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Coimbatore-35
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DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

23ECB101 – CIRCUIT ANALYSIS AND DEVICES

I YEAR/ II SEMESTER

UNIT 2 – NETWORK THEOREMS AND SOURCE TRANSFORMATION

TOPIC - Superposition Theorem

Superposition Theorem

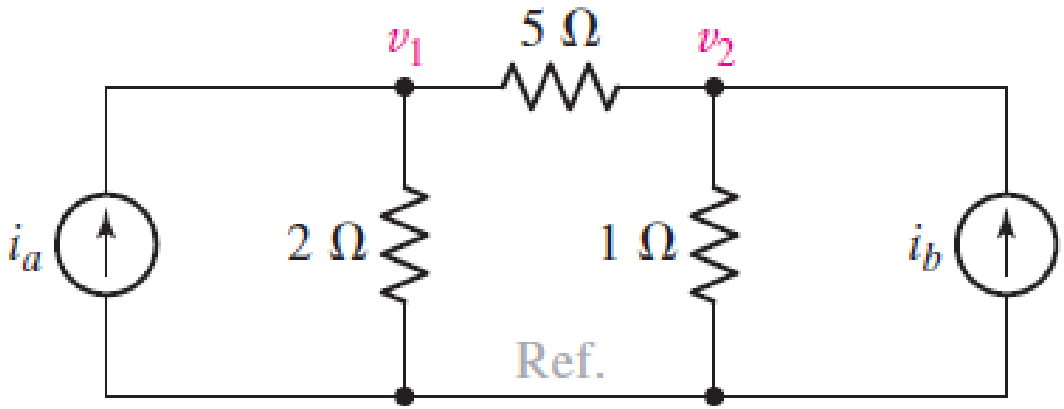
- The most important consequence of linearity is **superposition.**
- The circuit which contains two independent sources, the current generators that force the currents i_a and i_b into the circuit.
- Sources are often called *forcing functions* and the nodal voltages that they produce can be termed *response functions*, or simply *responses.*
- Both the forcing functions and the responses may be functions of time.

Nodal Equations

- The two nodal equations for this circuit are

$$0.7v_1 - 0.2v_2 = i_a$$

$$-0.2v_1 + 1.2v_2 = i_b$$



•Now let us perform experiment *x. We change the two forcing functions* to i_{ax} *and* i_{bx} *; the two unknown voltages will now be v1x and v2x . Thus,*

$$0.7v_{1x} - 0.2v_{2x} = i_{ax}$$
$$-0.2v_{1x} + 1.2v_{2x} = i_{bx}$$

•We next perform experiment *y by changing the source currents to* i_{ay} and i_{by} *and measure the responses* v_{1y} *and* v_{2y} *:*

$$0.7v_{1y} - 0.2v_{2y} = i_{ay}$$
$$-0.2v_{1y} + 1.2v_{2y} = i_{by}$$

- Let us *add or "superpose" the last two sets of* equations,

$$(0.7v_{1x} + 0.7v_{1y}) - (0.2v_{2x} + 0.2v_{2y}) = i_{ax} + i_{ay}$$

$$0.7v_1 - 0.2v_2 = i_a$$

and,

$$-(0.2v_{1x} + 0.2v_{1y}) + (1.2v_{2x} + 1.2v_{2y}) = i_{bx} + i_{by}$$

$$-0.2v_1 + 1.2v_2 = i_b$$

- we can perform experiment *x and note the responses, perform experiment y and note the* responses, and finally add the two sets of responses.

Power Absorption

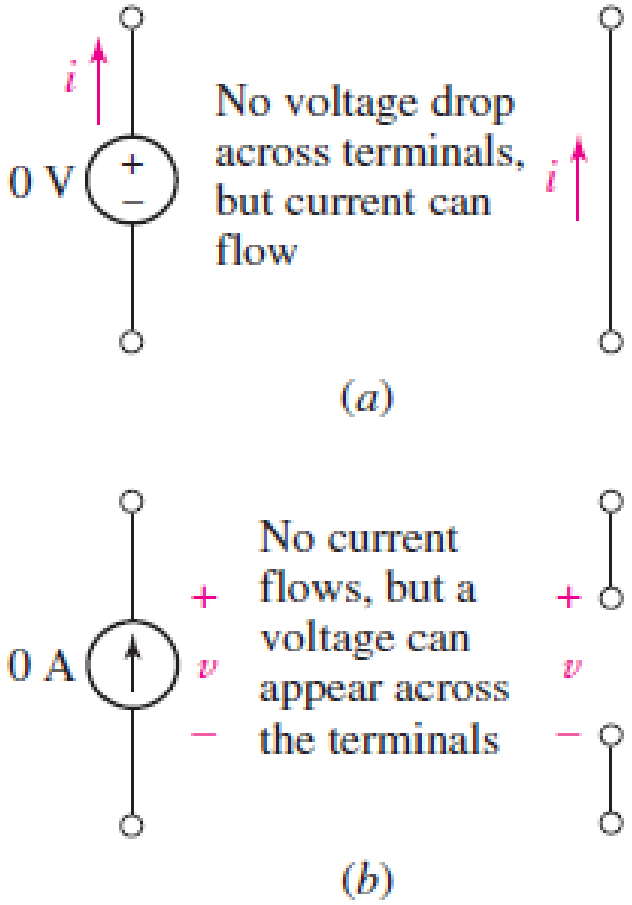
- This leads to the fundamental concept involved in the superposition principle:

to look at each independent source (and the response it generates) one at a time with the other independent sources “turned off” or “zeroed out.”

- If we reduce a voltage source to zero volts, we have effectively created a short circuit (Fig. a).
- If we reduce a current source to zero amps, we have effectively created an open circuit (Fig. b).

Thus, the ***superposition theorem can be stated as:***

In any linear resistive network, the voltage across or the current through any resistor or source may be calculated by adding algebraically all the individual voltages or currents caused by the separate independent sources acting alone, with all other independent voltage sources replaced by short circuits and all other independent current sources replaced by open circuits.

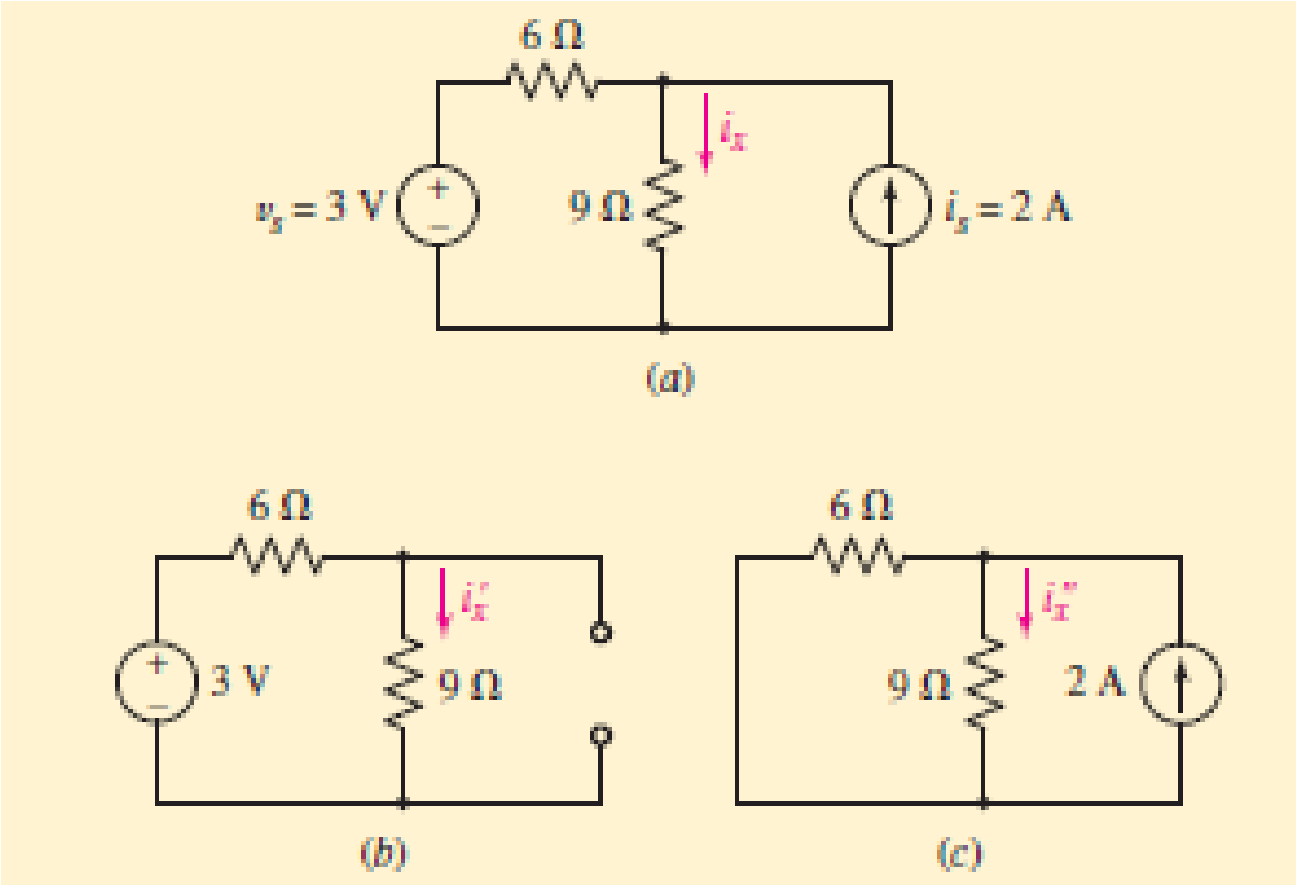


- The theorem states that we may find a given response by considering each of the three sources acting alone and adding the three results.
- Alternatively, we may find the response due to the first and second sources operating with the third inactive, and then add to this the response caused by the third source acting alone.
- This amounts to treating several sources collectively as a sort of "*supersource*."

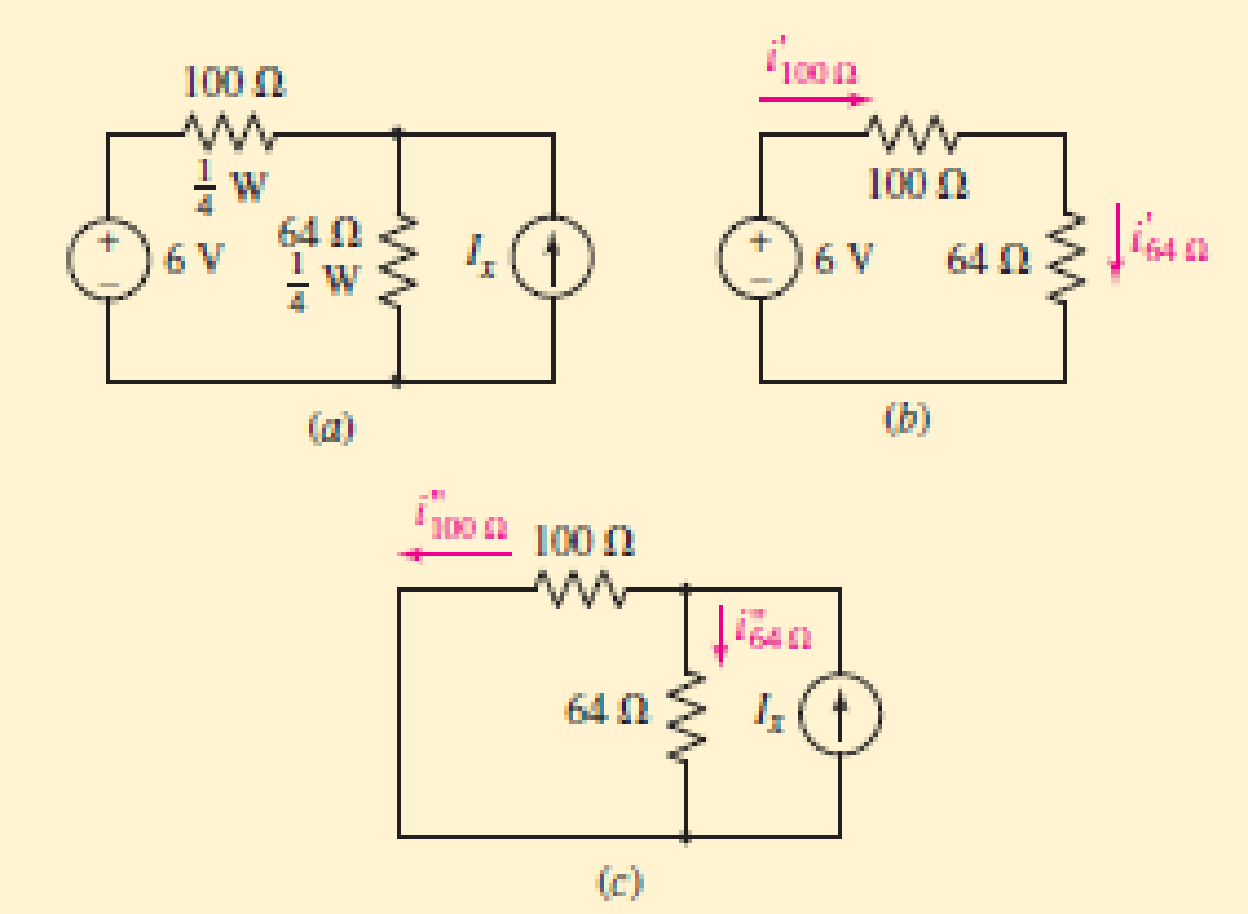
Summary of Basic Superposition Procedure

- Select one of the independent sources. Set all other independent sources to zero.
- Relabel voltages and currents using suitable
- Analyze the simplified circuit to find the desired currents and/or voltages.
- Repeat steps 1 through 3 until each independent source has been considered.
- Add the partial currents and/or voltages obtained from the separate analyses.
- Do not add power quantities.

Practice Questions 1



Practice Questions 2




THANK YOU