ELECENG 2CI5 Lab 5 Prelab

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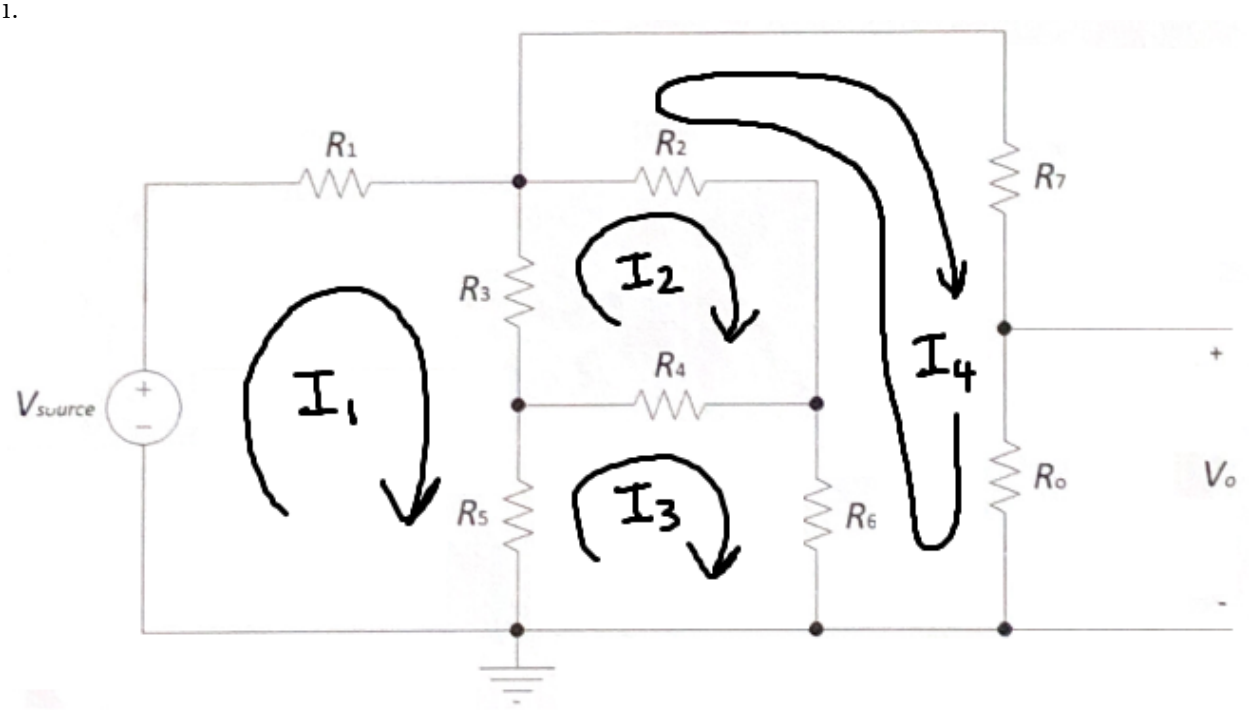
i.



Loop 1

$$\begin{aligned} R_1 I_1 + R_3(I_1 - I_2) + R_5(I_1 - I_3) &= V_{source} \\ (R_1 + R_3 + R_5)I_1 - R_3 I_2 - R_5 I_3 + 0I_4 &= V_{source} \end{aligned} \tag{1}$$

Loop 2

$$\begin{aligned} R_2(I_2 - I_4) + R_3(I_2 - I_1) + R_4(I_2 - I_3) &= 0 \\ -R_3 I_1 + (R_2 + R_3 + R_4)I_2 - R_4 I_3 - R_2 I_4 &= 0 \end{aligned} \tag{2}$$

Loop 3

$$\begin{aligned} R_4(I_3 - I_2) + R_5(I_3 - I_1) + R_6(I_3 - I_4) &= 0 \\ -R_5 I_1 - R_4 I_2 + (R_4 + R_5 + R_6)I_3 - R_6 I_4 &= 0 \end{aligned} \tag{3}$$

Loop 4

$$\begin{aligned} R_2(I_4 - I_2) + R_6(I_4 - I_3) + R_7 I_4 + R_o I_4 &= 0 \\ 0I_1 - R_2 I_2 - R_6 I_3 + (R_2 + R_6 + R_7 + R_o)I_4 &= 0 \end{aligned} \tag{4}$$

$$\begin{matrix}(1)\\(2)\\(3)\\(4)\end{matrix}\begin{bmatrix}(R_1+R_3+R_5) & -R_3 & -R_5 & 0\\ -R_3 & (R_2+R_3+R_4) & -R_4 & -R_2\\ -R_5 & -R_4 & (R_4+R_5+R_6) & -R_6\\ 0 & -R_2 & -R_6 & (R_2+R_6+R_7+R_o)\end{bmatrix}\begin{bmatrix}I_1\\I_2\\I_3\\I_4\end{bmatrix}=\begin{bmatrix}V_{source}\\0\\0\\0\end{bmatrix}$$

$$\begin{bmatrix}I_1\\I_2\\I_3\\I_4\end{bmatrix}=\begin{bmatrix}(R_1+R_3+R_5) & -R_3 & -R_5 & 0\\ -R_3 & (R_2+R_3+R_4) & -R_4 & -R_2\\ -R_5 & -R_4 & (R_4+R_5+R_6) & -R_6\\ 0 & -R_2 & -R_6 & (R_2+R_6+R_7+R_o)\end{bmatrix}^{-1}\begin{bmatrix}V_{source}\\0\\0\\0\end{bmatrix}$$

ii.

$$\begin{bmatrix}I_1\\I_2\\I_3\\I_4\end{bmatrix}=\begin{bmatrix}(R_1+R_3+R_5) & -R_3 & -R_5 & 0\\ -R_3 & (R_2+R_3+R_4) & -R_4 & -R_2\\ -R_5 & -R_4 & (R_4+R_5+R_6) & -R_6\\ 0 & -R_2 & -R_6 & (R_2+R_6+R_7+R_o)\end{bmatrix}^{-1}\begin{bmatrix}V_{source}\\0\\0\\0\end{bmatrix}$$

$$\begin{bmatrix}I_1\\I_2\\I_3\\I_4\end{bmatrix}=$$

$$\begin{bmatrix}(220\Omega+1k\Omega+1k\Omega) & -1k\Omega & -1k\Omega & 0\\ -1k\Omega & (1k\Omega+1k\Omega+10k\Omega) & -10k\Omega & -1k\Omega\\ -1k\Omega & -10k\Omega & (10k\Omega+1k\Omega+10k\Omega) & -10k\Omega\\ 0 & -1k\Omega & -10k\Omega & (1k\Omega+10k\Omega+10k\Omega+24.7k\Omega)\end{bmatrix}^{-1}\begin{bmatrix}4V\\0\\0\\0\end{bmatrix}$$

$$\begin{bmatrix}I_1\\I_2\\I_3\\I_4\end{bmatrix}=\begin{bmatrix}2.227\text{mA}\\0.535\text{mA}\\0.409\text{mA}\\0.101\text{mA}\end{bmatrix}$$

iii.

	$I_{calculated}$ (mA)	$I_{measured}$ (mA)
I_1	2.227	2.22
I_2	0.535	0.550
I_3	0.409	0.420
I_4	0.101	0.0995

iv.

$$V_o = I_4 R_o = 0.101mA \times 24.7k\Omega = 2.495V$$

The calculated value of V_o is 2.495V. The measured value of V_o is 2.482V.

v.

$$P_o = \frac{V_o^2}{R_o}$$

$$P_{o_{calculated}} = \frac{V_{o_{calculated}}^2}{R_o} = \frac{2.495^2}{24.7k} = 0.252mW$$

$$P_{o_{measured}} = \frac{V_{o_{measured}}^2}{R_o} = \frac{2.482^2}{24.7k} = 0.249mW$$

The calculated value of P_o using the calculated value of V_o is 0.252mW. The calculated value of P_o using the measured value of V_o is 0.249mW.

vi.
The measured value of V_o is 0.310V. The calculated value of P_o is 0.0961mW.

$$P_{o_{measured}} = \frac{V_o^2}{R_o} = \frac{0.310^2}{1k} = 0.0961mW$$

vii.