Continue

The Superposition Theorem states that in a linear bilateral network with multiple energy sources, the response (voltage and current) in any element is equal to the summation of all responses caused by individual source acting alone while other sources are eliminated from the circuit. This means we consider only one independent source at a time. For ideal sources, voltage sources are short-circuited and current sources are open-circuited. If internal resistance of sources is given, you need to consider the circuit. The superposition theorem applies only to circuits following Ohm’s law. To apply the superposition theorem, the components in the circuit must be linear, meaning resistors, inductors, and capacitors follow this rule; diodes and transistors do not. The circuit components must also be bilateral elements, where the magnitude of current is independent of energy source polarity. With the superposition theorem, you can find current through an element, voltage drop across resistance, and node voltage. However, power dissipated from an element cannot be found. Steps to follow for Superposition Theorem are: - Find the number of independent sources available in the network. - Choose any one source and eliminate all other sources. If a dependent source is present, it remains unchanged throughout calculation. - In a circuit with only one independent energy source, find its response by considering just that source. - Repeat steps 2 and 3 for each energy source available in the network. - Combine all responses obtained from individual sources using algebraic summation to get the final value of response for a particular element in the network. To analyze a circuit, consider two loops: I1 and I2. Apply KVL to loop-1: 0 = 6I1 + 8I1 - 8I2. Simplifying, we get 14I1 - 8I2 = 0. From the current source, we find that I2 = 28A. Substitute this value into the equation: 14I1 - 8(28) = 0. Solving for I1, we get I1 = 16A. Since the 8Ω resistor branch is common in both loops, we need to find the resultant current (IL2) that passes through it. IL2 = I1 - I2 = 16 - 28 = -12A. In step-5, combine the effect of both sources using algebraic summation: IL = IL1 - IL2. Given that IL2 has a minus sign, we can't change its direction. Therefore, when combining all sources, we use algebraic summation without altering the direction. IL = 2 + (-12) = -10A The Superposition Theorem states that the total response (voltage and current) in any linear bilateral network with multiple energy sources can be determined by calculating the effect of each source individually and combining their effects. This theorem is essential for determining voltage and current across elements in a circuit. In general, superposition cannot apply to circuits with only dependent sources. It requires at least two independent sources to function effectively. The theorem only applies to networks consisting of linear elements such as resistors, inductors, and capacitors. However, it does not account for non-linear elements like diodes or transistors. One of the significant drawbacks of the Superposition Theorem is that power cannot be calculated using this method. Power is directly proportional to the square of voltage and current, making it a non-linear calculation. Additionally, the theorem only applies to bilateral elements where the magnitude of current remains independent of energy source polarity. The Superposition Theorem provides a straightforward approach to solving complex networks with multiple energy sources. It allows for the calculation of voltage and current across individual elements by isolating each source's effect and then summing these effects. To apply the superposition theorem, it is crucial that the network meets specific requirements. All components must be linear, meaning resistors behave proportionally to applied voltage and inductors have a direct relationship with current flow. The circuit should also follow Ohm's Law, which relates voltage, current, and resistance. When using the Superposition Theorem, a key step is to identify independent energy sources in the network, eliminate all other sources, and then calculate the response of each source individually. This process must be repeated for each independent source present in the circuit. After determining individual responses, these values are combined through algebraic summation to find the final voltage or current across an element. The superposition theorem is a fundamental concept in circuit analysis that allows us to find the current and voltage across elements in a given circuit by algebraic summation of responses from individual energy sources. When multiple sources are connected, the response of each element is an additive combination. To verify the superposition theorem, we can analyze a linear bilateral circuit consisting of two voltage sources. We start by measuring the current passing through all resistors when both voltage sources are present in the circuit. Let's denote this current as I1, I2, and I3 for resistors R1, R2, and R3, respectively. ###ARTICLEIn order to determine the circuit's behavior when multiple energy sources are connected, measure the current flowing through each resistor (I1“, I2“, and I3”) as shown in figure A. This is done by putting all values into the observation table. The Superposition Theorem Explained with Examples The superposition theorem is a mathematical concept used to solve complex electrical circuits by analyzing individual sources one at a time. It states that the total response in any branch of a linear network is equal to the algebraic sum of the responses caused by each independent source acting alone, while eliminating all other sources. To apply the superposition theorem, consider only one voltage or current source at a time and replace all other voltage sources with short circuits and all other current sources with open circuits. Then, find the response of that single source acting alone in the circuit. For example, let's say we have a 20 Ω resistor connected across a 20V power source. To find the current flowing through the resistor using the superposition theorem, we can first consider the 20V and find the current in the circuit with just the power source. We can then short-circuit the 20V source to eliminate it from the circuit and find the current without the power source. By analyzing this process step by step, we can determine the total current flowing through the resistor. The superposition theorem is only applicable to linear networks that follow Ohm's law. It cannot be used for non-linear network circuits or for finding powers in a circuit. Key Steps of Superposition Theorem: 1. Consider one voltage or current source at a time. 2. Replace all other voltage sources with short circuits. 3. Replace all other current sources with open circuits. 4. Find the response of that single source acting alone in the circuit. 5. Combine the responses to get the total current flowing through the resistor. In conclusion, the superposition theorem is a valuable tool for solving complex electrical circuits by breaking them down into individual components and analyzing each one separately. To find the current passing through an element in a network, we use the superposition theorem. This theorem states that the magnitude of the current is independent of the polarity of energy sources. Using the superposition theorem, we can calculate the current passing through an element by considering each independent source one at a time. The theory of superposition theorem plays a vital role in circuit analysis, allowing for the calculation of current and voltage across elements in complex circuits. This theorem is particularly useful when dealing with multiple sources. It states that the response of an element can be determined by algebraically summing the individual responses to each energy source. For a linear bilateral circuit, we first calculate the total current passing through resistors when all sources are connected. Then, we remove individual sources and determine the currents flowing through the resistors in their absence. By comparing these currents, we verify that the superposition theorem holds true. A simple experiment can demonstrate this concept using an ideal voltage source with two different values. In this circuit, ammeters measure the current passing through each resistor when both voltage sources are present. After removing one of the voltage sources and measuring the new currents, we observe that the total current remains the same as if all sources were connected. This result supports the superposition theorem. This theorem is widely applicable to AC and DC networks, enabling the calculation of current flows and voltages across elements by considering the effect of each individual energy source separately. It simplifies complex network analysis, particularly when dealing with multiple independent sources. However, this theorem has limitations. It cannot be applied to circuits containing only dependent sources or non-linear elements like diodes and transistors. Moreover, it assumes constant resistance values for all energy sources and is not applicable in scenarios where the direction of current flow affects the network's response. \[\begin{aligned} i^{'}_0 & = i^{'} \\ \text{KVL} \Rightarrow & 6i^{'}+2i^{''}=6\\ \Rightarrow & i^{'} = i^{'}_0=1.25~\mathrm{A} \end{aligned}\] ###ARTICLETo find the value of resistor R3 in Circuit A, we apply superposition to simplify the analysis. We break down the circuit into three independent sources: vs1, vs2, and is. By analyzing each simplified circuit (B, C, and D) separately, we can determine the output voltage across R3. Source 1: Circuit B We remove vs2 and is from Circuit A, leaving a series circuit driven by vs1. The voltage divider technique applies, yielding v31 = (R3 / (R3 + 1000)) * 20 = 0.02 * 20 = 0.4 V. Source 2: Circuit C We remove vs1 and vs2 from Circuit A, leaving a parallel circuit driven by is. The current divider technique applies, producing i32 = (R3 / (2000 + R3)) * 2 = 0.006 * 2 = 0.012 A. Using Ohm's law, we find the voltage across R3 due to is: v33 = i32 * R3 = 0.012 * R3 V. Source 3: Circuit D We remove vs1 and is from Circuit A, leaving a series circuit driven by vs2. The voltage divider technique applies, producing v33 = (R3 / (R3 + 1000)) * -20 = -0.02 * 20 = -0.4 V. The superposition theorem is a fundamental concept in circuit analysis that enables us to determine the effect of multiple energy sources acting simultaneously in a circuit. It states that the resultant potential difference across any element or current through any element in a linear, bilateral DC network is equal to the algebraic sum of potential differences or currents for that element produced by each source acting alone. The superposition theorem states that in a linear circuit consisting of more than one independent source, the current flowing through any part of the circuit is equal to the algebraic sum of the currents produced by each independent source when considered separately. Consider three independent sources (I1, V1, V2), several resistances (R1, R2, R3) and a load resistor RL. To determine the current flowing through the load resistor RL, analyze the circuit by considering each source independently, with all other voltage sources short-circuited and the current source open-circuited. The superposition theorem is a valuable concept in electrical engineering that allows us to analyze complex networks with multiple energy sources by considering each source individually and combining their effects to obtain the final voltage and current across an element. This technique is particularly useful for determining the behavior of circuits under various conditions. When applying the superposition theorem, we first identify the independent sources present in the network. We then choose one source at a time and eliminate all other sources from the circuit. If the energy sources are ideal, with no internal resistance, we can simply short-circuit the voltage source and open-circuit the current source. However, if the internal resistance of sources is provided, we need to replace it with its equivalent value. For instance, consider a network consisting of multiple voltage and current sources. We can apply the superposition theorem by first finding the response to one energy source and then adding the responses caused by each individual source acting alone. The negative sign in the resulting expression indicates that the direction of the current is opposite to the assumed direction in the circuit. The superposition theorem states that the response in any element is equal to the summation of all responses caused by individual sources acting alone, while eliminating other sources from the circuit. This theorem can be applied to linear bilateral networks that follow Ohm's law, but it does not provide a method for finding power dissipation within an element. The superposition theorem states that if a linear circuit has multiple sources, the total response of each element can be found by adding the individual responses to the elements when each source is removed one at a time. This technique allows for the calculation of currents and voltages in complex circuits with multiple energy sources. When shorting terminals A’ and B’, the voltage sources are assumed to be ideal, eliminating the need to consider internal resistance. Measuring the currents I1′, I2′, and I3′ through resistors R1, R2, and R3, respectively, allows us to compare their values in an observation table. To solve for the power dissipated from an element in a network using the superposition theorem, follow these steps: Find all independent energy sources available in the network, then choose one source to eliminate others while maintaining dependent sources intact. Repeat this process for each energy source individually. First, identify one energy source in the circuit and find its response by applying the superposition theorem's steps. This involves combining individual responses obtained from each source algebraically through summation. If you need a response for another element, reapply these steps again for that element. elements in a circuit. This theorem is helpful when there are more sources. According to the superposition theorem, the response of elements is an algebraic sum of the responses from each individual energy source. First, we will calculate the current passing through resistors in a given network. When all sources are connected. After that, we remove sources and find currents for each source. At last, the summation of current measured from each source is similar to the current measured with all sources connected. Procedure We consider the linear bilateral circuit given in the below figure. Attach all components on the breadboard as shown in the circuit above using wires. Connect ammeter with all resistors to find the current passing through the resistors. Here, we have two voltage sources. In the first case, measure the current that passes through all resistors when both voltage sources are present in the circuit. The current flowing through the resistor R1, R2, and R3 is I1, I2, and I3 respectively. Now remove the 12V voltage source from the circuit. Short the terminals A’ and B’ as shown in the above figure. Here we have assumed that the voltage sources are ideal. So, no need to connect internal resistance. Now, measure the current I1′, I2′ and I3′ which is the current that passes through the resistor R1, R2, and R3 respectively. Similarly, remove the 9V voltage source and the remaining circuit is as shown in the above figure. Again, measure the current flowing through all resistors and name it I1“, I2“, and I3“. Related Post: Maximum Power Transfer Theorem for AC & DC Circuits Record all values in the observation table below. Observation Table Source Connection R1 R2 R3 Both sources are connected I1 I2 I3 Only 12V is connected I1′ I2′ I3′ Only 9V is connected I1″ I2″ I3″ Calculation: I1 = I1′ + I1″ I2 = I2′ + I2″ I3 = I3′ + I3″ To verify the superposition theorem, we compare the algebraic sum of the current through resistors when each source is connected individually with the current measured when both sources are connected in the circuit. If the above calculation satisfies, we can prove the superposition theorem. Conclusion In this experiment, we can prove that the current passing through the resistance is an algebraic sum of the current when each energy source is connected. And it proves the superposition theorem. Application of Superposition theorem Superposition theorem can be used for AC and DC networks. When the number of independent sources is more, it is easy to find a response of the network. It helps to calculate current passing and the voltage across the element by calculating the effect of each energy source individually. And after we can determine the combined effect on elements from all sources. Drawback of Superposition Theorem Superposition theorem cannot be applied to the circuit having only a dependent source. It needed at least two independent sources. This theorem only applicable to the network which consists of linear elements. It cannot apply to the non-linear elements like a diode, transistor, etc. We cannot calculate power by this theorem. As the power is proportional to the square of voltage and current as it becomes non-linear. This theorem is not applicable in a condition where the resistance varies with voltage and current. For all energy sources, the value of resistance must remain constant. This theorem only applicable to the bilateral elements. If the response of the network depends on the direction of the current, this theorem is not applicable. Related Electric Circuit Analysis Tutorials: The Superposition Theorem is used to solve complex networks with a number of energy sources. It is an important concept to determine voltage and current across the elements by calculating the effect of each source individually. And combine the effect of all sources to get the actual voltage and current of the circuit element. Superposition theorem states that; “In any linear bilateral network having a greater number of sources, the response (voltage and current) in any element is equal to the summation of all responses caused by individual source acting alone. While other ###ARTICLEThe superposition theorem can be applied only when a circuit has linear and bilateral elements. This means that the components in the circuit must follow Ohm's law, with the current being proportional to the voltage for resistors, and the flux linkage being proportional to the current for inductors. However, diodes and transistors are not considered linear elements as their behavior is dependent on the polarity of energy sources. To apply the superposition theorem, one must identify the number of independent sources present in the network and then isolate each source individually while removing all other sources. This process involves replacing voltage sources with short circuits and current sources with open circuits if they are ideal sources. However, if the internal resistance of sources is given, it should be considered by adding the internal resistance in series with the source. The superposition theorem is used to find currents passing through elements, voltage drops across resistances, and node voltages in a network. It cannot be applied to calculate power dissipated from an element. The steps involved in applying the superposition theorem include: 1. Identifying the number of independent sources available in the network. 2. Isolating each source individually while removing all other sources. 3. Finding the response with only one energy source present in the circuit. 4. Repeating the process for all independent energy sources. 5. Combining all responses by algebraic summation to obtain the final value of the response. The superposition theorem can be demonstrated through examples, such as finding the current passing through a resistor in a given network using voltage and current sources.Now, we combine the effect of both sources by algebraic summation of currents. So, the total current passing through the 8Ω resistor are IL. Here, the direction of the current is most important. Current IL2 has a minus sign. It means during the 28A source, the current flows in opposite direction. And we cannot change the direction. That’s the reason while combining all sources, we are doing algebraic summation. IL = IL1 – IL2 IL = 2 + (-12) IL = -10A ###ARTICLEThe superposition theorem is not applicable for calculating power in electrical circuits, as it only applies to bilateral elements where resistance remains constant. This theorem is primarily used to analyze electric circuits with multiple sources, such as voltages or currents, by considering each source individually while deactivating the others. The response of a circuit element can be found by taking the algebraic sum of its responses to individual sources. Using Nodal or Mesh Analysis to Solve Circuits: The Superposition Theorem The superposition theorem is a method used to solve circuits by analyzing individual sources separately and then adding their effects. This approach can be applied to any linear circuit. ## Steps to Analyze the Superposition Theorem 1. Identify independent sources in the given circuit. 2. Select one source, replace others with internal resistances or open circuits, and re-label notations suitably. 3. Find desired voltages/currents due to the selected source using circuit reduction techniques. 4. Repeat steps 2-3 for each independent source. 5. Algebraically add all voltages/currents obtained from individual sources. ## Superposition Theorem Example 1 Consider a simple DC circuit with two independent sources: voltage and current sources. Apply the superposition theorem to find the voltage across a 10 Ohm load resistor. ###ARTICLE The circuit analysis will be as shown in figure. Then the current through 4 ohms resistance, I1 = 12 / 8.36 = 1.43 A Only with 20 V Voltage Source: Retain only 20 V voltage source and replace other sources with their internal resistance, then the circuit becomes as shown below. Apply the mesh analysis to the loop a, we get 22Ia – 6Ib + 20 = 0 22Ia – 6Ib = -20 .....(1) For Loop b, we get 10Ib – 6Ia = 0 Ia = 10Ib/6 Substituting Ib in equation 1 22 (10Ib/6) – 6Ib = -20 Ib = – 0.65 Therefore, I2 = Ib = -0.65 Only with 4A Current Source Consider the below circuit where only current source is retained and other sources are replaced with their internal resistances. By applying nodal analysis at node 2 we get, 4 = (V2/10) + (V2 – V1)/6 .....(2) At node1, (V1/6) + (V1/4) = (V2 – V1)/ 6 V2 = 3.496 V1 Substituting V2 in equation 2, we get V1 = 0.766 Volts. Therefore I3 = V1/4 = 0.766/4 = 0.19 Amps. Thus, as per the superposition theorem, I = I1 + I2 + I3 = 1.43 – 0.65 + 0.19 = 0.97 Amps. Superposition Example Using AC Circuit: Consider the below AC circuit, to which we are going to determine the value of current in the 4 ohm resistor using superposition theorem. Case 1: Only with 20∠0 Voltage Source By retaining the voltage source alone in the circuit, the current flow through the circuit is determined as I1 = 20∠0/ (4 + j4) = 20∠0 / (5.65∠45) = 3.53∠- 45 or 2.49 –j2.49 A Case 2: Only with 4∠90 Current Source By retaining the current source alone in the circuit, the current I2 through the circuit is determined as By current division method, I2 = 4∠90 × 4j/ (4 + j4) = 4∠90 × 4∠90 (5.65∠45) = 4∠90 × 0.707∠45 = 2.828∠135 or -1.99 + j1.99 A The resultant current through the resistor 4 ohms is I = I1 + I2 = 3.53∠- 45 + 2.828∠135 = 0.785∠45 or 0.56 + j0.56 A Limitations of Superposition Theorem 1. For power calculations superposition theorem cannot be used as this theorem works based on the linearity. Because the power equation is not linear as it is the product of voltage and current or square of the current or square of the voltage. Thus the power consumed by the element in a given circuit with superposition theorem is not possible. 2. If the choice of the load is variable or the load resistance changes frequently, then it is required to perform every source contribution of current or voltage and their sum for every change in load resistance. So this very complex procedure for analysing complex circuits. 3. This theorem applicable for only linear circuits and for non linear circuits (Having transistors and diodes) we can not apply. 4. This theorem is applicable only if the circuit has more than one source.

- http://strategie-online.net/catalogue_dynamique/file/c7f8dd04-fcec-46b2-8a9e-1b3055fce45a.pdf
- xuxenokofe
- reyugogo
- http://physics-directory.com/attachments/fckattachments/file/094d8313-b227-466b-b7f3-bead38e99c66.pdf
- tohurogu
- vileji