Electrical Science: 2021-22
Lecture 7
Superposition Theorem

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Superposition Theorem

Applications of Superposition Theorem

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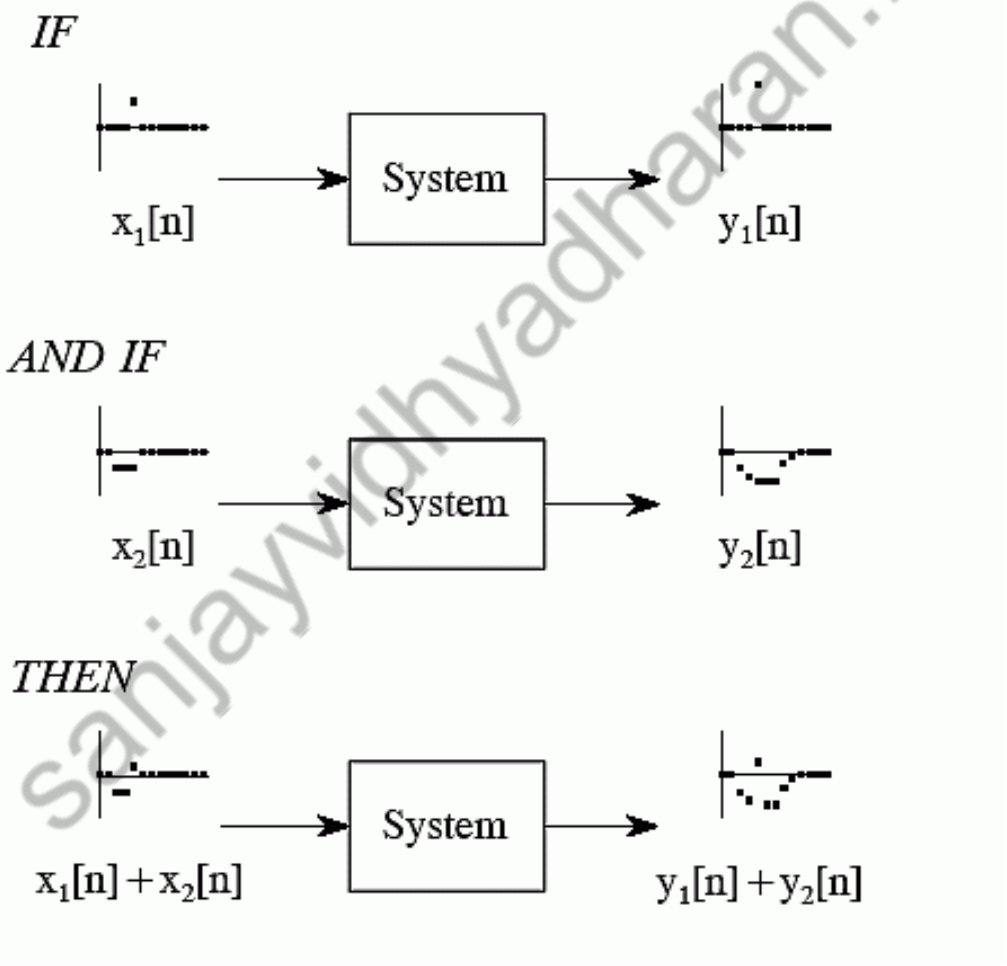
- Helps in analyzing a linear circuit with more than one independent source.
- It is used to find the value of voltage/current through a particular element of circuit
- Contribution by each independent source is computed separately.
- The output of a circuit is determined by summing the individual responses of each independent source.
- The idea of superposition rests on the linearity property (specifically, additivity)

Superposition Theorem

LINEARITY –ADDITIVE P ROPERTY



Superposition Theorem

LINEARITY –ADDITIVE P ROPERTY

Example: Ohm's Law
Voltage (output) developed across a resistor in response to applied current (input)

$V_1 = i_1R$ (for applied current i_1)
and
$V_2 = i_2R$ (for applied current i_2)

Then applying current $(i_1 + i_2)$ gives

$V = (i_1 + i_2)R = i_1 R + i_2R = V_1 + V_2$

Superposition Theorem

In any **linear bilateral network** containing two or more independent sources (voltage and/or current sources), the resultant current / voltage in any branch is the algebraic sum of currents / voltages caused by each independent source (with all other independent sources turned off).

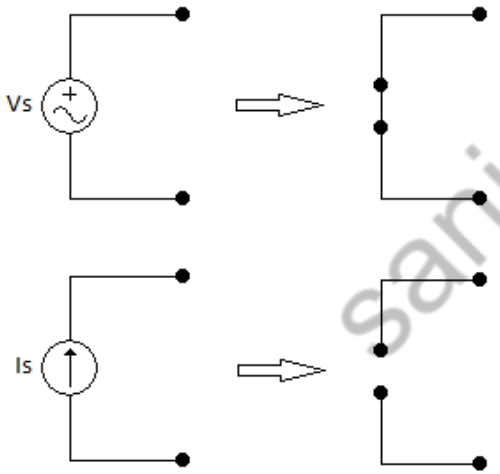
Superposition Theorem

Rules for Applying Superposition Theorem

1. To turn off a voltage source: Replace by its **internal resistance** (for non-ideal source) or short circuit (for ideal source).

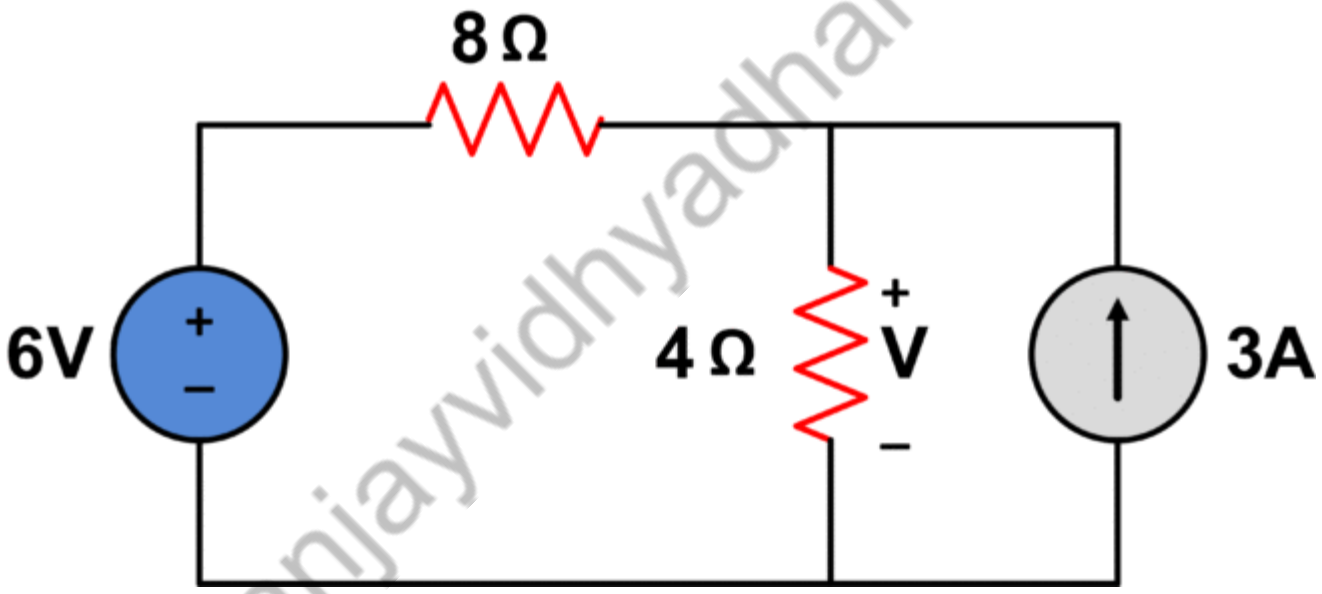
2. To turn off a current source: Replace by its **internal resistance** (for non-ideal source) or open circuit (for ideal source).

3. Dependent sources should be retrained as it is.



Superposition Theorem

Find V in the circuit given below:



Superposition Theorem

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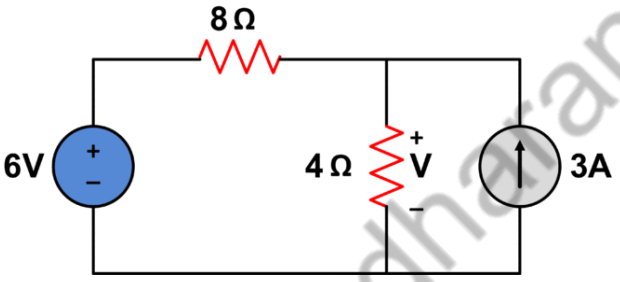
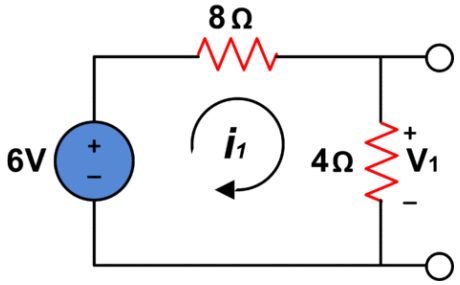
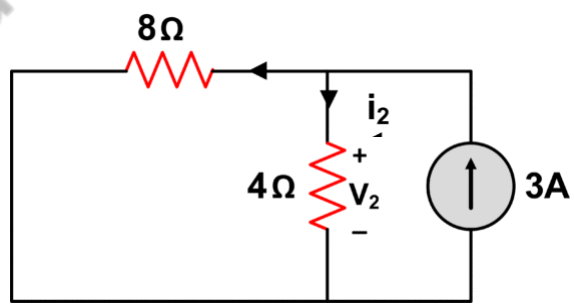






$$V_1 = \left(\frac{4}{8+4}\right) 6 = 2\ V$$

$$i_1 = \left(\frac{6}{12}\right) = 0.5\ A$$

$$i_2 = \left(\frac{8}{8+4}\right) 3 = 2\ A$$

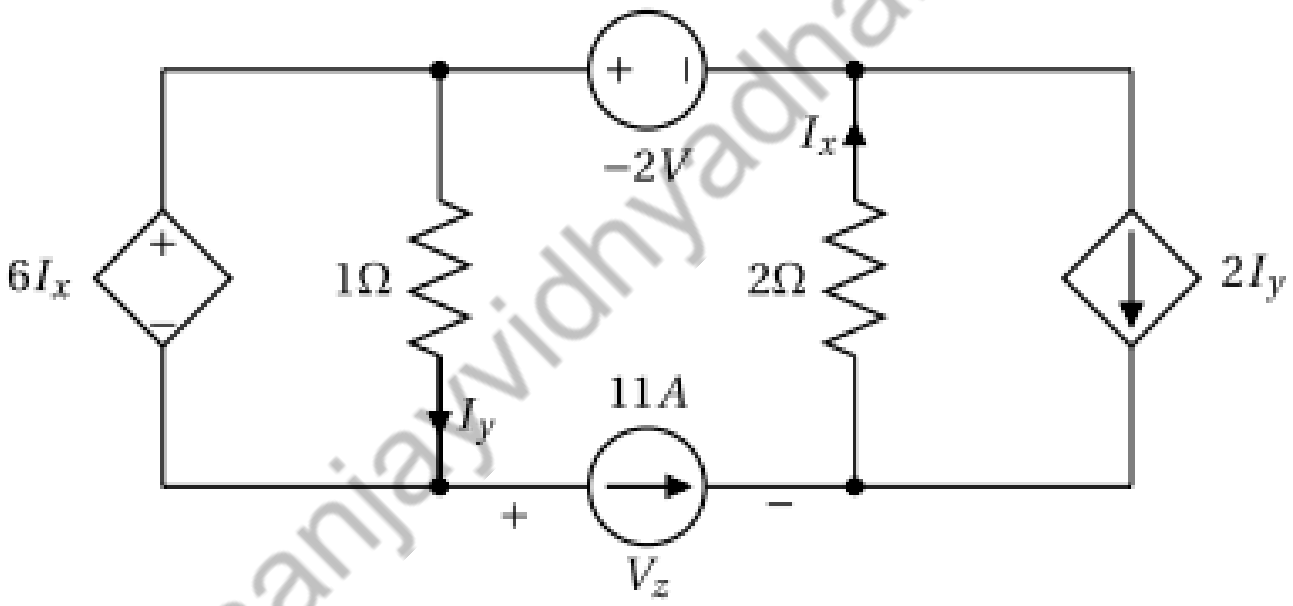
$$V_2 = 2 * 4 = 8\ V$$

$$V = 2 + 8 = 10\ V$$

$$i = 0.5 + 2 = 2.5\ A$$

Superposition Theorem

Find I_x, I_y and V_z in the circuit given below:



Superposition Theorem

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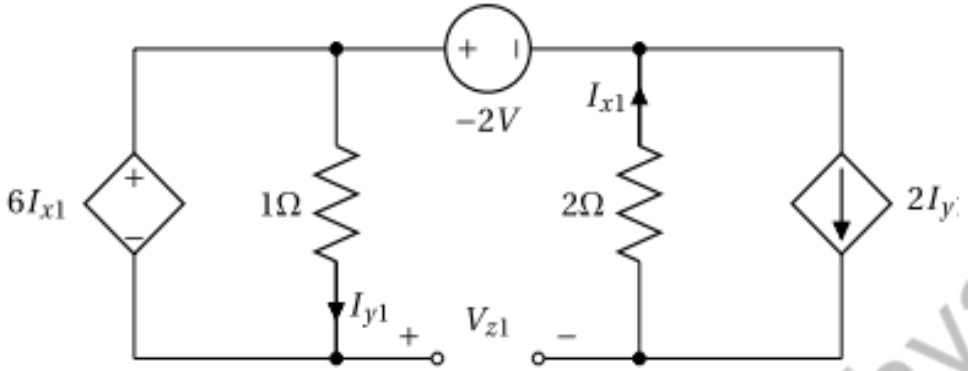
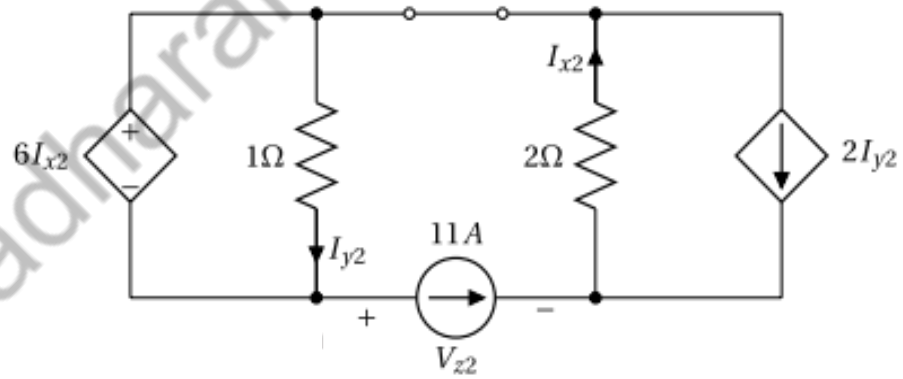




$6I_{x1} = I_{y1}$ $\quad I_{x1} = 2I_{y1}$

$I_{x1} = I_{y1} = 0$

$V_{z1} = -2\ V$

$$\begin{aligned} 6I_{x2} &= I_{y2} \\ I_{x2} - 2I_{y2} &= 11 \end{aligned} \rightarrow \begin{cases} I_{x2} = -1A \\ I_{y2} = -6A \end{cases}$$

$$+2\Omega \times I_{x2} + 1\Omega \times I_{y2} + V_{z2} = 0 \rightarrow V_{z2} = 8V.$$

$$I_x = I_{x1} + I_{x2} = -1A$$

$$I_y = I_{y1} + I_{y2} = -6A$$

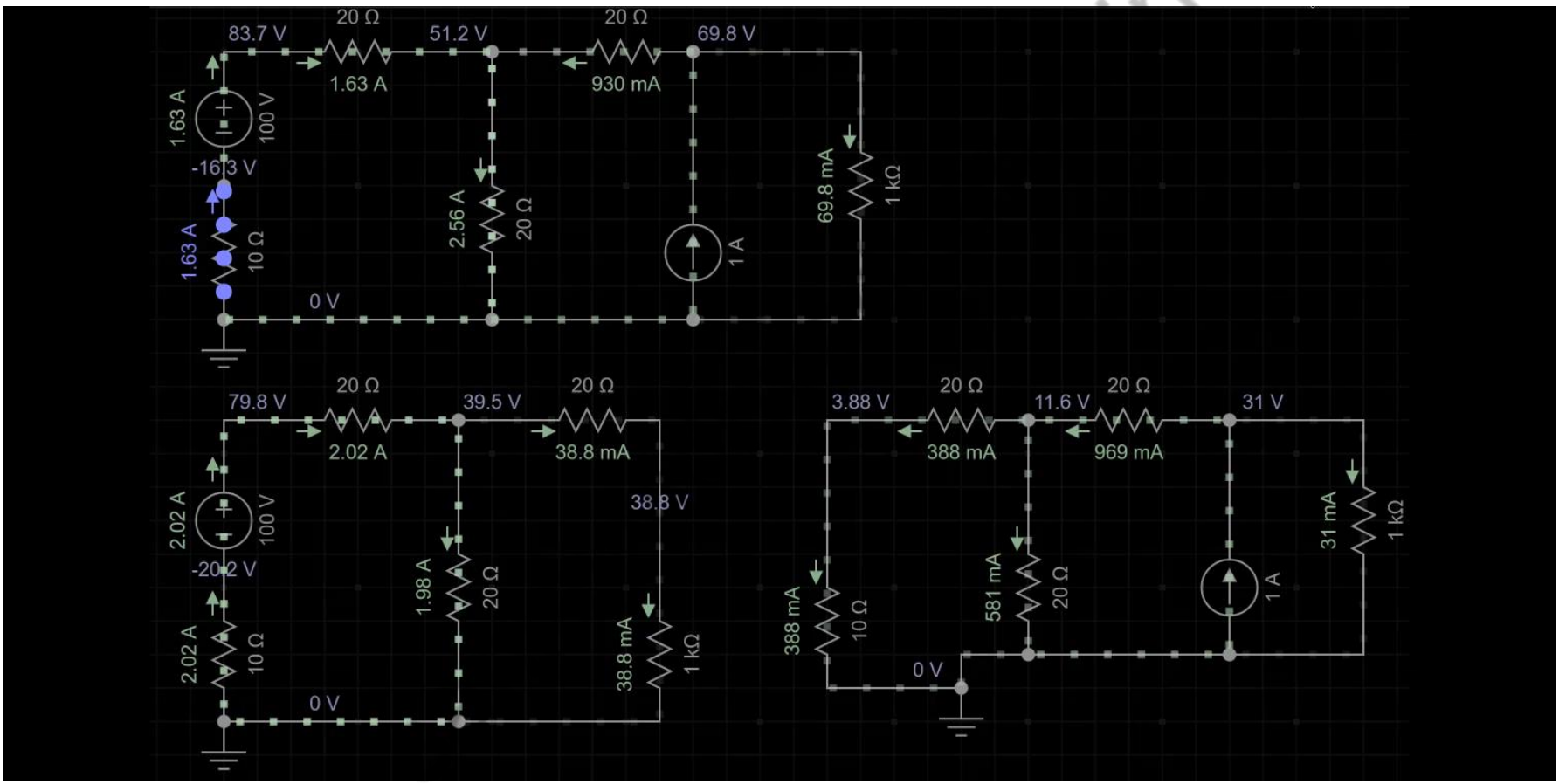
$$V_z = V_{z1} + V_{z2} = 6V$$

Superposition Theorem

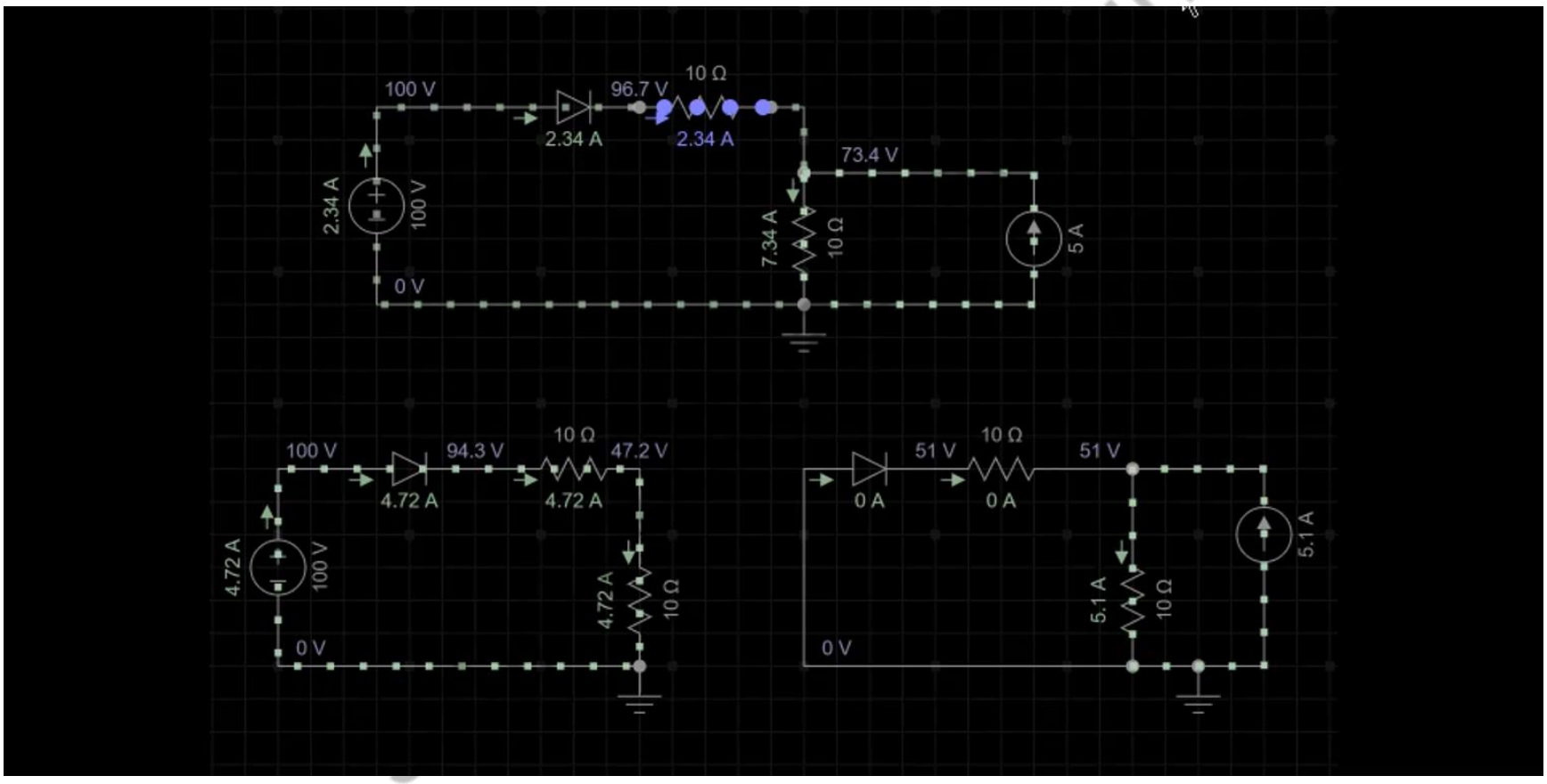
Limitations of Superposition Theorem

- Applicable only for linear circuits.
- There must be more than one source to apply this theorem

Superposition Theorem



Superposition Theorem



Thank you