Federal Urdu University of Arts,Science & Technology

LAB MANUAL

FIRST SEMESTER

BASIC ELECTRICAL & CIRCUIT ANALYSIS

BASIC ELECTRICAL & ELECTRONICS LAB

DEPARTMENT OF ELECTRICAL ENGINEERING

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Semester: _____________________________________

Batch: ____

CONTENTS

EXPERIMENT NO – 01

FAMILIARIZATION WITH BASIC LAB EQUIPMENT

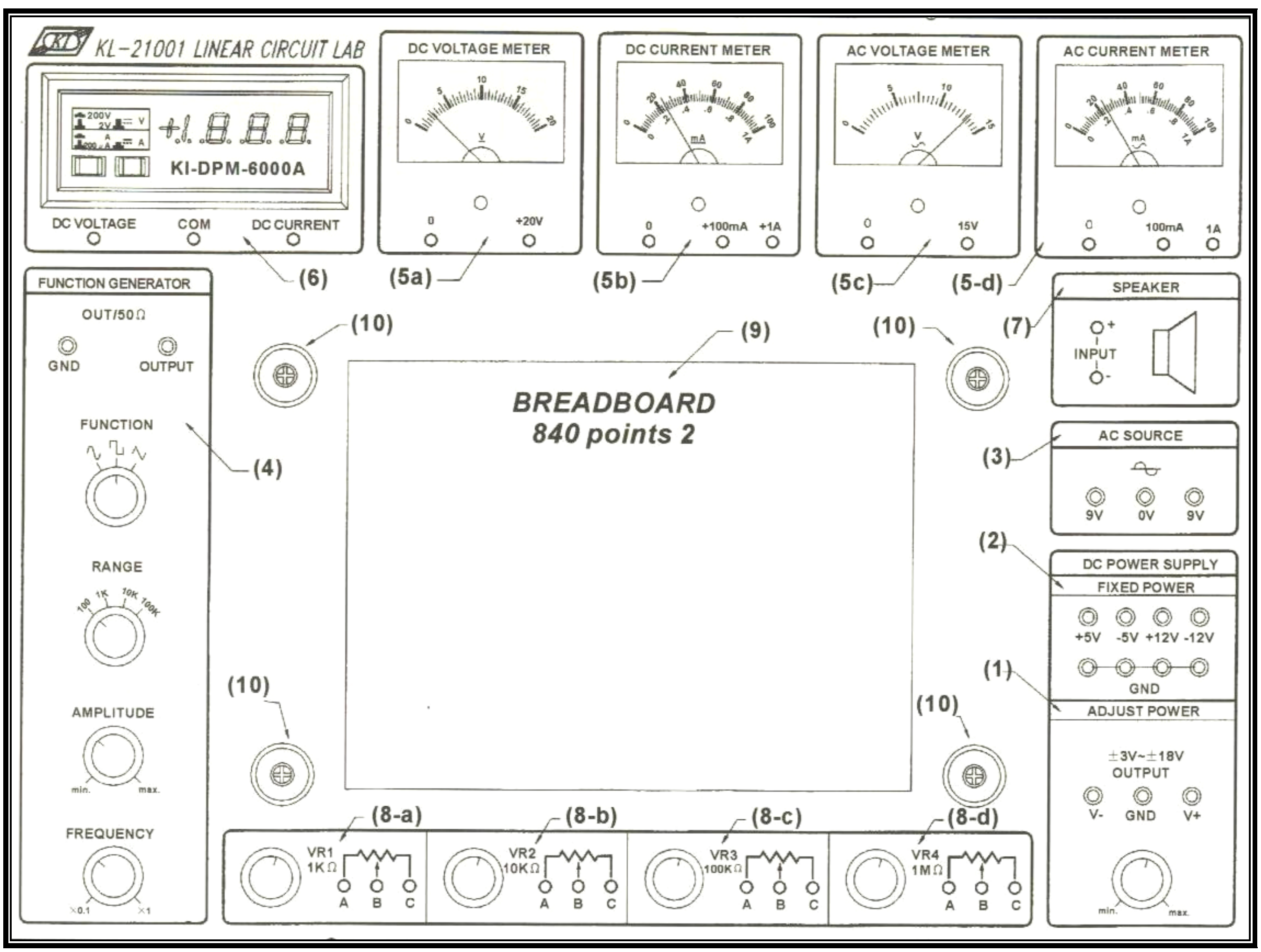
OBJECTIVE:

1. Familiarization with KL-100 Training System
2. Familiarization with the use of Basic Lab Equipments
   - Oscilloscope
   - Function Signal Generator
   - DC Power Supply
   - Multi-Meter

DISCRIPTION:

KL – 100 Training System (Main Unit)

Introduction and Operation of the top panel



Power Supply:

1. ***Dual DC Power Supply:*** Synchronous positive and negative voltage output. Turn the knob clockwise to increase voltage and counterclockwise to decrease Output range: ± 3V ~ ± 18V
2. ***Fixed DC Power Supply***: 4 preset outputs, ±5, ±12
3. ***AC Source:*** 9V ~ 0V ~ 9V

Signal Generator:

4. *Function Generator:* Block 4 on figure listed from top down
   - *OUTPUT:* 50Ω ± 10% output impedance.
   - *FUNCTION:* Waveform Selector (Triangle, Sine, Square)
   - *RANGE:* 100Hz ~ 100KHz selector (4 ranges)
   - *AMPLITUDE:* Amplitude controller, turn clockwise to increase
   - *FREQUENCY:* Frequency controller, turn clockwise to increase

Measuring Instruments:

5-a ***DC Voltmeter:*** 0~20V
5-b ***DC Amp meter:*** 0~100mA ~1A
5-c ***AC Voltmeter:*** 0~15V
5-d ***AC Amp meter:*** 0~100mA ~1A

The tiny holes below these four meters are for fine adjustment.

6. ***Digital DC Voltmeter/Amp meter:*** The volt/amp meter selector is on the bottom and the range selectors are on the left.

CAUTION: This is a 3-1/2 digit LED display. When the incoming voltage or current exceeds its limitation, a flashing "1" will be displayed. If this happens, reduce the input immediately. When 2000mA is selected and the input exceeds it, the internal fuse will be burned. A 2A fuse is included in the accessory pack for replacement purpose.

Input/output Devices

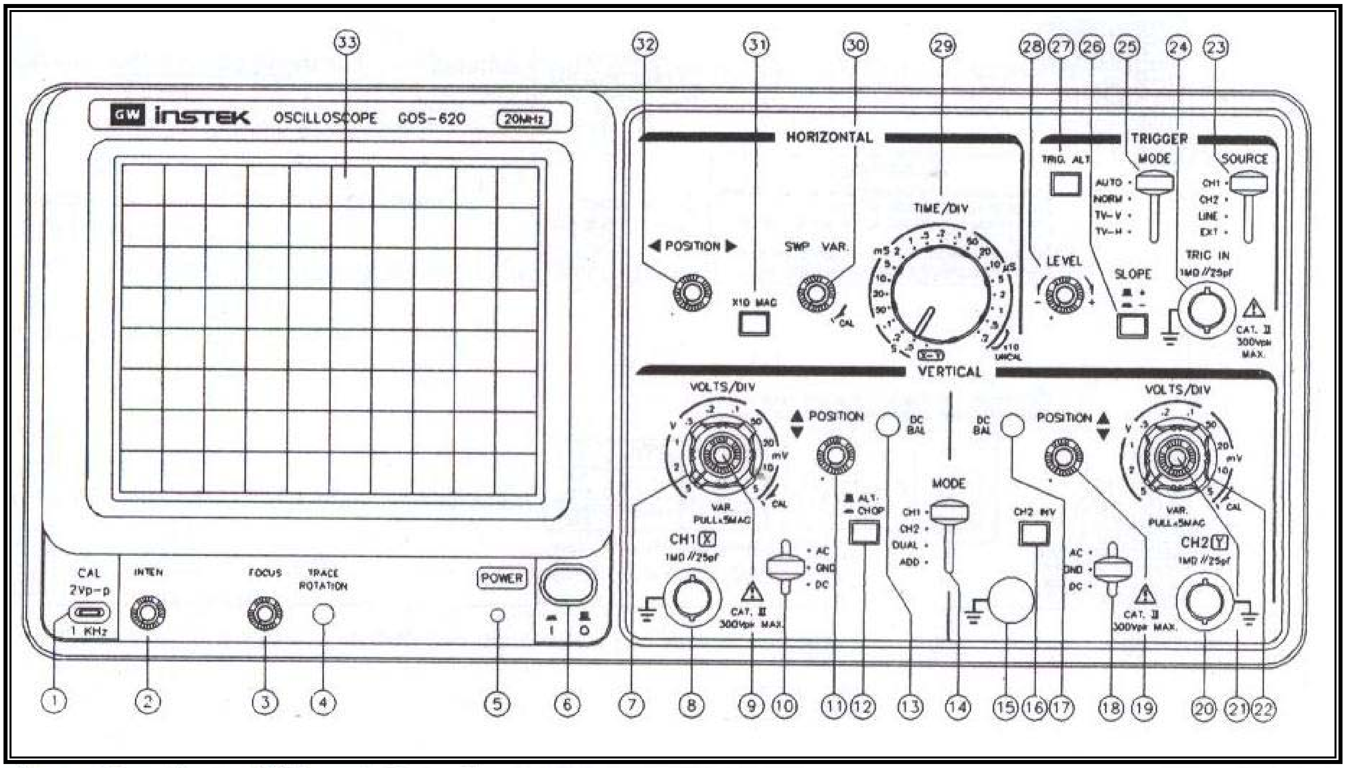
7. ***Speaker:*** an 8 Ω/0.25W speaker with driver circuit.

8-a 1K Ω, 0.25W potential meter, with A, B, C terminal
8-b 10 K Ω, 0.25W potential meters, with A, B, C terminal
8-c 100K Ω, 0.25W potential meter, with A, B, C terminal
8-d 1M Ω, 0.25W potential meter, with A, B, C terminal

9. ***External Connection***: Two 840 tie-point breadboard for circuit Prototyping and designing

10. Four modules mounting for securing the modules.

Dual Trace Oscilloscope 20MHz (GW INSTEK GOS-620)



Introduction of Front Panel

CRT :

POWER......................(6)
Main power switch of the instrument. When this switch is turned on, the LED (5) is also turned on.

INTEN........................(2)
Controls the brightness of the spot or trace.

FOCUS......................(3)
For focusing the trace to the sharpest image.

TRACE ROTATION....(4)
Semi-fixed potentiometer for aligning the horizontal trace in parallel with graticule lines.

FILTER.......................(33)
Filter for ease of waveform viewing.

Vertical Axis:

CH 1 (X) input............(8)
Vertical input terminal of CH 1.When in X-Y operation, X-axis input terminal.

CH 2 (Y) input............(20)
Vertical input terminal of CH 2.When in X-Y operation, Y-axis input terminal.

AC-GND-DC...............(10)(18)
Switch for selecting connection mode between input signal and vertical amplifier.
AC : AC coupling
GND : Vertical amplifier input is grounded and input terminals are disconnected.
DC : DC coupling

VOLTS/DIV...............(7)(22)
Select the vertical axis sensitivity, from 5mV/DIV to 5V/DIV in 10 ranges.

VARIABLE................(9)(21)

Fine adjustment of sensitivity, with a factor of ≥1/2.5 of the indicated value. When in the CAL position, sensitivity is calibrated to indicated value. When this knob is pulled out(x5 MAG state), the amplifier sensitivity is multiplied by 5.

CH1 & CH2 DC BAL.(13)(17)

These are used for the attenuator balance adjustment. See page 20 DC BAL adjustments for the details.

▲ ▼ POSITION............(11)(19)

Vertical positioning control of trace or spot.

VERT MODE.............(14)

Select operation modes of CH 1 and CH 2 amplifiers.

CH 1 : The oscilloscope operates as a single-channel instrument with CH 1 alone.
CH 2 : The oscilloscope operates as a single-channel instruments with CH 2 alone.
DUAL : The oscilloscope operates as a dual-channel instrument both CH 1 and CH 2.
ADD : The oscilloscope displays the algebraic sum (CH 1 + CH 2) or difference (CH 1 - CH 2) of the two signals. The pushed in state of CH 2 INV(16) button is for the difference (CH 1 - CH 2).

ALT/CHOP.................(12)

When this switch is released in the dual-trace mode, the channel 1 and channel 2 inputs are alternately displayed (normally used at faster sweep speeds).

When this switch is engaged in the dual-trace mode, the channel 1 and channel 2 inputs are chopped and displayed simultaneously (normally used at slower sweep speeds).

CH2 INV....................(16)

Inverts the CH2 input signal when the CH2 INV switch mode is pushed in The channel 2 input signal in ADD mode and the channel 2 trigger signal pickoff are also inverted.

Triggering:

EXT TRIG IN input terminal........(24)

Input terminal is used for external triggering signal. To use this terminal, set SOURCE switch (23) to the EXT position.

SOURCE.................(23)

Select the internal triggering source signal, and the EXT TRIG IN input signal.

CH 1 : When the VERT MODE switch(14) is set in the DUAL or ADD state, select CH 1 for the internal triggering source signal.
CH 2 : When the VERT MODE switch(14) is set in the DUAL or ADD state, select CH 2 for the internal triggering source signal.
TRIG.ALT(27) : When the VERT MODE switch(14) is set in the DUAL or ADD state, and the SOURCE switch(23) is selected at CH 1 or CH 2, with the engagement of the TRIG.ALT switch(27), it will alternately select CH 1 & CH 2 for the internal triggering source signal.
LINE : To select the AC power line frequency signal as the triggering signal.
EXT : The external signal applied through EXT TRIG IN input terminal(24) is used for the external triggering source signal.

SLOPE.....................(26)

Select the triggering slope.

"+" : Triggering occurs when the triggering signal crosses the triggering level in positive-going direction.
"- " : Triggering occurs when the triggering signal crosses the triggering level in negative-going direction.

LEVEL....................(28)

To display a synchronized stationary waveform and set a start point for the waveform.

Toward "+" : The triggering level moves upward on the display waveform.
Toward "-" : The triggering level moves downward on the display waveform.

TRIGGER MODE....(25)

Select the desired trigger mode.

AUTO : When no triggering signal is applied or when triggering signal frequency is less than 25 Hz, sweep runs in the free run mode.
NORM : When no triggering signal is applied, sweep is in a ready state and the trace is blanked out. Used primarily for observation of signal ≤ 25 Hz.
TV-V : This setting is used when observing the entire vertical picture of television signal.
TV-H : This setting is used when observing the entire horizontal picture of television signal.
(Both TV-V and TV-H synchronize only when the synchronizing signal is negative.)

Time Base

TIME/DIV......……….....(29)

Sweep time ranges are available in 20 steps from 0.2 uS/div to 0.5 S/div.

X-Y : This position is used when using the instrument as an X-Y oscilloscope.

SWP.VAR.........………...(30)

Vernier control of sweep time. This control works as CAL and the sweep time is calibrated to the value indicated by TIME/DIV. TIME/DIV of sweep can be varied continuously when shaft is out of CAL position. Then the control is rotated in the direction of arrow to the full, the CAL state is produced and the sweep time is calibrated to the value indicated by TIME/DIV. Counterclockwise rotation to the full delays the sweep by 2.5 time or more.

◂ ▸ POSITION......………...(32)

Horizontal positioning control of the trace or spot.

x 10 MAG.......………....(31)

When the button is pushed in, a magnification of 10 occurs.

Others

CAL…………...………….........(1)

This terminal delivers the calibration voltage of 2 Vp-p, 1kHz, positive square wave.

GND...............……………....(15)

Ground terminal of oscilloscope mainframe.

Introduction of Rear Panel

Z AXIS INPUT.................….(34)

Input terminal for external intensity modulation signal.

CH 1 SIGNAL OUTPUT.....(35)

Delivers the CH 1 signal with a voltage of approximately 20mV per 1 DIV into a 50-ohm termination. Suitable for frequency counting, etc.

EXPERIMENT NO – 02

MEASUREMENT OF RESISTANCE & CAPACITANCE

OBJECTIVE:

Introduction to the Measuring Methods of Resistance and Capacitance

EQUIPMENT/COMPONENTS REQUIRED:

1. Different Valued Resistors, Capacitors
2. VOM (Volt-Ohm-Milliammeter)
3. DMM (Digital Multimeter)

THEORY & PROCEDURE:

NOTE:

The purpose of this experiment is to acquaint you with the equipment, so do not rush. Learn how to read the meter scales accurately, and take your data carefully. You must become comfortable with the instruments if you expect to perform your future job function in a professional manner.

"Part 1: Resistance Measurement"

METHOD 1: Resistance Measurement using VOM/ DMM:

1. Resistance is never measured by an ohm-meter in a live network, due to the possibility of damaging the meter with excessively high currents and obtaining readings that have no meaning.
2. Always start with the highest range of the instrument and switch down to the proper range successively.
3. Use the range in which the deflection falls in the upper half of the meter scale.
4. Try to ascertain the polarity of dc voltages before making the measurement.
5. Whenever measuring the resistance of a resistor in a circuit, note whether there are any other resistive elements that could cause an error in the reading. It may be necessary to disconnect one side of the resistor before measuring.
6. Check the zero and ohms adjustments each time the range is changed.
7. When making measurements, grip the test prods by the handles as close to the lead end as possible. Do not allow the fingers to touch the prod tips while measuring.
8. Keep the instruments away from the edge of the workbench, and away from heat and dangerous fumes.

9. There is no zero adjustment on a DMM, but make sure that R=0 ohm when the leads are touching or an adjustment internal to the meter may have to be made. Any resistance above the maximum for a chosen scale will result in an O.L. indication.
10. The ranges are usually marked as multiples of R. For example,

R x 1, R x 10, R x 100, R x 1 k

The value of the resistor can be found by multiplying the reading by the range setting. For example, a reading of 11 on the R x 1 kΩ range is 11 x 1 kΩ= 11 k Ω, or 11, 000 Ω.

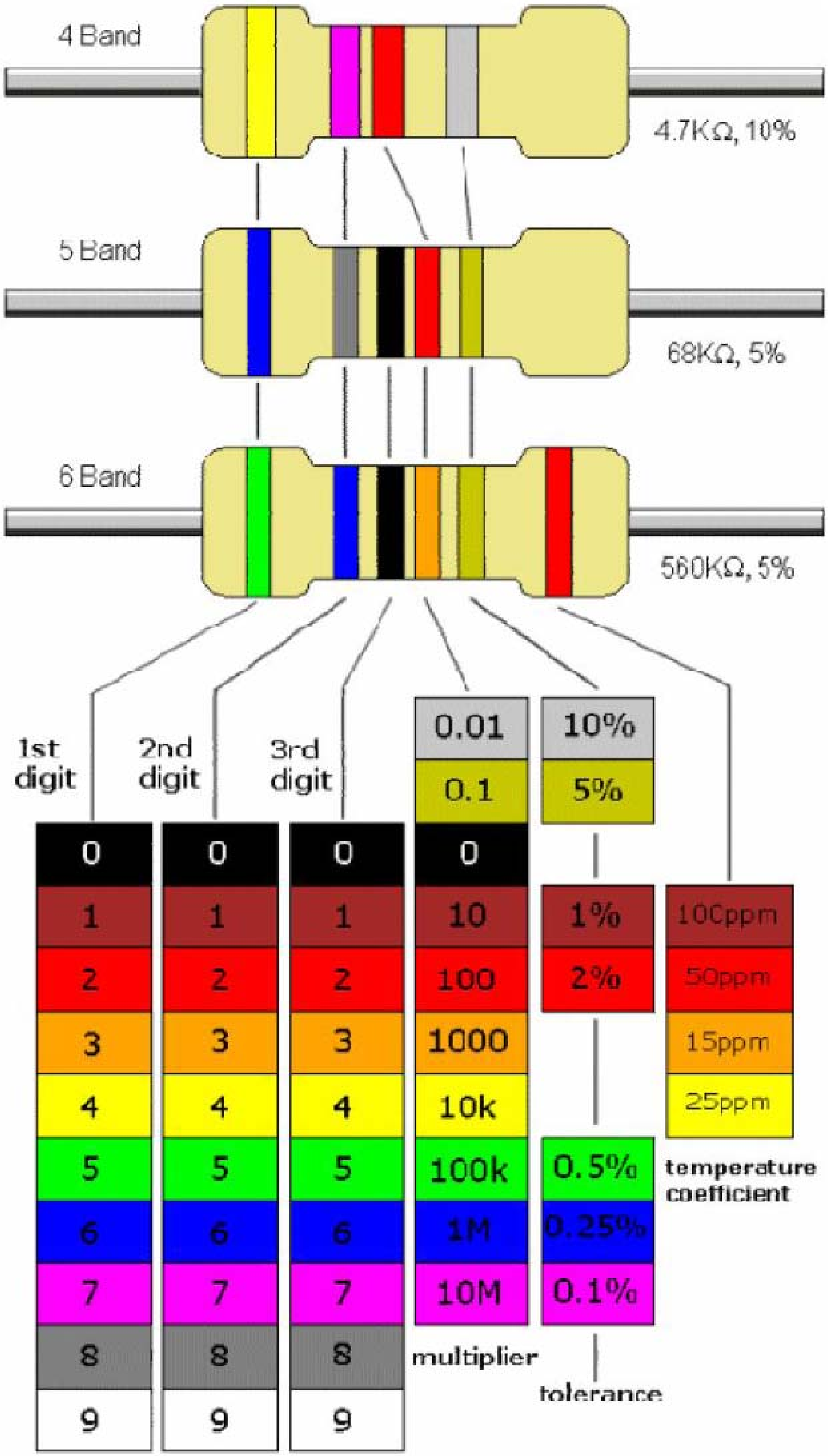
METHOD 2: Resistance Measuring Using Color Coding:

1. The resistance of many resistors can be determined by reading a series of colored bands imprinted on the resistor body. In this scheme called "Resistor Color Code" each colour represents a different decimal digit, as shown in fig. 1 and Table 2.

Table 2: Resistor Color Code:

Colour	Digit	Multiplier	Tolerance
Black	0	1	
Brown	1	10	± 1%
Red	2	100	± 2%
Orange	3	1K	
Yellow	4	10K	
Green	5	100K	± 0.5%
Blue	6	1M	± 0.25%
Violet	7	10M	± 0.1%
Grey	8		
White	9		
Gold		0.1	± 5%
Silver		0.01	± 10%
None			± 20%
Digit	Color	Digit	Color
0	**Black**	**7**	**Violet**

The first three bands of the color code are used to specify nominal value of the resistance, and the fourth, or tolerance band, gives the percent deviation from the nominal value that the actual resistor may have. Due to manufacturing variations, the actual resistance may be anywhere in a range equal to the nominal value plus or minus a certain percentage of that value.



4 Band
4.7KΩ, 10%
5 Band
68KΩ, 5%
6 Band
560KΩ, 5%
1st digit
2nd digit
3rd digit
0 1 2 3 4 5 6 7 8 9
0.01
0.1
0
10
100
1000
10k
100k
1M
10M
multiplier
10%
5%
1%
2%
0.5%
0.25%
0.1%
tolerance
100ppm
50ppm
15ppm
25ppm
temperature coefficient

Figure – 1

Capacitor Colour Code

A colour code was used on polyester capacitors for many years. It is now obsolete, but of course there are many still around. The colours should be read like the resistor code, the top three colour bands giving the value in pF. Ignore the 4th band (tolerance) and 5th band (voltage rating).

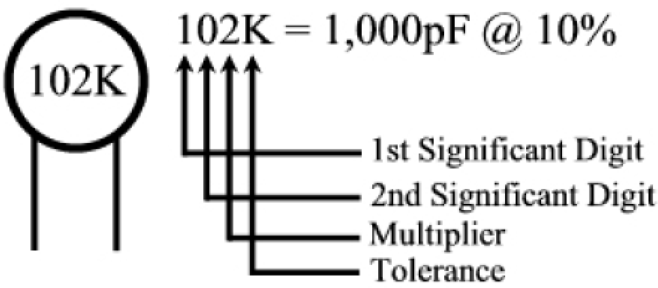
For example: brown, black, orange means
10000pF = 10nF = 0.01μF.

Note that there are no gaps between the colours bands, so 2 identical bands actually appear as a wide band.
For example: **wide red, yellow** means 220nF = 0.22μF.

Colour Code	
Colour	Number
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Grey	8
White	9

NUMERICAL CODES

Numerical Codes are used with non - electrolytic capacitors to specify their capacitance. Usually, these codes are 3 digit long, specifying the capacitance in Pico Farads; the first two digits are Tens and Units, where as the third digit is power of 10.



Common Temperature Coefficient Codes (Ceramic)	
Code	**Tolerance**
C	±0.25pF
J	±5%
K	±10%
M	±20%
D	±0.5pF
Z	+80% / -20%

For example: **102** means 1000pF = 1nF (not 102pF!)
For example: **472J** means 4700pF = 4.7nF (J means 5% tolerance).
For example: **333K** means 33000pF = 33nF (K means 10% tolerance).

Tens	Units	Power of 10	Capacitance
1	0	2	10×10^2 pF = 1000 pF = 1nF
4	7	2	$47x10^2$ pF=4.7nF±5%
3	3	3	$33x10^3$ pF=33nF±10%

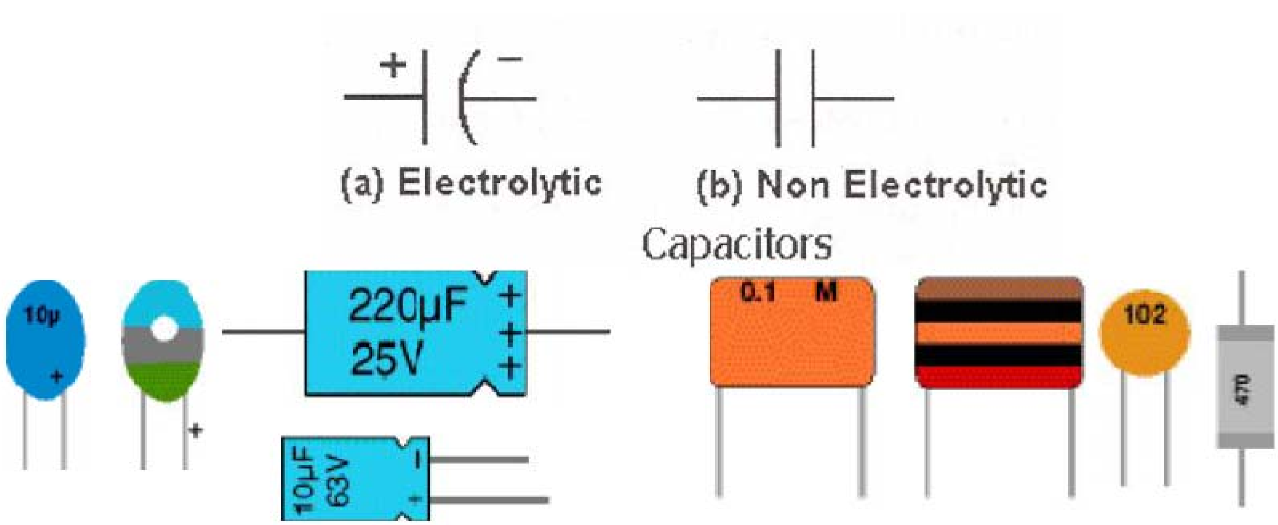
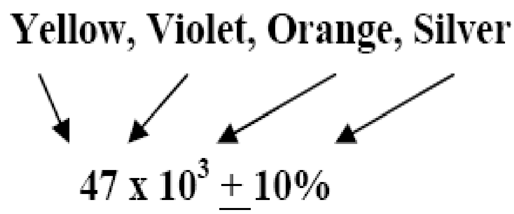


Figure – 2: Capacitors

2. The first two color bands specify the first two digits of the nominal value, and the third band represents the power of 10 by which the first two digits are multiplied.

3- The example below demonstrates these computations.

Solution:-



Thus,

Nominal resistance = 47 x 103 Ω = 47k Ω

The possible range of actual values is:

47 k Ω ± (0.1) 47 k Ω = 47kΩ ± 4.7k Ω

Or From **42.3 k**Ω to **51.7 k** Ω

<u>“Part 2: Capacitance Measurement:”</u>

<u>CAPACITOR:</u>

There are two types of capacitors, i.e. electrolyte and non - electrolyte capacitors. The non-electrolytic capacitors use Paper, Mica, Ceramic, Mylar, Glass, Porcelain, Polycarbonate, and Wax as Insulator. Figure 2 shows symbols of the two types of the capacitor. The difference in the use of the two types of capacitors is that non-electrolytic capacitors can be charged in any direction, where as the Electrolytic ones can only be charged in one direction. Electrolytic Capacitors are Polar; i.e., one of its two plates is Positive and other is Negative, whereas in non-electrolytic capacitors, both the plates are same, having no polarity.

OBSERVATION:-

TABLE –A

Resistors	Colour Bands 1 | 2 | 3 | 4	Colour Bands 1 | 2 | 3 | 4	Nominal Resistances	Maximum Resistances	Minimum Resistances
Example	Red, Red, Black, Gold	2 2 0 5 %	22Ω	23.1Ω	20.9Ω
1					
2					
3					
4					
5					

TABLE - B

Resistor	Measured Value (VOM / DMM)	Falls within specified tolerance
Example	23Ω	Yes
1		
2		
3		
4		
5		

EXPERIMENT NO: 03

VERIFICATION OF OHMS LAW

OBJECTIVE:

To Verify Ohms Law for a series resistive Network

EQUIPMENT/COMPONENTS REQUIRED:

1. DC Power Supply
2. Multi-meter
3. Bread Board
4. Resistors

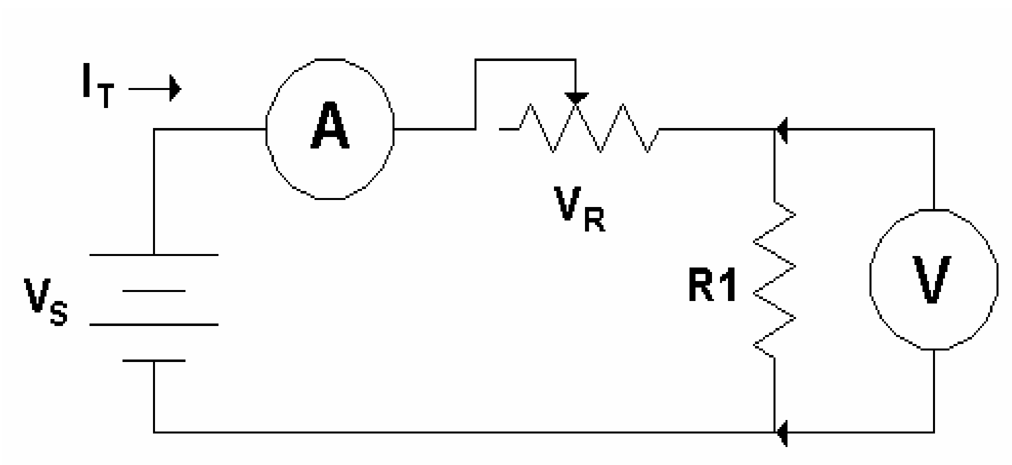
THEORY:

Ohms Law simply states that:

"The current is inversely proportional to the Resistance. The Ohms law can be combined mathematically to give the expression as I=V/R.

The Ohms law correctly expresses the relationship as for a fixed resistance, current increases when voltage increases, and for a fixed voltage, Current decreases when Resistance increases.

FIGURE:



Circuit Diagram for Ohms Law Verification

PROCEDURE:

1. Construct the circuit as shown in figure.
2. Apply power to the circuit and by varying R1 measure and record the voltage drop across R2 in the Table
3. Now, break the circuit at the input and place ammeter and measure the current flowing through the circuit and record in the table.
4. By measuring the voltage drop across , and the current through , the resistive circuit verify the Ohms law with the equation (I=V/R)

TABLE:

Vs	IT	R1	R2	V

RESULTS:

____

____

____

____

EXPERIMENT NO - 04

CHARACTERISTICS OF SERIES DC CIRCUIT

OBJECTIVE:

To investigate the characteristics of a series DC circuit

EQUIPMENT/COMPONENTS REQUIRED:

1. DMM
2. DC Supply
3. Resistors of 220Ω(RR Br), 330Ω(Or Or Br) & 430Ω(Y, Or, Br).

THEORY:

In a series circuit, (Fig 4.1), the current is the same through all of the circuit elements.

The total Resistance RT =R1 + R2 + R3.

By Ohm's Law, the Current "I" is

$$I = \frac{E}{R_T}$$

Applying Kirchoff's Voltage Law around closed loop of Fig 4.1, we find.

$$E = V_1 + V_2 + V_3$$

Where,

$$V_1 = IR_1,\ V_2 = IR_2,\ V_3 = IR_3$$

Note in Fig 4.1, that I is the same throughout the Circuit.

The voltage divider rule states that the voltage across an element or across a series combination of elements in a series circuit is equal to the resistance of the element divided by total resistance of the series circuit and multiplied by the total imp4ressed voltage. For the elements of Fig 4.1

$$\mathbf{V_1} = \frac{R_1E}{R_T}\ ,\ \mathbf{V_2} = \frac{R_2E}{R_T}\ ,\ \mathbf{V_3} = \frac{R_3E}{R_T}$$

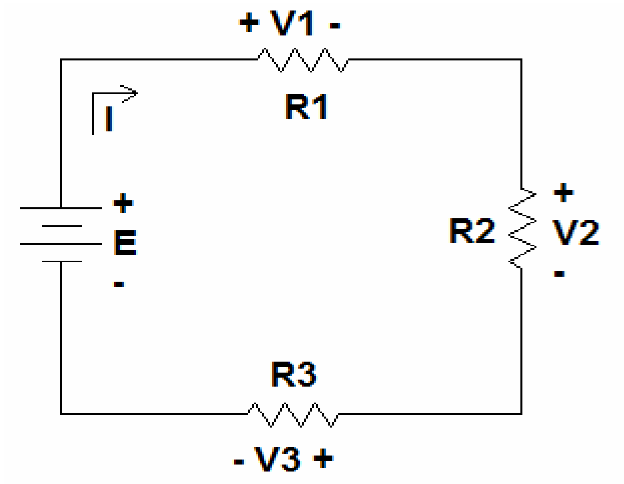


Figure – 4.1

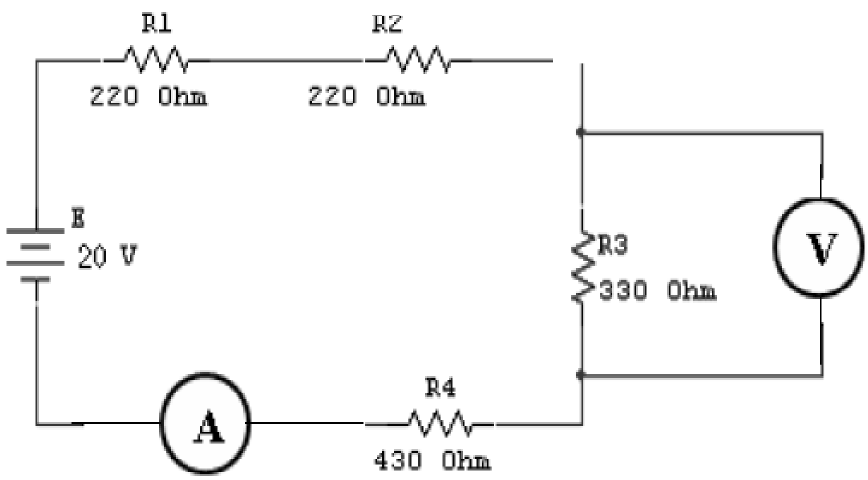


Figure – 4.2

PROCEDURE:

1. Construct the circuit shown in Fig 4.2.
2. Set the Dc supply to 12V by using DMM. Pick the resistances having values 220Ω, 330Ω& 430Ω. Also verify their resistance by using DMM.
3. Measure voltage across each resistor with DMM and record it in the Table (**b)**.
4. Measure Current I delivered by source.
5. Shut down and disconnect the power supply. Then measure input resistance RT across points A-E using DMM. Record that value.
6. Now Calculate, respective currents (using $I_1 = \frac{V_1}{R_1}$) and $R_T(R_T = \frac{E}{I})$
7. Calculate V1 & V2 using voltage divider rule and measured resistance value.
8. Create an open circuit by removing R3& measure all voltages and current I.

Note: Use measured value of resistance for all calculations.

OBSERVATIONS:

a. Resistors

S.No	Nominal Values (Ω)	Measured Values (Ω)	RT (Measured) (Ω)	RT (Calculated) (Ω)
1	R1=220 Ω			
2	R2=220 Ω			
3	R3=330 Ω			
4	R4=430 Ω			

b. Voltages

S.No	Measured Value (V)	Calculated Value (V) (VDR)	Measured Values When R3 is Open Circuited (V)
1			
2			
3			
4			

C. Current

S.No	Calculated Value (A) Ohms Law	Measured Value of I (A)	Measured Value of I When R3 is Open Circuited (A)
1			
2			
3			
4			

EXPERIMENT NO - 05

CHARACTERISTICS OF PARALLEL DC CIRCUITS

OBJECTIVE:

To Investigate the characteristics of parallel dc circuits

EQUIPMENT/COMPONENTS REQUIRED:

1. 15V DC Power Supply.
2. DMM.
3. 2x 1KΩ (Br, Black, Red).
4. 2KΩ(R, Black, Red).

THEORY:

In a parallel circuit (Fig 5.1) the voltage across parallel elements is the same.
The total or equivalent resistance (RT) is given by.

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \text{-------------------} + \frac{1}{R_N}$$

If there are only two resistors in parallel, it is more convenient to use.

$$\mathbf{R_T} = \frac{R_1 R_2}{R_1 + R_2}$$

In any case, the total resistance will **always be less** than the resistance of the smallest resistor of the parallel network. For the network of Fig 5.1. The currents are related by the following expression.

$$I_T = I_1 + I_2 + I_3 + \text{-----------} + I_N.$$

Applying current divider rule (CDR) & the network of Fig 5.2

$$I_1 = \frac{R_2 I_T}{R_1 + R_2} \quad \text{And} \quad I_2 = \frac{R_1 I_T}{R_1 + R_2}$$

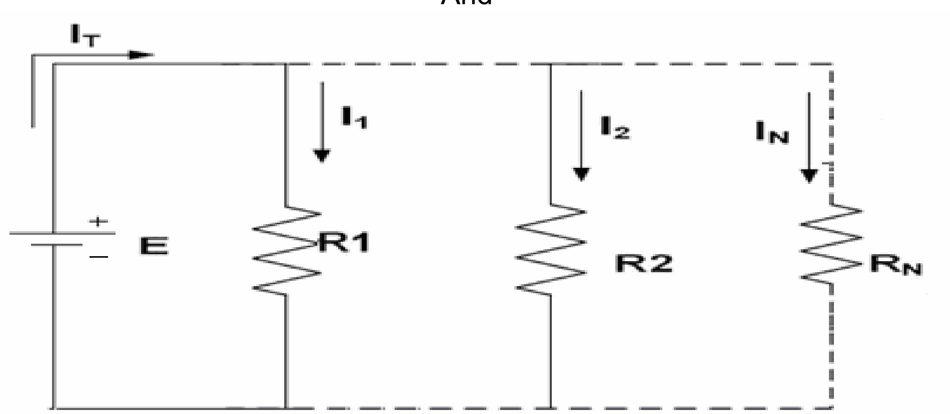


Figure – 5.1

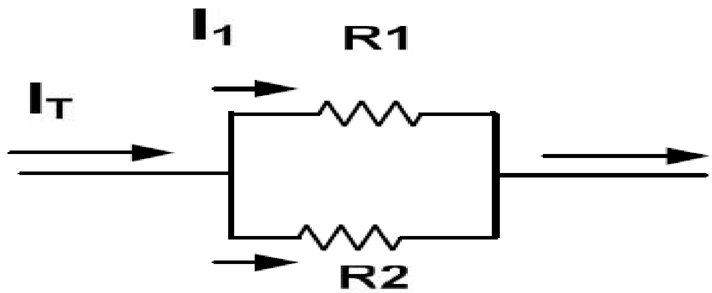


Figure – 5.2

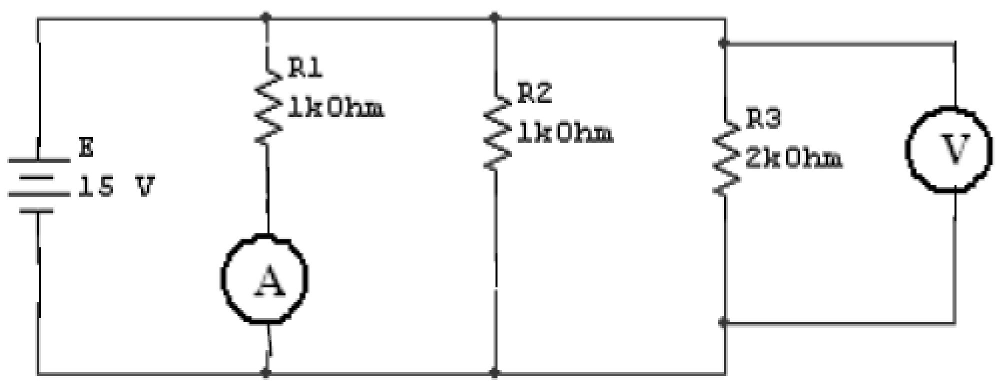


Figure – 5.3

For equal parallel resistors, the current divides equally and the total resistance is the value of one divided by the **'N'** number of equal parallel resistors, i.e.

$$\mathbf{R_T} = \frac{R}{N}$$

For a parallel combination of **N** resistors, the current **IK** through **RK** is.

$$\mathbf{I_K} = \mathbf{I_T} \;\mathbf{x}\; \frac{\frac{1}{R_K}}{\frac{1}{R_1} + \frac{1}{R_2} + \ldots\ldots\ldots\ldots + \frac{1}{R_N}}$$

PROCEDURE:

1. Construct the circuit shown in Fig 5.3.
2. Set the DC supply to 15V by using DMM. Pick the resistances values 1KΩ, 1KΩ, and 2KΩ. Also verify their resistance by using DMM.
3. Measure voltage across each resistor with DMM and record it in the Table b.
4. Measure the currents IT, I1, I2, and I3.
5. Shut down & disconnect the power supply. Then measure input resistance ‘RT’ across points A-B using DMM. Record that value.
6. Now calculate respective voltages (using V=IR) and RT (using equivalent resistance formula).
7. Calculate I1, I2 , I3 using CDR.
8. Create an open circuit by removing R2 and measure all voltages and currents.

Note: Use measured value of resistance for all calculations.

OBSERVATION:

a) Resistors:

S.No	Nominal Values (Ω)	Measured Value (Ω)	RT Measured (Ω)	RT Calculated (Ω)
1	R1 = 1K			
2	R2 = 1K			
3	R3 = 2K			

b) Voltages:

S.No	Measured Values (V)	Calculated Value (Ohms Law) (V)	Measured Values when R2 is Open Circuited (V)
1	V1 =	V1 =	V1 =
2	V2 =	V2 =	V2 =
3	V3 =	V3 =	V3 =

C) Current:

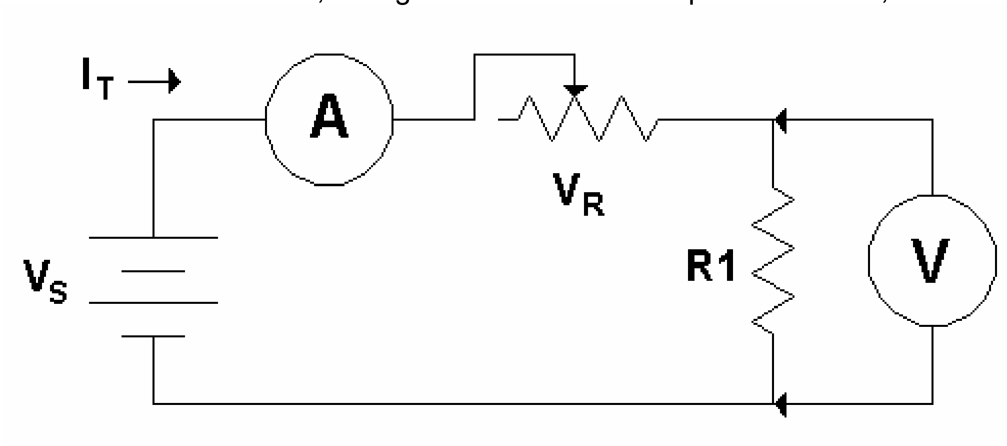
S.No	Measured Values (A)	Calculated Value (CDR) (A)	Measured Values when R2 is Open Circuited (A)
1	I1 =	I1 =	I1 =
2	I2 =	I2 =	I2 =
3	I3 =	I3 =	I3 =
4	IT =	IT =	IT =

EXPERIMENT NO - 06

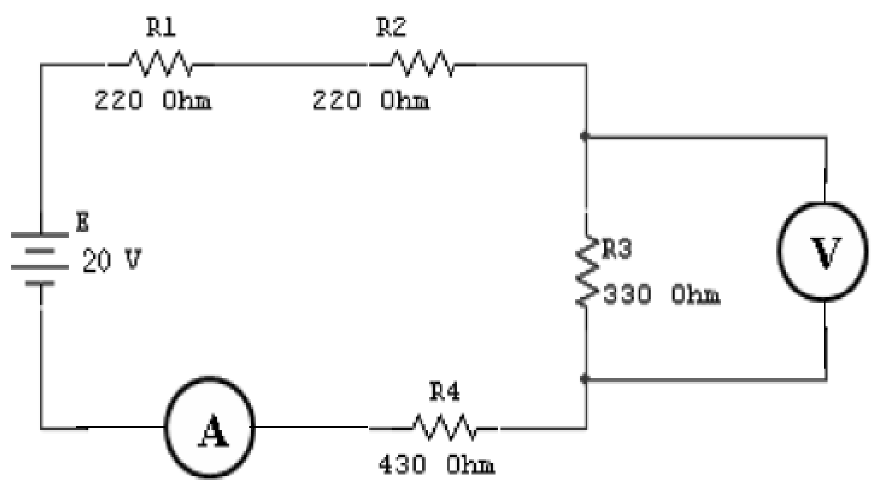
SOFTWARE SIMULATION

Verify Experiment 3 (Ohms Law), Experiment 4 (KVL) & Experiment 5 (KCL) by the use of Proteus / Electronic Workbench also Submit a printout of a proper labeled schematic. Include hand calculation.

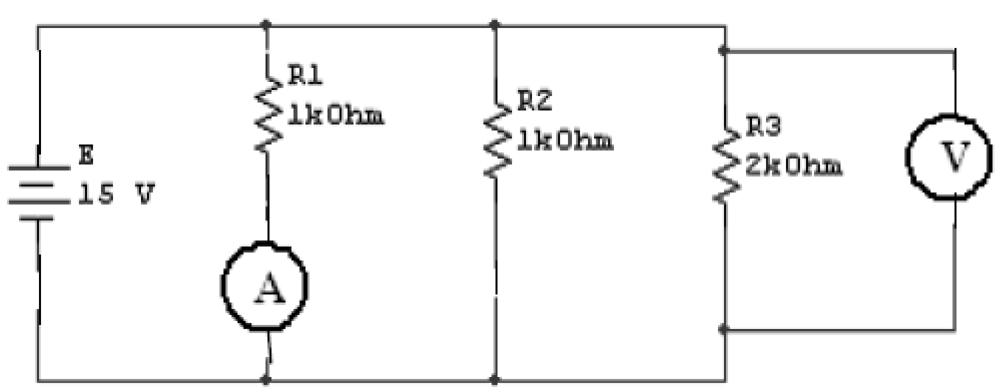
Use all values of resistances, voltages and currents of Experiment No: 3, 4 & 5.



Circuit Diagram for Ohms Law



Circuit Diagram for KVL



Circuit Diagram for KCL

EXPERIMENT NO - 07

MESH ANALYSIS

OBJECTIVE:

To analyze a two Mesh circuit and to determine the current in each branch of the circuit

EQUIPMENT/COMPONENTS REQUIRED:

1. DC Power Supply
2. Multi-meter
3. Bread Board
4. Resistors

THEORY:

Algebraic sum of voltages around a close loop is zero.

Applying KVL to mesh 1

$$-E1 + I1R1 + (I1 - I2)R2 = 0$$

$$I1(R1 + R2) - I2R2 = E1 \qquad \text{(1)}$$

Applying KVL to mesh 2

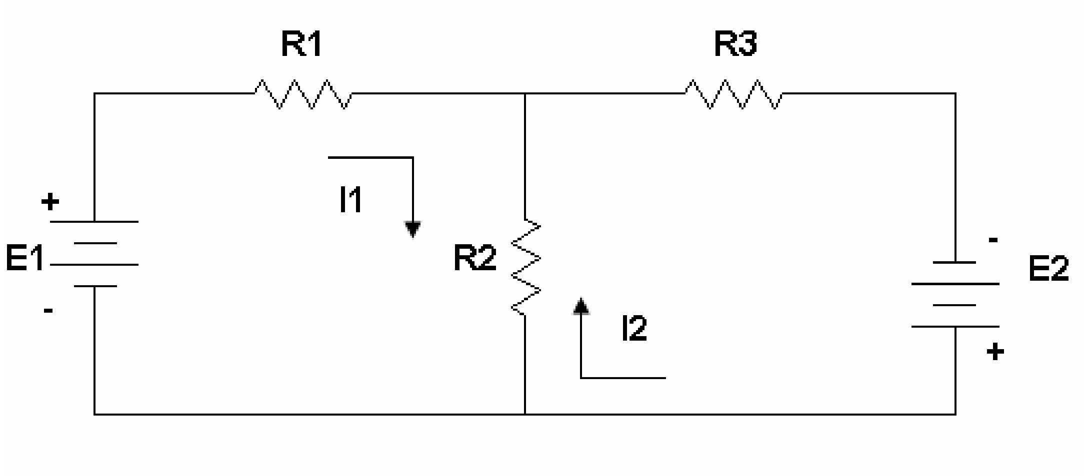
$$-E2 + (I2 - I1)R2 + I2R3 = 0$$

$$I2(R2 + R3) - I1R2 = E2 \qquad \text{(2)}$$

$$\begin{pmatrix} R1+R2 & -R2 \\ -R2 & R2+R3 \end{pmatrix} \begin{pmatrix} I1 \\ I2 \end{pmatrix} = \begin{pmatrix} E1 \\ E2 \end{pmatrix}$$

CALCULATION:

FIGURE:



Figure

PROCEDURE:

1. Construct the circuit shown in Fig
2. Set the DC supply E1=12V and E2=5V.
3. Pick the resistances. Also verify their resistance by meter and record it in table.
4. Measure the currents through resistances R1, R2 & R3 and record it in table.
5. Now Set the DC supply E1=5V and E2=12V.
6. Repeat step 4 & 5 and record all the values

Note: Use measured value for all calculations.

TABLE:

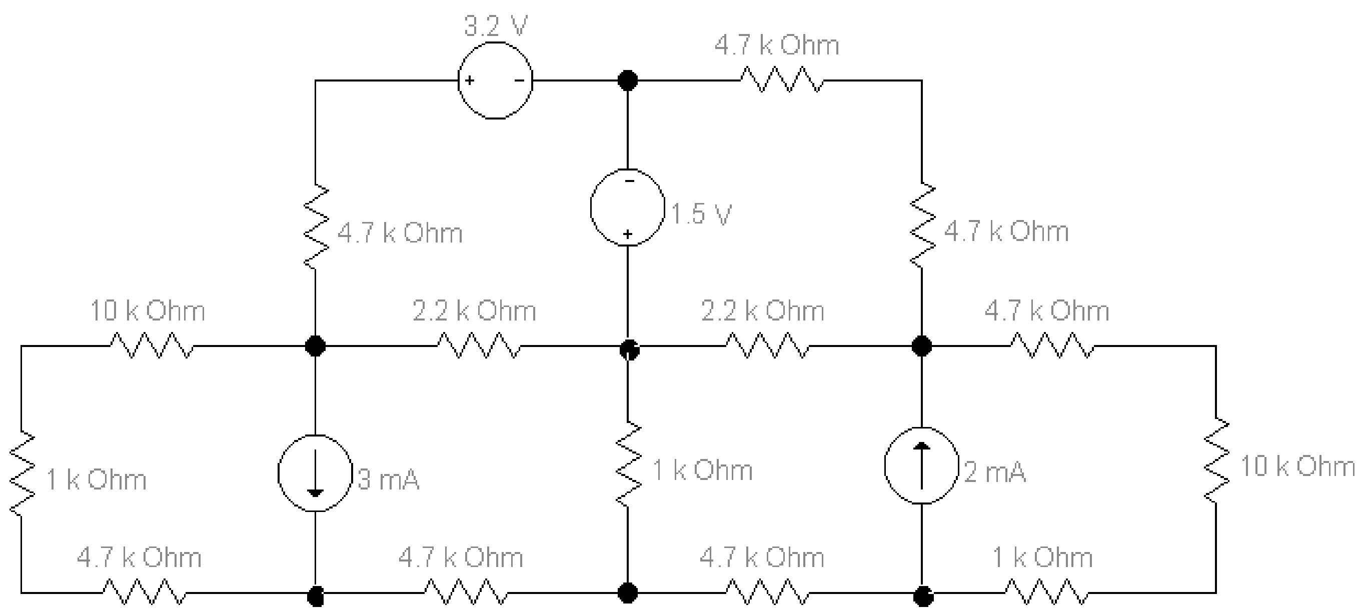
E_1	E_2	R_1	R_2	R_3	I_1	I_2	I_{R2}	V_{R1}	V_{R2}	V_{R3}
12v	5v									
5v	12v									

EXPERIMENT NO - 08

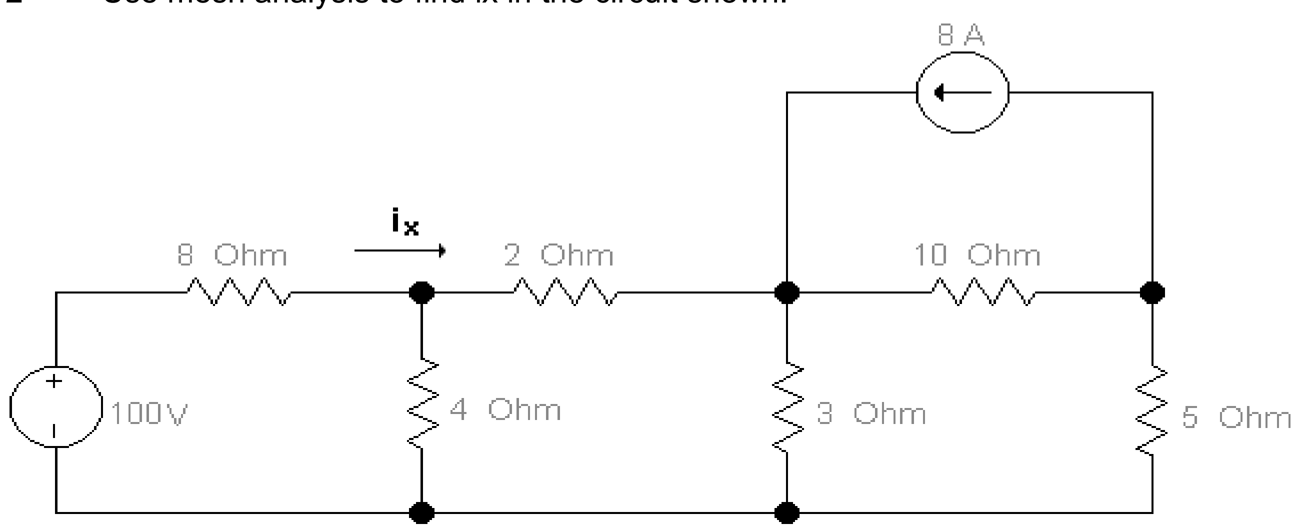
COMPUTER AIDED CIRCUIT ANALYSIS

Use Proteus / Electronic Work Bench to verify the solution of given questions also Submit a printout of a proper labeled schematic. Include hand calculation

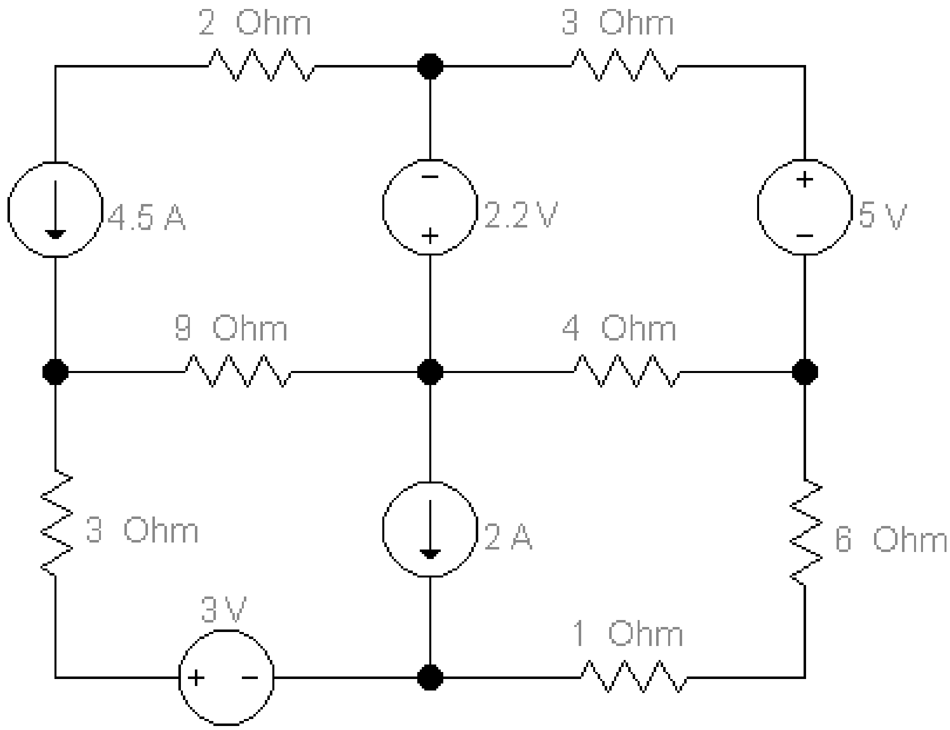
1- Determine the voltage across the 2-mA source. Assuming the bottom node is ground.



2- Use mesh analysis to find ix in the circuit shown.



3- Use the mesh concept to determine the power supplied by the 2.2-V source.



EXPERIMENT NO: 09

SUPERPOSITION THEOREM

OBJECTIVE:

To Verify Superposition Principle in DC Circuits

REQUIRED:

1- DMM
2- 2 DC Power Supplies,
3- Resistances (1k Ω, 2k Ω, 430k Ω)

THEORY:

The superposition principle states that:

> **"The current through or voltage across, any resistive branch of a multisource network is the algebraic sum of the contribution due to each source acting independently."**

When the effect of one source is considered, the others are replaced by their internal resistances. This principle permits one to analyze circuits without restoring to simultaneous equations.

Superposition is effective only for linear circuit relationship. Non-linear effects, such as power, which varies as the square of the current or voltage, cannot be analyzed using this principle.

FIGURE:

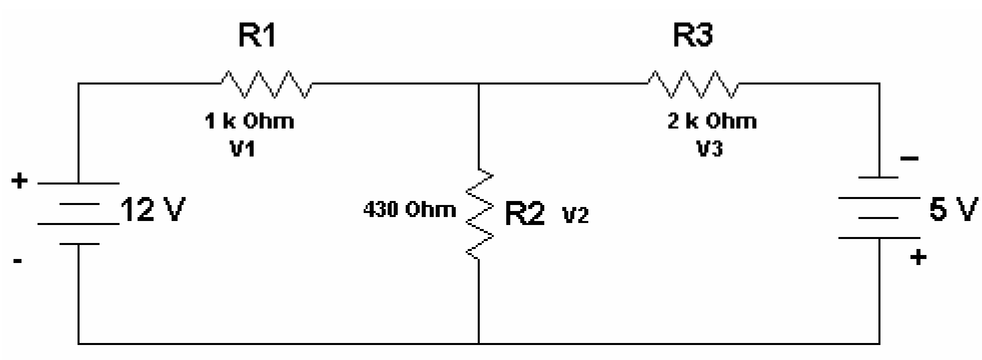


Fig-1

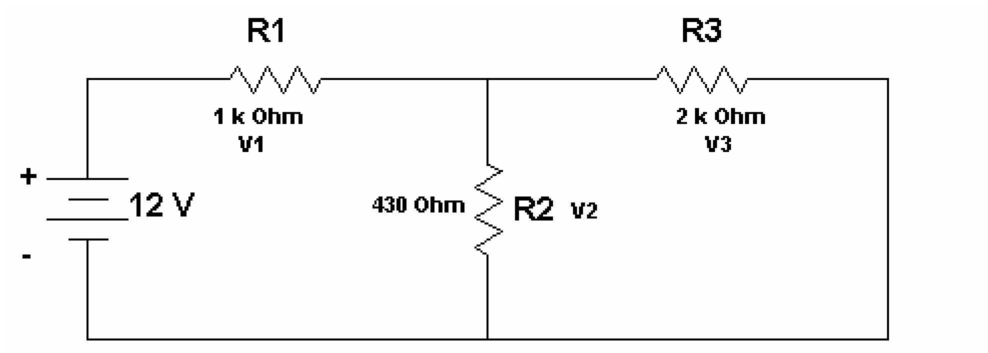


Fig – 2

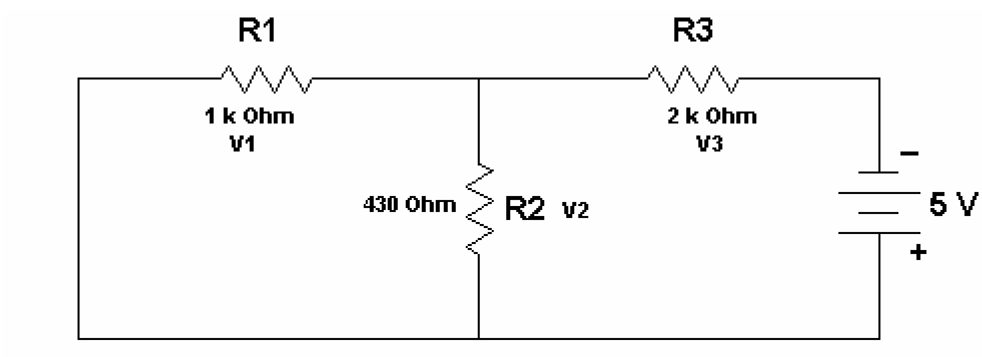


Fig – 3

PROCEDURE:

1. Construct the Network of Fig-1, where R1 = 1 k Ω, R2 = 430 Ω, R3 = 2 k Ω. Verify the resistances using DMM.
2. Using superposition and measured resistance values, calculate the currents indicated in observation Table (a), for the network of Fig-1. Next to each magnitude include a small arrow to indicate the current direction for each source and for the complete network.
3. Energize the network of Fig-1 and measure the voltages indicated in observation table b, calculate current in Table (b) using Ohm's Law. Indicate the polarity of the voltages and direction of currents on Fig-1.
4. Construct the network of Fig -2. Note that source E2 has been removed.
5. Energize the network of Fig -2 and measure the voltages indicated in Table (c). Calculate currents using Ohm's Law.
6. Now construct the network of Fig -3. Note that source E1 has been removed.
7. Energize the network of Fig -3 and measure the voltages indicated in Table (d). Calculate currents using Ohm's Law.
8. Using the results of steps # 3, 5 and 7, determine the power delivered to each resistor and insert in Table (e).

OBSERVATIONS:

Resistors:

	Nominal Values (Ω)	Measured Values (Ω)
1	1K	
2	430	
3	2K	

a) Calculated Values for the Network of Fig. 6.1

Due to E1	Due to E2	Algebraic Sum (∑)
I_1 =	I_1 =	I_1 =
I_2 =	I_2 =	I_2 =
I_3 =	I_3 =	I_3 =

b) Measured Values for the Network of Fig. 6.1

V_1	V_2	V_3	I_1	I_2	I_3

c) Measured Values for the Network of Fig. 6.2

V_1	V_2	V_3	I_1	I_2	I_3

d) Measured Values for the Network of Fig. 6.3

V_1	V_2	V_3	I_1	I_2	I_3

e) Power Absorbed (use measured values of I and V)

Due to E_1	Due to E_2	Sum of Columns 1 & 2	E_1 & E_2 Acting Simultaneously

EXPERIMENT NO: 10

VERIFICATION OF THEVENIN'S THEOREM

OBJECTIVE:

To Verify Thevenin Theorem by finding its Thevenin's Equivalent Circuit

REQUIRED:

1. VOM/DMM
2. Power Supply
3. Resistances (120Ω, 1k Ω, 390Ω)

THEORY:

Any linear circuit is equivalent to a single voltage source (Thevenin's Voltage) in series with single equivalent resistance (Thevenin's Equivalent Resistances)

The current flowing through a load resistance RL connected across any two terminals **A** and **B** of a network is given

FIGURE:

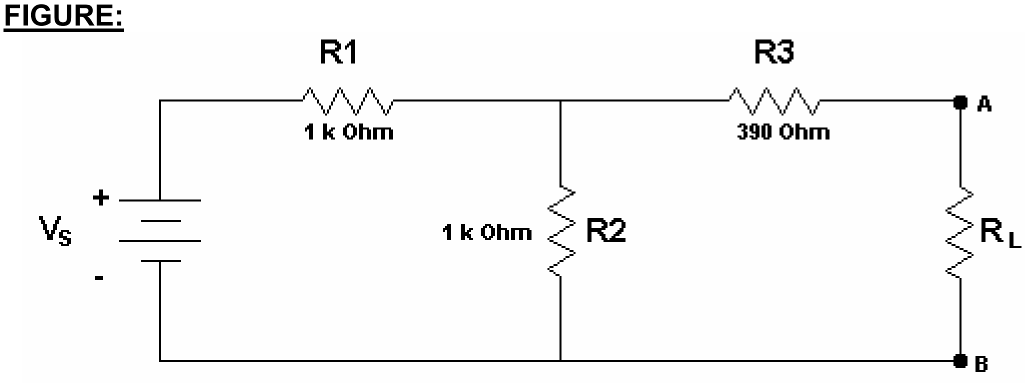


Fig – 1

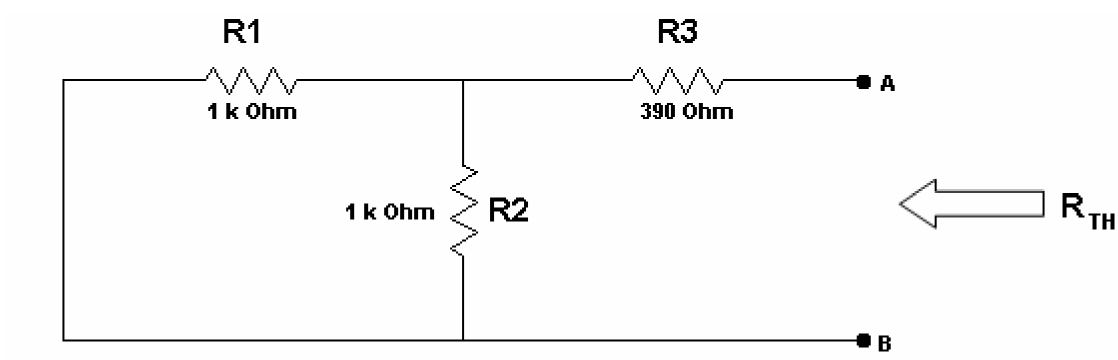


Fig – 2

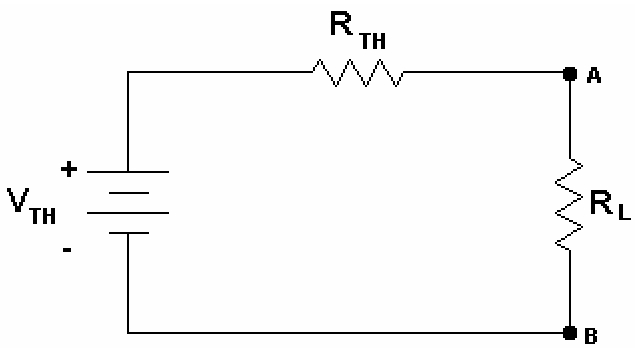


Fig – 3

PROCEDURE:

1. Reduce the circuit by calculating the Thevnin equivalent resistance across the terminals **A** & **B**
2. Determine the Thevinin equivalent voltage across terminals **"A"** and **"B"** for 5V, 10V, 15V.
3. Now, combine the Thevenin voltage with its resistance determines across 120Ω, 1K Ω, and 390 Ω resistors.

TABLE-1:

V_S	R_1	R_2	R_3	V_{TH}	R_{TH}
5V					
10V					
15V					

TABLE-2:

V_S	V_{TH}	R_{TH}	R_L	I_L
5V			**120**	
			390	
			1K	
10V			**120**	
			390	
			1K	
15V			**120**	
			390	
			1K	

EXPERIMENT NO: 11

VERIFICATION OF MAXIMUM POWER TTRANSFER THEOREM

OBJECTIVE:

To Verify Maximum Power Transfer Theorem

Discussion

Maximum power transfer theorem states that any linear network, if the load resistance equals its Thevenin's equivalent resistance, the load can yield a maximum power from sources.

Now we consider the Thevenin's equivalent shown in Fig 1. By Ohm's Law, the power dissipated in the Load P_{RL} can be expressed as follows.

$$I = E_{TH} \ / (R_{TH} + R_L)$$

$$P_{RL} = I^2 * R_L$$

$$P_{RL} = [E_{TH} / (E_{TH} + R_L)^2 * R_L$$

or

$$P_{RL} = (E_{TH}^2 * R_L) / (R_{TH} + R_L)^2$$

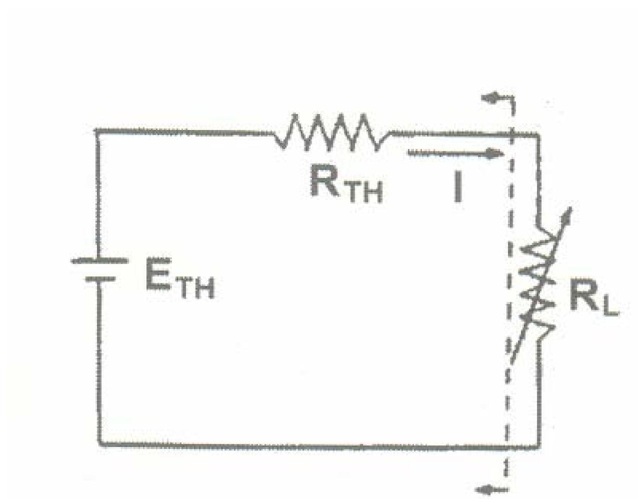


Figure-1

Suppose E_{TH} = 4V and R_{TH} = 5Ω, then P_{RL} can be expressed by the equation $P_{RL} = 16\ _{RL} / (5+R_L)^2$. Now we calculate and record each of the P_{RL} values for each R_L value from 1 Ω to 9 Ω increasing the step to 1 Ω. The results are listed in Table 1 and plotted in Fig 2. From both Table 1 and fig- 2, you can find that the maximum value of P_{RL} occurs at $R_L = R_{TH}$.

Table – 1

(Ohms)	(Watts)
1	0.445
2	0.655
3	0.750
4	0.790
5	0.800 ←
6	0.792
7	0.780
8	0.760
9	0.735

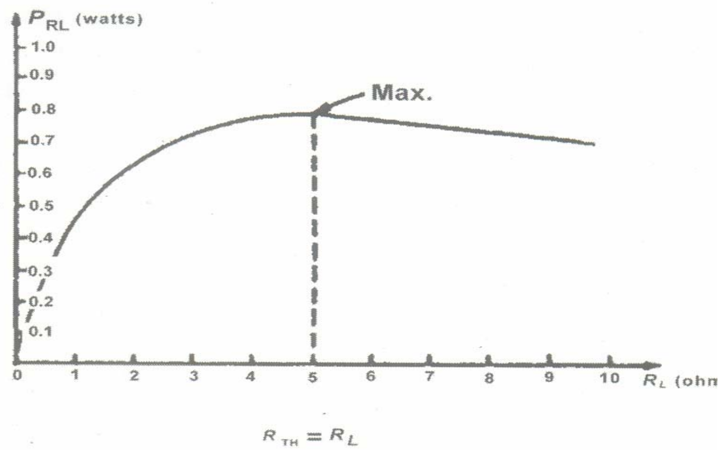


Figure -2

Procedure

1. Set the Module KL-13001 on the main KL-21001, and locate the block a.
2. According to Figs. 1 , complete the experiment circuit with short-circuit clips.
3. Apply +15V to +V.
   Turn off the power switch.
4. Adjust V_{R1} to 250 Ω. (Let R_1=R_{TH}, V_{R1}=R_l).
   Turn on the power.
   Measure and record the current flowing through VR1 as indicated by the milliammter.

   I = ________________________________ mA.

   Calculate and record the power dissipated by V_{R1} using the equation

   $P_{RL} = I^2 * R_L$. P_{RL}=________________________________ W.

   Turn off the power.
5. Adjust V_{R1} to 500 Ω and repeat step 4.

   I = ________________________________ mA

   P_{RL} = ________________________________ W
6. Adjust V_{R1} to 1 K Ω and repeat step 4.

   I = ________________________________ mA

   P_{RL} = ________________________________ W
7. Adjust V_{R1} to 1.25 K Ω and repeat step 4.

   I = ________________________________ mA

   P_{RL} = ________________________________ W
8. Adjust V_{R1} to 1.5 K Ω and repeat step 4.

   I=________________________________ mA

   P_{RL}= ________________________________ W
9. Complete Fig. 4 by using you measured I and calculated PRL values.

EXPERIMENT NO: 12

AC RC Circuit

OBJECTIVE:

To understand the characteristics of an RC series network in ac circuit

Discussion

When an ac voltage is applied across a pure resistance, the resultant current is in phase with the applied voltage. Resistance therefore has no phase angle associated with it and is written as R□0. When an ac voltage is applied across a pure capacitor, the resultant current leads the voltage by 90. Capacitance therefore has a phase angle associated with it. The opposition that a capacitor offers to the flow of alternating current is called capacitive reactance and is written as Xc□ -90, or –jXc. The magnitude of Xc is Xc=1/2π fC= 1/wC.

An RC series circuit with an ac supply voltage is shown Fig . The impedance of this circuit can be expressed as

$$Z_T = Z_1 + Z_2 = R\ 0 + X_C\ -90$$

The current in the across R is

$$E_R = I\ R$$

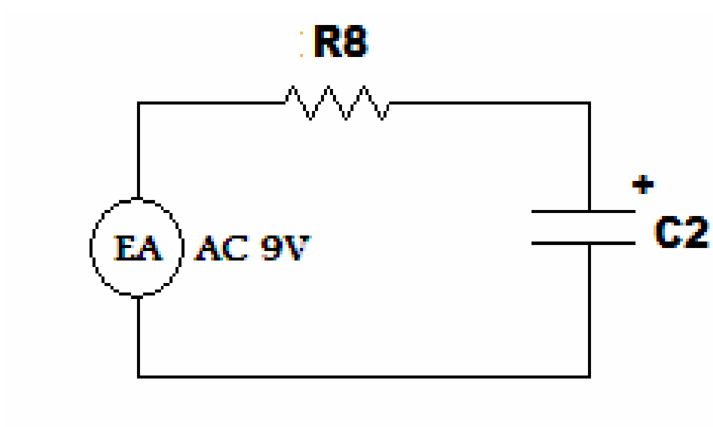
The voltage across C is

$$E_C = I\ X_C$$

By Kirchhoff's voltage law, then

$$\Sigma V = E - V_R - V_C = 0$$

Or $$E = \overrightarrow{V_R} + \overrightarrow{V_C}$$



Figure

Procedure

1. Set the module KL-13001 on the main unit KL-21001, and locate the block e.
2. According to Figs. 1 complete the experiment circuit with short-circuit clips. Apply the AC power 9V to E_A.
   Measure and record E_A = ________________________________ V
3. Calculated and record the values below.

Reactance of C_2	X_C	=	________________________________	Ω
Total impedance	Z_T	=	________________________________	Ω
Current in circuit	I	=	________________________________	mA
Voltage across R_8	R	=	________________________________	V
Voltage across C_2	E_C	=	________________________________	V
Power dissipated	P	=	________________________________	mW

4. Measure and record the values of ER and EC by using the ac voltmeter.

Voltage across R_8	R	=	________________________________	V
Voltage across C_2	E_C	=	________________________________	V

Are you sure the measured values equal to the calculated values of step 3?

Yes NO

4. Using the equation $E = \overrightarrow{V_R} + \overrightarrow{V_C}$, calculate the applied voltage of the circuit.

   E_A = ________________________________ V

   Does the calculated value equal the measured value of step 2?

   Yes NO

   If no, explain it.

   ____

5. Using the measured values of ER and EC, calculate and record the current I.

   I = ________________________________ mA

   Does the calculated value equal the measured value of step 3?

   YES **NO**

6. Using the values of R, X_C and Z_T, plot a vector diagram in space below.

EXPERIMENT NO: 13

AC RL Circuit

OBJECTIVE:

To understand the characteristics of an RL series network in ac circuit

Discussion

When an ac voltage is applied across a pure inductance, the current lags the voltage by **90** □ .Inductance therefore has phase angle associated with it .The opposition that an inductance offers to the flow of alternating current is called inductive reactance and may be expressed as $X_L < 90°$, or jX_L

The magnitude of X_L is X_L = 2πfL =2ωL

.

An RL series circuit with an ac supply voltage is shown in Fig-1.The impedance of this circuit can be expressed as

$$Z_T = Z_1 + Z_2$$
$$= R < 0° + X_L < +90°$$

The current in the circuit is

L =E/Z_T (the current lags the voltage)

The voltage across R is

V_R =l R

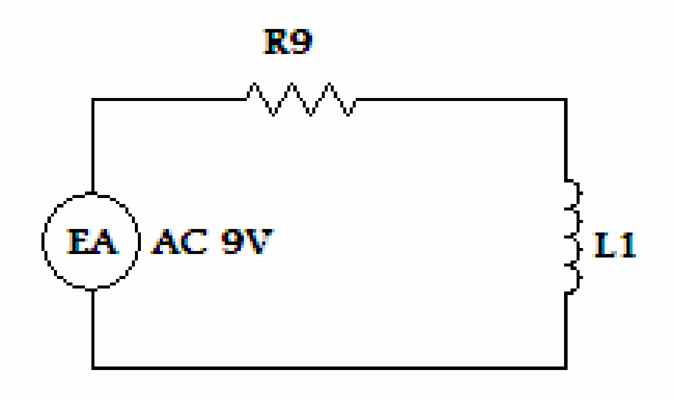
The voltage across l is

V_L =IX_L

By Kirchhoff s voltage law, then

$\sum$V= E - V_R - V_L =0

$$E = \overrightarrow{V_R} + \overrightarrow{V_L}$$



Figure

Procedure

1. Set the module KL -13001 on the main unit KL-21001, and locate the block f, link 0.5H inductance at L1 position.
2. According to Figure complete the experiment circuit with short –circuit clips. Apply the AC power 9V to EA.

   Measure and record EA. EA =__________________________V
3. Calculate and record the values below.

Reactance of L1	X_L =	________________________________	Ω
Total impedance	Z_T =	________________________________	Ω
Current in circuit	I =	________________________________	mA
Voltage across R9	V_R =	________________________________	V
Voltage across L1	V_L =	________________________________	V
Phase angle	θ=	________________________________	
Power dissipated	P=	________________________________	mW

4. Measure and record the values of V_R = and V_L =by Using the AC voltmeter.

Voltage across R9	V_R =	________________________________	V
Voltage across L1	V_L =	________________________________	V

5. Do the measured values equal the calculated values of step 3?

   Yes **No**

6. Using the equation $E = \overrightarrow{V_R} + \overrightarrow{V_L}$, calculate the applied voltage of the circuit

   EA = ________________________________ V

   Does the calculated value equal the measured value of step 2?

   Yes **No**

   If No explain it.

   ____

   ____

EXPERIMENT NO: 14

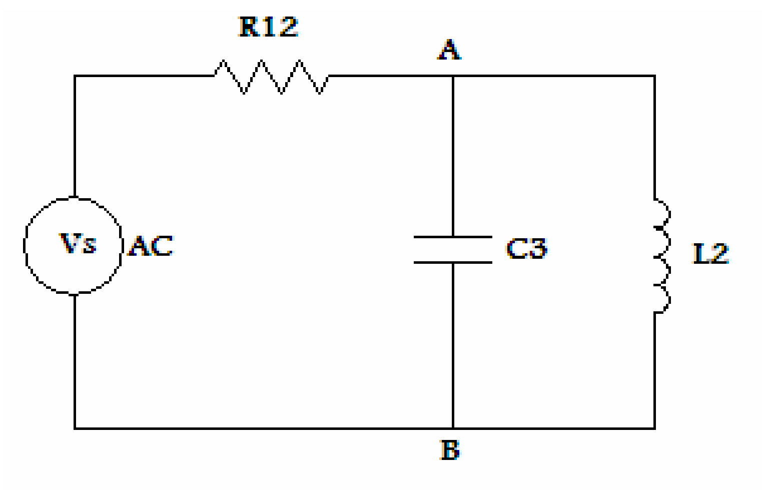
AC RLC Circuit

OBJECTIVE:

To understand the characteristics of an RLC series network in ac circuit

Discussion:

Figure shows an RLC series-parallel circuit with an ac power supply as mentioned before. The capacitive reactance X_C and inductive reactance X_L very with frequency. Therefore, the net impedance of the parallel circuit consisting of l2 and C3 will vary with input frequency. At some frequency which we will define as the resonant frequency f_r .the parallel circuit operates in resonance and X_L equals X_C the resonant frequency can be expressed as $f_r = 1/2\pi\sqrt{LC}$



Figure

Procedure

1. Set the module KL -13001 on the main unit KL -21001, and locate the block h.
2. According to Figure, complete the experiment circuit with short –circuit clips.
   The L2 is the 0.1H inductor provided.

3. Set the function selector of function generator to sine wave position .connect the oscilloscope to the output of function generator.

Adjust the amplitude and frequency control knobs to obtain an output of 1 KHz, 5Vp-p and connect it to the circuit input (I/P).

4. Using the oscilloscope, measure and record the voltage acrossL2, C3 and R12.

   V_L = ____________________V p-p

   V_C = ____________________V p-p

   V_R = ____________________V p-p

5. Using the equation $f_r = 1/2\pi\sqrt{LC}$, calculate and record the resonant frequency of the circuit.

   f_r =_____________________Hz

6. Vary the output frequency of function generator to obtain a maximum value of VAB.

   Using the oscilloscope, measure and record the input frequency

   f = ____________________Hz

7. Is there agreement between the frequency value f and the resonant frequency f_r of step 5?

   Yes **No**

EXPERIMENT NO: 15

Power in AC Circuit

OBJECTIVE:

To understand the characteristics of an RC series network in ac circuit

Discussion

Electrical power in a dc circuit is calculated by P=EI. This is also true in ac circuit with a pure resistor. When an ac voltage is applied across a resistor , the instantaneous variations of current through the resistor follow exactly the instantaneous changes in voltage .this is called that the current is in phase with the voltage.

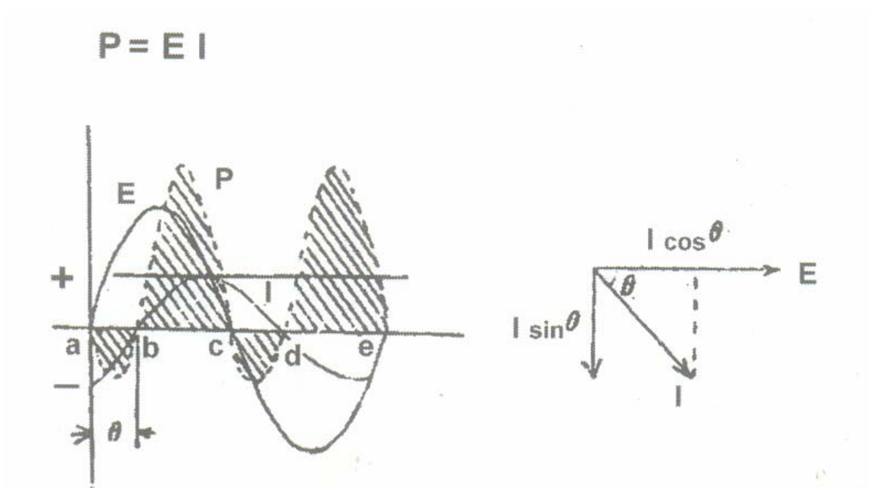


Figure-1

It is possible that the current is not phase with the voltage when a load contains reactive element such as in inductor or capacitor. See Fig. 1. The current I lags the voltage E by a phase angle θ. Since the instantaneous power is the product of the instantaneous current and voltage values, the instantaneous power curve can therefore be plotted as the areas shown by slanting lines.

The loads absorb energy during the instantaneous power in positive direction and returns energy during the instantaneous power in negative direction. In fig 1, the current I and voltage E appear a phase angle θ and the power P will be P=EIcos θ. If the current is in phase with the voltage (θ =0), the power will be P=EI.

PROCEDURE

1. Set the module KL-13001 on the main unit KL-21001, and located the block a.
2. Measure and record the resistance of R1. R1=_________________Ω
3. According to Fig. 2 , complete the experiment circuit with short-circuit clips. Apply the AC source 9V to E (A). Measure and record E(A).

E (A) =_________________V.

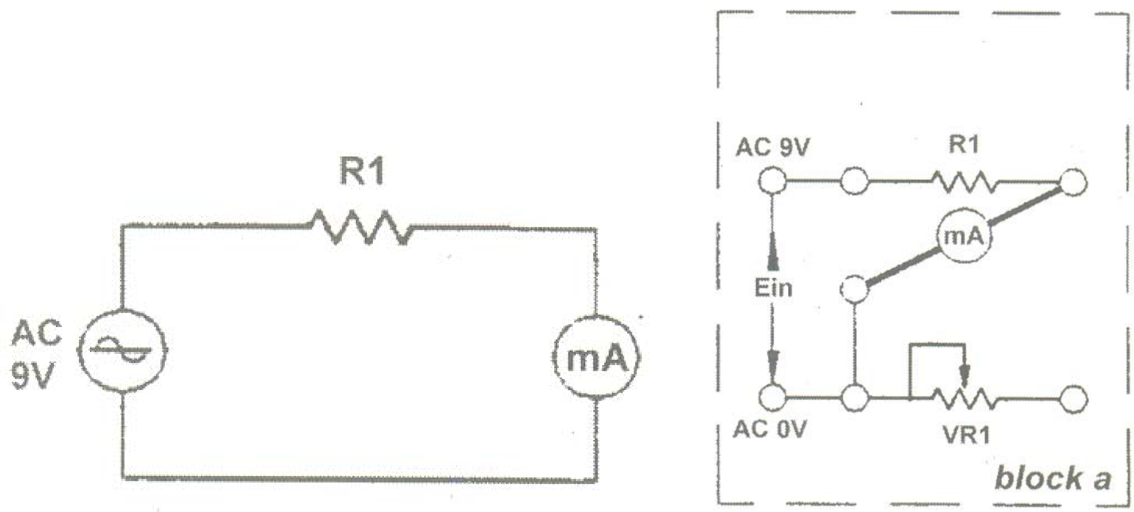


Figure-2

4. Measure and record the current value. I=_________________mA.
5. Using the equation P=EIcos θ, calculate the power dissipated by the circuit.

   P=_________________W

6. Using the equation P=$\frac{E2}{R}$, calculate and record the power dissipated by the resister R1.

   P=_________________W

7. Using the equation$P = I^2R$, calculate and record the power dissipated by the resistor R1.

   P=_________________W

8. Do all of the power values agree? **Yes** **No**
9. Turn off the power.

   Touch the body of R1 to feel the temperature.

   What is the form that power is converted into? _________________