CLASS #4: ANALYZE RESISTIVE CIRCUITS

OBJECTIVES
1) INTRODUCE KIRCHHOFF’S LAWS
2) ANALYZE CIRCUITS WITH RESISTORS
3) COMBINE CIRCUIT ELEMENTS

KIRCHHOFF’S LAWS

(i) CURRENT LAW: SUM OF ALL CURRENTS AT JUNCTION MUST BE 0

\[ \sum I_{\text{in}} = 0 \]

(ii) VOLTAGE LAW: ALGEBRAIC SUM OF ALL VOLTAGES IN ANY (AND ALL) LOOPS IS 0

\[ \sum V_{\text{loop}} = 0 \]

RESISTOR COMBINATIONS

1) SERIES

\[ R_1 \cdots \cdots R_n \]

\[ \sum R_i = R_{\text{eq}} \]

2) PARALLEL

\[ \frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots + \frac{1}{R_n} \]
<table>
<thead>
<tr>
<th>Source Combinations</th>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage in Series</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Voltage in Parallel</td>
<td></td>
<td>✓  (Violates KVL)</td>
</tr>
<tr>
<td>Current in Series</td>
<td></td>
<td>✓  (Violates KCL)</td>
</tr>
<tr>
<td>Current in Parallel</td>
<td>✓</td>
<td></td>
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</tbody>
</table>
Problem 1:

- All branches same voltage:

\[ 18 \times 10^3 i_1 = 9 \times 10^3 i_2 = 12 \times 10^3 i_3 = 12 \times 10^3 i_L \quad \text{KVL} \]

- Write all as \( i_L \):

\[ i_1 = \frac{2}{3} i_L \]
\[ i_2 = \frac{4}{3} i_L \]
\[ i_3 = i_L \]

Circuit can only be simplified since it is current (resistance, current etc., even others) would not work for voltage.

- KCL

\[ 3 - 3i_L + i_L = 2 \]
\[ 4i_L = -1 \]
\[ i_L = -0.25 \text{ mA} \]

- Note: Equivalent circuit

Use KCL earlier in

\[ \frac{1}{18} + \frac{1}{9} + \frac{1}{12} = \frac{1}{4} = \frac{1}{R_{eq}} \]
Problem #2

What is \( V_o \)?

\[ I_o = \frac{V}{R_{eq}} \]

- KCL at PT. A:

\[ V = \frac{3V}{3k\Omega} \]

\[ 3 \times 10^3 I_o = V \]

- Combine

\[ 4I_o = 10 \times 10^{-3} + \frac{3 \times 10^3}{6 \times 10^2} I_o \]

\[ I_o = 4mA \]

\[ R = \frac{V}{I_o} = V = 12V \]

- Current down 2\( k\Omega \) path w/2 resistors (series)

\[ I_{211} = \frac{12V}{6k\Omega} = 2mA \]

\[ \therefore V_o = I(R = 4k\Omega)(2mA) \]

\[ V_o = 8V \]