

LIST OF EXPERIMENTS

1. Introduction of MATLAB & SIMULINK software and its application for electrical circuit analysis.
2. Introduction of SCILAB software and its application for electrical circuit analysis.
3. Introduction of CIRCUIT MAKER software and its implementation for circuit analysis.
4. Verification the Kirchhoff's Voltage & Current law and validate the results.
5. To perform the Super position theorem
6. To verification of Thevenin's Theorem and validate its results.
7. To perform the Norton's theorem
8. To perform the Maximum Power Transfer theorem.
9. To calculate the open circuit & short circuit parameters of two port network & validate the results

EXPERIMENT NUMBER: 1

AIM:-Introduction of MATLAB & SIMULINK software and its application for electrical circuit analysis.

Introduction to Matlab

Getting started

To start MATLAB, navigate into the program list and click on "Matlab.exe".Your Matlab window should roughly look as in Figure . If it does not, click on "View" in the menu bar and select "Desktop layout", "Default".

Four main divisions appear in the window :

- "Current folder" : displays the content of the current work-directory,
- "Workspace" : lists the variables assigned by the user,
- "Command history": shows the last commands used,
- "Command window": where the commands are typed and the outputs

Displayed. In the following, we will mainly work in the "Command window", highlighted in Figure.

Creating you own work-directory

The current directory is displayed on the top part of the Matlab window

.

We advise you to start every new practical with creating a new work-Directory. To do that, click the "browse for folder" button (see Fig. 1.1)

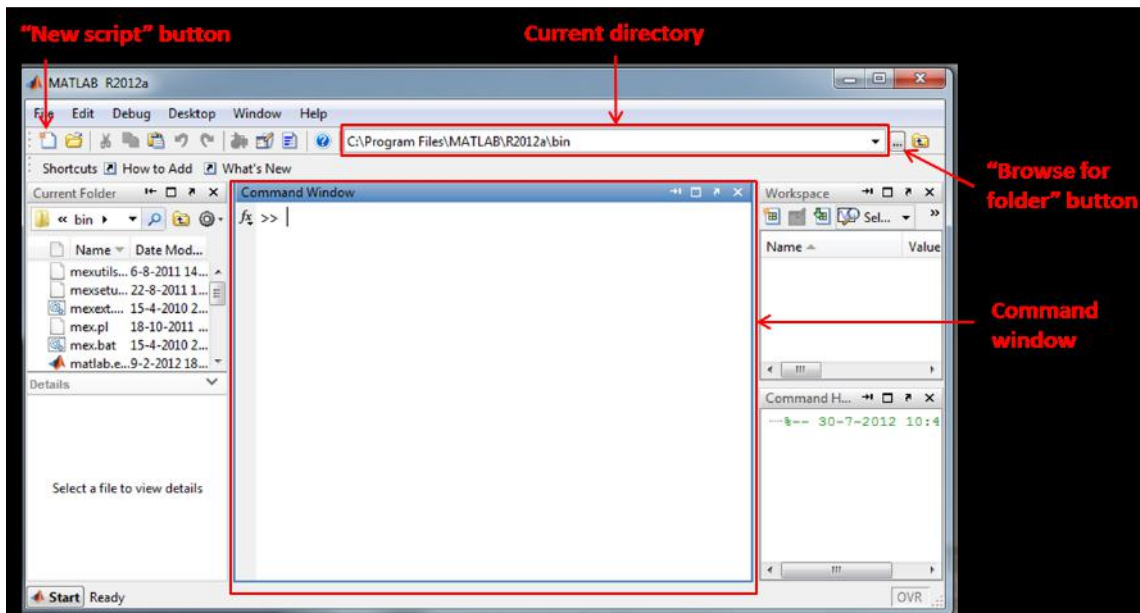
right to the "Current directory" drop-down list on the Matlab button-bar.

You can then browse through the directories and create a new folder at the

Desired location using the "New directory" button. For instance, create a

first folder called Matlab_practicals. In this folder create a folder called Practical1 in which your will be working on today.

You can also use this button to move to an already existing directory.



Introductory exercises

We will perform in this section some introductory exercises where Matlab is basically used as an "advanced" calculator.

Type in the command window $a = 32.8$ and then press "enter". The following lines appear:

```
>> a = 32.8
```

```
a =
```

```
32.8000
```

With this command, we de_fined a new variable a and assigned the value 32.8 to it.

_ Now let's type:

```
>> b = 3*a^2
```

and then press "enter". We de_fined a new variable, b , equal to 3 times the value of a squared. Its value is displayed in the command window.

The basic operations and their symbols are presented in Table 1.1.

_ Type now:

```
>> whos
```

and then press "enter". The following lines are displayed in the Matlab command window:

Name Size Bytes Class

a 1x1 8 double

b 1x1 8 double

Script files

A script, called also program, is a succession of Matlab commands written in a separate text file. Using script files allows you to organize and save series of commands. These scripts can be edited/extended/corrected anytime you want, and executed several times. Writing the commands into a script is necessary when you perform advanced data analysis, since it allows you to check/improve your methodology, but also to be sure to perform the exact same data processing for several datasets for instance. The scripts are user-created text files which can be written using Matlab editor.

Type:

```
>> edit
```

The Matlab editor window opens. In this window, you can write series of commands and save them. The resulting script is saved as *.m file. The "New script" button (see Fig. 1.1) can also be used to open the editor. It is important to add comment lines to your scripts to make them easier to understand. This is particularly useful when scripts are re-used long after they have been created. In a script file, anything written to the right of a percentage symbol is considered as a comment and will be ignored during the execution. In the Matlab editor, the comments appear in a different color (green by default).

A simple example of script can be found below:

```
% Example of a very simple Matlab script
% M. Tissier, 8-8-2012
% Initialization
clear
displacement = 12; % displacement (m)
time = 10; % duration (s)
% Calculation
v = displacement/time; % migration speed (m/s)
% Output
disp(['The migration speed is ' num2str(v) 'm/s'])
```

Once the script has been saved, you can run it by typing its name (with-out the ".m" extension) in the "Command window" and then press "enter".When a script file is executed, Matlab execute the commands in the order they are written.Relational and logical operators compares two numbers (or arrays) to determine if a comparison statement (e.g., $a < b$) is true or false.

If the comparison statement is false, it returns a zero. Type for in-stance:

```
>> 3<2
```

If the statement is true, such as

```
>> 3<6
```

it returns 1.

If Such comparisons are generally performed on arrays and can be very useful to analyse datasets. Define an array A such as:

```
>> A = [1:2:10;10:-2:1]
```

and then type

```
>> E = (A<5)
```

This command returns an array E which has the same size as A, but contains only ones and zeros. Each element of A is compared to 5, and, depending on the outcome of each comparison, the elements of E are filled with 1 or 0. Use the function sum to determine how many elements of A are smaller than 5. This method can be very useful to characterize large datasets where it is not possible to count one-by-one the elements satisfying a certain condition.

EXPERIMENT NUMBER: 2

AIM:-Introduction of SCILAB software and its application for electrical circuit analysis.

Introduction

SCILAB is a free scientific software for engineering and scientific applications. It bases on a numerical, programming and graphics environment; similar in operation but different syntax from MATLAB.

This is a self-contained package developed since 1990 by researchers from INRIA and ENPC (France); it is now maintained and developed by Scilab Consortium since its creation in May 2003.

Distributed freely and open source, Scilab is currently being used in educational and industrial environments around the world. Scilab includes hundreds of mathematical functions with the possibility to add interactively programs from various languages (C, Fortran...). It has sophisticated data structures (including lists, polynomials, rational functions, linear systems...), an interpreter and a high level programming language.

Scilab can be run using a variety of OS like UNIX, Linux, Windows(9X/2000/XP), etc.

How to use

Editing a command line enter a command line by typing after the prompt, or using Scipad to edit.

The Scilab window has the following Control buttons. Stop interrupts execution of Scilab and enters in pause mode. Resume continues execution after a pause entered as a command in a function or generated by the Stop button or Control C. Abort aborts execution after one (or several) pause, and returns to top-level prompt. Restart clears all variables and executes startup files. Quit quits Scilab. Kill kills Scilab shell script. Demos for interactive run of some demos.

File Operations facility for loading functions or data into Scilab, or executing script files.

Help : invokes on-line help with the tree of the man and the names of the corresponding items. It is possible to type directly help <item> in the Scilab window.

Graphic Window : select active graphic window New buttons can be added by the add menu command.

Examples

```
-->a=1;

-->A=2;

-->a+A
ans =

    3.

-->//Two commands on the same line

-->c=[1 2];b=1.5
b =

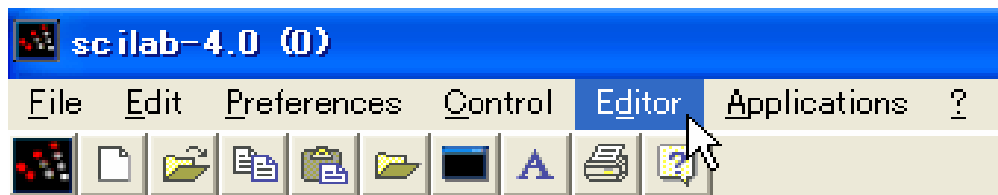
    1.5

-->//A command on several lines

-->u=1000000*(a*sin(A))^2+...
-->    2000000*a*b*sin(A)*cos(A)+...
-->    1000000*(b*cos(A))^2
u =

    81268.994
```

Programming: You can open Scipad to write your program



Programming Tools: Scilab supports a full list of programming tools loops, (for, while) conditionals, ($=$, $<=$, $>=$, $<>$ or $\sim=$) case selection, and creation new functions.

Special Function Commands: Scilab has several special commands which are used almost exclusively in functions. These are: `argn`: returns the number of input and output arguments for

the function • error: used to suspend the operation of a function, to print an error message, and to return to the previous level of environment when an error is detected.

EXPERIMENT NUMBER: 3

AIM:-Introduction of CIRCUIT MAKER software and its implementation for circuit analysis.

Introduction

In this course, we will be using the free student edition of a commercial program, [CircuitMaker](#), to design and simulate logic circuits.

Starting a New Design

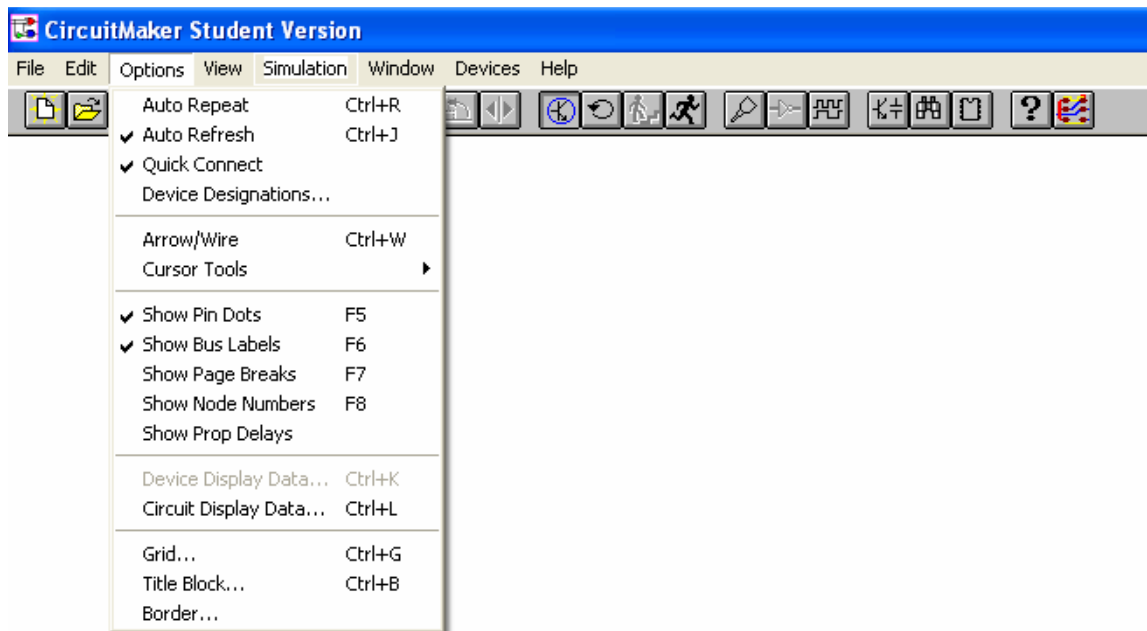
This program is user-friendly and well designed, but it is not something that you can just pick up and start using without some trial and error on part of the user, or with some kind of instruction. This is because it assumes you already know how to design digital logic circuits, and does not provide any tutorial material. Next we give you some pointers in order to help you get started and to avoid some common problems. There is also some help that comes with the program, but it tends to be sketchy.

1. The first thing to observe is that CircuitMaker can be used to design and simulate both analog and digital signals. (Wherever you see "Spice" in the help system, it's talking about analog simulation.) You can build your circuit with out concern for this fact, but when you simulate it (run it), you must be sure to do so in digital mode. If you don't, you'll get an error message, probably telling you that you need a ground node "before a valid spice Netlist can be generated". To avoid this problem click on the toolbar button with the symbol for a transistor on it (shown in the next figure).



Just get in the habit of clicking on the transistor button (it turns into an AND gate) every time you start running CircuitMaker.

2. If you care about the neatness of your diagrams, select *Grid (1)* under the Options menu, and select the "Snap to grid" option.



3. Use the *Devices* menu (2) to select gates, etc. to add to your circuit. Use the Wire Tool (3) to connect inputs and outputs together.



4. The most common input device is the digital logic switch, which alternates between outputting 0 and 1 each time you click on in. You can type a lower-case 's' to get one, or look for it in Hotkeys2 under the Devices menu, or select browse from the Devices menu, and select Digital -> Power.

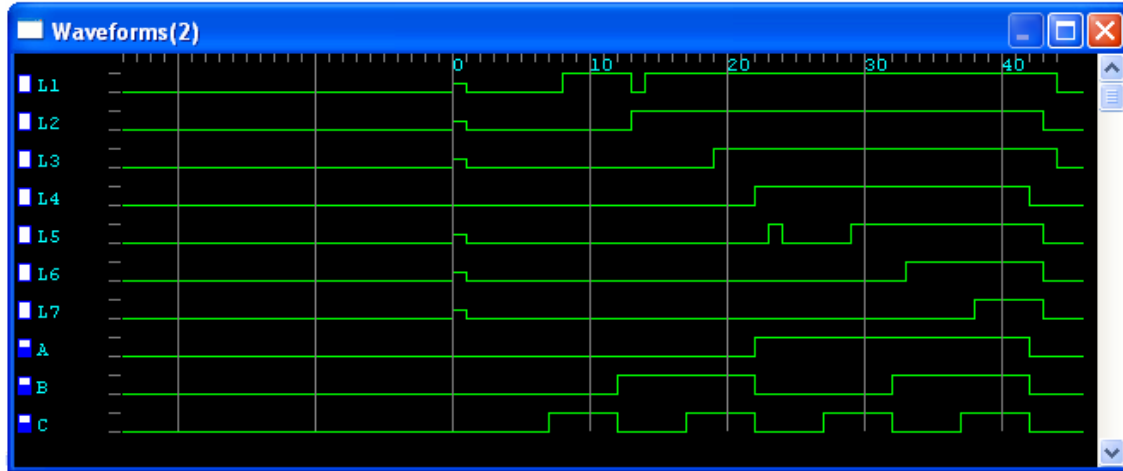
5. You can simulate your circuit one step (or propagation delay) at a time (4), or let it run at "full speed" (5.) Either way, you can use the probe tool (6) to look at the logic value of any part of your circuit. The probe will show H ("high"), L ("low"), or Z (indeterminate) as you make it hover over various parts of the circuit.



6. Sometimes, you will want to look at the waveforms for various parts of the circuit as you run your simulations. Use F12 to turn this option on, or press the waveform toolbar button (7). The waveforms are displayed in a separate window, so select "tile" from the Window menu to get them both to show on the screen.

7. The most common way to add traces to the waveforms window is to attach the Scope (8) tool to the wires you want to look at. Type a capital T to get a Scope tool, or select it from the Hotkeys2 menu under the Devices menu. To give nmeaningful names to your waveforms, double-click on the scope tool and type in the name you want to use.

8. You can move waveforms up and down by dragging their names in the waveforms window. The white boxes (9) to the left of the names are used for setting breakpoints. Breakpoints can be used to stop the simulation when the certain conditions are met. You can learn how to use breakpoints from the on-line help.



EXPERIMENT NUMBER: 4

AIM:- To verification of Kirchhoff's current and Kirchhoff's voltage law and validate its results.

APPARATUS AND SOFTWARE REQUIRED:

Connecting leads
Digital Multimeter
Kirchhoff's law kit

THEORY

KCL states that; "The algebraic sum of current at any node of the circuit is equal to zero (0)"

In other words, it simply means that the total current entering a node must be equal to the total current leaving a node.

Consider the case of few conductors meetings at a node shown in figure 1(a).

$$\sum I = 0$$

KVL state that the algebraic sum of voltage (or voltage drop) in any closed path of network that is traversed in a single direction is zero (0).

The algebraic sum of the product of current & resistance in each of the conductor in any closed path (or mesh) in a network plus the algebraic sum of e.m.f. in the path is zero (0).

$$\sum e = \sum IR \text{ drop in the closed loop}$$

PART A : Verification

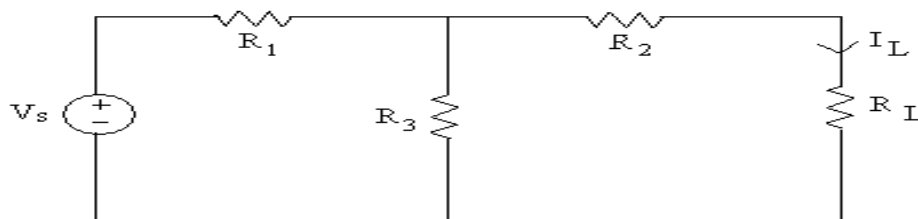


figure 1(a)

PROCEDURE FOR KCL:

1. Connect the circuit shown in figure.1. In this case ammeter will measure total current I.
2. Connect the ammeter in series with resistance R₁ to measure current I₁. Similarly connect the ammeter in series with resistance R₂, R₃ to measure branch current I₂, I₃ respectively.
3. Put the value of V_{dc}, I, I₁, I₂, R₁, R₂, R₃ in equations & verify each equation.

CALCULATION:

$$I = I_1 + I_2$$

PROCEDURE FOR KVL:

1. Connect the circuit shown in figure.1. In this case ammeter will measure total current I.
2. Connect the ammeter in series with resistance R₁ to measure current I₁ as shown in figure.2.
3. Similarly connect the ammeter in series with resistance R₂, R₃, to measure branch current I₂, I₃, respectively. Put the value of V_{dc}, I, I₁, I₂, R₁, R₂, R₃, in equations & verify each equation.

CALCULATION:

$$V_{dc} = IR_1 + IR_3$$

$$V_{dc} = IR_2 + IR_3 + IR_L$$

OBSERVATION TABLE:

FOR KCL

Measured Value			Calculated value			% Error
Total current (I) in A/mA	Branch current I ₁ (A/mA)	Branch current I ₂ (A/mA)	Total current (I) in A/mA	Branch current I ₁ (A/mA)	Branch current I ₂ (A/mA)	

FOR KVL

Measured Value			Calculated value			% Error
Total current(I) in A/mA	Loop current I ₁ (A/mA)	Loop current I ₂ (A/mA)	Total current(I) in A/mA	Loop current I ₁ (A/mA)	Loop current I ₂ (A/mA)	

RESULT AND CONCLUSION :

KCL & KVL is verified.

PRECAUTION:

1. Make connection before starting the experiment, or switching on the supply.
2. Make sure all connections are correct and proper.
3. Avoid loose connection in the circuit.
4. Record observed value carefully.

EXPERIMENT NUMBER: 5

AIM:- To verification of Superposition Theorem and validate its results.

APPARATUS AND SOFTWARE REQUIRED

1. Digital Multimeter
2. Superposition Theorem kit
3. Connecting wires

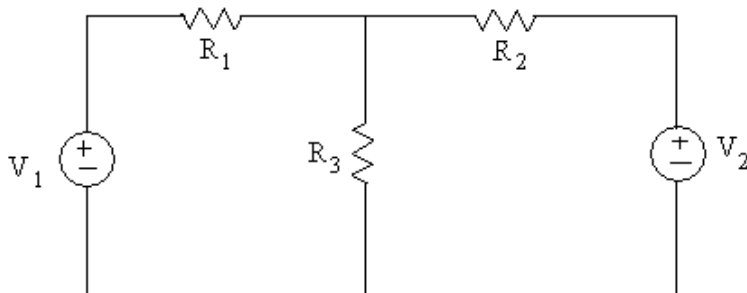
THEORY

The theorem finds use in solving a network where two or more sources are present and connected in series and in parallel. The statement for the Superposition Theorem can be given as;

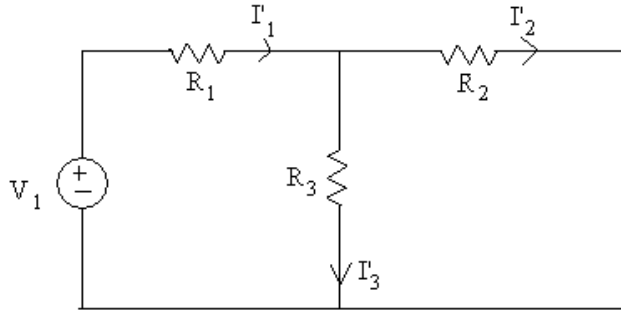
“If a number of voltage or current sources are acting simultaneously in a linear network, the resultant current or voltage in any branch is the algebraic sum of the currents and voltage that would be produced in it, when each source acts alone and replacing all other independent sources by their internal resistances.”

PART A: Verification

Explanation:



In this figure, to apply Superposition Theorem, let us first take the source V_1 alone at first replacing V_2 by short circuit.

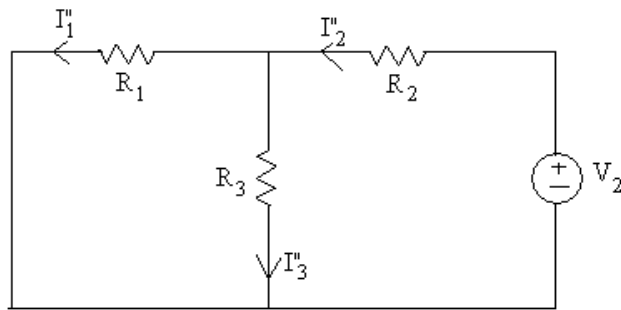


Here, $I_1' = V_1 / [R_2 R_3 / (R_2 + R_3) + R_1]$

$I_2 = I_1' R_3 / (R_2 + R_3)$

And $I_3' = I_1' - I_2'$

Next, removing V_1 by short circuit let the circuit be energized by V_2 only.



Here, $I_2'' = V_2 / [R_1 R_3 / (R_1 + R_3) + R_2]$

And, $I_1'' = I_2'' R_3 / (R_1 + R_3)$

Also, $I_3'' = I_2'' - I_1''$.

As per Superposition theorem,

$I_3 = I_3' + I_3''$

$I_2 = I_2' - I_2''$

$I_1 = I_1' - I_1''$.

PROCEDURE:

1. Set voltages V_1 and V_2 with the help of DC supply.
2. Connect the circuit on the Superposition kit.
3. Then find the current through the resistance where we will be finding the current. Let it will be I .

4. Now first short V_1 and find current through the resistance whom current will be finding. Let assume it will be I_1 .
5. Now short the voltage V_2 and then find the current through the same resistance. Let it will be I_2 .
6. Now add these two values and check it is same as the total current which is finding by the process 3rd.
7. Repeat the all process for various input voltages.

OBSERVATION TABLE:

S.NO	Measured Valve		Calculated value			% Error
	V_1	V_2	I_1	I_2	I	

RESULT AND CONCLUSION

As we find that the current in the desired branch due to number of sources in the network is equal to the algebraic summation of current in the branch, taking individual source at a time. And thus we find that the Superposition theorem is true and verified.

PRECAUTIONS:

1. Make connection before starting the experiment, or switching on the supply.
2. Make sure all connection is correct and proper.
3. Avoid loose connections in the circuit.
4. Record observed values carefully.

EXPERIMENT NUMBER: 6

AIM:- To verification of Thevenin's Theorem and validate its results.

APPARATUS REQUIRED

1. Digital Multimeter
2. Thevenin's Theorem kit type EE-131
3. Connecting leads

THEORY

The Thevenin's Theorem is extensively used to determine the current through or voltage across any one element in a network without going through the rigorous method of solving a set of network equations.

Statement of Thevenin's Theorem:

“Any two terminal bilateral linear networks can be replaced by an equivalent circuit consisting of a voltage source and a series resistor.”

PART A : Verification

Explanation

Let us consider a simple DC circuit as shown in figure 1(a). We are to find I_L by Thevenin's theorem.

In order to find the equivalent source, R_L is removed (figure 1(b)) and $V_{o/c}$ is calculated.

$$V_{o/c} = I R_3 = V_S R_3 / (R_1 + R_3)$$

Next, to find the internal resistance of the network (Thevenin's resistance or equivalent resistance) in series with $V_{o/c}$, the voltage source is removed (or deactivated) by a short circuit or replacing by their internal resistance. As shown in figure 1(c)

$$R_{Th} = R_2 + [R_1 R_3 / (R_1 + R_3)]$$

As per Thevenin's Theorem, the equivalent circuit being figure 1(c)

$$I_L = V_{o/c} / (R_{Th} + R_L)$$

CIRCUIT DIAGRAM

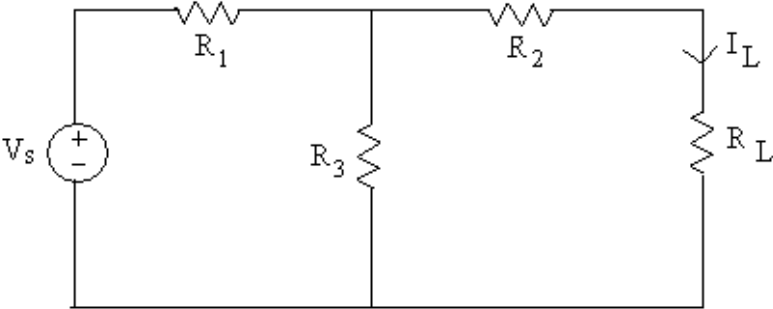


figure 1(a)

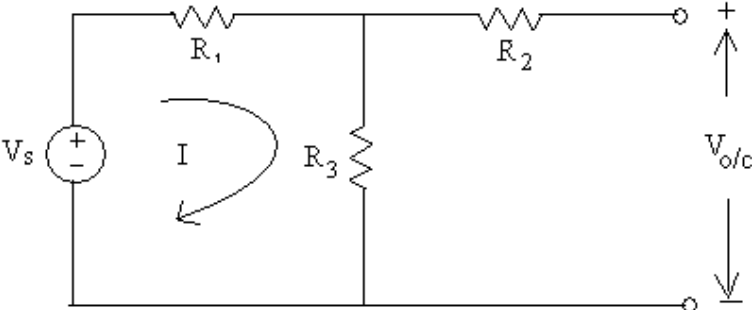


figure 1(b)

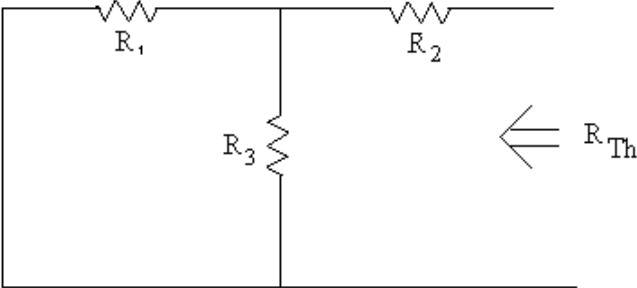


figure 1(c)

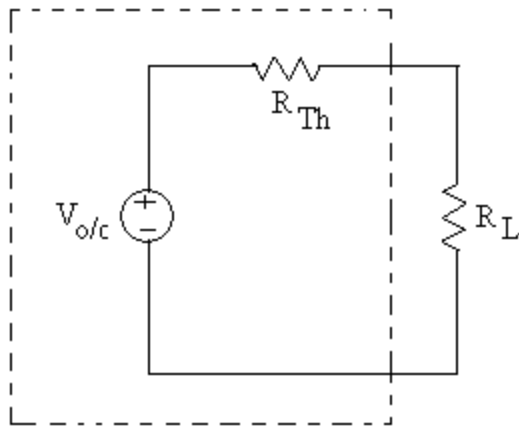


figure 1(d)

PROCEDURE

1. Connect voltmeter across the 10 V supply and adjust the voltage to 5v.
2. Set R_L to 5 k Ω .
3. Connect the 5V supply to T network of 2 k Ω resistance at the input and connect R_L at the out put of T network as shown in figure 1(a).
4. Connect voltmeter across R_L and switch on the supply and note down the voltage across R_L .
5. Calculate the current I_L using formula:

$$I_L = V_L / R_L$$

And note down in the observation table. Now disconnect R_L from the circuit and note down voltmeter reading which is V_{Th} . As shown in figure 1(b).

6. For this T network internal resistance (R_i or R_{Th}) is 3k Ω .
7. Now adjust supply voltage to V_{Th} using voltmeter.
8. Connect the combination of internal resistance $R_{Th} = 3k\Omega$ and R_L across adjusted power supply of V_{Th} as shown in figure 1(d).
9. Calculate Thevenin's load current I_{Th} through load R_L using formula:

$$I_{Th} = V_{Th} / (R_{Th} + R_L)$$

10. Repeat steps 1 to 9 using different supply voltage and load resistance (R_L) and note down corresponding value in the observation table.

CALCULATION:

$$R_{Th} = R_2 + [R_1 R_3 / (R_1 + R_3)]$$

$$I_{Th} = V_{Th} / (R_{Th} + R_L)$$

OBSERVATION TABLE

S.No.	Supply voltage (V)	R_L	V_L	I_L	Measured Value			Calculated value			% Error
					Thevenin's Voltage V_{Th}	Internal Resistance R_i or R_{Th}	I_{Th}	Thevenin's Voltage V_{Th}	Internal Resistance R_i or R_{Th}	I_{Th}	
1											
2											
3											

RESULT AND CONCLUSION:

The value of the calculated value of load current through R_L obtained by using Thevenin's Theorem and that obtained via Thevenin's equivalent circuit are found to be same and hence the Thevenin's Theorem is verified.

PRECAUTIONS

1. Make connection before starting the experiment, or switching on the supply.
2. Make sure all connections are correct or proper.
3. Avoid loose connection in the circuit.
4. Record observed value carefully.

EXPERIMENT NUMBER: 7

AIM:- To verification of Norton's theorem and validate its.

APPARATUS REQUIRED

1. Digital Multimeter
2. Norton's Theorem kit type EE-133
3. Connecting leads

THEORY

Norton's Theorem is converse of Thevenin's Theorem. It consists of an equivalent current source instead of equivalent voltage source as done in Thevenin's Theorem. It is also done to find the current through load terminals and voltage across it, without actually solving out for current and voltage of the entire network the statement for Norton's Theorem is:

“A linear active network consisting of independent and or dependent voltage and current sources and linear bilateral network elements can be replaced by an equivalent circuit consisting of a current source in parallel with a resistance, the current source being the short circuited current across the load terminal and the resistance being the internal resistance of the source network looking through the open circuited load terminals.”

PART A: Verification

Explanation

In order to find the current through R_L , the load resistance by Norton's Theorem, let us find R_L by short circuiting figure 1(a)

Obviously,

$$I = V_s / [R_1 + \{R_2 R_3 / (R_2 + R_3)\}]$$

And

$$I_{s/c} = [R_3 / (R_3 + R_2)] I$$

Next short circuit is removed and the independent source is deactivated as done in Thevenin's theorem

Here, $R_{Th} = R_2 + [R_1 R_3 / (R_1 + R_3)]$

As per Norton's theorem, the equivalent source circuit would contain a current source in parallel to the internal resistance, the current source being the short circuited current across the shorted terminals of the load resistor.

Obviously,

$$I_L = I_{s/c} [R_{int} / (R_{int} + R_L)]$$

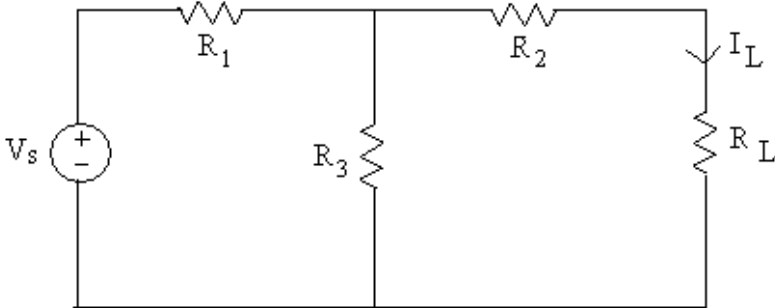


figure 1(a)

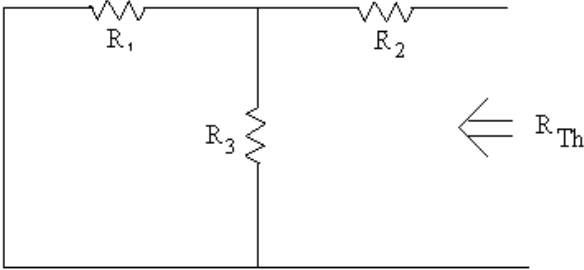


figure 1(c)

CIRCUIT DIAGRAM

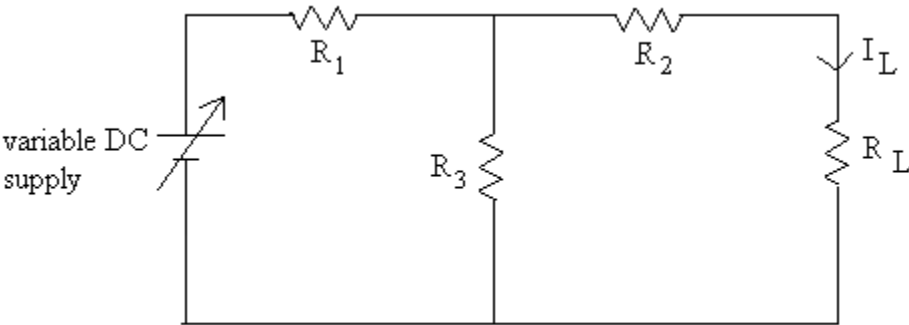


figure 1(a)

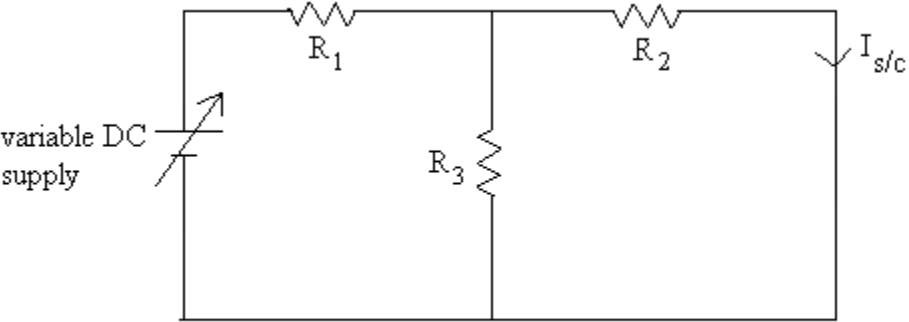


figure 1(b)

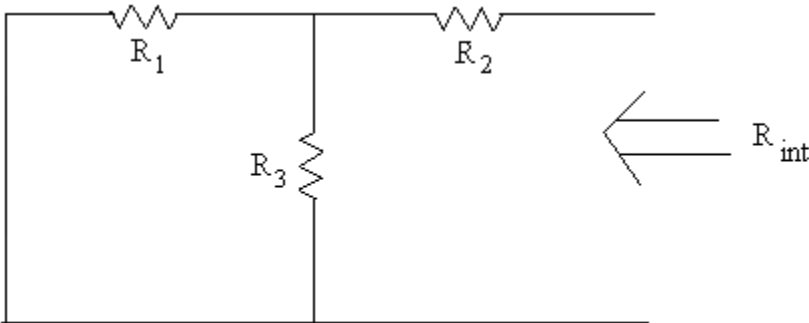


figure 1(c)

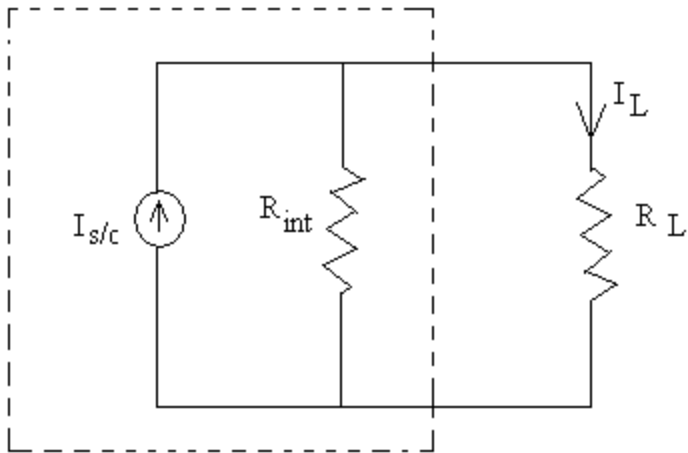


figure 1(d)

PROCEDURE

1. Connect voltmeter across the 10V supply and adjust the voltage to 5V.
2. Set the voltage to 5V.
3. Connect the 5V supply to the T network of $2k\Omega$ resistance at the input and connect as ammeter and load R_L at the output of the T network as shown in figure. Note down the conventional current I_L from the ammeter into observation table.
4. Disconnect the load R_L and place a short circuited element in place and note down ammeter reading which is short circuit current $I_{s/c}$ into observation table.
5. The internal resistance R_{int} of T network as viewed from the output terminal A-B is $3k\Omega$.
6. Now we can form a circuit for a parallel combination of a current source $I_{s/c}$ and internal resistance R_{int} as shown in figure which is equivalent to series combination of voltage source $E = I_{s/c} R_{int}$, and internal resistance R_{int} as shown in figure.
7. Connect the circuit as shown in figure; using appropriate values and note down load current I_{L1} into observation table.
8. Repeat steps 1 and 7 using different supply voltages and load resistance (R_L) and note down corresponding values in the observation table.

CALCULATION:

$$R_{Th} = R_2 + [R_1 R_3 / (R_1 + R_3)]$$

$$I_L = I_{s/c} [R_{int} / (R_{int} + R_L)]$$

OBSERVATION TABLE:

		Measured Value				Calculated value				% Error
S. No.	Supply voltage (V)	R_L	I_L	$I_{s/c}$	R_{int}	R_L	I_L	$I_{s/c}$	R_{int}	

RESULT AND CONCLUSION

The load current in the sample circuit and Norton's equivalent circuit is found to be same hence the Norton's theorem is verified.

PRECAUTIONS:

1. Make connection before starting the experiment, or switch on the supply.
2. Make sure all connections are correct and proper.
3. Avoid loose connections in the circuit.
4. Record observed values carefully.

EXERIMENT NUMBER: 8

AIM:- To verification of Maximum Power Transfer Theorem and validate its results

APPAARATUS REQUIRED:

1. Digital Multimeter
2. Maximum power transfer theorem kit
3. Connecting leads

THEORY:

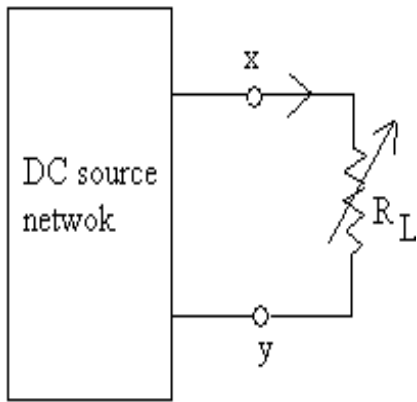
The theorem is useful in determining the value of load resistance for which there would be maximum power transfer from source to the given load. The statement for maximum power transfer theorem is as follows:

“A resistive load, when connected to DC network, receives maximum power when the load resistance is equal to the internal resistance (Thevenin’s equivalent resistance) of the source network as seen from the load terminals.”

PART A : Verification

Explanation:

A variable resistance R_L is connected to a DC source network as shown n figure (1a) while figure (1b) represents the Thevenin voltage V_0 and Thevenin resistance R_{Th} of the source network. The aim is to determine the value of R_{Th} such that it receives maximum power from the DC source.



1(a)

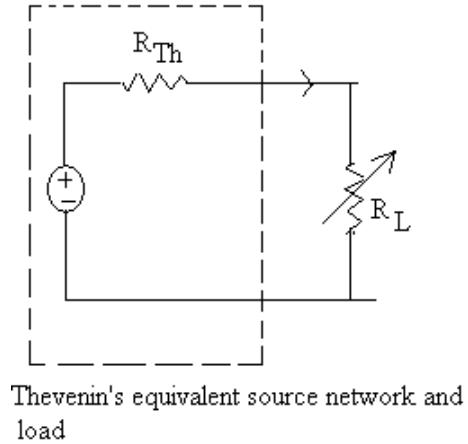


Figure 1(b)

Figure

With reference to figure (1b),

$$I = V_0 / (R_{Th} + R_L)$$

While the power delivered top the resistive load is

$$P_L = I^2 R_L = [V_0 / (R_{Th} + R_L)]^2 \times R_L$$

P_L can be maximized by varying R_L and hence, maximum power can be delivered when $(dP_L/dR_L) = 0$.

$$\begin{aligned} \text{However, } dP_L / dR_L &= 1 / [(R_{Th} + R_L)^2]^2 \\ &= [(R_{Th} + R_L)^2 d(V_0^2 R_L) / dR_L - V_0^2 R_L d(R_{Th} + R_L)^2 / dR_L] \\ &= [(R_{Th} + R_L)^2 V_0^2 - V_0^2 R_L \times 2(R_{Th} + R_L)] / (R_{Th} + R_L)^3 \\ &= V_0^2 (R_{Th} - R_L) / (R_{Th} + R_L)^3 \end{aligned}$$

But $dP_L/dR_L = 0$

Finally, $V_0^2 (R_{Th} - R_L) / (R_{Th} + R_L)^3 = 0$

Which gives, $(R_{Th} - R_L) = 0$

Or, $R_{Th} = R_L$.

Hence, it has been proved that power transfer from a DC source network to a resistive network is maximum when the internal resistance of the DC source network is equal to the load resistance.

$$\begin{aligned} \text{So, } P_{\max} &= V_0^2 R_{Th} / (R_{Th} + R_{Th})^2 \\ &= V_0^2 / 4R_{Th} \end{aligned}$$

Obviously, the power transfer by the source and delivered on the load will be same, so the during maximum power transfer the efficiency η becomes

$$\begin{aligned} \eta &= P_{\max} / P \times 100 \\ &= 50\% \end{aligned}$$

PROCEDURE:

1. Connect the circuit as shown in the figure.
2. Measure the value of load current (I_L) for different (suitable) values of load resistance (R_L).
3. Record them in observation table, by suitable value, means that the value of R_L should be equal to, or more than and less than R_S .
4. Repeat step 2 for different values of supply voltage (V_S).

CALCULATION:

$$P_{\max} = V_0^2 R_{Th} / (R_{Th} + R_{Th})^2$$

$$P_L = I^2 R_L = [V_0 / (R_{Th} + R_L)]^2 \times R_L$$

OBSERVATION TABLE:

		Measured Value				Calculated value				% Error
S.N	Supply voltage	R_S	R_L	I_L	$P = I^2 R_L$	R_S	R_L	I_L	$P = I^2 R_L$	

RESULT AND CONCLUSION:

Thus it is seen from the actual result obtained and the calculated values are in correlation and the Maximum Power Transfer Theorem is verified.

PRECAUTIONS:

1. Make connection before starting the experiment, or switching on the supply.
2. Make sure all connection is correct and proper.
3. Avoid loose connection in the circuit.
4. Record observed value carefully.

EXPERIMENT NUMBER: 9

AIM:- To Calculate the open circuit & short circuit parameters of two port network & validate the results.

APPERATUS REQUIRED:

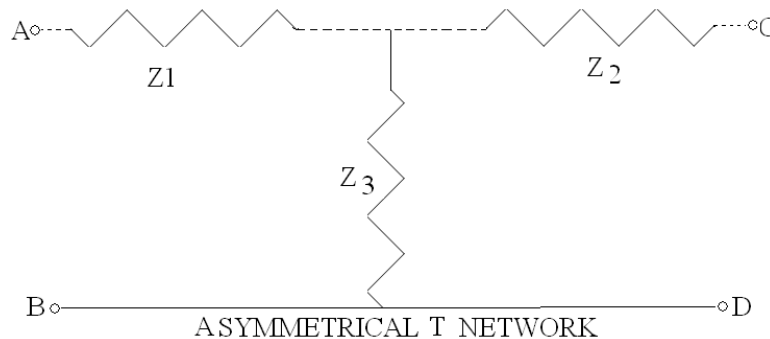
- 1: Trainer kit of 2-port network
- 2: Patch cords
- 3: Digital Multimeter

THEORY:

The network which is not symmetrical with respect to its input and output ports is known as an Asymmetric Network. It generally possesses different characteristic impedance on its two sides.

“T” Type Asymmetric Network:

The network looks like a “T” is called “T” type network. When the impedance Z_1 and Z_3 are not equal, then this is called asymmetric “T” type network. The Asymmetric “T” type Network is shown in figure.



PART A: Verification

Formula used to calculate the Image impedance of “T” networks:

$$Z_{i1} = [(Z_1 + Z_3/Z_2 + Z_3) (Z_1 Z_2 + Z_2 Z_3 + Z_1 Z_3)]^{1/2}$$

Or
$$= (Z_{o/c1} Z_{s/c1})^{1/2}$$

Where $Z_{o/c1}$ is the open circuit impedance between A & B points when C & D points are open. Whereas $Z_{s/c1}$ is the short circuit impedance across A & b points when C & D points are short circuited.

$$Z_{i2} = [(Z_2 + Z_3/Z_1 + Z_3) (Z_1 Z_2 + Z_2 Z_3 + Z_1 Z_3)]^{1/2}$$

Or
$$= (Z_{o/c} Z_{s/c2})^{1/2}$$

Where $Z_{o/c2}$ is the open circuit impedance between C & D points when A & B points are open. Whereas $Z_{s/c2}$ is the short circuit impedance across C & D points when A & B points are short circuited.

Formula used to calculate the Open circuit Impedance of “T” Network:

$$Z_{o/c1} = Z_1 + Z_3$$

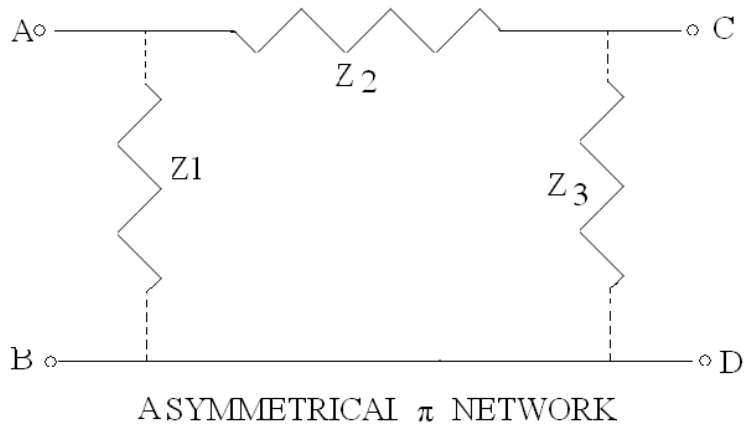
$$Z_{o/c2} = Z_2 + Z_3$$

Formula used to calculate the Short circuit Impedance of “T” Network:

$$Z_{s/c1} = Z_1 + (Z_2 Z_3 / Z_2 + Z_3)$$

$$Z_{s/c2} = Z_2 + (Z_1 Z_3 / Z_1 + Z_3)$$

“π” Type Asymmetrical Network: When the network is shown a π type with shunt impedance is not identical then the network is called “π” Type Asymmetrical network. This is shown in figure.



Formula used to calculate the Image Impedance of “ π ” type Network

$$Z_{i1} = [\{ Z_1(Z_2+Z_3)/Z_1+Z_2+Z_3 \} (Z_1Z_2/Z_1+Z_2) \}]^{1/2}$$

Or $= (Z_{o/c1} Z_{s/c1})^{1/2}$

Where $Z_{o/c}$ is the open circuit impedance between A & B points when C & D points are open. Whereas $Z_{s/c1}$ is the short circuit impedance across A & B points when C & D points are short circuited.

$$Z_{i2} = [\{ Z_3(Z_1+Z_2)/Z_1+Z_2+Z_3 \} (Z_2Z_3/Z_2+Z_3) \}]^{1/2}$$

Or $= (Z_{o/c2} Z_{s/c2})^{1/2}$

When $Z_{o/c2}$ is the open circuit impedance between C & D points when A & B points are open. Whereas $Z_{s/c2}$ is the short circuit impedance across C & D points when A & B points are short circuited.

Formula used to calculate the Open circuit Impedance of “ π ” Network

$$Z_{o/c1} = Z_1 (Z_2+Z_3) / Z_1+Z_2+Z_3$$

$$Z_{o/c2} = Z_3(Z_1+Z_2) / Z_1+Z_2+Z_3$$

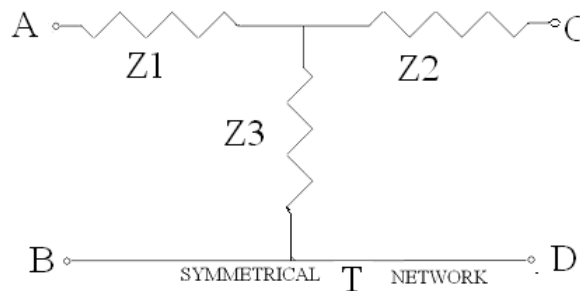
Formula used to calculate the Short Circuit Impedance of “ π ” Network

$$Z_{s/c1} = Z_1 Z_2 / Z_1 + Z_2$$

$$Z_{s/c2} = Z_2 Z_3 / Z_2 + Z_3$$

PROCEDURE:

For “T” type Asymmetrical Networks



1. Study the circuit configuration of Asymmetrical “T” Network printed on the front panel carefully.
2. Connect R_1 (400 Ω) & R_2 (1.5 k Ω) in the circuit through patch cords.
3. To measure the image impedance (Z_{i1}) of the “T” Network, connect Digital Multimeter (DMM) across A & B points of the circuit as shown in figure.
4. Set the mode of DMM to resistance range, now switch ON the DMM. Measure the resistance value. This is the open circuit impedance of the circuit denoted by $Z_{o/c1}$.
5. Now short circuit the C & D points through patch cord. Again note the value of resistance across A & B points. This is the short circuit impedance of the circuit denoted by $Z_{s/c1}$.
6. Calculate the value of image impedance (Z_{i1}) of the circuit by using formula:

$$Z_{i1} = [Z_{o/c1} Z_{s/c1}]^{1/2}$$

7. To measure the image impedance (Z_{i2}) of the “T” Network, connect Digital Multimeter (DMM) across C & d points of the circuit.
8. Set the mode of DMM to resistance range, now switch ON the DMM. Measure the resistance value. This is the open circuit impedance of the circuit denoted by $Z_{o/c2}$.
9. Now short circuit the A & B points through patch cord. Again note down the value of resistance across C & D points. This is the short circuit impedance of the circuit denoted by $Z_{s/c2}$.
10. Calculate the value of image impedance (Z_{i2}) of the circuit by using formula:

$$Z_{i2} = [Z_{o/c2} Z_{s/c2}]^{1/2}$$

OBSERVATION TABLE

Open circuit parameter

parameters	Reading	Remark
Z_{11}		
Z_{12}		
Z_{21}		
Z_{22}		

Short circuit parameter

parameters	Reading	Remark
Z_{11}		
Z_{12}		
Z_{21}		
Z_{22}		

CALCULATION

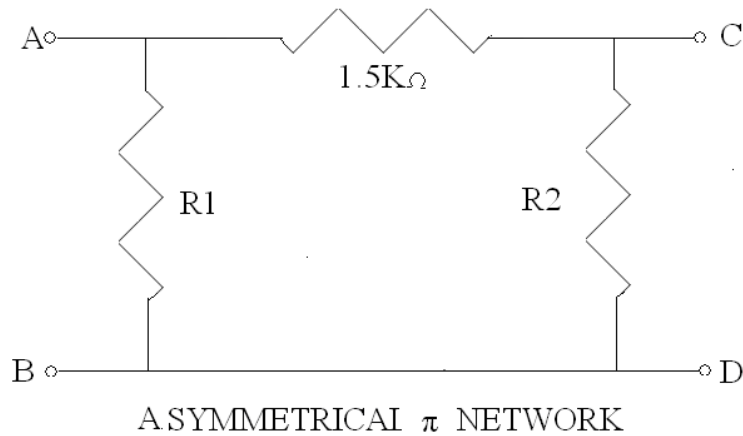
$$Z_{o/c1} = Z_1 (Z_2 + Z_3) / Z_1 + Z_2 + Z_3$$

$$Z_{o/c2} = Z_3 (Z_1 + Z_2) / Z_1 + Z_2 + Z_3$$

$$Z_{s/c1} = Z_1 Z_2 / Z_1 + Z_2$$

$$Z_{s/c2} = Z_2 Z_3 / Z_2$$

For “ π ” type Asymmetrical Networks



1. Study the circuit configuration of Asymmetrical “ π ” Network printed on the front panel carefully.
2. Connect R_1 (200Ω) & R_2 (680Ω) in the circuit through patch cords.
3. To measure the image impedance (Z_{i1}) of the “ π ” Network, connect Digital Multimeter (DMM) across A & B points of the circuit as shown in figure.
4. Set the mode of DMM to resistance range, now switch ON the DMM. Measure the resistance across A & B points. This value is Open circuit impedance of the circuit denoted by $Z_{o/c1}$.
5. Now short circuit the C & D points through patch cord. Again note down the value of resistance across A & B points. This value is the short circuit impedance of the circuit denoted by $Z_{s/c1}$.
6. Calculate the value of image impedance (Z_{i1}) of the circuit by using formula:

$$Z_{i1} = [Z_{o/c1} Z_{s/c1}]^{1/2}$$

7. To measure the image impedance (Z_{i2}) of the “ π ” Network, connect Digital Multimeter (DMM) across C & D points of the circuit.

8. Set the mode of DMM to resistance range, now switch ON the DMM. Measure the resistance value. This is the open circuit impedance of the circuit denoted by $Z_{o/c2}$.
9. Now short circuit the A & B points by patch cord. Again note down the value of resistance across C & D points. This is the short circuit impedance of the circuit denoted by $Z_{s/c2}$.
10. Calculate the value of image impedance (Z_{i2}) of the circuit by using formula:

$$Z_{i2} = [Z_{o/c2} Z_{s/c2}]^{1/2}$$

RESULT AND CONCLUSION

As we find that the current in the desired branch due to number of sources in the network is equal to the algebraic summation of current in the branch, taking individual source at a time. And thus we find that the Superposition theorem is true and verified.

PRECAUTIONS:

Make connection before starting the experiment, or switching on the supply.

1. Make sure all connection is correct and proper.
2. Avoid loose connection in the circuit.
3. Record observed value carefully.

