NETWORK ANALYSIS & SYNTHESIS LAB MANUAL

NEC-351

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SYLLABUS FOR NETWORK ANALYSIS & SYNTHESIS LAB

NEC -351: NETWORK ANALYSIS & SYNTHESIS LAB

1. Verification of principle of superposition with dc and ac sources.
2. Verification of Thevenin, Norton and Maximum power transfer theorems in ac circuits
3. Verification of Tellegin's theorem for two networks of the same topology.
4. Determination of transient response of current in RL and RC circuits with step voltage input.
5. Determination of transient response of current in RLC circuit with step voltage input for under damp, critically damp and over damp cases
6. Determination of frequency response of current in RLC circuit with sinusoidal ac input
7. Determination of z and h parameters (dc only) for a network and computation of Y and ABCD parameters.
8. Determination of driving point and transfer functions of a two port ladder network and verify with theoretical values.

STUDY AND EVALUATION SCHEME

SESSIONAL EVALUATION:-

CLASS TEST	**:**	**10 MARKS**
TEACHER'S ASSESMENT	**:**	**10 MARKS**
EXTERNAL EXAM	**:**	**30 MARKS**
TOTAL	**:**	**50 MARKS**

LIST OF EXPERIMENTS

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1. Verification of principle of superposition with dc and ac sources.
2. Verification of Thevenin, Norton and Maximum power transfer theorems in ac circuits
3. Verification of Tellegin's theorem for two networks of the same topology.
4. Determination of transient response of current in RL and RC circuits with step voltage input.
5. Determination of transient response of current in RLC circuit with step voltage input for under damp, critically damp and over damp cases
6. Determination of frequency response of current in RLC circuit with sinusoidal ac input
7. Determination of z and h parameters (dc only) for a network and computation of Y and ABCD parameters.
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S.NO.	NAME OF EXPERIMENT	DATE OF EVALUATION	GRADE

Experiment No.-1

Objective:
Study and verification of the DC Norton's theorem.

Equipments required:
1. Digital Multimeter
2. 2 mm patch cords
3. NV6509A Kit.

Circuit diagram:
Circuit used to study DC Norton's theorem is shown in Figure on NV6509A Kit.

Theory:
A linear active network consists of independent and 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.

R_N:

Calculate R_N by first setting all sources to zero (voltage sources are replaced by short circuits and current sources by open circuits) and then finding the resultant resistance between the two marked terminals. (If the internal resistance of the voltage and/or current sources is included in the original network, it must remain when the sources are set to zero.)

$R_N = R_3 + (R_1R_2 /R_1+R_2)$

I_N:

Calculate I_N by first short the load and find the short circuit current flowing through the shorted load terminals using conventional network analysis. $I_N = I (R_2/R_2+R_3)$ Norton's equivalent circuit is drawn by keeping R_N in parallel to current source as shown in Figure 1. Reconnect the load resistance (R_L) across the load terminal.

Procedure:
- Measure practical value of Norton's equivalent current IN of given circuit. Connect terminal 13 with +5V supply and terminal 16 with the ground as shown in figure.
- Measure current between terminals 14 and 17, for this, connect probs of multimeter between the terminals 14 and 17. It is the required value of Norton current IN.
- To measure theoretical value of Norton's equivalent current I_N. This is the value of current I flowing through 475E resistor. Value of I is calculated with the help of basic current laws.
- Compare theoretical and practical value of Norton's equivalent current IN.

To measure practical value of Norton's equivalent Resistance R_N of given circuit, proceed as follows:

- Disconnect the 2mm patch cord between terminals 13 and supply.

- Connect terminals 13 and terminal 16 so as to replace source by its internal resistance (assuming it negligible).
- Measure resistance between terminals 14 and terminal 17 using multimeter.
- It is the required value of Norton's equivalent resistance R_L.
- Measure theoretical value of Norton's equivalent resistance RN between terminals 14 and terminal 17 of the given circuit by using fundamentals of resistance in series and parallel.
- Compare theoretical and practical value of Norton's equivalent resistance R_N.
- To compare the given circuit with its Norton's equivalent circuit proceed as follows:
- Connect terminal 13 with +5V supply and terminal 16 with Gnd.
- Set the value of load resistance (RL) of given circuit and load of equivalent circuit same and equal.
- Connect multimeter between terminals 14 and 15 to measure load current I_L flowing through load resistance of given circuit.
- Connect terminal 22 and terminal 23 and Connect multimeter between terminals 18 and 19 and examine the value of current. This current is same as IN of the Linear circuit.
- Now we will measure load current (IL) in equivalent circuit. Procedure is as follows:
- Connect terminal 18 and 19 with the help of patch cord. Similarly terminal 22 and 23 are also to be connected.
- Connect a multimeter between terminals 20 and 21 to measure load current (IL) flowing through load resistance of Norton's equivalent circuit.
- Compare load current (IL) flowing through load resistance of linear circuit and load resistance of equivalent circuit.

Result:

- Theoretical value of Norton's equivalent current IN = …………
- Practical value of Norton's equivalent current IN =……………..
- Theoretical value of Norton's equivalent resistance RN = ……...
- Practical value of Norton's equivalent resistance RN = …………

(Yes/No), the value of_________ current is flowing through the load resistance of linear circuit and load resistance of equivalent circuit. In both the cases value of IL will be approximately equal. Hence Norton's theorem is verified.

Experiment No.-2

Objective:
Study and verification of the AC Superposition theorem.

Equipments required:
1. Digital multimeter.
2. 2 mm patch cords.
3. NV6509A

Circuit diagram:
Circuit used to study Superposition theorem is shown in Figure on Kit **NV6509A**.

Theory:
The total current in any part of a linear circuit equals the algebraic sum of the currents produced by each source separately. The Superposition theorem is an important concept in circuit analysis. It allows you to determine a voltage across a component or a branch current by calculating the effect of each source individually, and then algebraically adding each contribution.Superposition may be considered for circuit analysis when

- There are two or more energy sources.
- The sources are either voltage or current sources.
- The circuit is not too complex.

There are six steps used in applying the Superposition theorem to a circuit.

1. Select one energy source.
2. Remove all other sources by replacing voltage source with a short while retaining any internal source resistance.
3.Replacing current source with an open while retaining any internal resistances.
4.Calculate the desired voltage drops or branch currents paying attention to the voltage polarities and current directions.
5. Repeat steps 1 through 3 for each other source individually.
6. Algebraically add the contributions of each voltage or current.

Procedure:
1. To connect +12V AC supply, connect terminal 1 with terminal 24 and terminal 2 with terminal 28 with the help of patch cords.
2. To connect 6V AC supply, connect terminal 3 with terminal 27 and terminal 4 with terminal 31.
3. Short the terminal 26 with terminal 30 with the help of patch cord.
4. Connect multimeter between terminals 25 and 29 to measure current flowing through branch CD in presence of both voltage sources, say it is I.
5. Remove one of the supply (say 6V AC supply) from branch GH by disconnecting patch cords between terminal 27 and 31.
6. Short the terminal 27 and terminal 31 with the help of patch cord.

7. Measure the value of current flowing through branch CD in presence of single voltage source of 12V AC supply, say it is I'.

8. This time remove other supply (say 12V AC supply) from branch AB by disconnecting patch cords between terminals 1 and 24, 2 and 28.

9. Short the terminal 24 with terminal 28 with the help of patch cord.

10. Measure the value of current flowing through branch CD in presence of single voltage source of 6V AC supply, Say it is I''.

11. Compare the amount of current flowing in presence of both of the source with the sum of current flowing in case of individual source. These currents must follow the relation I=I'+I''

12. Repeat above procedure for other branches..

Result

(Yes/No), the sum of________ current flowing through branches in case of individual sources is nearly equals to the amount of current flowing through the same branch in case of both of the sources.

Experiment No – 3

Objective:
Study and verification of the DC Superposition theorem.

Equipments required:
1. Digital multimeter.
2. 2 mm patch cords.

Circuit diagram:
Circuit used to study Superposition theorem is shown in Figure on Kit.

Theory:
The total current in any part of a linear circuit equals the algebraic sum of the currents produced by each source separately. The Superposition theorem is an important concept in circuit analysis. It allows you to determine a voltage across a component or a branch current by calculating the effect of each source individually, and then algebraically adding each contribution. Superposition may be considered for circuit analysis when

- There are two or more energy sources.
- The sources are either voltage or current sources.
- The circuit is not too complex.

There are six steps used in applying the Superposition theorem to a circuit.

1. Select one energy source.
2. Remove all other sources by replacing voltage source with a short while retaining any internal source resistance.
3.Replacing current source with an open while retaining any internal resistances.
4.Calculate the desired voltage drops or branch currents paying attention to the voltage polarities and current directions.
5. Repeat steps 1 through 3 for each other source individually.
6. Algebraically add the contributions of each voltage or current.

Procedure:
1. Connect +12V DC power supply between terminal 32 and terminal 36. +12V terminal is to be connected with terminal 32 and ground is to be connected with terminal 36.
2. Connect +5V DC power supply between terminal 35 and terminal 39. +5V terminal is to be connect with terminal 35 and ground is to be connected with terminal 39.
3. Short the terminals 34 and 38 with the help of a patch cord.
4. Connect multimeter between terminals 33 and 37 to measure current flowing through branch CD in presence of both voltage sources, say it is I.
5. Remove one of the supply (say +12V) from branch AB by disconnecting patch cords between terminal 32 and +12V supply, 36 and Gnd.

6. Short the terminal 32 and terminal 36 with the help of patch cord.

7. Measure the value of current flowing through branch CD in presence of single voltage source of +5V, say it is I'.

8. This time remove other supply (say +5V) from branch GH by disconnecting patch cords between terminals 35 & +5V supply, 39 & Gnd.

9. Short the terminal 35 and terminal 39 the help of patch cord.

10. Measure the value of current flowing through branch CD in presence of single voltage source of + 5V, Say it is I''.

11. Compare the amount of current flowing in presence of both of the source with the sum of current flowing in case of individual source. These currents must follow the relation I=I'+I''

12. Repeat above procedure for other branches like EF.

Result:

________ (Yes/No), the sum of current flowing through branches in case of individual sources is nearly equals to the amount of current flowing through the same branch in case of both of the sources.

Experiment No.- 4

Objective:
Study and verification of the AC Reciprocity Theorem.

Equipments required:
1. Digital multimeter
2. 2 mm patch cords

Circuit diagram:
Circuit used to verify AC Reciprocity theorem is shown in Figure on Kit **NV6509A**.

Theory:
The Reciprocity theorem is applicable only to single-source networks and states the following: The current I in any branch of a network, due to a single voltage source E anywhere in the network, will equal the current through the branch in which the source was originally located if the source is placed in the branch in which the current I was originally measured. The location of the voltage source and the resulting current may be interchanged without a change in current. In other words, The current in any branch of a network, due to a single voltage source E anywhere else in the network, will equal the current through the branch in which the source was originally located if the source is placed in the branch in which the current I was originally measured. If Vs = Vs' then I1' = I2 Actually exists: (I1'/ Vs') = (I2/ Vs)

Procedure:
1. Connect 12V AC supply between terminal 24 and terminal 28.
2. Connect terminal 25 with terminal 29 and terminal 26 with terminal 30.
3. Connect multimeter between terminal 27 and 31 to measure current flowing through branch GH in the presence of single voltage source 12V AC supply in branch AB.
4. Interchange the position of supply and multimeter i.e., remove 2mm patch cord between terminal 1 and 24, 2 and 28, and multimeter from terminals 27 and 31 and connect 2mm patch cords between terminals 1 and 27, 2 and 31, 25 and 29, 26 and 30.
5. Connect an multimeter between terminals 24 and 28 to measure current flowing through branch AB in presence of 12V AC supply in branch GH.
6. Repeat above steps for the measurement of current flowing through any branch in the presence of voltage source of 6V AC supply in other branch also. Measure the current flow after interchanging position of supply and multimeter, as done above.
7. Compare the current flowing in first branch, when the source is in second branch, with the current flow in second branch when the source is in first branch.

Result:
________ (Yes/No), the current flowing in branch one, when the source is in the second branch is equal to the current flowing in second branch, when the source and
mutlimeter are interchanged.

Experiment No – 5

Objective:
Study and verification of the DC Reciprocity theorem.

Equipments required:
1. Digital multimeter.
2. 2 mm patch cords.

Circuit diagram:
Circuit used to verify DC Reciprocity theorem is shown in Figure on Kit.

Theory:
The Reciprocity theorem is applicable only to single-source networks and states the following: The current I in any branch of a network, due to a single voltage source E anywhere in the network, will equal the current through the branch in which the source was originally located if the source is placed in the branch in which the current I was originally measured. The location of the voltage source and the resulting current may be interchanged without a change in current. In other words, The current in any branch of a network, due to a single voltage source E anywhere else in the network, will equal the current through the branch in which the source was originally located if the source is placed in the branch in which the current I was originally measured. If Vs = Vs' then I1' = I2 Actually exists: (I1'/ Vs') = (I2/ Vs)

Procedure:
1. Connect +12V DC power supply with terminal 32 and Gnd with terminal 36 respectively.
2. Connect 2mm patch cords between terminal 33 and terminal 37, terminal 34 and terminal 38.
3. Connect Multimeter between terminal 35 and 39 to measure current flowing through branch GH in the presence of +12V supply in branch AB.
4. Interchange the position of supply and multimeter i.e., remove 2mm patch cord between +12V supply and terminal 32, terminal 36 and Gnd, and multimeter from terminals 35 and 39 and connect 2mm patch cords between +12 V supply and terminal 35, connect Gnd to39, 33 to 37 and 34 to 38.
5. Connect an multimeter between terminals 32 and 36 to measure current flowing through branch AB in presence of +12V supply in branch GH.
6. Repeat above steps for the measurement of current flowing through any branch in the presence of voltage source of +5V in other branch also. Measure the current flow after interchanging position of supply and multimeter, as done above.
7. Compare the current flowing in first branch, when the source is in second branch, with the current flow in second branch when the source is in first branch.

Result:
________ (Yes/No), the current flowing in branch one, when the source is in the second branch is equal to the current flowing in second branch, when the source an multimeter (ammeter) are interchanged.

Experiment No - 6

Objective :

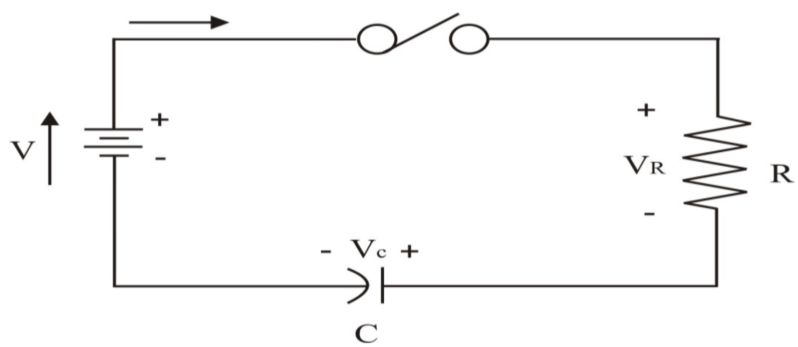
Study the transient response of a series RC circuit and understand the time constant concept with DC Power Supply.

Equipment Needed :

1. Digital Storage Oscilloscope (DSO)
2. NV6514 Kit

Theory:

When a circuit is switched from one condition to another either by a change in the applied voltage or a change in one of the circuit elements, there is a transitional period during which the branch currents and voltage drops change from their former values to new ones. After this transition interval called the transient, the circuit is said to be in the steady state.



Procedure :

Make the connections on the **NV6514 Transient Analysis of RC/RL Circuits** as shown in figure.

1. Make sure that the toggle switch connected across the DC Supply is in downward position.

2. Connect +5V DC Power Supply to the input of RC Circuit i.e., connect +5V terminal to terminal 1 and Gnd terminal to terminal 2.

3. Connect the mains cord to the Trainer and switch ‘On’ the mains supply.

4. Now switch ‘On’ the power switch of the trainer.

5. Switch the toggle switch in upward direction so that DC Supply will connect to the RC circuit.

6. Connect DSO across capacitor i.e. across TP1 and TP2. Keep DSO at 10 seconds or more Time Base.

7. Observe the transient response (exponentially rising) on DSO till the steady state (+5V DC level) is achieved i.e. for 50 seconds.

8. Now switch the toggle switch in downward direction so that resistor, R will short with capacitor, C.

9. Now observe the response (exponentially decaying) till it reaches reference level of DSO. Now
immediately press RUN/STOP Switch of DSO to hold the response shown on the DSO screen.

Calculations :

1. Theoretically,

Time Constant, TC = R C = ……………..

where R = 10 k , C = 1000 μF.

Practically (on DSO screen),

In the charging circuit, Time Constant is the time by which the capacitor attains the 63.2% of steady state voltage or final value (in our case, +5 V).

Time Constant or Time required to rise to 63.2% of 5 V
(i.e. 3.16 V) =…………

In the discharging circuit, Time Constant is time by which the capacitor discharges to 36.8% of its initial steady state voltage (in our case, +5 V).

Time Constant or Time required to decay to 36.8% of 5V
(i.e. 1.84 V) = ………….

2. Similarly, 2TC is the time required to achieve 86.5% of final or initial value of voltage.

Practically, 2TC = ……….

Theoretically, 2TC =……...

3. After 5TC, the voltage reach their final values which is also called steady state response..

Practically, 5TC = ……….

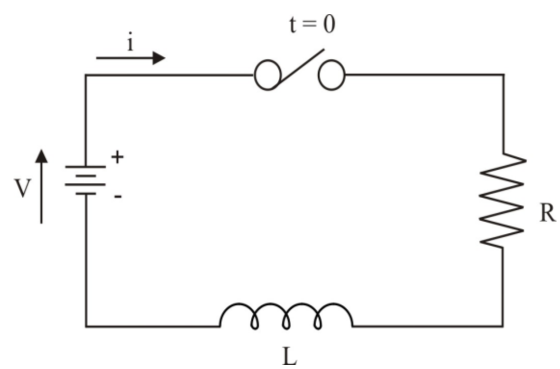
Theoretically, 5TC =……...

Experiment No – 7

Objective:
Study the transient response of a series RL circuit and understand the time constant concept with DC Power Supply.

Equipment Needed:
1. Digital Storage Oscilloscope (DSO)

Theory:
When a circuit is switched from one condition to another either by a change in the applied voltage or a change in one of the circuit elements, there is a transitional period during which the branch currents and voltage drops change from their former values to new ones. After this transition interval called the transient, the circuit is said to be in the steady state.



Procedure :
Make the connections on the **NV6514 Transient Analysis of RC/RL Circuits** as shown in figure.

1. Make sure that the toggle switch connected across the DC Supply is in downward position.

2. Connect +5 V DC Power Supply to the input of RL Circuit i.e. connect +5 V terminal to terminal 3 and Gnd terminal to terminal 4.

3. Connect the mains cord to the Trainer and switch ‘On’ the mains supply.

4. Now switch ‘On’ the power switch of the trainer.

5. Switch the toggle switch in upward direction so that DC Supply will connect to the RL circuit.

6. Connect DSO across inductor i.e. across TP1 and TP2. Keep DSO at 200 µs or 500 µs Time Base.

7. Observe the transient response (firstly sudden increase in voltage and then exponentially decaying) on DSO. Now immediately press RUN/STOP Switch of DSO to hold the response shown on the DSO screen.

8. Now switch the toggle switch in downward direction so that resistor, R will short with Inductor, L.

9. Now observe the response till it (first sudden increase of voltage in negative direction and then exponentially rising towards reference level) reaches reference level of DSO.

Calculations :

Theoretically,

Time Constant, TC =

L/R = ……………..

where

L = 141.37mH, R =1k

Practically (on DSO screen),

In the charging circuit, One Time Constant is the time by which the inductor attains the 36.8% of maximum

voltage (in our case, +5 V).

Time Constant or Time required to decay to 36.8% of 5 V (i.e. 1.84 V)= ………….