E-Content DEPARTMENT OF PHYSICS

GOVT. V.Y.T.PG AUTONOMOUS COLLEGE DURG 491001 CHHATTISGARH



Module: Superposition Theorem and its circuit diagram

Module is divided in four sections:

- 1. VIDEO CONTENT
- 2. (a) NOTES
 - (b) SUPPLEMENTARY MATERIAL
- 3. SUBJECTIVE ASSIGNMENT BASED ON MODULE
- 4. OBJECTIVE QUESTION BASED ON MODULE
- 5. FEEDBACK SECTION

Video Content: https://youtu.be/AfDpqpVETB4

In this video I explained Statement and derivation of Superposition theorem.



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Superposition Theorem
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2(a) NOTES age No. Superposition Theorem - 3. in any Statement- According to this theorem in any linear network containing impedances of and more than one source of emf the Current flowing in any branch is equal to vector sum of currents that would separately flow in that branch. If each Separately flow in man providered separately Source of emf were considered separately of course all the other sources hering replaced at that time by their internal Impedances. E.I. Explanation -2 Consider a network consists of two Source E, and E2 and impedances Z, Z2 Shown in figure. Let 57- and 52 are currents Zz shown mesh one- and mesh (2) respectively due to source P, and E. Jhen $= L_1 Z_1 + (L_1 + L_2) Z_3$ $L_1(Z_1 + Z_3) + L_2 Z_3 - O_{29}$ I2 Z2 + (E, PL2) Z3 =

PAGE No.: YOUV multiply eq" O by (Z2+Z3) and eq" (2) by Z3 and then subtract we get $E_1(Z_2 + E_3) - E_2 Z_3 = I_1 [(Z_1 + Z_3)(Z_2 + Z_3) - Z_3]$ $E_1(Z_2 + Z_3) - E_2 Z_3$ I. -E Z, Z2+Z, Z2+Z2Z2 Now consider the circuit in which source of emp E2 is absent, then bigure is Z_2 J.L Zz Let I, and Ig are currents in mesh and mesh 2 Applying Kirchoff's law $E_{1} = I_{1} Z_{1} + (L_{1} + L_{2}) Z_{2}$ $E_{1} = L_{1} (Z_{1} + Z_{2}) + L_{2} Z_{3} - G \times (Z_{2} + Z_{3})$ $I_2 Z_2 \neq (I_1 + I_2) Z_2$ $0 = I_1 Z_2 + I_2 (Z_2 + Z_3)$ 5 XZ3 Subtracting $(Z_1 + Z_3)(Z_2 + Z_3)$ $E_1(Z_2+Z_3) = I_1$ = (Z2+Z3) = II Z, Z2 + Z1 Z3 + Z2 Z3 hers sucher bosition theorem as provided

11 Page No.: Date: E, (Z2+Z3) Z, Z2 + Z, Z3 + Z2 Z3 Circuit Consider on ther we removed source of emg which circuit is Jhen 72 Zz Ê2 951 13 I'll are currents in mesh Dand 1 Lof mosh $(I_1' + L_2)$ I, Z, F 0: ZFZ 0 2 Z2+Z2 + 52 I2 Z2 -P F $= I_{1}^{H} Z_{2} f - I_{2}^{H}$ (Z, +Z2 Z2 Subtracting Zz E2 2,722 $(Z_2 + Z_q)$ E2 Z2 2, 22+2223+2321 3 rom 6 and we eg + . I. / + Similarly we Can prove Lo Thus superposition theorem Ś prove

2. (b) SUPPLEMENTARY MATERIAL

Superposition Theorem

Superposition theorem states that in any linear, active, bilateral network having more than one source, the response across any element is the sum of the responses obtained from each source considered separately and all other sources are replaced by their internal resistance. The superposition theorem is used to solve the network where two or more sources are present and connected.

In other words, it can be stated as if a number of voltage or current sources are acting in a linear network, the resulting current in any branch is the algebraic sum of all the currents that would be produced in it when each source acts alone while all the other independent sources are replaced by their internal resistances.

It is only applicable to the circuit which is valid for the ohm's law (i.e., for the linear circuit).

Explanation of Superposition Theorem

Let us understand the superposition theorem with the help of an example. The circuit diagram is shown below consists of two voltage sources V_1 and V_2 .



Circuit Globe



$$i'_3 = i'_1 - i'_2$$



$$i_3'' = i_2'' - i_1'$$



Step 1 – Take only one independent source of voltage or current and deactivate the other sources.

Step 2 – In the circuit diagram B shown above, consider the source E_1 and replace the other source E_2 by its internal resistance. If its internal resistance is not given, then it is taken as zero and the source is short-circuited.

Step 3 - If there is a voltage source than short circuit it and if there is a current source then just open circuit it.

Step 4 – Thus, by activating one source and deactivating the other source find the current in each branch of the network. Taking the above example find the current I_1 ', I_2 'and I_3 '.

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Step 5 – Now consider the other source E_2 and replace the source E_1 by its internal resistance r_1 as shown in the circuit diagram C.

Step 6 – Determine the current in various sections, I_1 , I_2 , and I_3 . **Step 7** – Now to determine the net branch current utilizing the superposition theorem, add the currents obtained from each individual source for each branch.

Step 8 – If the current obtained by each branch is in the same direction then add them and if it is in the opposite direction, subtract them to obtain the net current in each branch.

The actual flow of current in the circuit C will be given by the equations shown below:

 $I_{1} = I'_{1} - I''_{1}$ $I_{2} = I'_{2} - I''_{2}$ $I_{3} = I'_{3} - I''_{3}$

Thus, in this way, we can solve the superposition theorem.

Reference:

https://circuitglobe.com/what-is-superposition-theorem.html

3. ASSIGNMENT

1. Find the current through 3 Ω resistor using superposition theorem.



2. Find the voltage across through 15 Ω resistor using superposition theorem.





5. Use superposition theorem to determine the current delivered by the voltage source in the circuit of figure both source are DC



4. MULTIPLE CHOICE QUESTIONS

1. In superposition theorem, when we consider the effect of one voltage source, all the other voltage sources are _____

a) Shorted

b) Opened

c) Removed

d) Undisturbed

2. In superposition theorem, when we consider the effect of one current source, all the other voltage sources are _____



4. Superposition theorem is valid for

a) Linear systems

b) Non-linear systems

c) Both linear and non-linear systems

d) Neither linear nor non-linear systems

5. Superposition theorem does not work for

- a) Current
- b) Voltage
- c) Power

- d) Works for all: current, voltage and power
- Ans: 1 (a), 2.(a), 3.(b), 4.(a), 5.(c)

5. FEEDBACK QUESTIONS

1. Did the lecture cover what you were expecting?

- 2. What is your opinion about the video lecture?
- 3. How much this session was useful from the knowledge and information point of view?
- 4. Are you satisfied with the content of the video lecture and given questions?
- 5. If you could change one specific thing what would that be?