



# UIT'S

UNIVERSITY OF INFORMATION TECHNOLOGY & SCIENCES

## Lab Manual

EEE 152

Fundamental of Electrical Engineering Lab



Department of CSE

## **Primitives**

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Course Code: EEE 152

Course Title: Fundamental of Electrical Engineering Lab

Credit: 1

Contact Hour per Week: 2

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## **Assessment:**

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Attendance: 20%

Lab Performance: 30%

Lab Viva: 20%

Quiz: 30%

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## **Reference:**

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Books:

1. Fundamental of Electric Circuits by Charles K. Alexander and Matthew N. O. Sadiku.
2. Introductory Circuit Analysis by Boylestad.

## Index

S. No	CONTENTS	PAGE No.
1.	Department Vision	1
2.	Department Mission	1
3.	PEOs	1
4.	Course Objectives and Outcomes	2
<b>Experiments</b>		
1.	Familiarization with electrical components, instruments and resistor's color code.	06
2.	Verification of Kirchhoff's Voltage Law (KVL) and Kirchhoff's Current Law (KCL).	14
3.	Study of a combination of series and parallel circuits.	16
4.	Study of Superposition theorem.	17
5.	Study of Thevenin's theorem	18
6.	Study of maximum power transfer theorem.	19
7.	Introduction to oscilloscope, familiarization with AC waves, measuring maximum value, average value, r.m.s value and frequency by oscilloscope and proof of KVL theorem.	20
8.	Study on the characteristics of R-L and R-C series circuits.	22
9.	Analysis of RLC series circuit and verification of KVL in AC Circuits	24
10.	Analysis of RLC parallel circuit and verification of KCL in AC circuits.	26
11.	Analysis of Series Resonance.	
12.	Analysis of Parallel Resonance.	

## **A. Department Vision**

The vision of the Department of Computer Science and Engineering is to scaffold the next generation of engineers and scientists in a student-centered learning environment to reach digital fluency in Computer Science & Engineering. The challenge is to make the student's competent, skilled leader in the wake of the ever-changing and challenging global work environment of the 21st century.

## **B. Department Mission**

The mission of the Department of Computer Science is to achieve national prominence by providing outstanding education and research training to our undergraduate students for their productive careers in industry, academia, and government. We will help our students develop the skills to solve the complex technological problems of modern society and also provide a framework for promoting collaborative and multidisciplinary activities. The students should be competent professionals through research, active teaching disciplinary and ethical learning including inculcating moral values and societal concerns and thus attain nation's premier small research and teaching Computer Science departments to tackle advantage.

## **C. PEOs**

### **PEO 01: THINK CRITICALLY:**

Our education system is more geared towards making the students acquiring knowledge but fails to capture their imagination. We want to change that by introducing the students to the exciting world of logic, rationalization, and decision making through games and apps. We will introduce our students to various development, analysis, and synthesis tools and will engage them in research early in their studies.

### **PEO 02: DESIGN CONSCIENTIOUSLY**

A broad liberal arts curriculum covering computer science as well as related technical subjects will provide students with a deeper understanding of the engineering issues and trade-offs that cross disciplines. Courses in humanities and social sciences will equip them with the knowledge and awareness to become responsible members of society who understand the social, political, economic and environmental impact of their decisions. Graduates will become ethical professionals with the ability to work individually or in multidisciplinary teams to design sustainable solutions to complex real-world problems under real-world constraints.

### **PEO3: IMPLEMENT EFFICIENTLY**

A strong emphasis is placed on developing the students' ability to identify and analyze a problem, and to then define the computing requirements appropriate to its solution

about factors such as sustainability, scalability, available resources, and constraints. We ensure that our students are kept up-to-date with knowledge and practice of the most current tools and techniques and that they develop an appreciation for continued improvement through self-training or formal graduate study. Graduates efficiency will possess the ability to design and implement efficient and future-proof software solutions to problems of varying sizes and complexities using modern software development principles and practices.

#### **D. COURSE OBJECTIVES:**

1. To familiarize with ammeter, voltmeter, multimeter and resistance color coding.
2. To understand KVL, KCL and series parallel circuits
3. To learn about Thevenin theorem, superposition theorem and maximum power transfer theorem.
4. To familiarize with RL, RC and RLC circuits.

#### **E. COURSE OUTCOMES:**

1. The students shall be able to measure voltage, current and resistance.
2. The students should be able to apply circuit theorem in circuit analysis.
3. They will be able to know about RL, RC and RLC series circuits.

## Experiment No.01:

**Title: Familiarization with electrical components, instruments and resistor's color code.**

**Objectives:** To get acquainted with different equipment and components used in circuit laboratory.

### Equipment List:

1. Breadboard
2. Voltmeter
3. Ammeter
4. Multimeter
5. DC Source
6. Resistors

### Theory:

**Ohm's law:** Ohm's law deals with the relationship between voltage and current in a conductor. This law states that at fixed temperature the current passing through a conductor between two points is proportional to the voltage (or potential difference) across the two points and inversely proportional to the resistance between them. In mathematical terms it is written as  $V = IR$ , where  $V$  is the potential difference in Volts,  $I$  is the current in Amperes and  $R$  is a constant. The constant  $R$  is called the resistance and is measured in Ohms ( $\Omega$ ). The potential difference is also known as voltage drop and is denoted by both  $E$  and  $V$ .

**Current:** The electric current through a conductor is defined as the amount of electric charge flowing through the conductor in unit time. This is expressed as  $I = Q/t$ , where  $Q$  is the charge in Coulombs (C),  $t$  is in seconds and unit of  $I$  is Ampere.

**Voltage:** To move an electron in a conductor in any direction requires some work or energy transfer. This is performed by an external force created by chemical sources (batteries), generators or power supplies.

**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.

Voltmeters are made in a wide range of styles. Instruments permanently mounted in a panel are used to monitor generators or other fixed apparatus. Portable instruments, usually equipped to also measure current and resistance in the form of a multimeter, are standard test instruments

used in electrical and electronics work. Any measurement that can be converted to a voltage can be displayed on a meter that is suitably calibrated; for example, pressure, temperature, flow or level in a chemical process plant. Voltmeter is a measuring instrument containing an indicating needle over a dial showing Volts. The voltage is measured by placing two probes on two points across an element. Digital voltmeters show the numerical values on a LCD screen.

General purpose analog voltmeters may have an accuracy of a few percent of full scale, and are used with voltages from a fraction of a volt to several thousand volts. Digital meters can be made with high accuracy, typically better than 1%. Specially calibrated test instruments have higher accuracies, with laboratory instruments capable of measuring to accuracies of a few parts per million. Meters using amplifiers can measure tiny voltages of microvolts or less.

**Ammeter:** An ammeter is a measuring instrument used to measure the electric current in a circuit. Electric currents are measured in amperes (A), hence the name. Instruments used to measure smaller currents, in the milli ampere, microampere range, are designated as *milli ammeters, micro ammeters or*. 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.

Ammeter is a measuring instrument containing an indicating needle over a dial showing current in Amperes. The current passing through an element is measured by placing the two probes in series through the element. Digital ammeters show the numerical values on a LCD screen.

**Wattmeter:** A typical wattmeter in educational labs has two voltage coils (pressure coils) and a current coil. We can connect the two pressure coils in series or parallel to each other to change the ranges of the wattmeter. Another feature is that the pressure coil can also be tapped to change the meter's range. If the pressure coil has range of 300 volts, the half of it can be used so that the range becomes 150 Volts.

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 connected in series with the circuit, while the potential coil is connected in parallel. Also, on analog wattmeter, the potential coil carries a needle that moves over a scale to indicate the measurement. 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 *and* the voltage, thus conforming to the equation  $W=VA$  or  $P=VI$ .

**Multimeter:** A multimeter or a multi tester, also known as a VOM (Volt-Ohm meter), is an electronic measuring that combines several measurement functions in one unit. A typical

multimeter would include basic features such as the ability to measure voltage, current, and resistance. Analog multimeter use a micro ammeter whose pointer moves over a scale calibrated for all the different measurements that can be made. Digital multimeter (DMM, DVOM) display the measured value in numerals, and may also display a bar of a length proportional to the quantity being measured. Digital multimeter are now far more common than analog ones, but analog multimeter are still preferable in some cases, for example when monitoring a rapidly-varying value.



Figure 1: Analog and Digital Multimeter

A Multimeter is a measuring instrument that combines several functions in one unit. Most instruments include an ammeter, voltmeter and an ohmmeter. Nowadays, both analog and digital meters are available. Modern multimeters can measure other parameters also.

**Resistors:** A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. The ratio of the voltage applied across a resistor's terminals to the intensity of current in the circuit is called its resistance, and this can be assumed to be a constant (independent of the voltage) for ordinary resistors working within their ratings. The current through a resistor is in direct proportion to the voltage across the resistor's terminals. This relationship is represented by Ohm's law:  $I = V/R$ , where  $I$  is the current through the conductor in units of amperes,  $V$  is the potential difference measured across the conductor in units of volts, and  $R$  is the resistance of the conductor in units of ohms.

Resistors are common elements of electrical networks and electronic circuits and are ubiquitous in electronic equipment. Practical resistors can be made of various compounds and films, as well as resistance wire (wire made of a high-resistivity alloy, such as nickel-chrome). Resistors are

also implemented within integrated circuits, particularly analog devices, and can also be integrated into hybrid and printed circuits.

The electrical functionality of a resistor is specified by its resistance: common commercial resistors are manufactured over a range of more than nine orders of magnitude. When specifying that resistance in an electronic design, the required precision of the resistance may require attention to the manufacturing tolerance of the chosen resistor, according to its specific application. The temperature coefficient of the resistance may also be of concern in some precision applications. Practical resistors are also specified as having a maximum power rating which must exceed the anticipated power dissipation of that resistor in a particular circuit: this is mainly of concern in power electronics applications. Resistors with higher power ratings are physically larger and may require heat sinks. In a high-voltage circuit, attention must sometimes be paid to the rated maximum working voltage of the resistor.

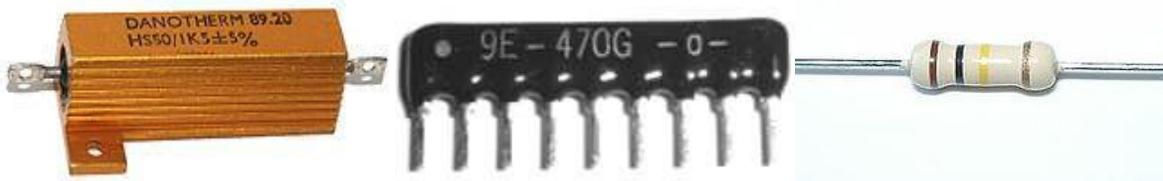


Figure2: Different types of resistor

**Resistor Color Coding:** A 2260 ohm, 1% precision resistor with 5 color bands (E96 series), from top 2-2-6-1-1; the last two brown bands indicate the multiplier (x10), and the 1% tolerance. The larger gap before the tolerance band is somewhat difficult to distinguish. To distinguish left from right there is a gap between the C and D bands.

- band **A** is first significant figure of component value (left side)
- band **B** is the second significant figure (Some precision resistors have a third significant figure, and thus five bands.)
- band **C** is the decimal multiplier
- band **D** if present, indicates tolerance of value in percent (no band means 20%)

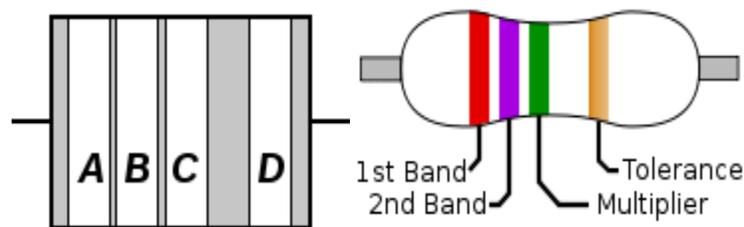


Figure 4: Resistor color coding

For example, a resistor with bands of yellow, violet, red, and gold will have first digit 4 (yellow in table below), second digit 7 (violet), followed by 2 (red) zeros: 4,700 ohms. Gold signifies that the tolerance is  $\pm 5\%$ , so the real resistance could lie anywhere between 4,465 and 4,935 ohms.

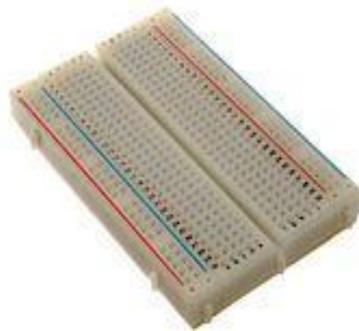
Resistors manufactured for military use may also include a fifth band which indicates component failure rate (reliability); refer to MIL-HDBK-199 for further details. Tight tolerance resistors may have three bands for significant figures rather than two, or an additional band indicating temperature coefficient, in units of ppm/K. All coded components will have at least two value bands and a multiplier; other bands are optional.

The standard color code per EN 60062: 2005 is as follows:

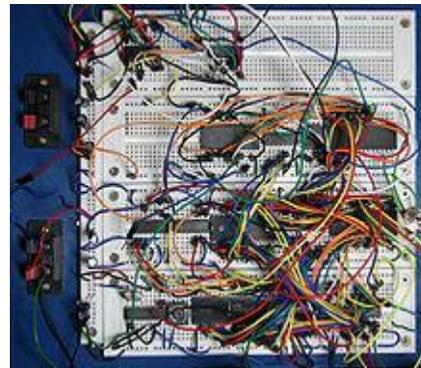
Color	Significant figures	Multiplier	Tolerance	Temp. Coefficient (ppm/K)
Black	0	$\times 10^0$	–	250 U
Brown	1	$\times 10^1$	$\pm 1\%$ F	100 S
Red	2	$\times 10^2$	$\pm 2\%$ G	50 R
Orange	3	$\times 10^3$	–	15 P
Yellow	4	$\times 10^4$	( $\pm 5\%$ ) –	25 Q
Green	5	$\times 10^5$	$\pm 0.5\%$ D	20 Z
Blue	6	$\times 10^6$	$\pm 0.25\%$ C	10 Z
Violet	7	$\times 10^7$	$\pm 0.1\%$ B	5 M
Gray	8	$\times 10^8$	$\pm 0.05\%$ (A) ( $\pm 10\%$ )	1 K
White	9	$\times 10^9$	–	–
Gold	–	$\times 10^{-1}$	$\pm 5\%$ J	–
Silver	–	$\times 10^{-2}$	$\pm 10\%$ K	–
None	–	–	$\pm 20\%$ M	–

**Breadboard:** A breadboard (or proto board) is usually a construction base for prototyping of electronics. The term "breadboard" is commonly used to refer to a solder less breadboard (plug board). A breadboard originally was a flat wooden cutting board used to support a loaf of bread (or other foods) while it was being sliced; this original meaning is still in use, but has a new additional meaning as "a base for prototyping". The concept of "bread boarding" as prototyping is not confined to electronic design; "mechanical breadboards" have been and continue to be used by mechanical engineers.

Because the solderless breadboard for electronics does not require soldering, it is reusable. This makes it easy to use for creating temporary prototypes and experimenting with circuit design. Older breadboard types did not have this property. A strip board (vero-board) and similar prototyping printed circuit boards, which are used to build semi-permanent soldered prototypes or one-offs, cannot easily be reused. A variety of electronic systems may be prototyped by using breadboards, from small analog and digital circuits to complete central processing units (CPUs).



(a)  
Solderless breadboard with 400  
connection points



(b)  
A binary counter wired up on a large  
solder less breadboard

Figure 3: Breadboard and implementation of circuitry

**Power Supplies:** A power supply is a device that supplies electric power to an electrical load. The term is most commonly applied to electric power converters that convert one form of electrical energy to another, though it may also refer to devices that convert another form of energy (mechanical, chemical, solar) to electrical energy. A regulated power supply is one that controls the output voltage or current to a specific value; the controlled value is held nearly constant despite variations in either load current or the voltage supplied by the power supply's energy source.

Every power supply must obtain the energy it supplies to its load, as well as any energy it consumes while performing that task, from an energy source. Depending on its design, a power supply may obtain energy from:

- Electrical energy transmission systems. Common examples of this include power supplies that convert AC line voltage to DC voltage.
- Energy storage devices such as batteries and fuel cells.
- Electromechanical systems such as generators and alternators.
- Solar power.

A power supply may be implemented as a discrete, stand-alone device or as an integral device that is hardwired to its load. Examples of the latter case include the low voltage DC power supplies that are part of desktop computers and consumer electronics devices.

Commonly specified power supply attributes include:

- The amount of voltage and current it can supply to its load.
- How stable its output voltage or current is under varying line and load conditions.
- How long it can supply energy without refueling or recharging (applies to power supplies that employ portable energy sources).



(a)

A home-made linear power supply (used here to power amateur radio equipment)

(b)

A linear DC power supply

(c)

Programmable power supplies

Figure 3: Different power suppliers

## Use of measuring instrument:

### Voltage Measurement:

Set the voltage on the breadboard to an arbitrary voltage between 10 to 15 Volts. Measure this voltage with different types of multimeters and probes. For one measurement use the DVM in the board.

Table-01

Meter ① (Volts)	Meter ② (Volts)	Meter ③ (Volts)	DVM reading (Volts)	Average (Volts)

### Measuring Values of Resistors:

Calculate the values of some resistors using color code. Then measure the values using multimeters and compare the results.

Table-02

Resistor	Color Code Values (ohms)	Multimeter Values (ohms)
R <sub>1</sub>		
R <sub>2</sub>		
R <sub>3</sub>		

### Calculation in a circuit:

Construct a circuit taking a standard series parallel combination from the text book. Calculate the total resistance  $R_T$ , total current  $I$ , voltages  $V_{ab}$  and  $V_{cd}$ . Again measure the same values using multimeter and compare the results.

Table-03

Applied Voltage	Measured values				Multimeter readings			
	$R_T$	$I$	$V_{ab}$	$V_{cd}$	$R_T$	$I$	$V_{ab}$	$V_{cd}$
5 V								
10 V								
15 V								

## Experiment No. 02:

### Title: Verification of Kirchhoff's Voltage Law (KVL) and Kirchhoff's Current Law (KCL)

**Objectives:** To verify Kirchhoff's Voltage and Current laws through experiments.

**Theory:** Kirchhoff's Voltage Law (KVL) in a DC circuit states that, "the algebraic sum of the voltages around any closed path is zero." In other words "the sum of the voltage rises is equal to the sum of voltage drops around any closed loop." In symbolic form KVL can be expressed as

$$\sum_i V_i = 0$$

Where  $i$  is used for different voltage rises and drops around the loop.

KCL in a DC circuit states that the algebraic sum of the currents entering and leaving a node is zero." In other words, the sum of the currents entering a node must be equal to the sum of the currents leaving the node. In equation form

$$\sum_n I_n = 0$$

Where  $n$  is used for different currents entering and leaving the node.

#### Equipment List:

1. Digital Trainer Board
2. Voltmeter
3. Ammeter
4. AVO meter or Multimeter
5. DC Source
6. Resistors

#### Circuit Diagram:

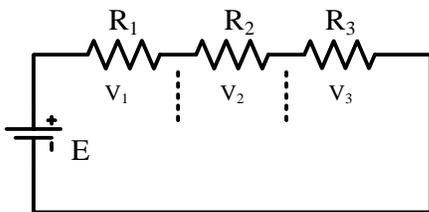


Fig.1: Circuit for Verification of KVL

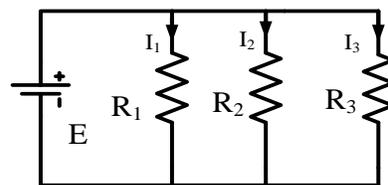


Fig.2: Circuit for Verification of KCL

**Experimental procedure:**

1. Connect the circuit as shown in figure 1.
2. Measure the voltages across each elements of the circuit.
3. Fill the following table with necessary calculations.

Sl. No.	R <sub>1</sub>	R <sub>2</sub>	R <sub>3</sub>	I		V <sub>1</sub>		V <sub>2</sub>		V <sub>3</sub>		V=V <sub>1</sub> +V <sub>2</sub> +V <sub>3</sub>	Error% (M-C)/C
				C (A)	M (A)	C (V)	M (V)	C (V)	M (V)	C (V)	M (V)		

4. Connect the circuit as shown in figure 2.
5. Measure the currents through each branch.
6. Fill in the following table with necessary calculation.

Sl. Nos.	R <sub>1</sub>	R <sub>2</sub>	R <sub>3</sub>	I		I <sub>1</sub>		I <sub>2</sub>		I <sub>3</sub>		I=I <sub>1</sub> +I <sub>2</sub> +I <sub>3</sub>	Error% (M-C)/C
				C (A)	M (A)	C (I)	M (I)	C (I)	M (I)	C (I)	M (I)		

## Experiment No. 03:

### Title: Study of a combination of series and parallel circuits.

**Objectives:** To study the basic laws of series and parallel circuits and to find the total circuit current and equivalent resistances of two different circuits.

**Theory:** Combination of series and parallel resistances and their equivalents, and KVL and KCL in relation to them.

#### Equipment List:

1. Digital Trainer Board
2. Voltmeter
3. Ammeter
4. AVO meter or Multimeter
5. DC Source
6. Resistors

#### Circuit Diagram:

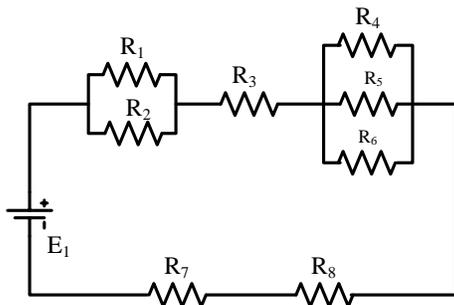


Figure-1

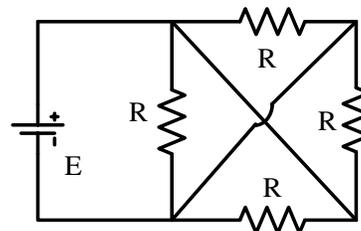


Figure-2

#### Experimental procedure:

1. Connect the circuit as shown in figure-1.
2. Measure the voltages across each resistance and currents of each branch.
3. Then connect the circuit as shown in figure-2. Measure the total current and equivalent resistance. Also measure voltage across each resistance.

## Experiment No. 04:

### Title: Study of Superposition theorem.

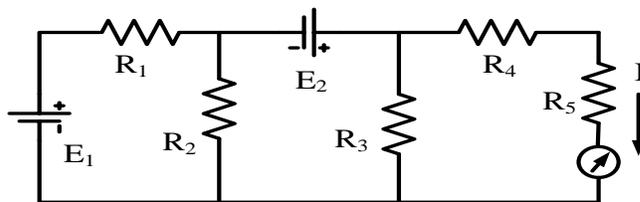
**Objectives:** To verify superposition theorem.

**Theory:** Superposition theorem states that in any linear, active, bilateral network having more than one source, the response across any element is the sum of the responses obtained from each source considered separately and all other sources are replaced by their internal resistance. The superposition theorem is used to solve the network where two or more sources are present and connected.

### Equipment List:

1. Digital Trainer Board
2. Voltmeter
3. Ammeter
4. AVO meter or Multimeter
5. DC Source
6. Resistors

### Circuit Diagram:



### Experimental procedure:

1. Construct the network as shown in the figure.
2. Measure the current  $I$  and voltage across  $R_5$  using voltmeter.
3. Set the voltage source  $E_1$  to zero leaving the other and calculate the current through and voltage across  $R_5$ .
4. Replace the voltage source  $E_1$  to the original value and set  $E_2$  to zero and calculate current through and voltage across  $R_5$ .
5. Add the two currents and voltages and compare with measured values with two sources together.

## Experiment No. 05:

### Title: Study of Thevenin's theorem.

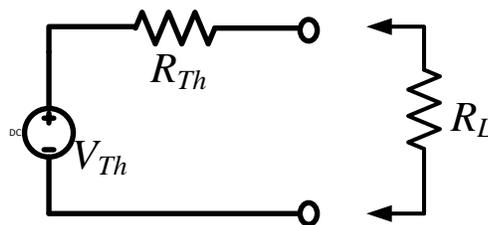
**Objectives:** To prove Thevenin's theorem by finding the Thevenin equivalent circuit and then finding the load voltage and load current.

**Theory:** The Thevenin's theorem is a procedure by which a complex circuit is reduced to an equivalent series circuit consisting of a single voltage source  $V_{Th}$  and a resistance  $R_{Th}$ . Load voltage and load current is then easily determined by connecting the load resistance  $R_L$  in series with the equivalent circuit.

#### Equipment List:

1. Digital Trainer Board
2. Voltmeter
3. Ammeter
4. AVO meter or Multimeter
5. DC Source
6. Resistors

#### Circuit Diagram:



#### Experimental procedure:

1. Construct the circuit according to diagram.
2. Keep the portion of the circuit for which the Thevenin's equivalent is to be determined.
3. Remove the voltage sources by a short circuit and replace the current sources by an open circuit.
4. Place a suitable voltage source at load position and measure the total current. Determine the Thevenin's resistance by dividing the voltage source by the total current.
5. Return the sources to their original position and determine  $V_{Th}$  which is open circuit voltage at load position.
6. Prepare the Thevenin's circuit, connect the load resistance and verify the theorem.

## Experiment No. 06:

### Title: Study of maximum power transfer theorem.

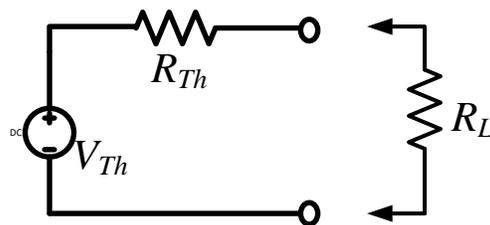
**Objective:** To find the conditions for maximum power to be dissipated by the connected circuit and verify the theorem.

**Theory:** The maximum power transfer theorem states that the maximum amount of power will be dissipated by a load resistance when the load resistance is equal to the Thevenin/Norton resistance of source network.

#### Equipment List:

1. Digital Trainer Board
2. Voltmeter
3. Ammeter
4. AVO meter or Multimeter
5. DC Source
6. Resistors

#### Circuit Diagram:



#### Experimental procedure:

1. Construct the circuit according to diagram.
2. Keep the portion of the circuit for which the Thevenin's equivalent is to be determined.
3. Remove the voltage sources by a short circuit and replace the current sources by an open circuit.
4. Place a suitable voltage source at load position and measure the total current. Determine the Thevenin's resistance by dividing the voltage source by the total current.
5. Return the sources to their original position and determine Thevenin voltage which is open circuit voltage at load position.
6. Prepare the Thevenin's circuit, connect the load resistance and measure voltage and current through load resistance. Compare results with the theorem.

## Experiment No. 07:

**Title: Introduction to oscilloscope, familiarization with AC waves, measuring maximum value, average value, r.m.s value and frequency by oscilloscope and proof of KVL theorem.**

**Objectives:** Familiarization of alternating voltage and current and their measurements.

### Theory and Methodology:

An oscilloscope is a test & measurement instrument that rapidly measures voltage over time. It records the voltage across certain points in a circuit and displays voltage (Y-axis) as a function of time (X-axis) on a screen. It is essentially a very fast voltmeter with the capability of data-logging and plotting. One of the key characteristics of an oscilloscope is the speed at which it can measure and record the voltage. On a specification sheet, it is called **sampling rate**. The sampling rate of an oscilloscope is typically measured by the number of points it can measure over a second.

Any periodic variation of current or voltage where the current (or voltage), when measured along any particular direction, goes positive as well as negative, is defined to be an AC quantity. Sinusoidal AC wave shapes are the ones where the variation (current or voltage) is a sine function of time.

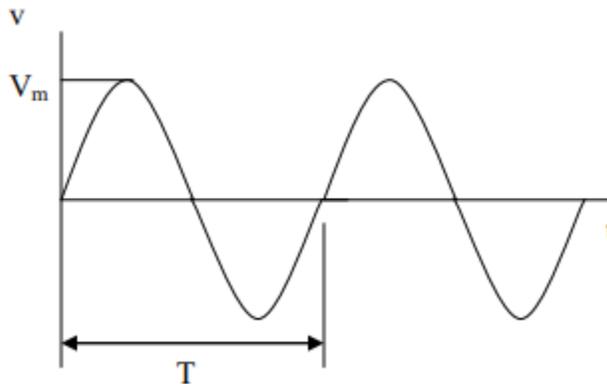


Figure 1. An ac (sinusoidal) voltage waveform

For the wave form in Figure.1, Time period = T, Frequency  $f = 1/T$ ,  $v = V \sin 2\pi ft = V \sin(2\pi/T)t$ .

**Effective value:** Effective (r.m.s) values of sinusoidal waveforms are given as:

$$V = \sqrt{\frac{1}{T} \int_0^T v^2 dt} = \frac{V_m}{\sqrt{2}} \quad (\text{For sinusoidal wave})$$

$$I = \sqrt{\frac{1}{T} \int_0^T i^2 dt} = \frac{I_m}{\sqrt{2}} \quad (\text{For sinusoidal wave})$$

These values are directly measured in ac voltmeter / ammeters.

### Equipment List:

- Oscilloscope
- Function generator
- Resistor:  $100\ \Omega$
- Inductor:  $2.4\text{mH}$
- Capacitor:  $1\ \mu\text{F}$  /  $10\ \mu\text{F}$
- SPST switch
- Connecting wire.
- Bread board

### Circuit Diagram:

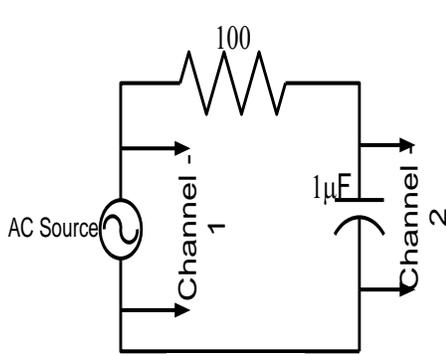


Figure-2

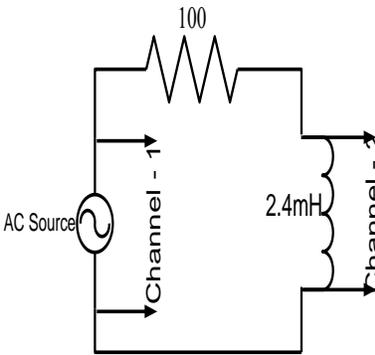


Figure-3

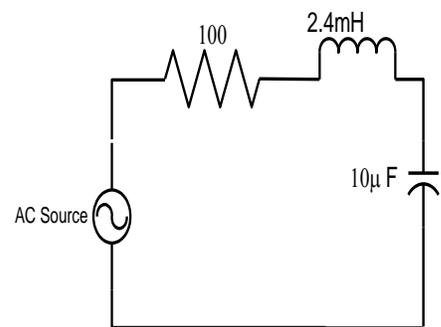


Figure-4

### Experimental Procedure:

1. Construct the circuit as shown in the figure-2. Connect channel 1 of the oscilloscope across function generator and channel 2 of the oscilloscope across R.
2. Set the amplitude of the input signal  $10\text{V}$  peak to peak and the frequency at  $1\ \text{kHz}$ . Select sinusoidal wave shape.
3. Measure peak value of the both wave shapes.
4. Calculate r.m.s value, average value of the wave shapes.
5. Proof KVL theorem.
6. Do the same experiment for the figure-3 and figure-4.

---

### Report:

01. Determine the r.m.s value, average value of  $100 \sin 2\pi t \times 50$ .

## Experiment No. 08

### Title: Study on the characteristics of R-L and R-C series circuits.

**Objectives:** Comparing alternating voltage and current measurements with theoretical calculations.

**Theory:** The RC circuit (Resistor Capacitor Circuit) will consist of a Capacitor and a Resistor connected either in series or parallel to a voltage or current source. These types of circuits are also called as RC filters or RC networks since they are most commonly used in filtering applications. An RC circuit can be used to make some crude filters like low-pass, high-pass and Band-Pass filters. A first order RC circuit will consist of only one Resistor. The RL Circuit (Resistor Inductor Circuit) will consist of an Inductor and a Resistor again connected either in series or parallel. A series RL circuit will be driven by voltage source and a parallel RL circuit will be driven by a current source. RL circuit are commonly used in as passive filters.

#### Equipment List:

1. Oscilloscope
2. Function generator
3. Resistor:  $100 \Omega$
4. Inductor:  $2.4\text{mH}$
5. Capacitor:  $1 \mu\text{F} / 10 \mu\text{F}$
6. SPST switch
7. Connecting wire.
8. Bread board

#### Circuit Diagram:

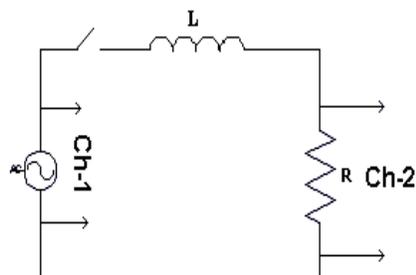


Fig.1

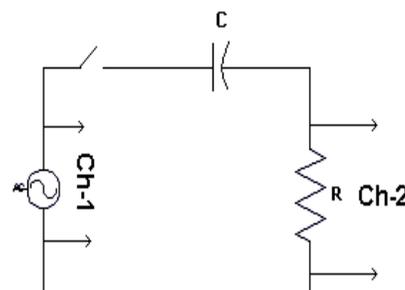


Fig.2

#### Experimental Procedure:

1. Construct the circuit as shown in the fig.1. Connect channel 1 of the oscilloscope across function generator and channel 2 of the oscilloscope across R.
2. Set the amplitude of the input signal  $10\text{V}$  peak to peak and the frequency at  $1 \text{ kHz}$ . Select sinusoidal wave shape.

3. Measure peak value of the both wave shapes.
4. Determine phase relationship between the waves.
5. Write down the wave equations for I and E.
6. Calculate resistance and reactance from the relevant data.
7. Do the same experiment setting input frequency 5kHz and 10kHz.
8. Complete the following table.

**Table-01**

f	E	I	$Z = \frac{E}{I}$ (Polar form)	Z (Rectangular form)	R	X <sub>L</sub>	V <sub>R</sub> =IR	V <sub>L</sub> =IX <sub>L</sub>
1 kHz								
5 kHz								
10 kHz								

9. Now construct the circuit as shown in fig.2. Connect channel 1 of the oscilloscope across function generator and channel 2 of the oscilloscope across R.
10. Do the same procedure stated in 2 to 7. Complete the following table.

**Table-02**

f	E	I	$Z = \frac{E}{I}$ (Polar form)	Z (Rectangular form)	R	X <sub>C</sub>	V <sub>R</sub> =IR	V <sub>C</sub> =IX <sub>C</sub>
1 kHz								
5 kHz								
10 kHz								

## Experiment No. 09:

### Title: Analysis of RLC series circuit and verification of KVL in AC circuits.

**Objectives:** Comparing alternating voltage and current measurements with theoretical calculations in a circuit containing resistance, inductance and capacitance.

**Theory:** A RLC circuit as the name implies will consist of a Resistor, Capacitor and Inductor connected in series or parallel. The circuit forms an Oscillator circuit which is very commonly used in Radio receivers and televisions. It is also very commonly used as damper circuits in analog applications. The resonance property of a first order RLC circuit is discussed. The RLC circuit is also called as series resonance circuit, oscillating circuit or a tuned circuit. These circuit has the ability to provide a resonant frequency signal.

#### Equipment List:

1. Oscilloscope
2. Variac
3. Rheostat: 100  $\Omega$
4. Inductor Bank
5. Capacitor Bank
6. SPST switch
7. Connecting wire

#### Circuit Diagram:

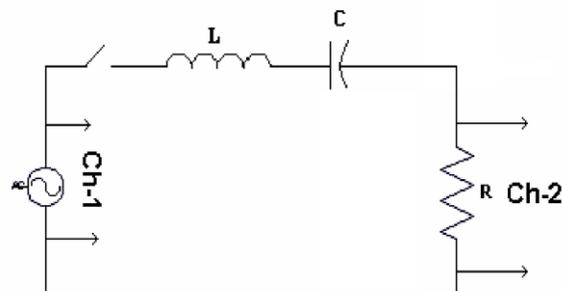


Fig.1

#### Experimental Procedure:

1. Construct the circuit as shown in the fig.1. Connect channel 1 of the oscilloscope across variac and channel 2 of the oscilloscope across R.
2. Set the amplitude of the input signal 10V peak to peak.
3. Set all the switches of inductor & capacitor bank in “off” position.
4. Determine phase relationship between the waves.
5. Measure value of I.

6. Measure value of  $V_R$ ,  $V_L$  &  $V_C$ .
7. Draw the complete vector diagram.
8. Set all the switches of inductor bank in “on” position and one switch of capacitor bank in “on” position and repeat step 4-7
9. Set all the switches of capacitor bank in “on” position and one switch of inductor bank in “on” position and repeat step 4-7.

**Table-01**

E	I	$\phi$	$V_R$	$V_L$	$V_C$	$V_R + V_L + V_C$	
							Resistive
							Inductive
							Capacitive

## Experiment No. 10:

### Title: Analysis of RLC parallel circuit and verification of KCL in AC circuits.

**Objectives:** Comparing alternating voltage and current measurements with theoretical calculations in a parallel circuit containing resistance, inductance and capacitance.

**Theory:** The **Parallel RLC Circuit** is the exact opposite to the series circuit. The analysis of a parallel RLC circuits can be a little more mathematically difficult than for series RLC circuits. This time instead of the current being common to the circuit components, the applied voltage is now common to all so we need to find the individual branch currents through each element. The total impedance,  $Z$  of a parallel RLC circuit is calculated using the current of the circuit similar to that for a DC parallel circuit, the difference this time is that admittance is used instead of impedance.

#### Equipment List:

- Oscilloscope
- Function generator
- Resistor:  $1\ \Omega$  (1),  $100\ \Omega$  (2)
- Inductor:  $2.4\ \text{mH}$
- Capacitor:  $1\ \mu\text{F}$
- SPST switch
- Connecting wire.

#### Circuit Diagram:

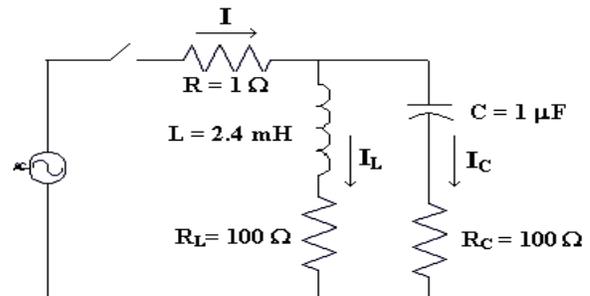


Fig.1

#### Experimental Procedure:

1. Construct the circuit as shown in the fig.1. Connect channel 1 of the oscilloscope across function generator and channel 2 of the oscilloscope across  $R_L$
2. Set the amplitude of the input signal  $10\text{V}$  peak to peak and the frequency at  $5\ \text{kHz}$ . Select sinusoidal wave shape.
3. Determine phase relationship between the waves.
4. Measure value of  $I_L$ .
5. Now connect channel 2 of oscilloscope across  $R_C$ .
6. Determine phase relationship between the waves.
7. Measure value of  $I_C$ .
8. Measure total current  $I$
9. Draw the complete vector diagram.
10. Do the same work for setting input frequency  $1\ \text{kHz}$  and  $10\ \text{kHz}$ .

**Table-01**

f	E	I <sub>L</sub>	$\theta_L$	I <sub>C</sub>	$\theta_C$	I <sub>L</sub> +I <sub>C</sub>	I
5kH							
1kHz							
10kHz							

**Report:**

1. Complete Table-1.
2. Draw the complete vector diagram 5kHz, 1kHz and 10kHz input frequency.
3. Verify KCL.
4. Comment on the role of frequency to  $\theta_L$  and  $\theta_C$ .

## Experiment No. 11:

### Title :Analysis of Series Resonance.

**Objectives :**To establish the point of resonance by changing frequency in a series circuit containing resistance, inductance and capacitance and comparing it with theoretical value.

**Theory and Methodology:** Would be discussed in the class.

#### Equipment List:

- Oscilloscope
- Function generator
- Resistor: 100  $\Omega$
- Inductor: 2.4mH
- Capacitor: 1 $\mu$ F
- SPST switch
- Connecting wire.
- Bread board

#### Circuit Diagram:

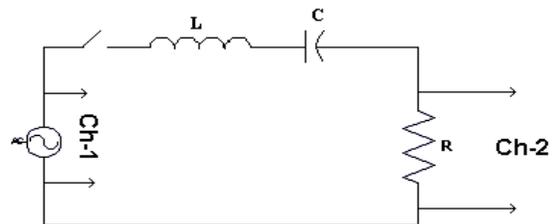


Fig.1

#### Experimental Procedure:

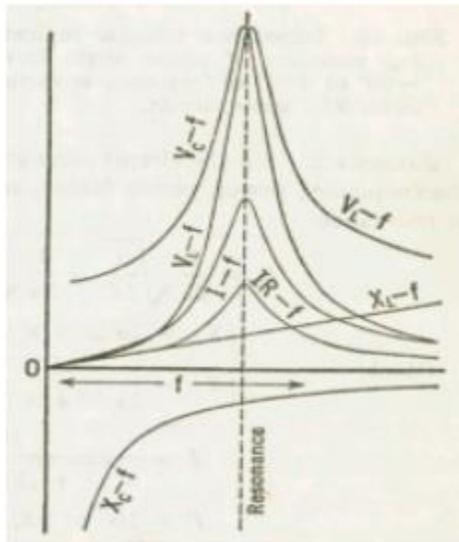
1. Construct the circuit as shown in the fig.1. Connect channel 1 of the oscilloscope across function generator and channel 2 of the oscilloscope across R.
2. Set the amplitude of the input signal 10V peak to peak and the frequency at 1 kHz. Select sinusoidal wave shape.
3. See the waves in dual mode or X-Y mode. And gradually increase the frequency and locate the point where phase difference of the waves is zero. This is our resonance point ( $f_m$ ).
4. Now determine the current (I) at resonance frequency and Determine the frequencies ( $f_1$  and  $f_2$ ) where current is ( $I/\sqrt{2}$ ).
5. Determine Q factor ,

$$Q = \frac{\omega_m}{\omega_2 - \omega_1} = \frac{f_m}{f_2 - f_1}$$

6. Record the variation of of I,  $V_C$ ,  $V_L$ ,  $V_R$ ,  $X_L$  and  $X_C$  with frequency in table-1 below.
7. Plot the change of I,  $V_C$ ,  $V_L$ ,  $V_R$ ,  $X_L$  and  $X_C$  with frequency on the same graph paper.

Table-1

$f$	$I$	$V_C$	$V_L$	$V_R$	$X_L$	$X_C$



**Report:**

1. Complete Table-1.
2. Plot the complete diagram mentioned in No.7.
3. Establish the point of resonance.
4. Compare with value calculated theoretically.

**Discussion:**

Discuss about what has been learnt through this experiment.

## Experiment No. 12:

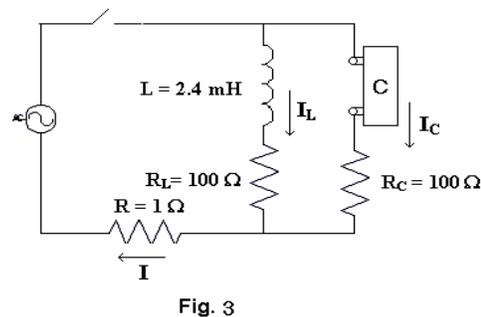
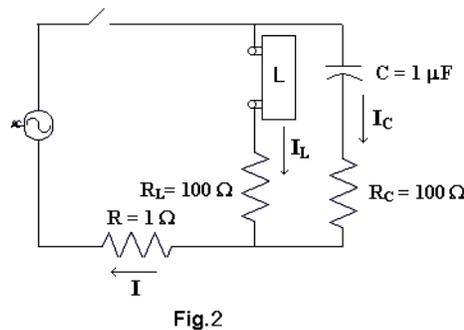
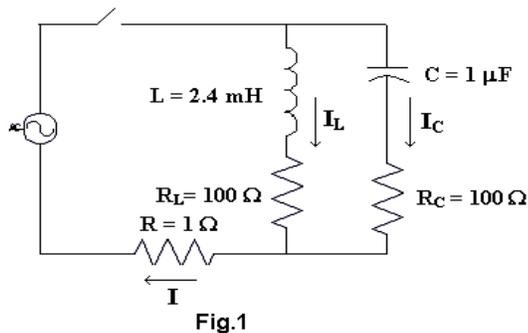
### Title: Analysis of Parallel Resonance.

**Objectives :** To establish the point of resonance in a parallel circuit containing resistance, inductance and capacitance and comparing it with theoretical value.

#### Equipment List:

- Oscilloscope
- Function generator
- Resistor:  $1\Omega$ (1),  $100\Omega$  (2).
- Inductor:  $2.4\text{ mH}$
- Capacitor:  $1\mu\text{F}$
- Decade inductor box.
- Decade capacitor box.
- SPST switch
- Connecting wire.
- Bread board

#### Circuit Diagram:



#### Experimental Procedure:

1. Construct the circuit as shown in the fig.1. Connect channel 1 of the oscilloscope across function generator and channel 2 of the oscilloscope across R.

2. Set the amplitude of the input signal 10V peak to peak and the frequency at 1 kHz. Select sinusoidal wave shape.
3. See the waves in dual mode or X-Y mode. And gradually increase the frequency and locate the point where phase difference of the waves is zero. This is our resonance point ( $f_m$ ).
4. Now for different values of frequency determine the value of  $I$ ,  $I_L$  and  $I_C$ .

Table-1: Resonance by varying frequency

f	I	$I_L$	$I_C$

5. Now construct the circuit as shown in the fig.2.
6. Set the amplitude of the input signal 10V peak to peak and the frequency at 1 kHz. Select sinusoidal wave shape.
7. Set  $L=0$  and measure values of  $I$ ,  $I_L$  and  $I_C$ .
8. Gradually increase  $L$  and measure values of  $I$ ,  $I_L$  and  $I_C$  for each  $L$ .

Table-2: Resonance by varying inductance

L	I	$I_L$	$I_C$

9. Theoretically draw the circle diagram for varying  $L$  and verify whether your measured values are on the circle or not.
10. Now construct the circuit as shown in the fig.2. and do the same experiment for variable capacitance.

Table-3: Resonance by varying capacitance

C	I	$I_L$	$I_C$

**Report:**

1. Complete table-1, table-2 and table-3.
2. Plot the variation of  $I$ ,  $I_L$  and  $I_C$  on the same graph paper.
3. Draw circle diagram for resonance by varying inductance and capacitance and verify whether your measured values are on the circle or not.

**Discussion:**

Discuss about what has been learnt through this experiment.