

Christian Garcia

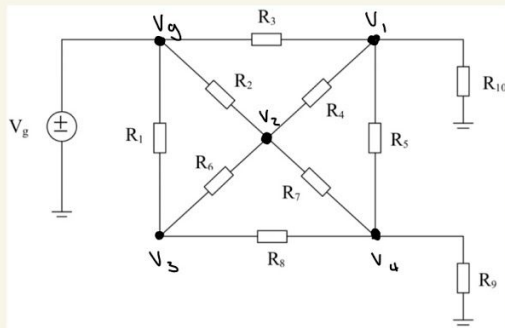
ELEN 50L

Wednesday 2:15 PM

4 November 2020

Project 1 Report

Part 1: PreLab



$$V_g = 12$$
$$R_1, R_4, R_6, R_8, R_{10} = 1 \text{ k}\Omega$$
$$R_2, R_3, R_5, R_7 = 1.5 \text{ k}\Omega$$

$$V_1: \frac{V_1 - V_g}{R_3} + \frac{V_1 - V_2}{R_4} + \frac{V_1 - V_4}{R_{10}} + \frac{V_1}{R_{10}} = 0$$

$$V_2: \frac{V_2 - V_g}{R_2} + \frac{V_2 - V_1}{R_4} + \frac{V_2 - V_3}{R_6} + \frac{V_2 - V_4}{R_7} = 0$$

$$V_3: \frac{V_3 - V_g}{R_1} + \frac{V_3 - V_2}{R_6} + \frac{V_3 - V_4}{R_8} = 0$$

$$V_4: \frac{V_4 - V_1}{R_{10}} + \frac{V_4 - V_2}{R_7} + \frac{V_4 - V_3}{R_8} = 0$$

$$V_{oc} = V_4$$

$$R_{th} = \frac{V_{oc}}{I_{sc}}$$

$$\frac{V_2}{R_7} + \frac{V_2 - V_3}{R_6} + \frac{V_2 - V_1}{R_4} + \frac{V_2 - V_g}{R_2} = 0$$

$$\frac{V_3}{R_8} + \frac{V_3 - V_2}{R_6} + \frac{V_3 - V_4}{R_1} = 0$$

$$\frac{V_1}{R_5} + \frac{V_1}{R_{10}} + \frac{V_1 - V_2}{R_4} + \frac{V_1 - V_g}{R_3} = 0$$

Part 2:

$$\frac{V_1 - V_9}{R_3} + \frac{V_1 - V_2}{R_4} + \frac{V_1 - V_4}{R_5} + \frac{V_1}{R_{10}} = 0$$

$$V_1 \left(\frac{1}{R_3} + \frac{1}{R_4} + \frac{1}{R_5} + \frac{1}{R_{10}} \right) - V_2 \left(\frac{1}{R_4} \right) - V_4 \left(\frac{1}{R_5} \right) - V_9 \left(\frac{1}{R_{10}} \right) = 0$$

$$V_1 \left(\frac{10}{3} \right) - V_2 - \frac{2}{3} V_4 = 8$$

$$\frac{V_2 - V_9}{R_2} + \frac{V_2 - V_1}{R_4} + \frac{V_2 - V_3}{R_6} + \frac{V_2 - V_4}{R_7} = 0$$

$$V_2 \left(\frac{1}{R_2} + \frac{1}{R_4} + \frac{1}{R_6} + \frac{1}{R_7} \right) - V_1 \left(\frac{1}{R_4} \right) - V_3 \left(\frac{1}{R_6} \right) - V_4 \left(\frac{1}{R_7} \right) - \frac{V_9}{R_2} = 0$$

$$V_2 \left(\frac{10}{3} \right) - V_1 - V_3 - \frac{2}{3} V_4 = 8$$

$$\frac{V_3 - V_9}{R_1} + \frac{V_3 - V_2}{R_6} + \frac{V_3 - V_4}{R_8} = 0$$

$$V_3 \left(\frac{1}{R_1} + \frac{1}{R_6} + \frac{1}{R_8} \right) - V_2 \left(\frac{1}{R_6} \right) - V_4 \left(\frac{1}{R_8} \right) - \frac{V_9}{R_1} = 0$$

$$3V_3 - V_2 - V_4 = 12$$

$$\frac{V_4 - V_1}{R_5} + \frac{V_4 - V_2}{R_7} + \frac{V_4 - V_3}{R_8} = 0$$

$$V_4 \left(\frac{1}{R_5} + \frac{1}{R_7} + \frac{1}{R_8} \right) - V_1 \left(\frac{1}{R_5} \right) - V_2 \left(\frac{1}{R_7} \right) - V_3 \left(\frac{1}{R_8} \right) = 0$$

$$\frac{2}{3} V_4 - \frac{2}{3} V_1 - \frac{2}{3} V_2 - V_3 = 0$$

$$\begin{bmatrix} \frac{10}{3} & -1 & 0 & -\frac{2}{3} \\ -1 & \frac{10}{3} & -1 & -\frac{2}{3} \\ 0 & -1 & 3 & -1 \\ -\frac{2}{3} & -\frac{2}{3} & -1 & \frac{7}{3} \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \\ V_3 \\ V_4 \end{bmatrix} = \begin{bmatrix} 8 \\ 8 \\ 12 \\ 0 \end{bmatrix}$$

$$V_1 = 7 \text{ V}$$

$$V_2 = 9.33 \text{ V}$$

$$V_3 = 10.11 \text{ V}$$

$$V_4 = 9 \text{ V}$$

$$V_{oc} = V_4 = 9 \text{ V}$$

$$V_9 = 12$$

$$R_1, R_4, R_6, R_8, R_{10} = 1 \text{ k}\Omega$$

$$R_2, R_3, R_5, R_7 = 1.5 \text{ k}\Omega$$

$$\frac{V_2}{R_7} + \frac{V_2 - V_3}{R_6} + \frac{V_2 - V_1}{R_4} + \frac{V_2 - V_9}{R_2} = 0$$

$$V_2 \left(\frac{1}{R_7} + \frac{1}{R_6} + \frac{1}{R_4} + \frac{1}{R_2} \right) - V_3 \left(\frac{1}{R_6} \right) - \frac{V_1}{R_4} - \frac{V_9}{R_2} = 0$$

$$\frac{10}{3} V_2 - V_3 - V_1 = 8$$

$$\frac{V_3}{R_8} + \frac{V_3 - V_2}{R_6} + \frac{V_3 - V_4}{R_1} = 0$$

$$V_3 \left(\frac{1}{R_8} + \frac{1}{R_6} + \frac{1}{R_1} \right) - V_2 \left(\frac{1}{R_6} \right) - \frac{V_4}{R_1} = 0$$

$$3V_3 - V_2 = 12$$

$$\frac{V_1}{R_5} + \frac{V_1}{R_{10}} + \frac{V_1 - V_2}{R_4} + \frac{V_1 - V_9}{R_3} = 0$$

$$V_1 \left(\frac{1}{R_5} + \frac{1}{R_{10}} + \frac{1}{R_4} + \frac{1}{R_3} \right) - V_2 \left(\frac{1}{R_4} \right) - \frac{V_9}{R_3} = 0$$

$$\frac{10}{3} V_1 - V_2 = 8$$

$$\begin{bmatrix} -1 & \frac{10}{3} & -1 \\ 0 & -1 & 3 \\ \frac{10}{3} & -1 & 0 \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix} = \begin{bmatrix} 8 \\ 12 \\ 8 \end{bmatrix}$$

$$V_1 = 4 \text{ V}$$

$$V_2 = 5.33 \text{ V}$$

$$V_3 = 9.78 \text{ V}$$

$$R_{th} = \frac{9}{12} = 750 \text{ }\Omega$$

$$i_{sc} = \frac{V_1}{R_3} + \frac{V_2}{R_7} + \frac{V_3}{R_8}$$

$$i_{sc} = \frac{4}{1.5} + \frac{5.33}{1.5} + \frac{9.78}{1}$$

$$i_{sc} = 12 \text{ mA}$$

>> ELEN50Project1

Vth =

9.0000

Isc =

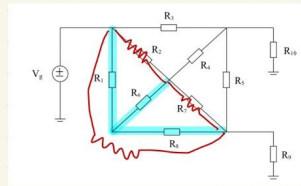
12

Rth =

750.0000

Part 3:

iii)



$$V_g = 12$$

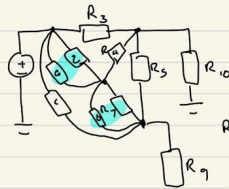
$$R_1, R_4, R_6, R_8, R_{10} = 1 \text{ k}\Omega$$

$$R_2, R_3, R_5, R_7 = 1.5 \text{ k}\Omega$$

$$R_a = \frac{R_1 R_2 + R_1 R_3 + R_2 R_3}{R_3} = 3$$

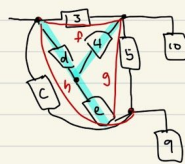
$$R_b = \frac{R_1 R_2 + R_1 R_3 + R_2 R_3}{R_1} = 3$$

$$R_c = \frac{R_1 R_2 + R_1 R_3 + R_2 R_3}{R_2} = 3$$



$$R_d = R_1 + R_2 = \frac{1}{1.5} + \frac{1}{3} = 1 \rightarrow 1$$

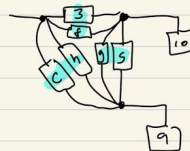
$$R_e = R_3 + R_7 = \frac{1}{1.5} + \frac{1}{3} = 1 \rightarrow 1$$



$$R_f = \frac{R_4 R_5 + R_4 R_6 + R_5 R_6}{R_6} = 3$$

$$R_g = \frac{R_4 R_5 + R_4 R_6 + R_5 R_6}{R_4} = 3$$

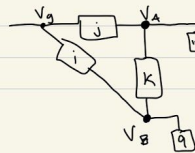
$$R_h = \frac{R_4 R_5 + R_4 R_6 + R_5 R_6}{R_5} = 3$$



$$R_i = R_c + R_h = \frac{1}{3} + \frac{1}{3} = \frac{2}{3} \rightarrow \frac{3}{2}$$

$$R_j = R_3 + R_f = \frac{1}{1.5} + \frac{1}{3} = 1 \rightarrow 1$$

$$R_k = R_g + R_5 = \frac{1}{3} + \frac{1}{1.5} = 1 \rightarrow 1$$



$$0 = \frac{V_A - V_g}{R_j} + \frac{V_A - V_B}{R_k} + \frac{V_A}{R_{10}}$$

$$0 = \frac{V_B - V_A}{R_k} + \frac{V_B - V_g}{R_i}$$

$$0 = V_A - V_g + V_A - V_B + V_A$$

$$12 = 3V_A - V_B$$

$$\frac{V_g}{R_i} = V_B - V_A + \frac{V_A}{R_i}$$

$$8 = -V_A + \frac{2}{3}V_B$$

$$\begin{bmatrix} 3 & -1 \\ -1 & 5/3 \end{bmatrix} \begin{bmatrix} V_A \\ V_B \end{bmatrix} = \begin{bmatrix} 12 \\ 8 \end{bmatrix}$$

$$V_A = 7 \text{ V}$$

$$V_{oc} = V_B = 9 \text{ V}$$

$$V_B = 9 \text{ V}$$

$$\frac{V_A}{R_k} + \frac{V_A}{R_{10}} + \frac{V_A - V_g}{R_j} = 0$$

$$V_A \left(\frac{1}{R_k} + \frac{1}{R_{10}} + \frac{1}{R_j} \right) = 12$$

$$3V_A = 12$$

$$V_A = 4 \text{ V}$$

$$i_{sc} = \frac{V_A}{R_k} + \frac{V_g}{R_i} = 4 + 8 = 12 \text{ mA}$$

$$R_{th} = \frac{V_{oc}}{i_{sc}} = \frac{9}{12} = 750 \Omega$$

$$P_{max} = i^2 r \rightarrow i = \frac{V}{r}$$

$$= \frac{V^2}{r^2} (r) = \frac{V^2}{2r} = \frac{9^2}{2(1000)} = 0.027 \text{ W}$$

$$P_{max} = 0.027 \text{ W}$$

Part 4: All my resistors were 500 Ohms

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>> ELEN50Project11
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Vth =
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|
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9.3913
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Isc =
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31.6098
```

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Rth =
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```
297.1014
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Part 5:

