1) Consider the circuit shown in Figure 1 below.

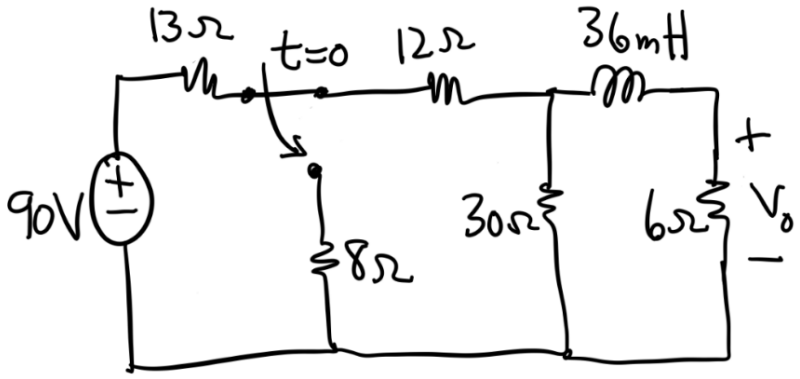


Figure 1. Circuit for Problem 1.

a) The response $V_0(t)$ for $t > 0$ can be written as

$$V_0(t) = A + Be^{-ct},$$

where A and B are in units of volts and c has units of rps (i.e., rad/sec; c is the reciprocal of the time constant). State your by-hand solutions for A, B, and c, and list your A, B, and c values with appropriate units in proper engineering notation format with two decimal places of precision.

Also, sketch the response. Label the plot axes on your sketch and otherwise make your sketch neat-looking and easy to comprehend.

b) Use the LTSpice verification testbench which has been provided to you to verify your by-hand answers for A, B, and c. List the *maxerror* value you attained from the LTSpice verification testbench; you should ensure that the *maxerror* value listed in the Spice Error Log (ctrl-L) is less than or equal to the value given in the testbench comment. If you do not achieve a *maxerror* less than or equal to the value given in the testbench comment, **something is wrong**, and you should work to resolve the issues with your by-hand solutions for A, B, and c prior to submitting. Attach a screenshot of the Spice Error Log showing the value of *maxerror* that you attained.

[**continued on next page**]

Circuit $t=0^-$

$V_o(0^-) = V_o(0^+)$

V_o = Voltage divider

$$V_o = V_s\left(\frac{R_B}{R_A+R_B}\right) \leftarrow \begin{bmatrix} R_A = 13\Omega + 12\Omega = 25\Omega \\ R_B = \frac{30\cdot 6}{30+6} = 5\Omega \end{bmatrix}$$

$$V_o = 90V\left(\frac{5\Omega}{25\Omega+5\Omega}\right)$$

$V_o(0^-) = V_o(0^+) = 15V$

B = 15V

Find A, B, c in

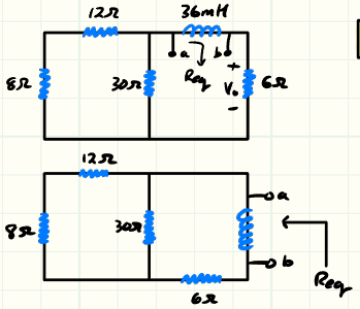
$V_o(t) = A + Be^{-ct}$

$A = v(\infty)$

$B = [v(0^+) - v(\infty)]$

$c = 1/\tau$

at $t = \infty$, V_s is disconnected and so $V_o(\infty) = 0$



$$R_{eq} = (6\Omega) + \left(\frac{(8+12)\cdot 30}{(8+12)+30}\right)$$

$R_{eq} = 18\Omega$

A = 0V

$c = \frac{1}{\tau}$

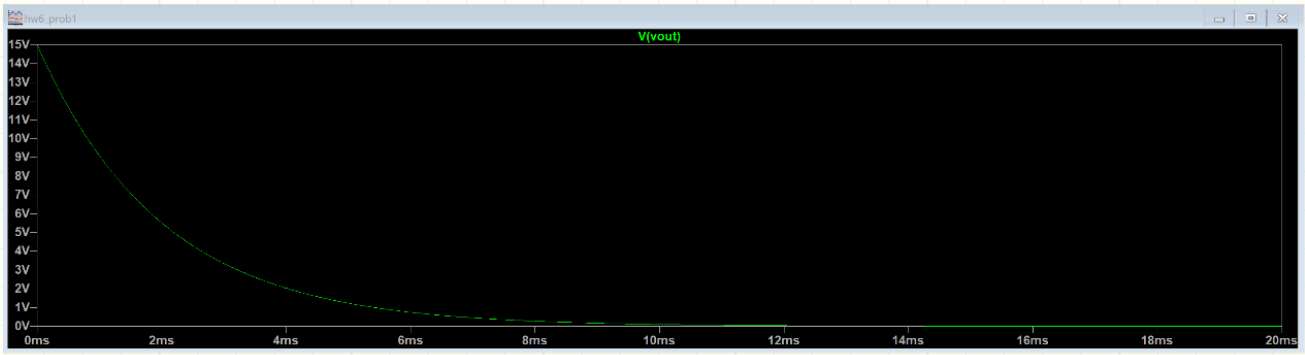
$\tau = \frac{L}{R_{eq}}$

$\tau = \frac{36mH}{18\Omega} = 0.002s$

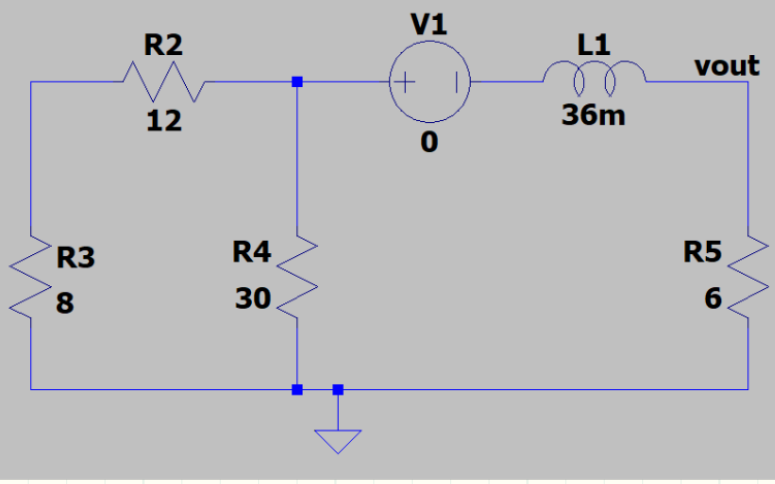
$c = 1/0.002$

c = 500 rad/s

$V(t) = 15e^{-500t}$



maxerror: MAX(abs(v(vout)-v(voutcheck)))=0.00269952158477 FROM 0 TO 0.02



2) Consider the circuit shown in Figure 2 below.

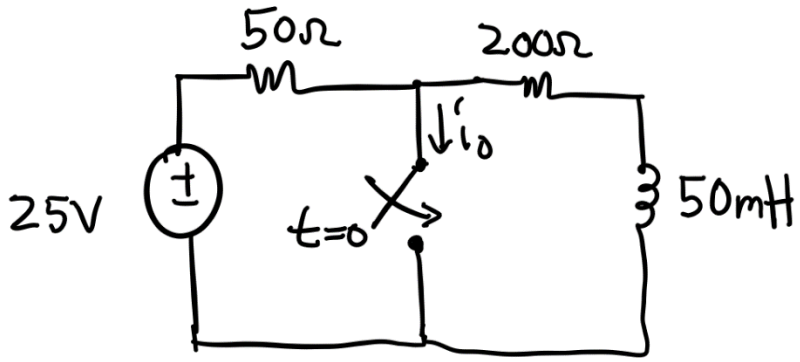


Figure 2. Circuit for Problem 2.

a) The response $i_0(t)$ for $t > 0$ can be written as

$$i_0(t) = A + Be^{-ct},$$

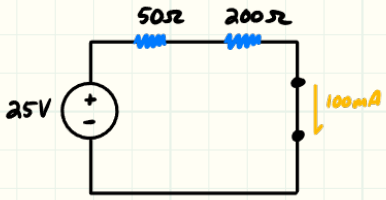
where A and B are in units of amps and c has units of rps (i.e., rad/sec; c is the reciprocal of the time constant). State your by-hand solutions for A, B, and c, and list your A, B, and c values with appropriate units in proper engineering notation format with two decimal places of precision.

Also, sketch the response. Label the plot axes on your sketch and otherwise make your sketch neat-looking and easy to comprehend.

b) Use the LTSpice verification testbench which has been provided to you to verify your by-hand answers for A, B, and c. List the *maxerror* value you attained from the LTSpice verification testbench; you should ensure that the *maxerror* value listed in the Spice Error Log (ctrl-L) is less than or equal to the value given in the testbench comment. If you do not achieve a *maxerror* less than or equal to the value given in the testbench comment, **something is wrong**, and you should work to resolve the issues with your by-hand solutions for A, B, and c prior to submitting. Attach a screenshot of the Spice Error Log showing the value of *maxerror* that you attained.

[**continued on next page**]

CKT at $t=0^-$



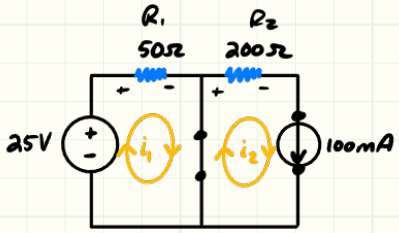
$$i = \frac{V}{R}$$

$$i(0^-) = \frac{V_s}{R_{eq}}$$

$$i(0^-) = \frac{25V}{200\Omega + 50\Omega}$$

$$i(0^-) = 100mA$$

CKT at $t=0^+$



$i_2 = 100mA$

$0 = -V_s + R_1(i_1)$

$V = i_1 R_1$

$\frac{25V}{50\Omega} = 500mA = i_1$

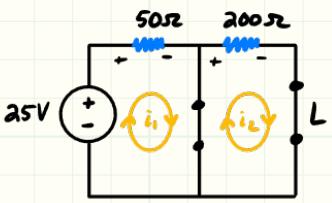
$i_o = i_1 - i_2$

$i_o = 500mA - 100mA$

$i_o = 400mA$

$\beta = -100mA$

CKT at $i(t \to \infty)$



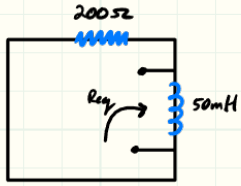
$i_2 = 0$; because current flows the path of least Resistance and skip loop 2.

$i_1 = 500mA$

$A = 500mA$

Finding τ

$\tau = L/R_{eq}$



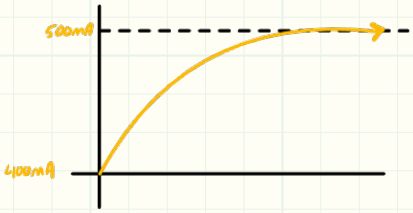
$R_{eq} = 200\Omega$

$\tau = \frac{50mH}{200\Omega} = 0.00025$

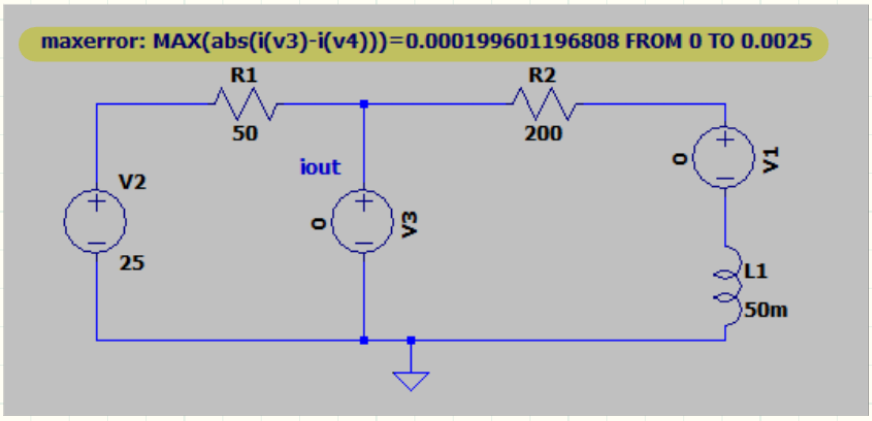
$C = \frac{1}{\tau}$

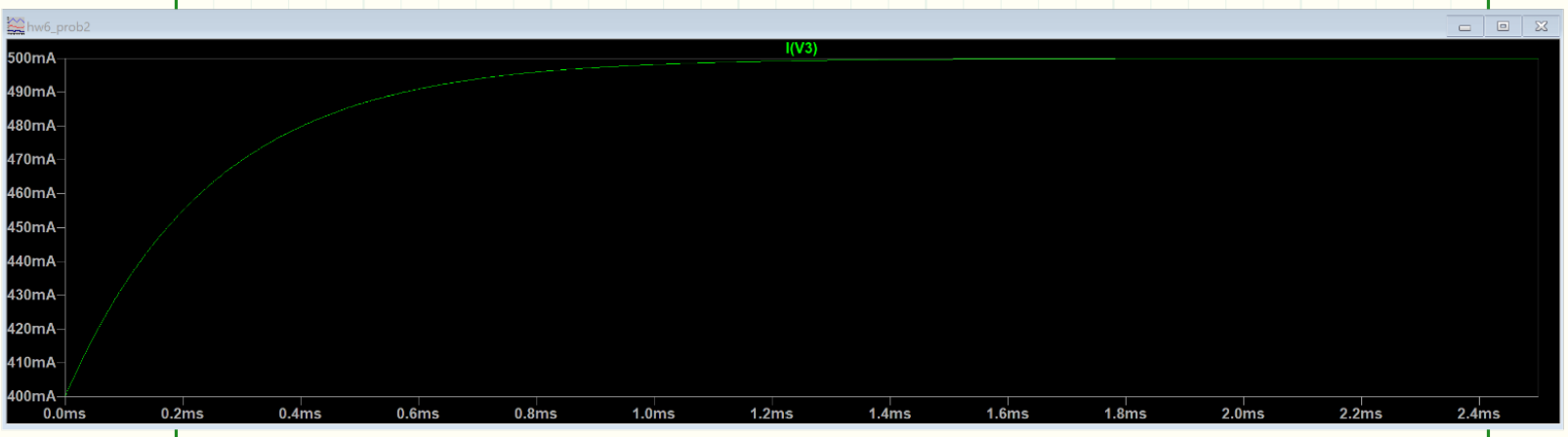
$C = 1/0.00025 = 4000 rps$

$C = 4000 rps$



$i_o(t) = 500 - 100e^{-4000t}$





3) Consider the circuit shown in Figure 3 below.

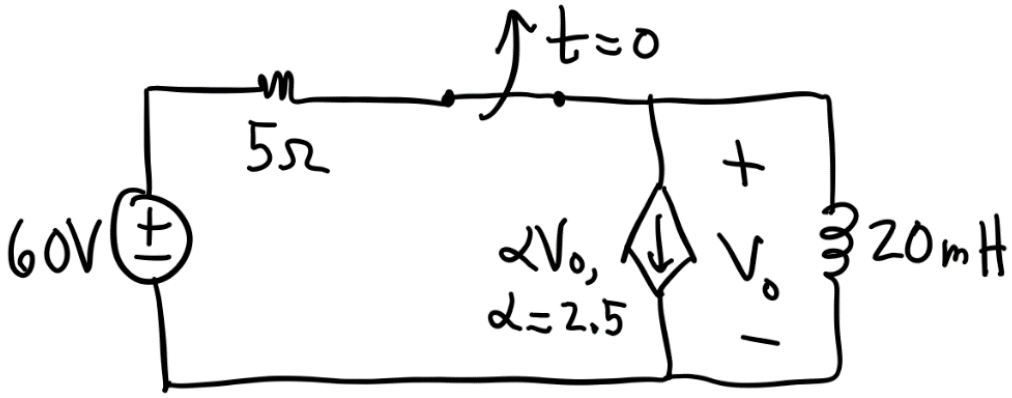


Figure 3. Circuit for Problem 3.

a) The response $V_0(t)$ for $t > 0$ can be written as

$$V_0(t) = A + Be^{-ct},$$

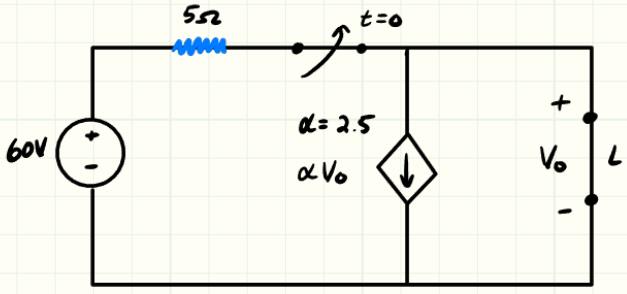
where A and B are in units of volts and c has units of rps (i.e., rad/sec; c is the reciprocal of the time constant). State your by-hand solutions for A, B, and c, and list your A, B, and c values with appropriate units in proper engineering notation format with two decimal places of precision.

Also, sketch the response. Label the plot axes on your sketch and otherwise make your sketch neat-looking and easy to comprehend.

b) Use the LTSpice verification testbench which has been provided to you to verify your by-hand answers for A, B, and c. List the *maxerror* value you attained from the LTSpice verification testbench; you should ensure that the *maxerror* value listed in the Spice Error Log (ctrl-L) is less than or equal to the value given in the testbench comment. If you do not achieve a *maxerror* less than or equal to the value given in the testbench comment, **something is wrong**, and you should work to resolve the issues with your by-hand solutions for A, B, and c prior to submitting. Attach a screenshot of the Spice Error Log showing the value of *maxerror* that you attained.

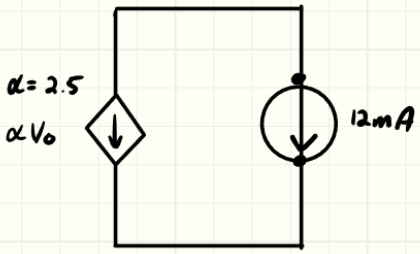
[**continued on next page**]

CKT at $t=0^-$



$i = V/R \quad i = 60V/5\Omega = 12A$

CKT at $t=0^+$



$\alpha V_0 + 12mA = 0$

$2.5V_0 = -12mA$

$V_0 = \frac{-12mA}{2.5}$

$V_0 = -4.8V$

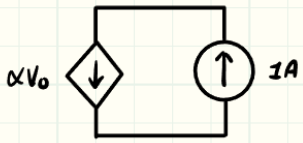
B = -4.8V

at $t \to \infty$,

there is no Voltage drop, so $V_0(\infty) = 0$

A = 0V

Finding τ



$\alpha V_0 = 1A$

$2.5V_0 = 1A$

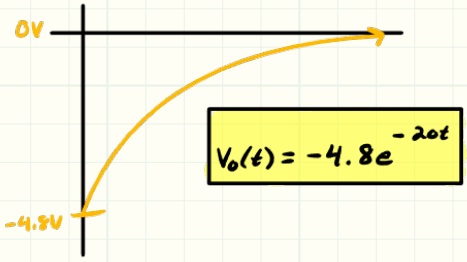
$V_0 = 1/2.5 = 0.4$

$R_{eq} = 0.4$

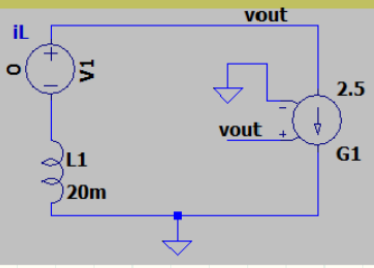
$\tau = \frac{L}{R_{eq}} = \frac{20mH}{0.4} = 0.05$

$C = 1/\tau = 1/0.05 = 20rps$

C = 20rps



maxerror: MAX(abs(v(vout)-v(voutcheck)))=0.000112577250486 FROM 0 TO 0.5



4) Consider the circuit shown in Figure 4 below.

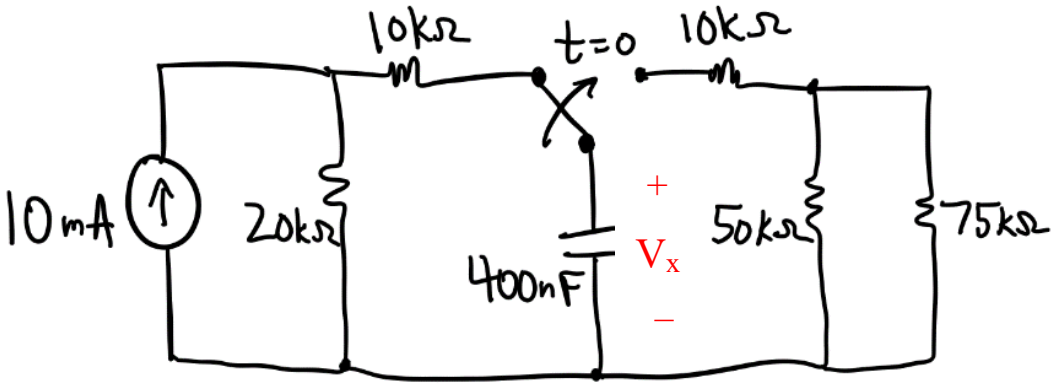


Figure 4. Circuit for Problem 4.

a) The response $V_x(t)$ for $t \geq 0$ can be written as

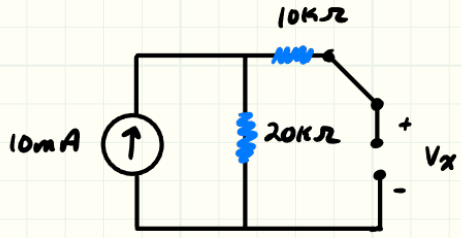
$$V_x(t) = A + Be^{-ct},$$

where A and B are in units of volts and c has units of rps (i.e., rad/sec; c is the reciprocal of the time constant). State your by-hand solutions for A, B, and c, and list your A, B, and c values with appropriate units in proper engineering notation format with two decimal places of precision.

Also, sketch the response. Label the plot axes on your sketch and otherwise make your sketch neat-looking and easy to comprehend.

b) Use the LTSpice verification testbench which has been provided to you to verify your by-hand answers for A, B, and c. List the *maxerror* value you attained from the LTSpice verification testbench; you should ensure that the *maxerror* value listed in the Spice Error Log (ctrl-L) is less than or equal to the value given in the testbench comment. If you do not achieve a *maxerror* less than or equal to the value given in the testbench comment, **something is wrong**, and you should work to resolve the issues with your by-hand solutions for A, B, and c prior to submitting. Attach a screenshot of the Spice Error Log showing the value of *maxerror* that you attained.

CKT at $t = 0^-$

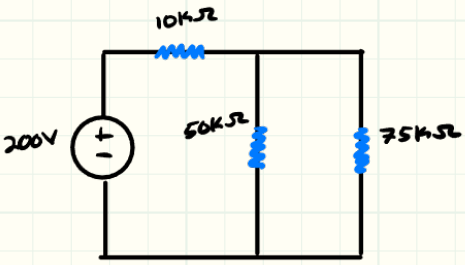


$V = IR$

$V_x = (10mA)(20k\Omega)$

$V_x = 200V$

CKT at $t = 0^+$



$V_x(0^-) = V_x(0^+)$

B = 200V

at $V(\infty)$,

all sources are deactivated

so all voltage goes to zero

$V_x(\infty) = 0$

A = 0V

$\tau = RC$

$\tau = R_{eq} \cdot 400nF$

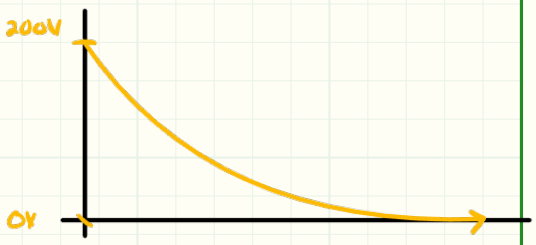
$\tau = \left[\left(\frac{50k \cdot 75k}{50k + 75k}\right) + 10k\right] \cdot 400nF$

$\tau = 0.016$

$C = 1/\tau$

$C = 1/0.016$

C = 62.5rps



$V_x(t) = 200e^{-62.5t}$