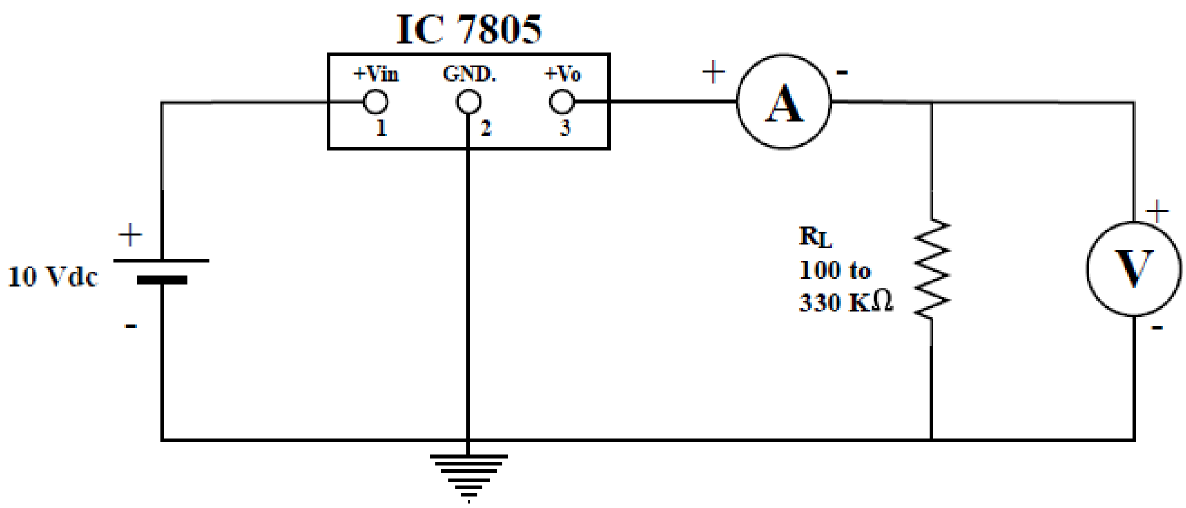
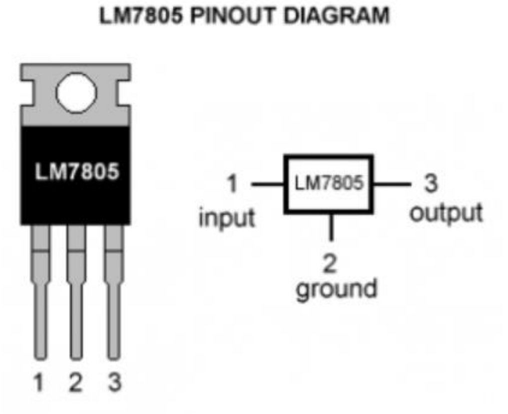


Fig.2 Load Regulation

THEORY:

Voltage sources in a circuit may fluctuate, resulting in not providing fixed voltage outputs. A voltage regulator IC maintains the output voltage at a constant value. 7805 Voltage Regulator, a member of the 78xx series of fixed linear voltage regulators used to maintain such fluctuations, is popular integrated circuit (IC).

The xx in 78xx indicates the output voltage it provides. 7805 IC provides +5 volts regulated power supply with provisions to add a heat sink.



7805 Voltage Regulator IC Specifications

- Minimum Input voltage is 7V
- Maximum Input Voltage is 35V
- Current rating Ic = 1A
- Maximum Output Voltage V_{Max}=5.2V
- Minimum Output Voltage V_{Min}=4.8 V

PROCEDURE:

1. For IC 7805-line regulation, make the connection as shown in Fig1.
2. Switch on the kit.
3. Increase the input voltage from which the regulating circuit starts regulating the output voltage. (i.e. from 7V DC to 15V DC)
4. Note the reading of input and output voltage.
5. Similarly, Connect the circuit as per Fig. 2 and not the reading for load regulation for IC 7805, keep the input voltage constant i.e. 10V DC.
6. Take the no-load output voltage reading. Now change the load resistance from 300 Ω to 100 Ω note the output voltage.

OBSERVATION TABLE:

For Line Regulation:

For RL = 300 Ω

Sr. No.	Input Voltage V_{in} (V)	Load Current I_L (mA)	Output Voltage V_o (V)
1			
2			
3			
4			
5			

Load Regulation:

For V_{in} = 10 V DC

Sr. No.	Load Resistor R_L (Ω)	Load Current I_L (mA)	Output Voltage V_o (V)
1	Open		
2	300		
3	200		
4	100		

CONCLUSION:

Date: **Signature of Faculty**