DRONACHARYA
College of Engineering

LAB MANUAL

NETWORK THEORY
(EC-316-F)

III SEMESTER ECS

Department of Electronics & Communication Engg.
Dronacharya College of Engineering
Khentawas, Gurgaon – 123506

LIST OF EXPERIMENTS

A: Simulation based

1. Introduction of circuit creation & simulation software like TINAPRO, P-Spice, Dr.-Spice/other relevant Software

2. To find the resonance frequency, Band width of RLC series circuit using any of above software.

3. Transient response of RC, RL circuit on any of above software.

4. To plot the frequency response of low pass filter and determine half-power frequency.

5. To plot the frequency response of high pass filter and determine the half-power frequency.

6. To plot the frequency response of band-pass filter and determine the band-width.

B: Hardware Based

1. To Calculate and verify Thvenin theorem.

2 To Calculate and verify Nortan theorem.

3. To calculate and verify "Z" parameters of a two port network.

4. To calculate and verify “Y” parameters of a two port network.

5. To determine equivalent parameter of parallel connections of two port network and study loading effect.

6. To calculate and verify "ABCD" parameters of a two port network.

NOTE: Ten experiments are to be performed, out of which at least seven experiments should be performed from above list. Remaining three experiments may either be performed from the above list or designed & setup by the concerned institution as per the scope of the syllabus.

A: Simulation based

EXPERIMENT-1

AIM: To Study Tina Pro Software.

THEORY:

TINA offers many useful and advanced features for designing, testing, and teaching electronics. These include
S-parameter models, network analysis, Fourier series and Fourier spectrum analysis, noise analysis, symbolic
analysis, post-processing of analysis results, phasor diagrams, Nyquist diagrams, a built-in interpreter, multiparameter
optimization, and much more.

T**INA Design Suite** is a powerful yet affordable circuit simulation and PCB design software package for analyzing, designing, and real time testing of analog, digital, VHDL, MCU, and mixed electronic circuits and their PCB layouts. You can also analyze SMPS, RF, communication, and optoelectronic circuits; generate and debug MCU code using the integrated flowchart tool; and test microcontroller applications in a mixed circuit environment. A unique feature of TINA is that you can bring your circuit to life with the optional USB controlled TINALab II and LogiXplorer hardware, which turns your computer into a powerful, multifunction T&M instrument. Electrical engineers will find TINA an easy to use, high performance tool, while educators will welcome its unique features for the training environment.

Easy to use schematic entry. Enter any circuit within minutes with TINA's easy-to-use schematic editor. Enhance your schematics by adding text and graphics elements such lines, arcs arrows, frames around the schematics and title blocks. Choose components from the large library containing more than 20,000 manufacturer models. You can check schematics for errors with TINA's advanced ERC functions. The schematic editor supports complex hierarchical designs, team design and version control.

Powerful analysis tools. Analyze your circuit through more than 20 different analysis modes or with 10 high tech virtual instruments. Present your results in TINA's sophisticated diagram windows, on virtual instruments, or in the live interactive mode where you can even edit your circuit during operation, develop, run, debug and test VHDL & MCU applications.

Design Tool. This powerful tool works with the design equations of your circuit to ensure that the specified inputs result in the specified output response. The tool offers you a solution engine that you can use to solve repetitively and accurately for various scenarios. The calculated component values are automatically set in place in the companion TINA schematic and you can check the result by simulation. This new feature is also very useful for semiconductor and other electronics component manufacturers to provide application circuits along with the design procedure.

Optimization. Using TINA's built-in Optimization tool unknown circuit parameters can be determined automatically so that the network can produce a predefined target output values, minimum or maximum. Optimization is useful not only in the design of electronic circuits, but also in teaching, to construct examples and problems. It is a very good tool to refine the results provided by a design procedure or tune already working circuits.

Integrated PCB design. The new fully integrated layout module of TINA has all the features you need for advanced PCB design, including multilayer PCB's with split power plane layers, powerful autoplacement & autorouting, rip-up and reroute, manual and "follow-me" trace placement, DRC, forward and back annotation, pin and gate swapping, keep-in and keep-out areas, copper pour, thermal relief, fanout, 3D view of your PCB design from any angle, Gerber file output and much more.

Advanced presentation tools. Make stand-out reports and presentations of schematic diagrams, annotations, formulas provided by symbolic analysis, Bode plots, Nyquist diagrams, poles and zeros, transient responses, digital waveforms, and other data using linear or logarithmic scales. Customize presentations using TINA's advanced drawing tools to control text, fonts, axes, line width, color and layout. You can create, edit and print documents directly inside TINA or cut & paste your results into your favorite word processing or DTP package.

Importing Spice models. Create new TINA components from any Spice subcircuit, whether created by yourself, downloaded from the Internet, obtained from a manufacturer's CD or from portions of schematics turned into subcircuits. TINA automatically represents these subcircuits as a rectangular block, but you can create any shape you like with TINA's Schematic Symbol Editor. You can also use TINA's parameter extractor program to calculate model parameters from catalog or measurement data and then add the new devices into the catalog.

Educational tools. Educational tools. TINA also includes unique tools for testing students' knowledge, monitoring progress and introducing troubleshooting techniques. With optional hardware it can be used to test real circuits for comparison with the results obtained from simulation. With the Live 3D breadboard tool you can automatically build a life-like 3D picture of a solderless breadboard. When you run TINA in interactive mode, components like switches, LEDs, instruments, etc. become "live" and will work on the virtual breadboard just as in reality. You can use this capability of TINA to prepare and document lab experiments. You can also use the integrated Flowchart Editor and Debugger to generate and debug the MCU code, learning and teaching microcontroller programming.

Virtual Instruments: Oscilloscope, Function Generator, Multimeter, Signal Analyzer/Bode Plotter, Network Analyzer, Spectrum Analyzer, Logic Analyzer, Digital Signal Generator, XY Recorder.

Real time measurements. TINA is far more than a circuit simulator with virtual measurements. You can install optional, supplementary hardware that allows real-time measurements controlled by TINA's on screen virtual instruments.

TINALab II multifunction PC Instrument. With the TINALab II high speed PC instrument you can turn your laptop or desktop computer into a powerful, multifunction test and measurement instrument. Whichever instrument you need multimeter, oscilloscope, spectrum analyzer, logic analyzer, arbitrary waveform generator, or digital signal generator it is at your fingertips with a click of the mouse. In addition TINALab II can be used with the TINA circuit simulator program for comparison of circuit simulation and measurement results as a unique tool for circuit development, troubleshooting, and the study of analog and digital electronics.

CONCLUSION: Hence we have studied the Tina Pro Software.

NT LAB
EXPERIMENT NO :2

AIM: To find resonance frequency , Bandwidth , Q - factor of RLC series circuit

APPARATUS REQUIRED : Tina Pro Software

BRIEF THEORY : The ckt. is said to be in resonance if the current is in phase with the applied Voltage . Thus at Resonance, the equivalent complex impedance of the ckt. consists of only resistance R. Since V & I are in phase, the power factor of resonant ckt. is unity.

The total impedance for the series RLC ckt. is

$Z = R + j(X_L - X_C) = R + j(\omega L – 1/\omega C)$

$Z = R + jX$

The ckt. is in resonance when X = 0, i.e

$Z = R$

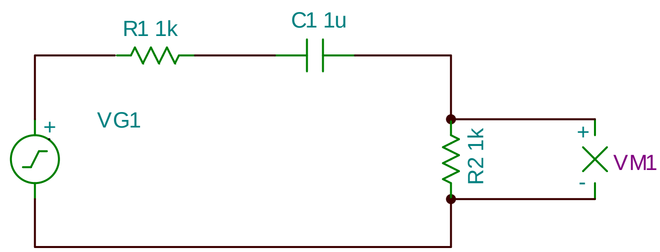
Series resonance occurs when, $X_L = X_C$, i.e

$\omega L = 1/\omega C$

$2\pi f_r L = 1/ 2\pi f_r C \Rightarrow f_r^2 = 1/ 4\pi^2 LC$

$f_r = 1/ 2\pi(LC)½$

CIRCUIT DIAGRAM:



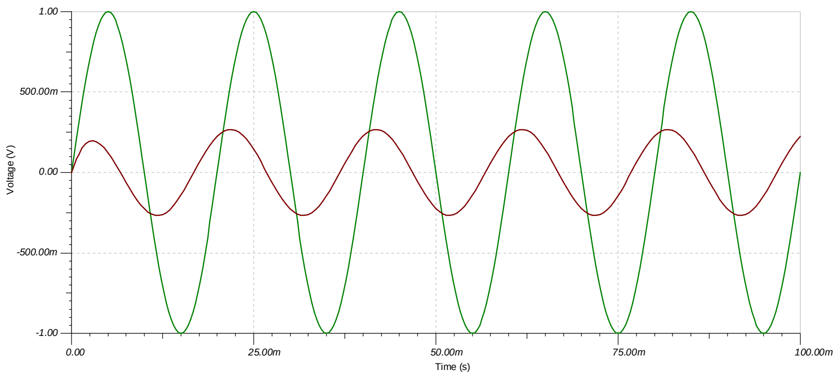
SAMPLE CALCULATION:

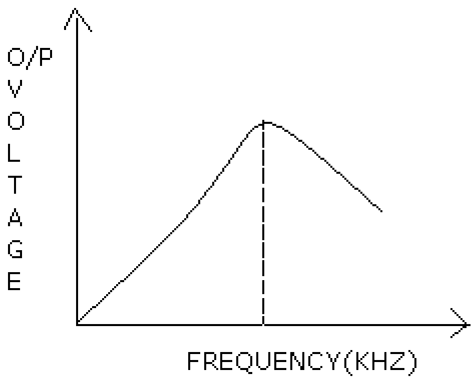
$Fr = V_{max}$

Bandwidth = $(f_2 – f_1)$ KHz, $f2 – f1 = 0.707V_{max}$

$Q = f_r$ / Bandwidth

GRAPH:





RESULT/CONCLUSIONS: The resonance frequency , bandwidth & Q - factor of RLC series circuit has been calculated

DISCUSSIONS: At cut-off frequencies the voltage becomes $1/(2)^{1/2}$Vm

PRECAUTIONS :

a) Make the connections according to the circuit diagram.
b) Make sure the proper parameter.

QUIZ/ANSWERS:

Q1.Define resonance	A1.At resonance the circuit is purely resistive in nature . So,the voltage & the current will be in phase.
Q2. In series resonance the current is ------- & the impedance is -----------.	A2. Maximum , minimum
Q3. In parallel resonance the current is ------- & the impedance is -----------.	A3. Minimum , maximum
Q4. Define bandwidth	A4.The frequency band within the limits of lower & upper half power frequency is called the bandwidth
Q5 Define selectivity	A5.It is defined as the ratio of resonant frequency (f_0) to the bandwidth of the circuit i.e Selectivity = $f_0/f_2 – f_1$

Q6. At frequency below resonant frequency (f_0) , what will be the nature of overall reactance ?	A6.At $f < f_0$, the overall reactance will be capacitive
Q7. At frequency above resonant frequency (f_0) , what will be the nature of overall reactance ?	A7. At $f > f_0$, the overall reactance will be inductive
Q8. Does resonance occurs in dc or ac circuits?	A8. Resonance occurs in ac circuits only.
Q9. What is the effect of resistance on the frequency response curve ?	A9.The frequency response curve with small resistance rises steeply & has a tall narrow peak while the curve with large resistance rises less steeply & has a low broad peak.

N T LAB
EXPERIMENT NO : 3

AIM: To study and plot the transient response of RL circuit

APPARATUS REQUIRED : Tina Pro Software

BRIEF THEORY : Let switch K be at position 1. When it is switched to 2 then the =n becomes

$$L\,di/dt + Ri = 0$$

$$di/i = -R/L\,dt$$

Integrating & then taking log on both sides

$\log i = -R\,t/L + \log c$ where c is constant

or, $\log i = -Rt / L + \log c$

or, $i = c\,e^{-Rt/l}$ -------------(1)

This is the general solution of RL circuit if the value of C2 is calculated then the result is known as particular solution.

Just before switching at t = 0,

$$i(0) = V / R$$

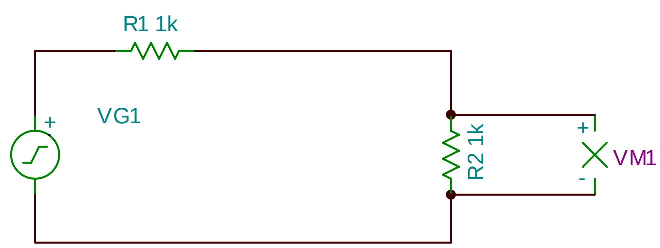
∴ **P**utting in equation (1)

$I(0) = C_2\,e^{V/R}$, $C_2 = V / R$

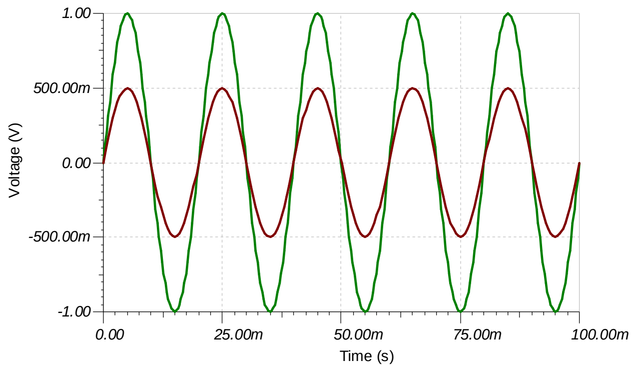
∴ Particular solution is

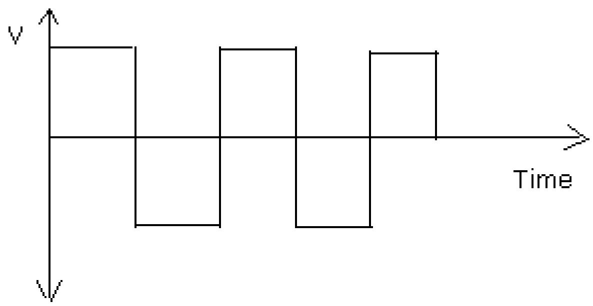
$$i = V / R\,e$$

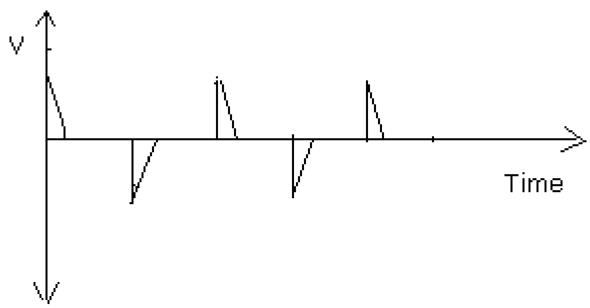
CIRCUIT DIAGRAM:



GRAPH:







RESULT/CONCLUSIONS: Transient response of RL circuit has been studied and the results obtained are shown on the graph.

QUIZ/ANSWERS:

Q1. Define steady state	A1. A circuit having constant sources is said to be in ste state if the currents & voltages do not change with time .
Q2. Define transient state	A2. The behaviour of the voltage or current when it is ch from one state to another state is called transient state.
Q3. Define transient time .	A3.The time taken for the circuit to change from one steady state to another steady state is called transient time

Q4. Define natural response	A4. It is defined as the response, which depends upon the nature of the circuit, when we consider a circuit containing storage elements, which are independent of sources
Q5. Define impulse function	A5. It is defined as the function having very low pulse width & very high amplitude
Q6.The transient response occurs a) only in resistive circ b)only in inductive circuit c) only in capacitive circuit d in (b) & (c)	A6. (d)
Q7. Inductor does not allow sudden changes a) in currents b) in voltages c) in both (a) & (b) d) in none of the above	A7. (a)
Q8. The time constant of series R-L circuit is (a) LR (b) L/ C (c) R/L	A8. (b)
Q9. Write the function of inductor.	A9. (i) To pass low frequency (ii) AC block , DC pass
Q10. Write the Laplace transform of Ramp function.	A10.$1/s^2$

NT LAB
EXPERIMENT NO – 4

AIM :- To study and plot the transient response of RC circuit.

APPARATUS REQUIRED : Tina Pro Software

BRIEF THEORY : Let initially the K is at 1, if it is moved to position 2, then apply KVL,

$1/C \int i\, dt + Ri = V$

Differentiating w.r.t 't'

$1/C\ i + R\, di/dt = 0$

$R di/dt = -1/C i$

$di/i = 1/RC dt$

Integrating w.r.t to'i' & then taking log on both sides

$\text{Log } i = -1/RC\ t + C_2$

$i = C_2\, e^{-t/CR}$ -----(1)

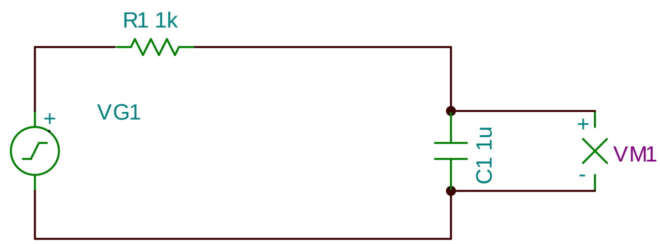
On putting I = V/R in equation (1)

$V/R = C_2 e^{-t/CR}$

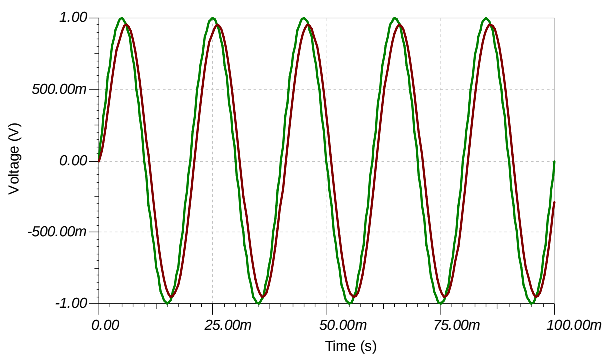
At t = 0 , $C_2 = V/R$

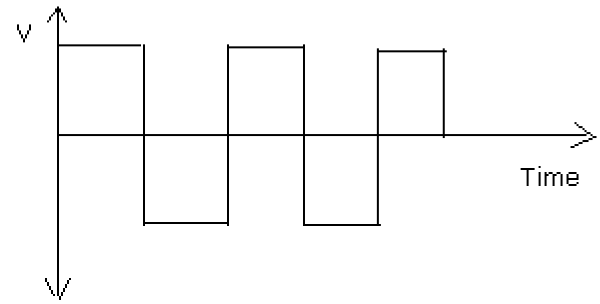
$i = V/R\ e^{-t/RC}$

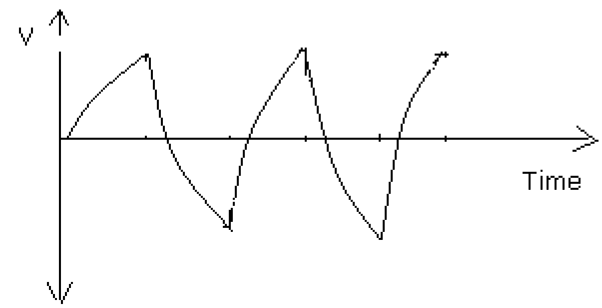
CIRCUIT DIAGRAM:



GRAPH:







RESULT/CONCLUSIONS: Transient response of RC circuit has been studied and the results obtained are shown on the graph.

DISCUSSION: The capacitor charges and discharges within one minute.

QUIZ ANSWERS:

Q1.What is the function of function generator?	A1.To provide pulses of different shapes
Q2.Capacitor does not allow sudden changes in currents b)in voltages c)in both (a) & (b) d)in none of the above	A2. (b)
Q3.Transient behaviour occurs in any circuit when a) there are sudden changes of applied voltage b) the voltage source is shorted c) the ckt. is connected or disconnected from the supply d) all the above happen.	A3. (d)
Q4.Write time constant of series R-C ckt. ?	A4.Time constant (ς) = RC.
Q5 .Write functions of capacitor?	A5. (i) To pass high frequency (ii) DC block, AC pass
Q6.How much a capacitor is charged or discharged in one minute?	A6.A capacitor is charged up to 63.2% & discharged by 37% in one minute

Q7.Write the Laplace transform of Unit impulse function	A7.Unity.
Q8.Write the other name of Unit impulse function.	A8.Direc delta.
Q9.Write application of Laplace transform.	A9. In solving the transient behaviour of the electric circuits
Q10.Write the Laplace transform of unit step function.	A10.1/s .

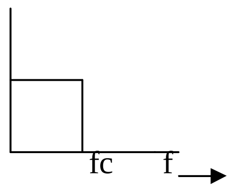
N T LAB

EXPERIMENT NO : 5

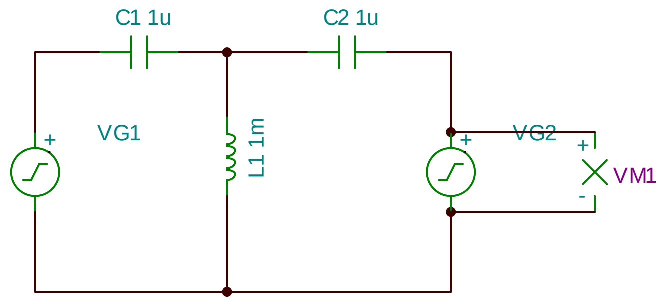
AIM: To plot the frequency response of High pass filter and determine the half-power frequency

APPARATUS REQUIRED: Tina Pro Software

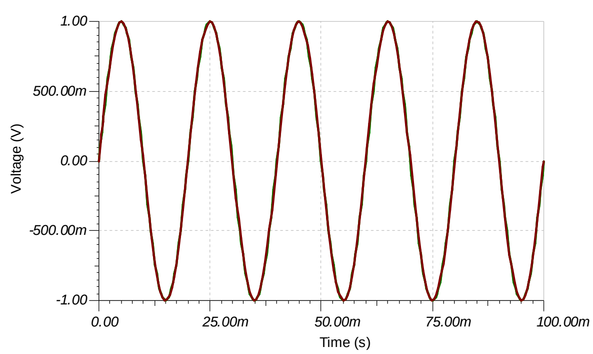
BRIEF THEORY : A HP filter attenuates all frequencies below a designated cut-off frequency f_c , & passes all freq. above f_c. Thus the pass band of this filter is the freq. range above fc & the stop band is the freq. range below fc. An attenuation characteristic of a HP filter is shown in fig.



CIRCUIT DIAGRAM:



GRAPH0:



SAMPLE CALCULATION:

$$\alpha = 20 \log V_2/V_1$$

RESULT/CONCLUSION: The frequency response of High Pass Filter has been plotted on the graph .Also its half-power frequencies has been determined.

DISCUSSION: High Pass Filter passes the frequencies above cut-off frequencies.

QUIZ/ANSWERS:

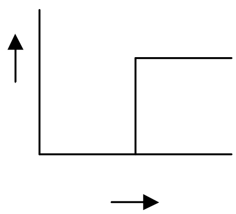
Q1 .Define Filter ?	A1. A filter is an electrical network that can transmit signals within a specified frequency range
Q2. Define Pass Band?	A2. The frequency range which is passed by the filter is called pass band
Q3. Define Stop Band?	A3. The frequency range which is suppressed by the filter is called stop band.
Q4. Define Cut-Off frequency?	A4. The frequency that separates the pass band & attenuation band is known as the cut-off frequency.
Q5. Define High Pass Filter?	A5. A high pass filter attenuates all frequency below the cut-off frequency & allows to pass all other frequencies above the cut-off frequency
Q6. A high pass filter is one which a) passes all high freq. b)attenuates all low freq. c)attenuates all freq. below a designated cut-off freq. & passes all freq. above cut-off	A6. (c)
Q7. Where filter circuits are used ?	A7. Filter circuits are used in TV receivers, audio amplifiers etc
Q8.What are the units of attenuation?	A8 . Decibles (dB) & Nepers.
Q9. An ideal filter should have a) Zero attenuation in the pass band b) Infinite attenuation in the pass band c) Zero attenuation in the attenuation band	A9. (a)
Q10.In the m-derived high pass filter, the resonant frequency is to be chosen so that it is a)Above the cut-off frequency b)Below the cut-off frequency c)None of the above	A10.(b)

<u>**N T LAB**</u>
<u>**EXPERIMENT NO: 6**</u>

<u>AIM:</u>To plot the frequency response of Low pass filter and determine the half-power frequency

<u>APPARATUS REQUIRED:</u> Tina Pro Software

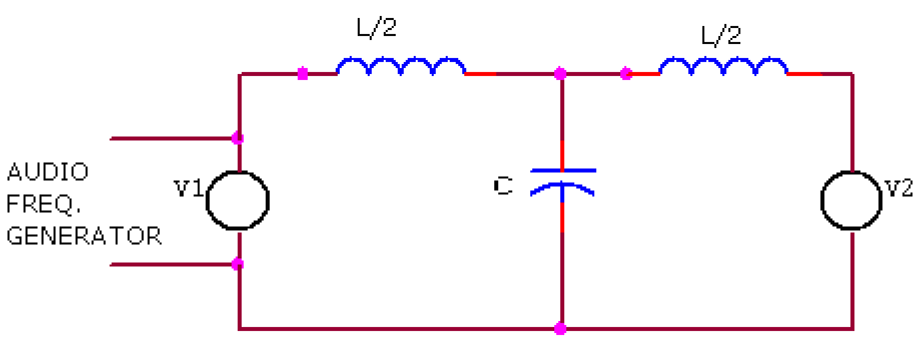
<u>BRIEF THEORY:</u> A Low pass filter is one which passes without attenuation all frequencies up to the cut-off frequency f_c & simultaneously attenuates all other frequencies greater than f_c. The attenuation characteristic of an ideal L P filter is shown in fig.



This filter transmits all frequencies from zero to cut-off frequency.The band is called pass band. The frequency range over which transmission does not take place is called the stop band.

$$\mathbf{f_c = 1/\ \pi(LC)^{1/2}}$$

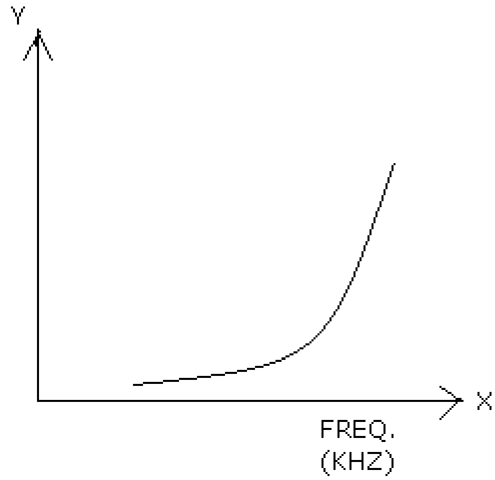
<u>CIRCUIT DIAGRAM:</u>



<u>SAMPLE CALCULATION:</u>

$\alpha = 20 \log V_2/V_1$

GRAPH:



RESULT/CONCLUSION: The frequency response of Low Pass Filter has been plotted on the graph. Also its half-power frequencies has been determined.

DISCUSSION: Low Pass Filter passes the frequencies below cut-off frequencies

QUIZ/ANSWERS:

Q1. Define Low Pass Filter?	A1.The low pass filter allows all frequencies up to the specified cut-off frequency to pass through it & attenuates all the other frequencies above the cut-off frequencies.
Q2. Define cut-off frequency?	A2. It demarcates the pass band & the stop band.
Q3. What is the freq. Range of Pass Band?	A3. The frequency range of pass band is from 0 to f_c.
Q4. What is the freq. Range of Stop Band?	A4. The frequency range of stop band is from f_c to ∞.
Q5. Relation between Decibel & Nepers?	A5. Attenuation in dB = 8.686 * attenuation in nepers
Q6.Neper ----------- *dB.	A6.0.115.
Q7.In the m-derived high pass filter, the resonant frequency is to be chosen so that it is a)Above the cut-off frequency b)Below the cut-off frequency c)None of the above	A7. (a)
Q8.Give the classification of filters depending upon the relation between Z_1 & Z_2	A8. Constant K- filters & m-derived filters.
Q9. Give the classification of filters on the basis of frequency	A9. Low pass , High pass , band pass & band elimination filters
Q10.Define decibel.	A10. It is defined as ten times the common

	logarithms of the ratio of input power to the output power.

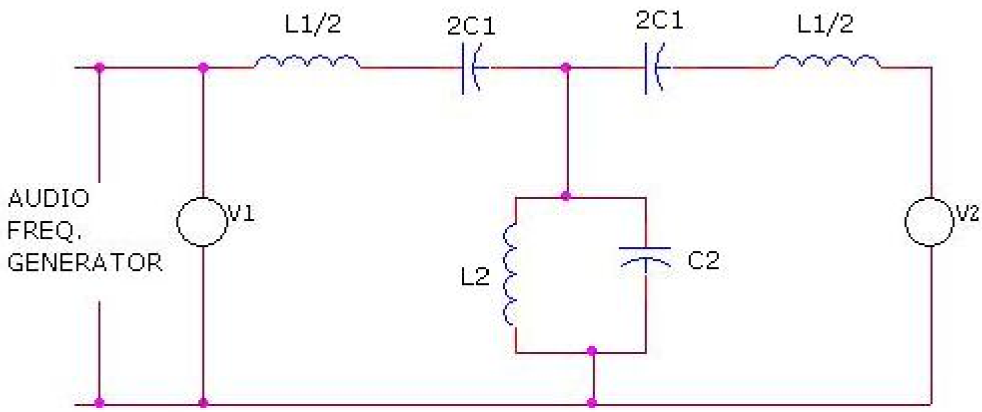
N T LAB
EXPERIMENT NO : 7

AIM: To study frequency response of Band pass filter

.**APPARATUS REQUIRED:** Tina Pro Software

BRIEF THEORY: A band pass filter passes freq. Between two designated cut-0ff freq.& attenuates all other freq. . BPF has two cut-off freq. As shown in fig. f1 is called lower cut-off freq.& f2 is upper cut-off freq.

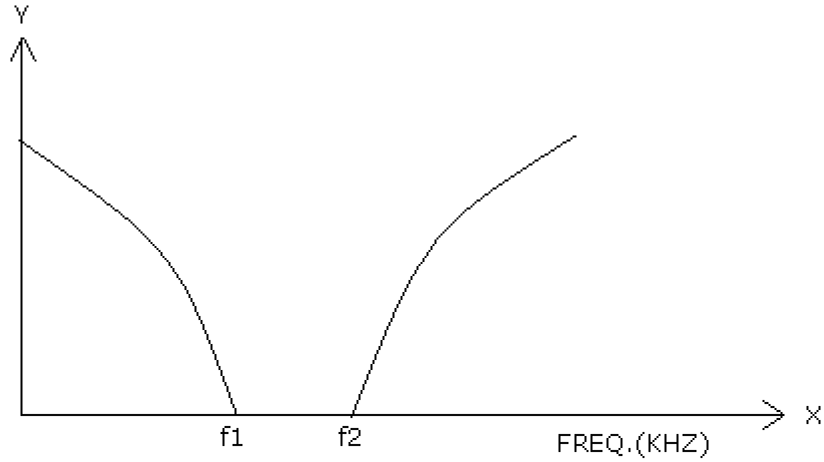
CIRCUIT DIAGRAM:



SAMPLE CALCULATION:

$\alpha = 20 \log V_2/V_1$

GRAPH:



RESULT/CONCLUSION: The frequency response of Band Pass Filter has been plotted on the graph and its bandwidth has been calculated .

DISCUSSION: The Band Pass Filter is obtained by connecting Low Pass and High Pass Filter in cascade provided that the Low Pass Filter has cut-off frequency higher than High Pass Filter.

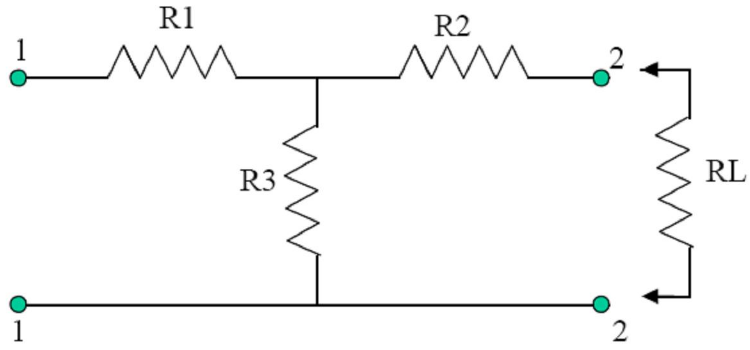
QUIZ/ANSWERS:

Q1. Define Band Pass Filter?	A1.It is a combination of two parallel tuned circuits
Q2. Can a combination of Low Pass& High Pass Filters use as a Band Pass filter, how?	A2.Yes, By cascading LPF & HPF provided that the low pass filter has cut-off frequency higher
Q3. A Band Pass Filter is one which passes all high freq. b) attenuates all low freq. c) attenuates all freq. below a designated cut-off frequency & passes all above cut-off frequency	A3. (c)
Q4. The propagation constant of a symmetrical T-section & π-section are the same (a) true (b) false	A4. True.
Q5. What is Prototype Filter?	A5. Any filter where the relationship $Z_1Z_2 = R_0^2$ is maintained is known as constant K or prototype filter.
Q6. Define Attenuators?	A6. An attenuator is a two-port resistive network & its propagation function is real
Q7. Write the expression of resonance frequency in terms of two cut-off frequencies?	A7.$f_o = (f_1 f_2)^{1/2}$.
Q8. Explain the making of High Pass Filter	A8 .Capacitors in series arm & inductor in series arm.
Q9. Define Neper .	A9.It is defined as thee natural logarithm of the ratio of input voltage (or current) to the output votage (or current) provided that the network is terminated in its characteristic impedance Z_0.
Q10. Is filter a resistive or reactive network	A10. Reactive network

B: Hardware Based

N T LAB
EXPERIMENT NO : 1

AIM: - To verify Thevenin‛s theorem.
APPARATUS: - Bread board, resistors, D.C. power supply, multimeter, connecting wires, etc.
CIRCUIT DIAGRAM:-



THEORY:-
The current flowing through the load impedance R_L connected across the terminals 2 & 2 ^{l} of a network containing impedance & energy sources is the same as it would flow if this load impedance were connected across a simple constant voltage source whose generated emf is an open circuited voltage, measured across the network terminals 2 & 2 ^{l}. Its internal impedance is the same as the impedance of the network looking back into the terminals 2 & 2 ^{l} , when all sources have been replaced by impedances and sources with output terminals 2 & 2 ^{l}. across which load impedance R_L is connected.

PROCEDURE:-

1. Apply dc voltage across terminals 1-1 ^{l} , call this voltage as V_{dc}.
2. Connect voltmeter across terminals 2-2 ^{l} and measure voltage on voltmeter. This voltage is known as open circuit voltage or Thevenin‛s voltage (V_{th}).
3. Vary the dc voltage across terminals 1-1 ^{l} and repeat step 2, take two/three readings.
4. Disconnect the applied voltage at terminals 1-1 ^{l} and voltmeter at terminals 2-2 ^{l} .
5. Now short terminals 1-1 ^{l} and connect multimeter across terminals 2-2 ^{l} . With the help of multimeter measure resistance between terminals 2-2 ^{l} . This is known as Thevenin‛s resistance (R_{th}).
6. Calculate V_{th} and R_{th} by theoretical calculations, the theoretical values and measured values of V_{th} and R_{th} should be approximately equal.
7. Connect load resistor R_L across terminals 2-2 ^{l} and measure I_L for applied dc voltage.

OBSERVATION TABLE:-

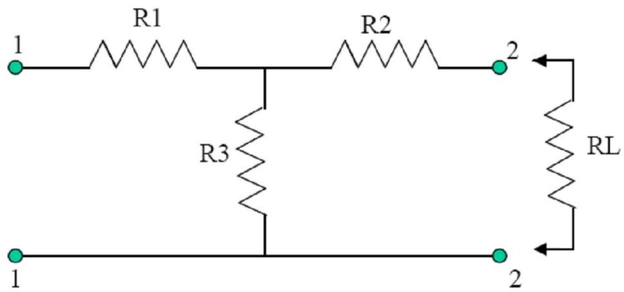
Sr.No.	Vdc	Measured values			Theoretical values		
		Rth	Vth	I_L	Rth	Vth	I_L

CONCLUSION: - The theoretical values and measured values of V_{th} and R_{th} and I_L are approximately equal, hence Thevenin's theorem has been verified.

N T LAB
EXPERIMENT NO : 2

AIM: - To verify Norton's theorem.
APPARATUS: - Breadboard, milliammeter (0-50mA), D.C. power supply (0-30V), multimeter, resistors, connecting wires, etc.

CIRCUIT DIAGRAM:-



THEORY:-
Any two terminal linear network, consisting of generators and impedances, can be replaced with an equivalent circuit consisting of a current source I_{sc} in parallel with an admittance Y_{AB} . The Isc is short circuit current between the network and Y_{AB} is the admittance measured between the terminals, with all energy sources eliminated except their internal impedances.

PROCEDURE:-

1. Apply d. c. voltage across terminals $1\text{-}1^{1}$ called this voltage V_{dc}.
2. Connect milliammeter across terminals $2\text{-}2^{1}$ and measure current, this is the short circuit (I_{sc}) current.
3. Vary the d. c. voltage across terminals $1\text{-}1^{1}$ and repeat step 2, take three readings.
4. Disconnect the applied voltage at terminals $1\text{-}1^{1}$ and milliammeter at terminals $2\text{-}2^{1}$.
5. Short terminals $1\text{-}1^{1}$ and connect Multimeter (keep it on resistance range) across terminals $2\text{-}2^{1}$, and note down the reading , this resistance is known as Req.
6. Calculate I_{sc} and R_{eq} by using formulae, the calculated values and measured values of I_{sc} and R_{th} should be approximately equal.
7. Connect R_L across terminals $2\text{-}2^{1}$ and measure I_L by milliammeter for applied D.C. voltage.

OBSERVATION TABLE:-

Sr.No.	Vdc	Measured values			Calculated values		
		Isc	Req	I_L	Isc	Req	I_L

CONCLUSION: - The Calculated values and measured values of I_{sc}, I_L, R_{eq} are approximately equal; hence Norton's theorem has been verified.

N T LAB
EXPERIMENT NO : 3

AIM: To calculate and verify 'Z' parameters of two-port network

APPARATUS REQUIRED : Power Supply, Bread Board, Five resistances, Connecting Leads Voltmeter , Ammeter

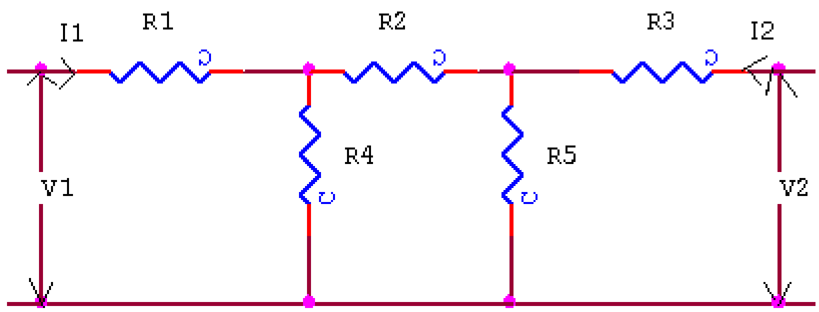
BRIEF THEORY : In Z parameters of a two-port , the input & output voltages V_1 & V_2 can be expressed in terms of input & output currents I_1 & I_2. Out of four variables (i.e V_1 ,V_2 , I_1 , I_2) V_1& V_2 are dependent variables whereas I_1 & I_2 are independent variables .Thus ,

$$V_1 = Z_{11}I_1 + Z_{12} I_2 \quad \text{-----(1)}$$

$$V_2 = Z_{21}I_1 + Z_{22} I_2 \quad \text{----(2)}$$

Here Z_{11} & Z_{22} are the input & output driving point impedances while Z_{12} & Z_{21} are the reverse & forward transfer impedances.

CIRCUIT DIAGRAM:



PROCEDURE:

a) Connect the circuit as shown in fig. & switch 'ON' the experimental board.

b) First open the O/P terminal & supply 5V to I/P terminal. Measure O/P Voltage & I/P Current

c) Secondly, open the I/P terminal & supply 5V to O/P terminal. Measure I/P Voltage & O/P Current using Multimeter.

d) Calculate the values of Z parameter using Equation (1) & (2).

e) Switch 'OFF' the supply after taking the readings.

OBSERVATION TABLE:

S.N.O	When I/P is open ckted			When O/P is open ckted		
	V_2	V_1	I_2	V_2	V_1	I_1

SAMPLE CALCULATION:

(1) When O/P is open circuited i.e. $I_2 = 0$

$Z_{11} = V_1/I_1$ $Z_{21} = V_2/I_1$

(2) When I/P is open circuited i.e. $I_I = 0$

$Z_{12} = V_1/I_2$ $Z_{22} = V_2/I_2$

RESULT/CONCLUSION: The Z-parameters of the two port network has been calculated and verified .

DISCUSSION: The Z-parameters are open circuit parameters

PRECAUTIONS:

a) Make the connections according to the circuit diagram. Power supply should be switched off.
b) Connections should be tight.
c) Note the readings carefully.

QUIZ /ANSWERS:

Q1. Define Z parameters?	A1. In Z parameters, the input & output voltages V_1 & V_2 can be expressed in terms of input & output currents I_1 & I_2 .
Q2. List the four variables used in Z- parameter representation	A2.The four variables are V_1 , V_2 , I_1 & I_2
Q3. List the two dependent variables used in Z-parameter representation	A3.The two dependent variables are V_1 & V_2 .
Q4. List the two independent variables used in Z- parameter representation.	A4. The two independent variables are I_1 & I_2 .
Q5. Define input driving point impedance	A5.The input driving point impedance is defined as the ratio of input voltage to the input current
Q6. Define output driving point impedance	A6. The output driving point impedance is defined as the ratio of output voltage to the output current.
Q7. Define reverse transfer impedance.	A7.The reverse transfer impedance is defined as ratio of input voltage to the output current
Q8. Define forward transfer impedance	A8. The forward transfer impedance is defined as ratio of output voltage to the input current

Q9. Write condition for reciprocity.	A9.Condition for reciprocity is $Z_{12} = Z_{21}$.
Q10.Write condition for symmetry.	A10.Condition for symmetry is $Z_{11} = Z_{22}$.

NT LAB
EXPERIMENT NO : 4

AIM: To calculate and verify 'Y' parameters of two-port network

APPARATUS REQUIRED :.Power supply, Bread Board, Five resistances, Connecting Leads, Voltmeter , Ammeter .

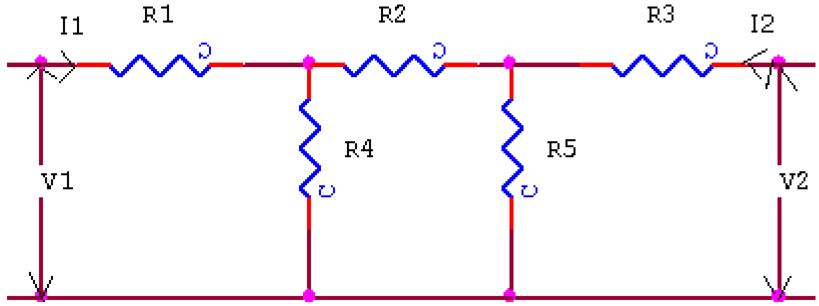
BRIEF THEORY : In Y parameters of a two-port , the input & output currents I_1 & I_2 can be expressed in terms of input & output voltages V_1 & V_2 . Out of four variables (i.e I_1 , I_2 , V_1 , V_2) I_1& I_2 are dependent variables whereas V_1 & V_2 are independent variables.

$$I_1 = Y_{11}V_1 + Y_{12}V_2 \quad \text{------(1)}$$

$$I_2 = Y_{21}V_1 + Y_{22}V_2 \quad \text{-------(2)}$$

Here Y_{11} & Y_{22} are the input & output driving point admittances while Y_{12} & $Y_{21}$are the reverse & forward transfer admittances.

CIRCUIT DIAGRAM:



PROCEDURE :

a) Connect the circuit as shown in fig. & switch 'ON' the experimental board.

b) First short the O/P terminal & supply 5V to I/P terminal. Measure O/P & I/P current

c) Secondly, short the I/P terminal & supply 5V to O/P terminal. Measure I/P & O/P current using multimeter.

d) Calculate the values of Y parameter using Eq. (1) & (2) .

e) Switch 'off' the supply after taking the readings.

OBSERVATION TABLE:

S.N.O	When I/P is short ckted			When O/P is short ckted		
	V_2	I_1	I_2	V_1	I_1	I_2

SAMPLE CALCULATION:

(1) When O/P is short circuited i.e. $V_2 = 0$

$Y_{11} = I_1/V_1$ $\quad$ $Y_{21} = I_2/V_1$

(2) When I/P is short circuited i.e. $V_I = 0$

$Y_{12} = I_1/V_2$ $\quad$ $Y_{22} = I_2/V_2$

RESULT/CONCLUSION: The Y-parameters of the two port network has been calculated and verified .

DISCUSSION: The Y-parameters are short circuit parameters

PRECAUTIONS :

a) Make the connections according to the circuit diagram. Power supply should be switched off.
b) Connections should be tight.
c) Note the readings carefully.

QUIZ/ANSWERS :

Q1. Define Y parameters ?	A1.In Y-parameters the input & output currents I_1 & I_2 can be expressed in terms of input & output voltages V_1 & V_2 .
Q2. List the four variables used in Y- parameter representation	A2.The four variables are I_1 , I_2 , V_1 and V_2 .
Q3. List the two dependent variables used in Y-parameter representation	A3.The two dependent variables are I_1 & I_2
Q4. List the two independent variables used in Y- parameter representation	A4. The two independent variables are V_1 & V_2 .
Q5. Define input driving point admittance	A5.The input driving point admittance is defined as the ratio of input current to the input voltage .
Q6. Define output driving point admittance	A6. The output driving point admittance is defined as the ratio of output current to the output voltage .
Q7. Define reverse transfer admittance	A7.The reverse transfer ratio is defined as ratio of input current to the output voltage
Q8. Define forward transfer admittance	A8. The forward transfer ratio is defined as ratio of output current to the input voltage

Q9. Write condition for reciprocity .	A9.Condition for reciprocity is $Y_{12} = Y_{21}$.
Q10. Write condition for symmetry.	A10.Condition for symmetry is $Y_{11} = Y_{22}$

N T LAB
EXPERIMENT NO: 5

AIM: To calculate and verify 'ABCD' parameters of two-port network

APPARATUS REQUIRED: Power Supply, Bread Board, Five resistances, Connecting Leads Voltmeter, Ammeter.

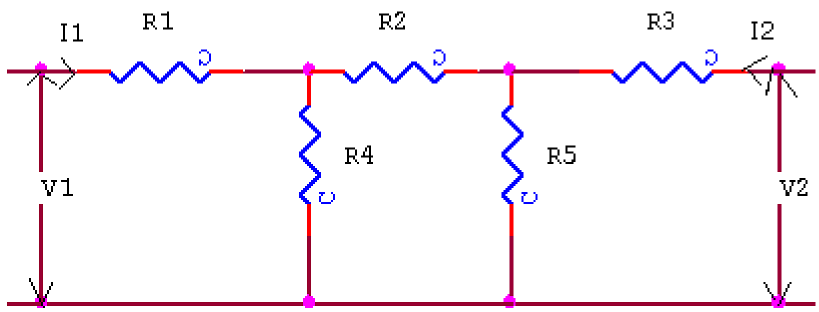
BRIEF THEORY: ABCD parameters are widely used in analysis of power transmission engineering where they are termed as " Generalized Circuit Parameters" . ABCD parameters are also known as "Transmission Parameters". In these parameters, the voltage & current at the sending end terminals can be expressed in terms of voltage & current at the receiving end. Thus,

$$V_1 = AV_2 + B(-I_2)$$

$$I_1 = CV_2 + D(-I_2)$$

Here "A" is called reverse voltage ratio, "B" is called transfer impedance "C" is called transfer admittance & "D" is called reverse current ratio.

CIRCUIT DIAGRAM:



PROCEDURE :

a) Connect the circuit as shown in fig. & switch 'ON' the experimental board.
b) First open the O/P terminal & supply 5V to I/P terminal. Measure O/P voltage & I/P current
c) Secondly, short the O/P terminal & supply 5V to I/P terminal. Measure I/P & O/P current using multimeter.
d) Calculate the A, B, C, & D parameters using the Eq. (1) & (2).

OBSERVATION TABLE:

S.N.O	When O/P is open ckted	When O/P is short ckted

	V_1	V_2	I_1	V1	I_2	I_1

SAMPLE CALCULATION:

(1)When O/P is open circuited i.e. I2 = 0

$A = V_1/V_2$ $\qquad$ $C = I_1/V_2$

(2) When O/P is short circuited i.e. V2 = 0

$B = -V_1/I_2$ $\qquad$ $D = -I_1/I_2$

RESULT/CONCLUSION: The ABCD-parameters of the two-port network has been calculated and verified.

DISCUSSION: ABCD parameters are transmission parameters

PRECAUTIONS:

a) Make the connections according to the circuit diagram. Power supply should be switched off.

b) Connections should be tight.

c) Note the readings carefully.

QUIZ/ANSWERS:

Q1. Define transmission parameters	A1. In these parameters, the voltage & current at the sending end terminals can be expressed in terms of voltage & current at the receiving end.
Q2. Why ABCD parameters are also called as transmission parameters?	A2. ABCD parameters are also called as transmission parameters because these are used in the analysis power transmission lines
Q3. Where they are used?	A3. Transmission line theory & cascade network
Q4. Define reverse voltage ratio(A) .	A4. It is defined as the ratio of sending end voltage to the receiving end voltage
Q5. Define transfer impedance (B).	A5. It is defined as the ratio of sending end voltage to the receiving end current with the receiving end current assumed to be in reverse direction

Q6. Define transfer admittance (C).	A6. It is defined as the ratio of sending end current to the receiving end voltage
Q7. Define reverse current ratio (D).	A7. It is defined as the ratio of sending end current to the receiving end current with the receiving end current assumed to be in reverse direction
Q8. Write the units of parameters B & C.	A8. Unit of parameter B is ohm & of C is mho.
Q9. Write the units of parameters A & D.	A9. Both parameters A & D are unitless.
Q10.Write the condition for symmetry & reciprocity.	A10.The condition for symmetry is A = D & the condition for reciprocity is AD – BC = 1.

N T LAB
EXPERIMENT NO : 6

AIM: To determine equivalent parameters of parallel connection of two-port network

APPARATUS REQUIRED: Power Supply, Bread Board, Five Resistances, Connecting Leads, Voltmeter, Ammeter

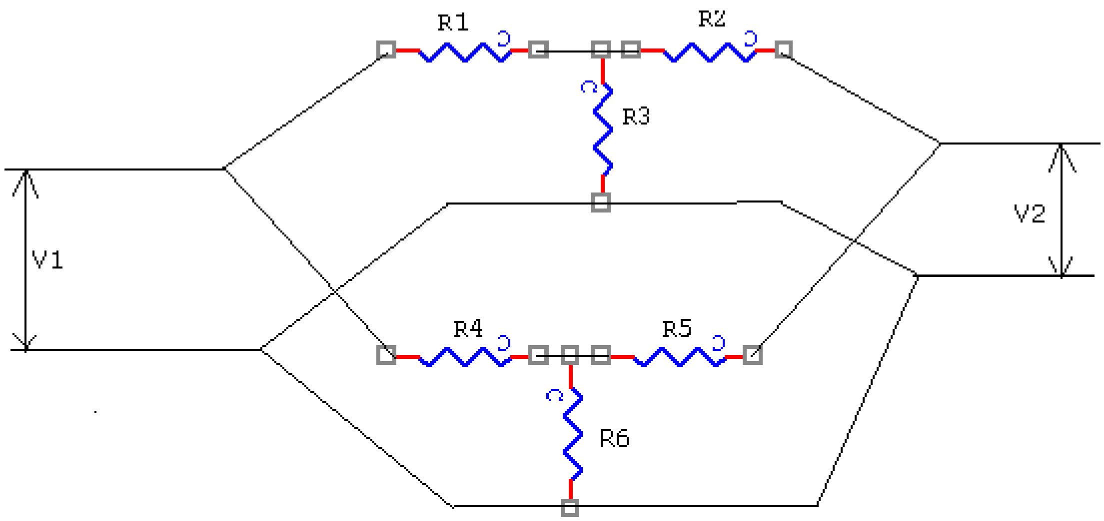
BRIEF THEORY: Consider two port N/Ws connected in parallel so that they have common reference node, then the equation of the N/Ws A&B in terms of Y parameters are given by

$$Y11 = Y11A + Y11B$$
$$Y12 = Y12A + Y12B$$
$$Y21 = Y21\ A + Y21\ B$$
$$Y22 = Y22\ A + Y22\ B$$

Thus we see that each Y parameter of the parallel N/W is given as the sum of the corresponding parameters of the individual N/Ws.

CIRCUIT DIAGRAM:

5



PROCEDURE:

a) Connect the N/Ws A&B separately on the Bread board according to the fig.
b) Take the Reading according to the observation table & calculate Y parameters
c) for both N/Ws & add them.
d) Connect the two N/Ws A&B in parallel & take the readings.
e) Calculate the Y parameters of llel connected N/Ws.
f) Verify that the sum of parameters of A&B N/Ws is equal to the parameters of
g) parallel connected N/Ws.

OBSERVATION TABLE:

S.N.O	When I/P is short ckted			When O/P is short ckted		
	V_2	I_1	I_2	V_1	I_1	I_2

SAMPLE CALCULATION:

(3) When O/P is short circuited i.e. $V_2 = 0$

$Y_{11} = I_1/V_1$ $Y_{21} = I_2/V_1$

(4) When I/P is short circuited i.e. $V_1 = 0$

$Y_{12} = I_1/V_2$ $Y22 = I_2/V_2$

RESULT/CONCLUSION: The Y-parameters of parallel connection of two-port network has been determined .

DISCUSSION: The overall Y-parameters of a parallel connection is equal to sum of individual network parameters.

PRECAUTIONS:

a) Make the connections according to the circuit diagram. Power supply should be switched off.
b) Connections should be tight.
c) Note the readings carefully.

QUIZ/ANSWERS:

Q1. What will be the total admittance if the two networks are connected in series?	A1. The total admittance (Z) = $Z_1 + Z_2$
Q2. What will be the total admittance if the two networks are connected in parallel ?	A2. The total admittance (Y) = $Y_1 + Y_2$
Q3. Which parameter is used for the representation of parallel connection of two port network ?	A3.Y-parameters
Q4 .Which parameter is used for the representation of series connection of two port network ?	A4. Z-parameters
Q5. Difference between Z & Y parameters	A5. Z-parameters are called open circuit parameters while Y-parameters are called short circuit parameters. Z-parameters are used for series connection while Y-parameters are used for parallel connection.
Q6 .What do you mean by cascade connection?	A6.The network is said to be in cascade when the output of one port becomes the input for second network.

Q7. Is Z inversely proportional to Y in one port network?	A7.Yes.
Q8.Is Z inversely proportional to Y in two port network?	A8.No.
Q9.A two port network is simply a network inside a black box & the network has only a) two terminals b) two pairs of accessible terminals two pairs of ports	A9.(b)
Q10.The number of possible combinations generated by four variables taken two at a time in a two-port network is (a) Four (b) two (c) six	A10.(c)