EECS 16A Dis 8A Notes

Friday, September 3, 2021 1:38 PM

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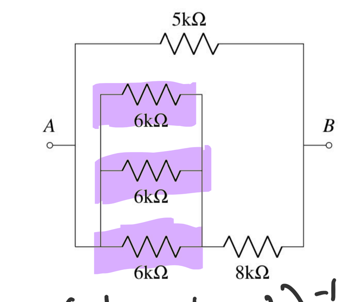
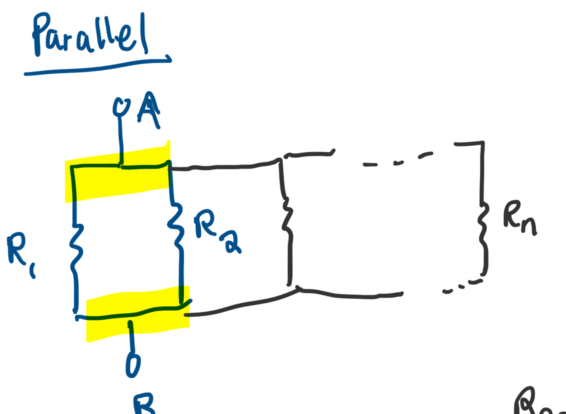
1. Series and Parallel Combinations

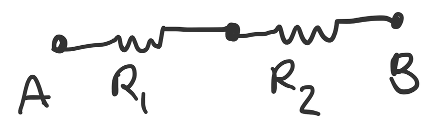
For the resistor network shown below, find an equivalent resistance between the terminals A and B using the resistor combination rules for series and parallel resistors.



Parallel



Series



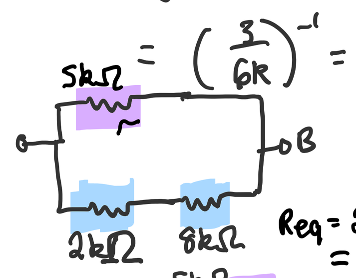
$R_{eq} = R_1 + R_2$

$R_{eq} = R_1 + R_2 + \dots + R_n$

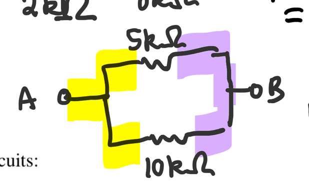
$R_{eq} = \left(\frac{1}{6k} + \frac{1}{6k} + \frac{1}{6k}\right)^{-1} = \left(\frac{3}{6k}\right)^{-1} = 2k\Omega$

$R_{eq} = \left(\frac{1}{R_1} + \frac{1}{R_2}\right)^{-1} \Leftrightarrow R_{eq} = \frac{R_1 R_2}{R_1 + R_2}$

$R_{eq} = \left(\frac{1}{R_1} + \frac{1}{R_2} + \dots + \frac{1}{R_n}\right)^{-1}$



$R_{eq} = 2k\Omega + 8k\Omega = 10 k\Omega$



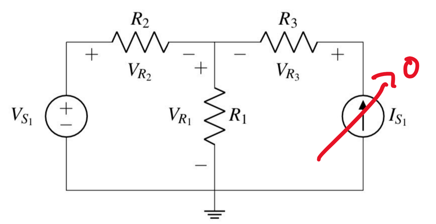
$R_{eq} = \left(\frac{1}{5k} + \frac{1}{10k}\right)^{-1} = \left(\frac{2}{10} + \frac{1}{10k}\right) = \left(\frac{3}{10k}\right)^{-1} = 3.33k\Omega$

2. Superposition

For the following circuits:

i. Use the superposition theorem to solve for the voltages across the resistors. First, redraw the circuits with just one source (while zero-ing the other source). Then, for each circuit solve for each element voltage. Finally, sum the voltages at each node.

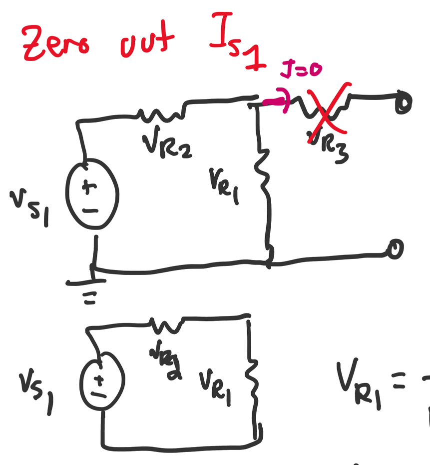
(a)



Superposition:

1. Leave one independent source on at a time
2. Measure resulting voltages & currents
3. Sum up voltages & currents for final solution.

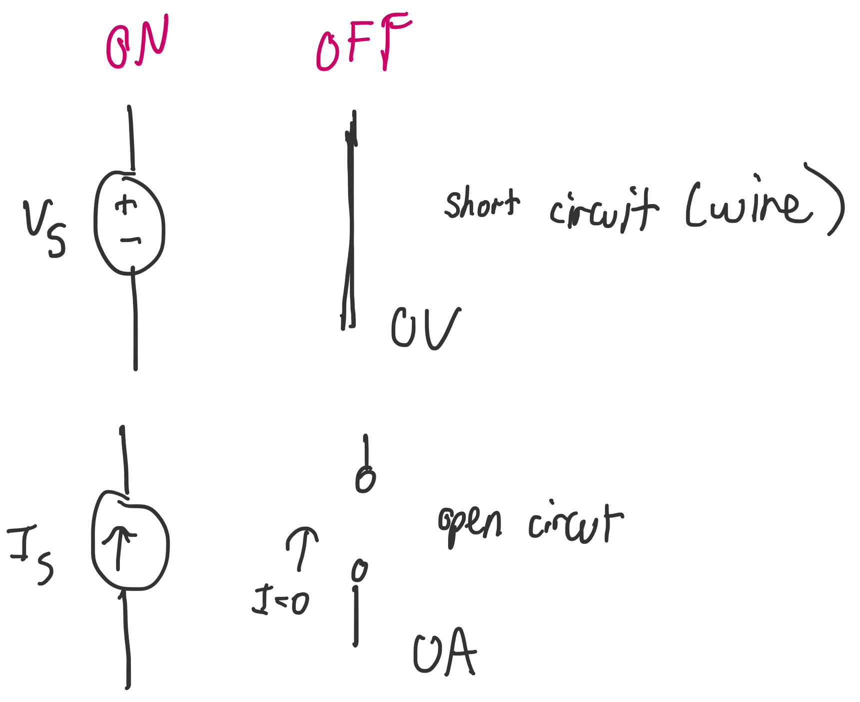
Phase 1. Zero out I_{S_1}

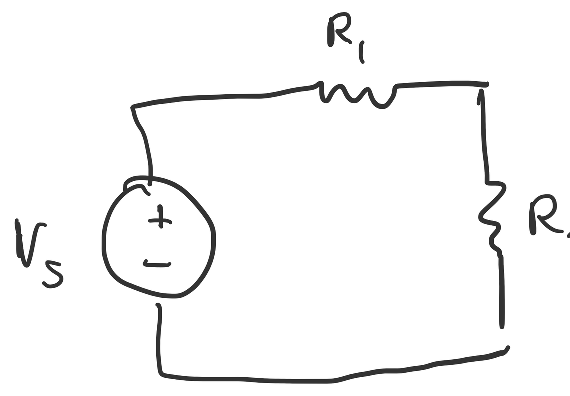


$V_{R_1} = \frac{R_1}{R_1 + R_2} \cdot V_{S_1}$

$V_{R_2} = V_{S_1} - V_{R_1} = \frac{R_2}{R_1 + R_2} \cdot V_{S_1}$

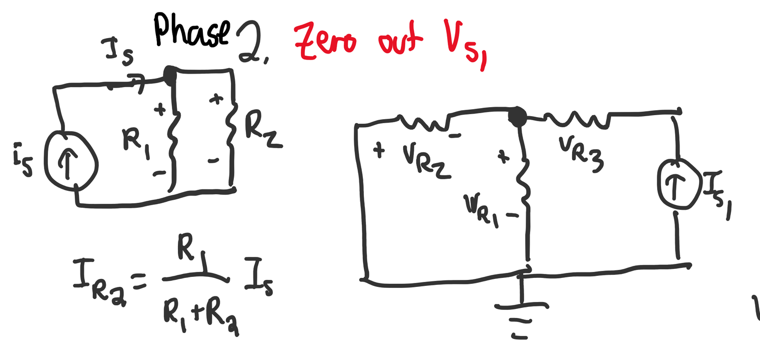
ON OFF





$V_{R2} = \frac{R_2}{R_1 + R_2} \cdot V_S$

Phase 2. Zero out V_{S_1}



$I_{R_2} = \frac{R_1}{R_1 + R_2} I_S$

$I_{R_2} = \frac{-R_1}{R_1 + R_2} I_{S_1}$

$I_{R_1} = \frac{R_2}{R_1 + R_2} I_{S_1}$

$V = IR$

$V_{R_2} = \frac{-R_1}{R_1 + R_2} I_{S_1} \cdot R_2$

$V_{R_1} = \frac{R_2}{R_1 + R_2} I_{S_1} \cdot R_1$

$I_{R_3} = I_{S_1}$

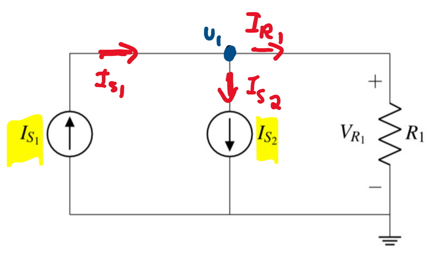
$V_{R_3} = I_{S_1} \cdot R_3$

$V_{R_1} = \frac{R_2}{R_1 + R_2} I_{S_1} \cdot R_1 + \frac{R_1}{R_1 + R_2} V_{S_1}$ $\quad V_{R_2} = \frac{-R_1}{R_1 + R_2} I_{S_1} \cdot R_2 + \frac{R_2}{R_1 + R_2} V_{S_1}$ $\quad V_{R_3} = I_{S_1} \cdot R_3$

Added voltages from phases 1 and 2

☆Note: Polarities in phases 1 & 2 must remain the same when using superposition

(b)



KCL @ u_1: $I_{S_1} = I_{S_2} + I_{R_1}$

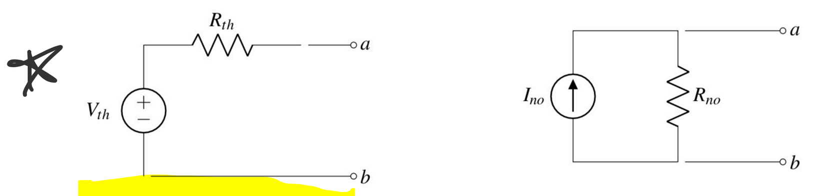
$I_{S_1} - I_{S_2} = I_{R_1}$

$V_{R_1} = I_{R_1} \cdot R_1$

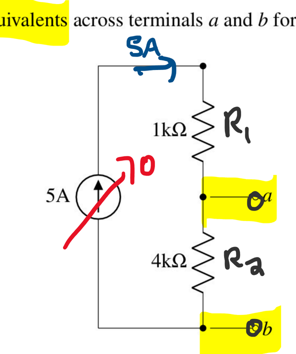
$V_{R_1} = (I_{S_1} - I_{S_2}) \cdot R_1$

3. Thevenin and Norton Equivalence

The general Thévenin and Norton equivalents are shown below:



Find the Thévenin and Norton equivalents across terminals a and b for the circuit given below.



Thevenin:

1. Connect open circuit across terminals to measure V_{th}.
2. Zero out independent sources and apply a test current/voltage to find R_{th}.

Norton:

1. Connect short circuit across terminals to measure I_{No}.
2. Zero out independent sources and apply a test current/voltage to find R_{th}.

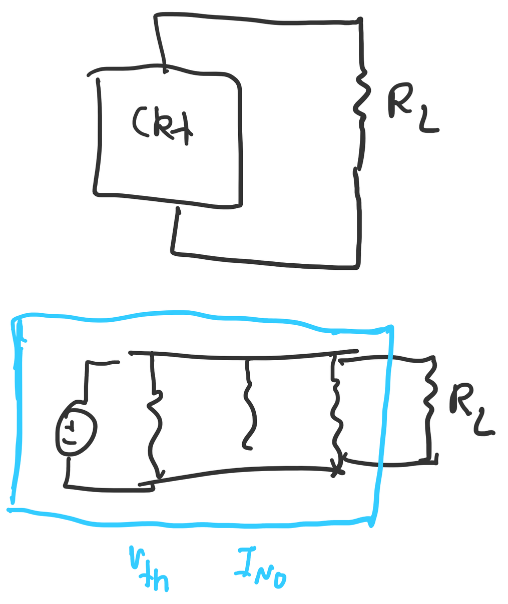
1. Connect open ckt across terminals a & b

$V_{R_2} = I_{R_2} \cdot R_2$

$= 5A \cdot 4k\Omega$

$= 20 kV$

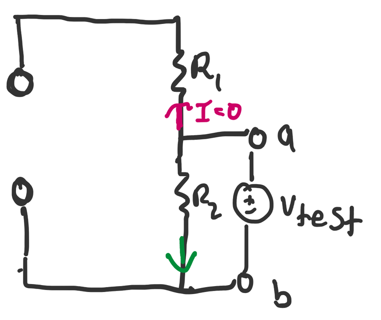
$V_{th} = 20kV$



$R_{th} = R_{No}$

☆ $I_{No} = \frac{V_{th}}{R_{th}}$ $\quad V_{th} = I_{No} R_{No}$

2.



$V_{R_2} = V_{test}$

$I_{R_2} = I_{test}$

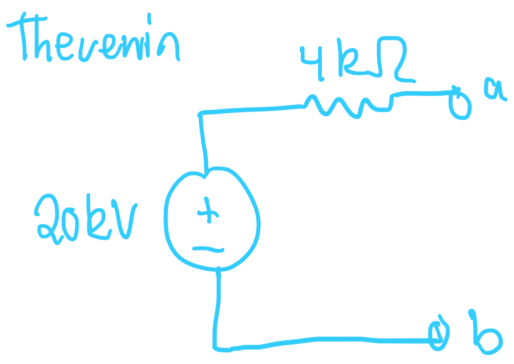
$R_{th} = \frac{V_{test}}{I_{test}} = \frac{V_{R_2}}{I_{R_2}} = R_2$

$R_{th} = R_2 = 4k\Omega$

$\frac{V_{test}}{I_{test}} = R_2$

$R_{th} = 4k\Omega$ $\quad I_{No} = \frac{V_{th}}{R_{th}} = 5A$

Thevenin



Norton: