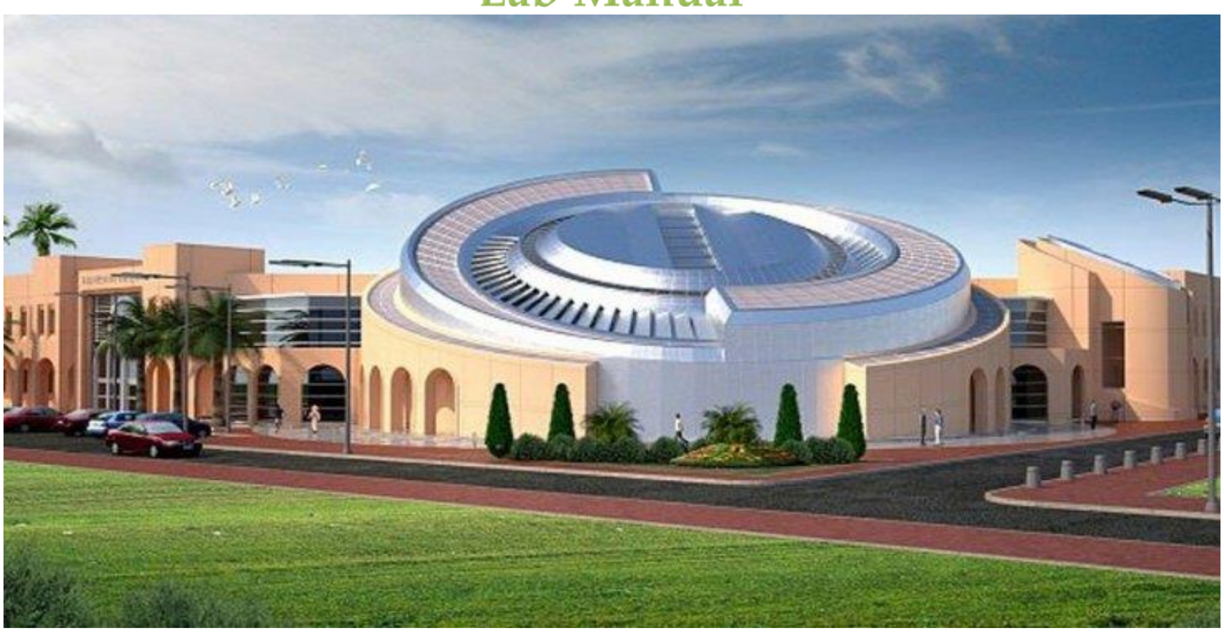
KING FAISAL UNIVERSITY
College Of Engineering

DEPARTMENT OF ELECTRICAL ENGINEERING

EE247: ELECTRIC CIRCUITS LAB

"Lab Manual"



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Major Topics covered and schedule in weeks:

Topic	Week #	Courses Covered
Introduction and Lab safety.	1	EE241
Introduction to laboratory test and measurement equipments.	2	
Resistors color codes & power rating	3	
Verification of the Ohms Law	4	
Verification of the Kirchoff' law	5	
Series & parallel circuits; voltage & current divider rules	6	
Network analysis: mesh & nodal methods	7	
Verification of the Superposition theorem	8	
Design and execution of an experiment to model a thevenin- circuit for transfer maximum power	9	
Transients response of R-C circuit	10	
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Design and execution of an experiment to analysis transient response of RLcircuit	12	
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Design Project presentation	14	
Revision	15	
Final Exam	16	

Specific Outcomes of Instruction (Lab Learning Outcomes):

1. Familiarity with basic electric equipment like DC power sources, signal generators, and measuring instruments
2. An ability to use color code to determine resistance value of a resistor, and familiarization with resistor power rating
3. An ability to apply Ohm’s and Kirchhoff’s laws
4. An ability to validate parallel and series circuits, voltage and current dividers
5. An ability to apply mesh, nodal Analyses and superposition theorem.
6. An ability to apply the Thevenin’s, Norton's &maximum power theorem is using hardware and with the aid of Multisim.
7. An ability to identify, design and build RC&RL transient circuits.

Student Outcomes (SO) Addressed by the Lab:

z	Outcome Description General Engineering Student Outcomes	Contribution
1.	an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	
2.	an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors	
3.	an ability to communicate effectively with a range of audiences	
4.	an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts	
5.	an ability to function effectively on a team whose members together provide leadership,	

	create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	
6.	an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	
7.	an ability to acquire and apply new knowledge as needed, using appropriate learning strategies	

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Experiment 1: Introduction to Laboratory Test and Measurement Equipment

I. Objective:

To introduced and trained to the equipment, instruments and components that will be used in this lab

II. Test Standard

548-1984 - IEEE Standard

III. Theory:

1. Voltage power supply

In this lab fixed voltage power supply (Peak Tech 6075 model) available. It provides 2 adjustable outputs for constant voltage and current, which can be connected in parallel or in series that means max. Output voltage 60 V (in series) and max. Output current 10 A DC (in parallel).

Specifications: Output Current 2x0-5 A DC; 2x0-30 V DC; 5V/3A fixed;Residual Ripple U 0.5 - 1 mV RMS; Residual Ripple I 3 mA RMS; Operating Voltage 115 V/230 V AC; 50/60 Hz switchable.

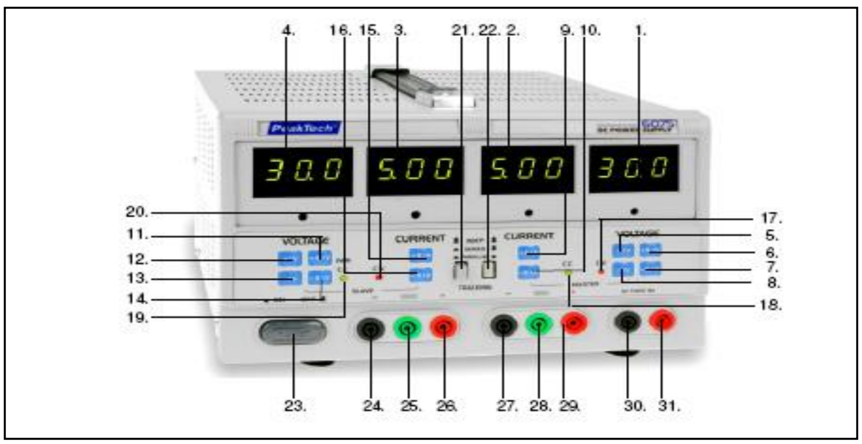


Figure 1: Voltage Power supply

Where,

1. Master output Voltage indicator
2. Master output current indicator
3. Slave output current A indicator
4. Slave output Voltage V indicator
5. Master output Voltage adjustor, step increment of 1V; continuous if not released.
6. Master output Voltage adjustor, step increment of 0.1V; continuous if not released.

7. Master voltage adjustor; step down of 0.1V, continuous decrease if not released.
8. Master voltage adjustor; step down of 1V, continuous decrease if not released.
9. Master current adjustor, increment of 0.1A, continuous if not released.
10. Master current adjustor; step down of 0.1A, continuous decrease if not released.
11. Slave output voltage adjustor, increment of 0.1V, continuous if not released.
12. Slave output voltage adjustor, increment of 1V, continuous if not released.
13. Slave output voltage adjustor; step down of 1V unit, continuous decrease if not released.
14. Slave output voltage adjustor; step down of 0.1V unit, continuous decrease if not released.
15. Slave output current adjustor; increment of 0.1A unit, continuous if not released.
16. Slave output current adjustor; step down of 0.1A unit, continuous decrease if not released.
17. Master Voltage Output Display (CV)
18. Master Current Output Display (CC)
19. Slave current status or Duel power status Display. (CC)
20. Slave voltage output display (CV)
21. Duel power independent, serial, on/off control.

2. Universal Plug-in Board

In this lab the universal plug-in board (figure1) is available for to do all the experiments. It is size 297 x 300 mm. The symmetrical arrangement of the socket areas, containing 9 electrically interconnected 4-mm sockets, makes possible the use of plug-in elements of different sizes with pin spacing's of 50 mm or 100mm.Contact resistance is less than 5 mille Ohm, permitting currents up to 10 A. Because of the low capacitance of 1.5 pF between adjoining areas, the universal boards are also suitable for experiments with high frequency circuits well into the MHz range.

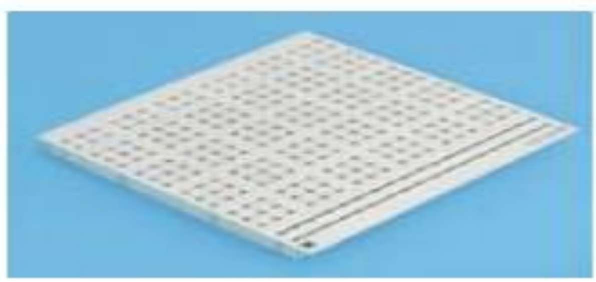


Figure 2:Plug in board

3. Plug-in Elements

In this lab components like resistor capacitor, diodes etc are in plug in type (figure 2).The 2- and 4-terminal plug-in elements consists of a transparent housing with a detachable front plate, and specially designed long-life plugs. Thus the built-in components are visible and can be easily replaced should they be damaged. The component symbols on the front allow for a close correspondence between circuit diagram and assembled circuit.

Figure 3: Plug-in Components

4. Digital Multimeter (DMM)

This instrument can measure voltage, current and resistor values. In this lab it would be used as: ohmmeter to measure the resistance value of different resistors, voltmeter to measure the values of AC/DC voltage and as Ammeter to measure the value of current flow through the component.

Figure 4: MultiMeter

5. Oscilloscope

In this lab have two channel oscilloscopes is available for to measure the AC parameters in graphical manner. Its bandwidth 0-40MHZ (-3db). It's Input impedance: 1 MOhm, 15 pF, max. 400 V.

Figure 5: Oscilloscope

6. Function Generator

The main function of this device is to generate various type of waveforms such as:

(a) Sinusoidal waveform.
(b) Square waveform.
(c) Triangular waveform.

These waveforms could be of different output voltage levels, and DC offset positive or negative of different levels.

Figure 6: Function Generator

IV. Apparatus:

- Fixed DC voltage power supply
- Controlled DC voltage power supply
- Plug-in board
- Digital Multimeter (**DMM**)
- Function generator
- Oscilloscope
- Resistors and decade resistance box
- Capacitors and capacitance box
- Inductors
- Cables, wires and leads
- Connecters

V. Procedure:

- Switch on the each equipment and learn the function of it.

VI. Experimental Work:

- Students fix the equipment’s in the workstation and build the small circuit for testing by using meters and oscilloscope.

References:

- https://www.britannica.com/technology/electric-circuit.

Experiment 2: Resistors Color Codes & Power Rating

I. Objective:

1. Determine the resistance of a selection of carbon resistors by color codes.

2. Compare values obtained with voltage current readings.

3. Observe power dissipation property of carbon resistors.

II. Test Standard

548-1984 - IEEE Standard

III. Theory:

The approximate value of a carbon resistor can be found by 4 color bands on it. The 9 colors in the sequence are black, brown, red, orange, yellow, green, blue, violet, grey and white. Carbon resistors may have a fifth band which indicates reliability of the resistor. Figure 3 shows the color code structure.

Example: Brown Red Orange Gold
1 2 10^3 5% = 12 KΩ, ±5%

IV. Apparatus:

- DC power supply
- Digital multimeter
- Assorted resistors

V. Procedure:

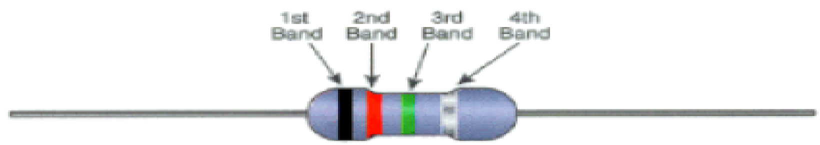
1. Get from instructor 3 carbon resistors. Find the nominal value and the tolerance of each resistance using the color codes and record in Table 1. Note the relation between the power rating and the physical size of the resistance.
2. Using the digital multimeter as an ohmmeter, measure and record the resistance of each resistor.

Table 1

Resistor	**R1**	**R2**	**R3**
Nominal value			
Tolerance			
Color codes			
Ohmmeter reading			
% relative difference			

% Relative Difference = $\dfrac{\text{Measured Value} - \text{Nominal Value}}{\text{Nominal Value}} * 100$

Resistor Color Code Chart



Color	1st Band (1st Figure)	2nd Band (2nd Figure)	3rd Band (Multiplier)	4th Band (Tolerance)
Black	0	0	10^0	
Brown	1	1	10^1	
Red	2	2	10^2	±2%
Orange	3	3	10^3	
Yellow	4	4	10^4	
Green	5	5	10^5	
Blue	6	6	10^6	
Violet	7	7	10^7	
Gray	8	8	10^8	
White	9	9	10^9	
Gold			10^{-1}	±5%
Silver			10^{-2}	±10%

(B) Power Rating Characteristics of Resistors:

1. Using an ohmmeter, measure and record the resistance of the resistor supplied.
2- Connect the circuit as shown in Figure 2 for R = 100 Ω (2W resistor).
3- Vary the input voltage source (**Vs**) from 10 to 20 volts and measure V and I.
4- Record your results in Table 2.

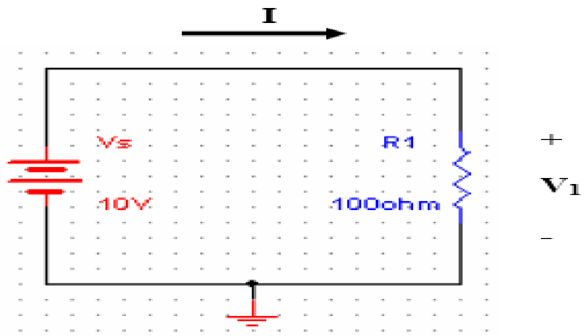


Figure 2

Table 2

Source Voltage	**10**	**12**	**14**	**16**	**18**	**20**
Measured Voltage						
I (A)						
R=V/I (Ω)						
P= V I (W)						

VI. Experimental Work:

Using the plug-in board and rated components construct the circuits and fill the tables for each of them.

References:

https://www.britannica.com/technology/electric-circuit.

Experiment 3: Ohms Law

I. Objective:

1. Verify Ohm's law.
2. Determine the relationship for voltage and current for constant resistance.
3. Determine value of resistance from slope of I-V characteristic curve.

II. Test Standard

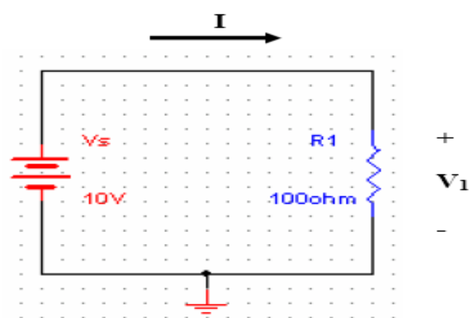
548-1984 - IEEE Standard

III. Theory:

Ohm's law states that "I α V i.e. current is directly proportional to the voltage", as "the current increases the voltage drop also increases", keeping the resistance constant and that "Current is inversely proportional to the Resistance", as "the Resistance increases, the Current decreases provided That the Voltage remains constant".

$I \propto V$, $I \propto 1/R \rightarrow V = IR$

Power $P = VI \longrightarrow P = I^2R$



IV. Apparatus:

- DC power supply
- Digital multimeter
- Assorted resistors

V. Procedure:

1. Build the circuit of Figure.1 using *Multisim Electronics Workbench*. Connect a multimeter between the terminals of resistor and set it to read resistance. Click the Simulation Switch to run analysis. Record the value of resistance R_1 in Table 1

2. Build the circuit given in Figure.1.Set V_S = 10V and R_1=100Ω. Click Simulation Switch to run analysis. Record voltage 'V_1' across resistor R_1 by connecting a multimeter in parallel to it. Record the value of current 'I' flowing through R_1 by connecting another multimeter in

series to R_1. Note down the values in Table 1. From the voltage current readings verify Ohm's law $V_1=R_1I$. Considering multimeter reading as reference, calculate %error.

3. Vary the dc supply voltage Vs in steps of 2V and record current in each case. Enter your results in Table 2.

VI. Experimental Work:

- Using the plug-in board and rated components construct the circuits and fill the tables for each of them.
- Build the circuit as shown in fig 1.Using meters measure V&I. Enter your results in table 1&2.

Table 1: Resistance Measurement

	Ohmmeter Reading	Ohm's Law ($R_1=V_1/I$)		
Work bench	R_1 =	V_1=	I =	R_1 =
Hardwired	R_1 =	V_1=	I =	R_1 =
% Error				

Table 2: V-I measurements

Workbench		Hardwired	
V (volt) (mA)	**I (mA)**	**V (volt)**	**I (mA)**
0		0	
2		2	
4		4	
6		6	
8		8	
10		10	

References:

https://www.britannica.com/technology/electric-circuit.

Experiment 3: Kirchhoff's Laws

I. Objective:

To investigate the Kirchhoff laws.

II. Test Standard

548-1984 - IEEE Standard

III. Theory:

KVL: The total voltage drop across a closed loop is zero.
KCL: The algebraic sum of all currents entering and exiting a node must equal zero.

IV. Apparatus:

- DC power supply
- Digital multimeter
- Assorted resistors

V. Procedure:

1. Compute the voltage and current as shown in figure 1&2 verify KVL and KCL.

2. Construct the circuit shown in Figure 1 and figure 2 using multisim workbench. Measure the voltage and current enter in table 1&2.

KVL:

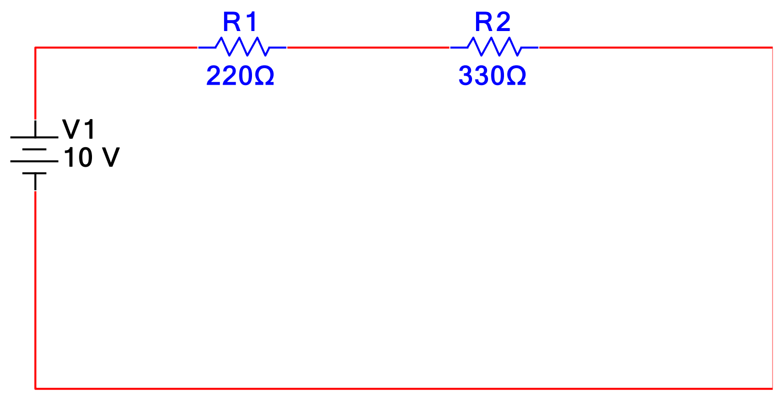


Figure 1: KVL circuit

$$V = IR_1 + IR_2$$

$$V = V_1 + V_2$$

VI. Experimental Work:

1. Connections are made as per the circuit diagram as shown in figure 1.
2. Switch on the power supply.
3. Vary the dc power supply to a specified voltage (10volt) and note down the corresponding voltmeter readings.
4. Repeat the step 3 for various DC power supply voltage and tabulate the readings.

Table 1

Power supply voltage (input)	V_1 (volts)	V_2 (volts)	$V_{total}=V_1+V_2$ (Volts)	Type
10				**Simulation results**
12				
14				
10				**Hardwired results**
12				
14				

KCL:

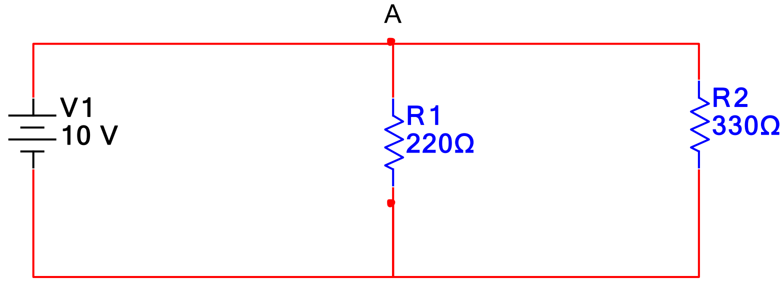


Figure 2 KCL circuit

$V = I_1R_1 = I_2R_2$

At the Junction A: $I = I_1 + I_2$ **(or)** $I - I_1 - I_2 = 0$

1. Connections are made as per the circuit diagram as shown in figure 2.
2. Switch on the power supply.
3. Vary the dc power supply to a specified voltage (10volt) and note down the corresponding ammeter readings.
4. Repeat the step 3 for various DC power supply voltage and tabulate the readings.

Table 2

supply voltage(Input)	I total(measured value)	I_1	I_2	I total $=I_1+I_2$ (calculated value)	Type
10					Simulation results
12					
14					
10					Hardwired results
12					
14					

References:

https://www.britannica.com/technology/electric-circuit.

Experiment 5: Series & Parallel Circuits; Voltage Divider & Current Divider Rules

I. Objective:

- To study the voltage current relationships of series and parallel circuits
- To verify the current divider and voltage divider rules.

II. Test Standard

548-1984 - IEEE Standard

III. Theory:

KVL: The total voltage drop across a closed loop is zero.

KCL: The algebraic sum of all currents entering and exiting a node must equal zero.

IV. Apparatus:

- DC power supply
- Digital multimeter
- Assorted resistors

V. Procedure:

Measure and record the resistance of the following four resistors. Compare these measurements to the nominal values.

Table 1

	Nominal value	Measured value	Relative difference
R1	**100Ω**		
R2	**220Ω**		
R3	**470Ω**		

$$\% \textbf{ Relative Difference (RD)} = \frac{\text{Measured Value} - \text{Nominal Value}}{\text{Nominal Value}} * 100$$

2.Connect the circuit in Figure 1 without the power supply connected. Measure the equivalent resistance, Req, of the circuit. Compare this measurement to a calculated value determined from the individually measured values. Do your calculations and measurements make sense?

Table 2

	Measured value	**Calculated value**	**Relative difference**
Req			

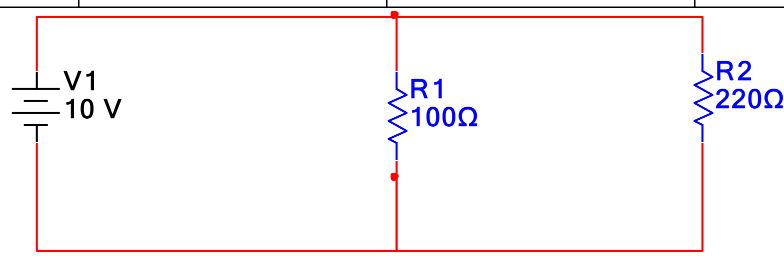


Figure 1 Parallel circuit

3. Now connect your power supply to the circuit. Set your power supply to 10 V after the circuit is connected. Remember to verify this voltage with a mulitmeter.

4. Measure and record the currents I_S, I_{R1}, I_{R2}. How do these compare to the calculated values that you would determine using the Current Divider Rule (**CDR**)?

Table 3

##	**I_S**	**I_{R1}**	**I_{R2}**
Measured value			
Calculated using *nominal* values of resistance			
RD with respect to measured			
Calculated using *measured* values of resistance			
RD with respect to measured			

For a parallel circuit given in Figure 1, the branch currents can be written in terms of the total

Current as,

$$I1 = R2/(R1 + R2) \times IS$$

$$I2 = R1/(R1 + R2) \times IS$$

Where I_S –Source current ; $I_1 = I_{R1}$; $I2 = I_{R2}$

This is termed as ***the current divider rule*** **(CDR).**

Series circuit / Voltage divider Rule:

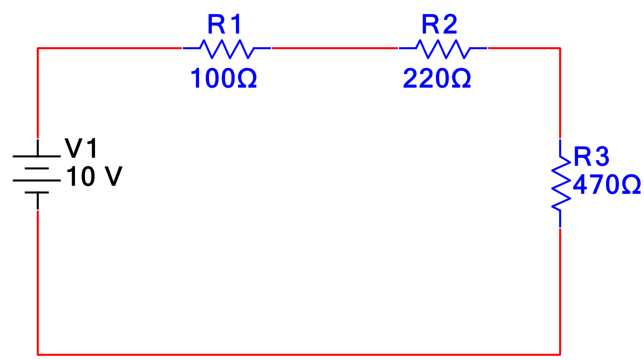


Figure 2 Series circuit

For a series circuit shown in Figure 2, the voltages across resistors R_1, R_2 and R_3 can be written as,

$$V1 = R1/(R1 + R2 + R3) \times VS$$
$$V2 = R2/(R1 + R2 + R3) \times VS$$
$$V3 = R3/(R1 + R2 + R3) \times VS$$

This is the ***voltage divider rule*** **(VDR)**.

VI. Experimental Work:

1. Connect the circuit in Figure 2 without the power supply connected. Measure the equivalent resistance, R_{eq}, of the circuit. Compare this measurement to a calculated value determined from the individually measured values. Do your calculations and measurements make sense?

Table 4

	Measured value	Calculated value	Relative difference
Req			

2. Now connect your power supply to the circuit. Set your power supply to 10 V after the circuit is connected. Remember to verify this voltage with a mulitmeter.

3. Measure and record the currents *Vs, V1, V2, and V3*. How do these compare to the Calculated values that you would determine using the voltage Divider Rule (VDR)?

Table 5

##	Vs	V_1	V_2	V_3
Measured value				
Calculated using *nominal* values of resistance				
RD with respect to measured				
Calculated using *measured* values of resistance				
RD with respect to measured				

References:

https://www.britannica.com/technology/electric-circuit.

Experiment 6: Network Analysis: Mesh & Nodal Methods

I. Objective

- To use the node-voltage circuit analysis method to determine all the node voltages in a circuit with respect to a reference node.
- To use the mesh-current circuit analysis method to determine all the mesh currents in a circuit.

II. Test Standard

548-1984 - IEEE Standard

III. Theory:

KVL: The total voltage drop across a closed loop is zero.

KCL: The algebraic sum of all currents entering and exiting a node must equal zero.

IV. Apparatus:

- DC power supply
- Digital multimeter
- Assorted resistors

V. Procedure:

The circuit shown in Figure 1 will be used to investigate the node-voltage and mesh current methods of analyzing circuits (Again, labeled currents flow to the right (for currents in horizontal branches) or downward (for vertical branches).

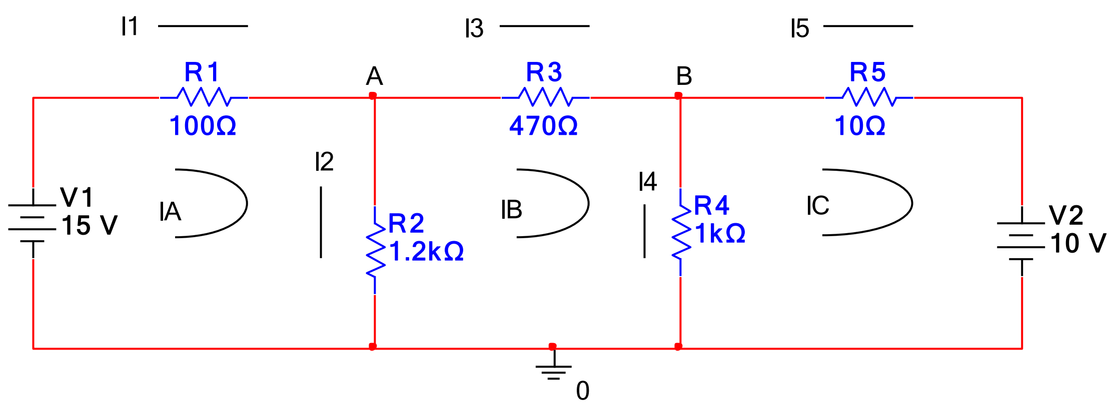


Figure 1

1. Compute the node voltages V_A and V_B.
2. Compute the branch currents I1, I2, I3, I4, and I5 using the values of the voltage sources and the node-voltages computed in the previous step.
3. Compute the mesh-currents IA, IB, and IC (they flow clockwise around the indicated loops

4.Construct the circuit shown in fig 1 on multisim work bench measure the nodal voltages and branch currents.

VI. Experimental Work:

The circuits of Figures 1 will now be used to verify the node-voltage and mesh-current methods.

1. Construct the circuit shown in Figure 1.
2. Measure the node-voltages V_A and V_B using digital multi-meter in the voltmeter mode.

VA=………………………. volts VB=…………………….volts

3. Measure the branch currents I_1, I_2, I_3, I_4, and I_5 using a properly connected digital multi-meter in ammeter mode.

I_1=………..I_2=…………I_3=………… I_4=…………I_5=…………

References:

https://www.britannica.com/technology/electric-circuit.

Experiment 7: Superposition Theorem

I. Objective

Experimentally verify the principle of superposition on a resistive circuit.

II. Test Standard

548-1984 - IEEE Standard

III. Theory:

In a linear lumped element, bilateral electric circuit energized by two or more sources, the current in any resistor is equal to the algebraic sum of the separate currents in each resistor when each source act, separately.

The Voltage sources are short-circuited and the current sources are open circuited in order to replace the other sources by their respective internal resistances.

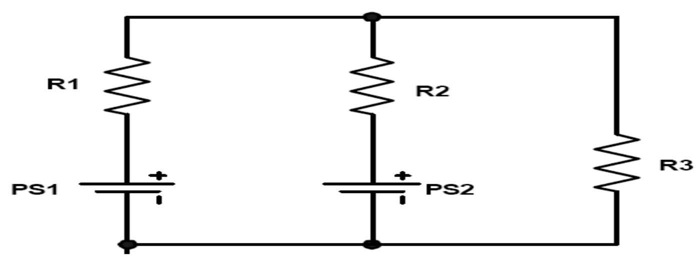


Figure 1: Resistive circuit with two sources

IV. Apparatus:

- DC power supply
- Digital multimeter
- Assorted resistors

V. Procedure:

1. From the circuit shown in Figure 1, determine the voltages and currents for each individual element using the Superposition principles. Also calculate the power dissipated by each element.
2. Construct a circuit shown in figure 1 on multisim workbench measure and tabulate the each element voltage, currents and power. From the results verify superposition theorem.
3. Attach a copy of your calculations and simulation results with pre-lab report.

VI. Experimental Work:

1. Connect the circuit shown in Figure 1, but replace PS2 with a short circuit.
   R1 = 470 Ω, R2 = 510 Ω, R3 = 1 kΩ. Set the output of PS1 to 10 V.
2. Measure and record the following voltages and currents (***specify polarity and/or direction***).

V_{R1} = ______________________V V_{R2} = _______________________V

V_{R3} = ______________________V I_{R1} = _______________________mA

I_{R2} = _______________________mA I_{R3} = _______________________mA

3. Repeat the measurements from step 1 with PS1 replaced by a short and PS2 connected into the circuit. Set PS2 =15 V.

V_{R1} = ______________________V V_{R2} = _______________________V

V_{R3} = ______________________V I_{R1} = _______________________mA

I_{R2} = _______________________mA I_{R3} = _______________________mA

1. Once again repeat the measurements from step 1, but with both sources connected in the circuit. Readjust each supply to the voltages specified in the previous steps.

V_{R1} = ______________________V V_{R2} = _______________________V

V_{R3} = ______________________V I_{R1} = ______________________mA

I_{R2} = _______________________mA I_{R3} = ______________________mA

References:

https://www.allaboutcircuits.com/textbook/direct-current/chpt-10/superposition-theorem/

Experiment 8: Design and Execution of an Experiment to Model a Thevenin-Equivalent Circuit for Transfer Maximum Power

I. Objective

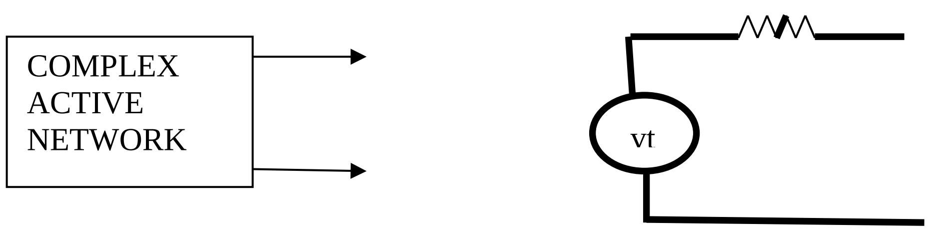
Experimentally verify the principle of Thevenins and maximum rules on a resistive circuit.

II. Test Standard

548-1984 - IEEE Standard

III. Theory:

Any linear active network with output terminals A,B can be replaced by a single voltage source V_{th} in series with a single resistance R_{th}.



Where,

R_{th} -Thevenin's resistance.

V_{th} -Thevenin's voltage.

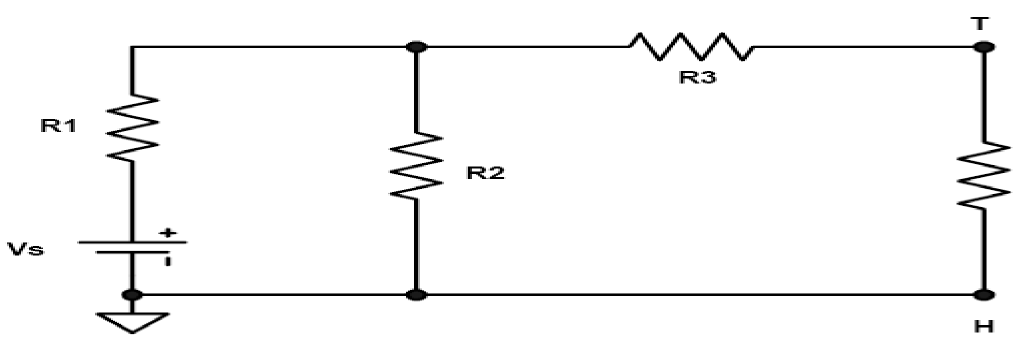


Figure 1. DC Circuit

Components values: Vs = 12 V R_1 = 1.2 kΩ R_2 = 1 kΩ R_3 = 1 kΩ R_L = 470 Ω

IV. Apparatus:

- DC power supply
- Digital multimeter
- Assorted resistors

V. Procedure:

1. For the circuit shown in Figure 1, calculate the thevenin voltage, and thevenin resistance at terminals T and H.
2. Draw the thevenin equivalent circuit.
3. Construct the circuit shown in figure 1 on a multisim workbench. Simulate measure thevenin voltage and thevenin's resistance.
4. Attach a copy of your calculations and simulation circuits results to your pre-lab report.

VI. Experimental Work:

1. Construct the circuit in Figure 1. Using an ohmmeter, measure and record the thevenin resistance at terminals T and H.(**remove supply and replace it with a short circuit & load resistance and replace with open circuit**)

R_{th} = _____________ Ω

2. Using a voltmeter, measure and record the thevenin voltage.(**remove load resistance and replace with open circuit**)

V_{th} = _______________ V

3. Measure and record the terminal voltage and current associated with R_L connected into the circuit as shown in fig 1.

V_{RL} = _____________ V I_{RL} = _____________ mA

4. Draw thevenin's equivalent circuit.

5.Connect a load resistance (R_L=470Ω) with thevenins equivalent circuit. Apply Vth source voltage measure load voltage & current.

V_{RL1}= ________________V I_{RL1}=___________________mA

DESIGN MAXIMUM POWER TRANSFER CIRCUIT:

- Write an experimental procedure to determine a Thevenin-equivalent model for an maximum power state. Include a circuit diagram and the steps of your procedure.
- Execute your procedure, and determine the parameters of your model. Draw a circuit diagram of your model with the parameters.Show your result in terms of graph (Plot R_L Vs P_L). Check your model against measured values. Check your model with worst case conditions.Comment on how good a model you have. Submit a report with results to your instructor.

References:

https://www.allaboutcircuits.com/textbook/direct-current/chpt-10/superposition-theorem/

Experiment 9: Transients of First Order R-C Circuit

I. Objective

To study the transient response of a first order R-C circuits.

II. Test Standard

548-1984 - IEEE Standard

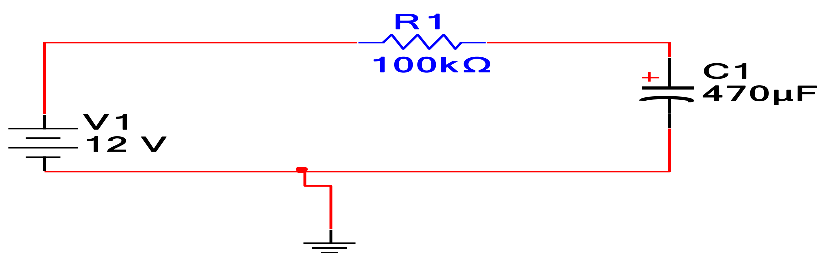
III. Theory:

The capacitor in the circuit of Figure 1 is assumed to have no initial voltage. When the switch is closed, the capacitor begins to charge. The voltage Vc(t) across the capacitor for t=0 is given as,

$$Vc(t) = E(1 - e^{t/RC}) \text{ ----------------------- } (1)$$

The current through the capacitor is expressed as,

$$I\,c = E/R * e^{t/RC} \text{ ------------- } (2)$$



IV. Apparatus:

- DC power source
- Multimeter
- Capacitor, 470µF, 16V dc
- Resistor, 100KΩ
- One switch & one stop-watch

V. Procedure:

1. Build the circuit given in figure 2 on *Multisim Electronics Workbench*.
2. Run the Transient Analysis. The procedure is given as:
   a. Select Simulate on Main Menu
   b. Select Analysis

c. Select Transient Analysis
d. Select Analysis Parameters
e. Initial Conditions set to zero
f. Start time 0 s
g.End time 120 s
h. Select Output Variables

→ Select node 2 (left box, this is the node for capacitor voltage, you might have different node number for capacitor voltage)

→ Select plot during simulation (right box)

i. Select Simulate

3. Observe the wave shape. Print your results. Using the cursor tool record the results and enter the results into Table 1 at the given time instants.
4. Plot Vc vs time (in the event you could not get a print).

VI. Experimental Work:

Build the circuit given in Figure 3 with laboratory hardwired components.

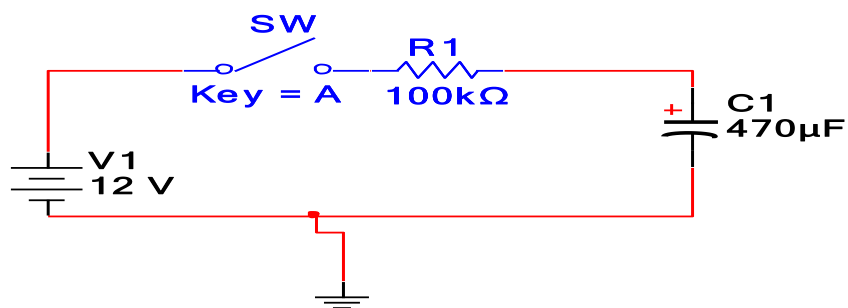


Figure 3: Transient RC circuit

2.Turn switch on and measure the voltage across the capacitor using a multimeter. Keep counts of time using a timer watch. Follow the time schedule as given in Table1.

Table 1

Time (sec)	0	20	40	60	80	100	120
Vc(multiSim)							
Vc(hardwired)							

References:

https://www.allaboutcircuits.com/textbook/direct-current/chpt-10/superposition-theorem/

Experiment 10: Design and Execution of an Experiment to Analysis Transient Response of R-L Circuit

I. Objective

To study the transient response of a first order R-C circuits.

II. Test Standard

548-1984 - IEEE Standard

III. Theory:

Usually square waveform signal apply to the RL circuit to analyse the transient response of the circuit. The pulse-width relative to the circuit's time constant determines how it is affected by the R-L circuit.

Time Constant (τ): It is a measure of time required for certain changes in voltages and currents R-L circuits. Generally, when the elapsed time exceeds five time constants (5τ) after switching has occurred, the currents and voltages have reached their final value, which is also called steady-state response.

The time constant of an R-L circuit is the equivalent inductance divided by the Thévenin resistance as viewed from the terminals of the equivalent inductor.

$$\tau = L / R \text{-------------- (1)}$$

A Pulse is a voltage or current that changes from one level to the other and back again. If a waveform's hight time equals its low time, as in figure, it is called a square wave. The length of each cycle of a pulse train is termed its period (T). The pulse width (tp) of an ideal square wave is equal to half the time period.

The relation between pulse width and frequency for the square wave is given by:

$$f=1/2tp \text{------------------- (2)}$$

In an R-L circuit, voltage across the inductor decreases with time while in the R-C circuit the voltage across the capacitor increased with time. Thus, current in an R-L circuit has the same form as voltage in an R-C circuit: they both rise to their final value exponentially according to 1 – e-t/τ.

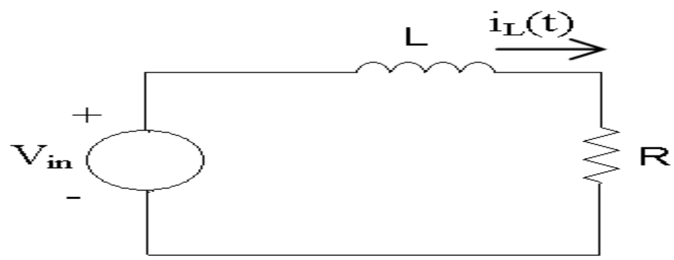


Figure 1 Series R-L circuit

The expression for the current build-up across the Inductor is given by

iL(t) = V/R (1 – e-(R/L)t) t ≥ 0   ------------------------------- (3)

Where, V is the applied source voltage to the circuit for t ≥ 0.

The expression for the current decay across the Inductor is given by:

iL(t) = i0 e-(R/L)t t ≥ 0   --(4)

Where,

i0 is the initial current stored in the inductor at t = 0

L/R = τ is time constant.

Since it is not possible to directly analyze the current through Inductor on a Scope, we will measure the output voltage across the Resistor. The resistor waveform should be similar to inductor current as VR=ILR. From the resistor voltage on the scope, we should be able to measure the time constant τ which should be equal to τ = L / Rtotal .

Here, Rtotal is the total resistance and can be calculated from Rtotal = R inductance+ R.

R inductance is the measured value of inductor resistance and can be measured by connecting inductance to an ohm-meter prior to running the experiment.

V. Procedure:

Design a circuit using only resistors inductor in series which, when connected as in Figure.The design should use the design criteria listed below.

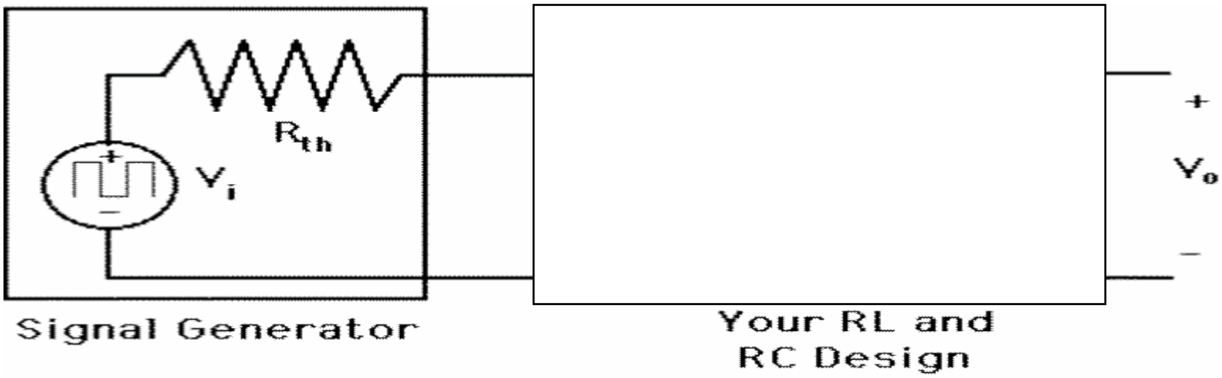


Figure 5. Schematic of the design.

Write an experimental procedure to determine R&in **Your RL circuit** signal of an RL circuit under transient state.Include a circuit diagram and the steps of your procedure.Execute your procedure, and determine the parameters of your model. Draw a circuit diagram of your model with the parameters. Check your model against measured values. Examine your output waveform and find the time that corresponds to 63% of V_R . Comment on how good a model you have. Submit your report to the instructor.

VI. Experimental Work:

1.Consider R and square wave signal input frequency as design variables.

2.Let time constant(be approximately) 11.9 μs.

3.Use L = 1.2mH and internal resistance of an inductor (r) is 0.8 ohms in the RL design.

4. determines applied frequency at tp = 5τ.

5.Vin= 4 volts (p-p) square wave voltage.

References:

https://www.allaboutcircuits.com/textbook/direct-current/chpt-10/superposition-theorem/