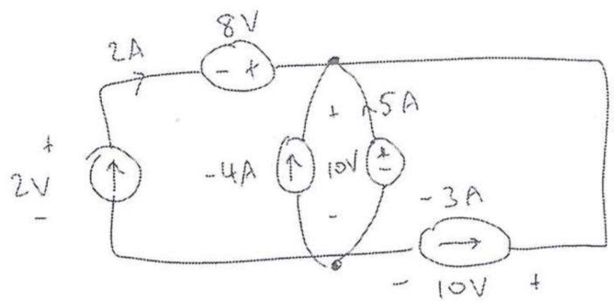
Name: **Student ID:**

Pre-tutorial 4 Questions (to be attempted before class on May 3rd, 2019)

Chapter 2, Ex 20: Power absorbed

Determine which of the five sources are being charged (absorbing positive power), and show that the algebraic sum of the five absorbed power values is zero.

$\xrightarrow{i}$ + −
P = VI (absorbed)



2V source $P = V(-I) = 2\times(-2) = -4W$ absorbed
or 4W generated.

8V source $P = V(-I) = 8\times(-2) = -16W$ absorbed
or 16W generated.

−4A source $P = V(-I) = 10\times(-(-4)) = 40W$ absorbed.

10V source $P = V(-I) = 10\times(-5) = -50W$ absorbed
or 50W generated

−3A source $P = V(-I) = 10\times(-(-3)) = 30W$ absorbed.

Σ Powers = 0

$-4 - 16 + 40 - 50 + 30 = 0$ ✓

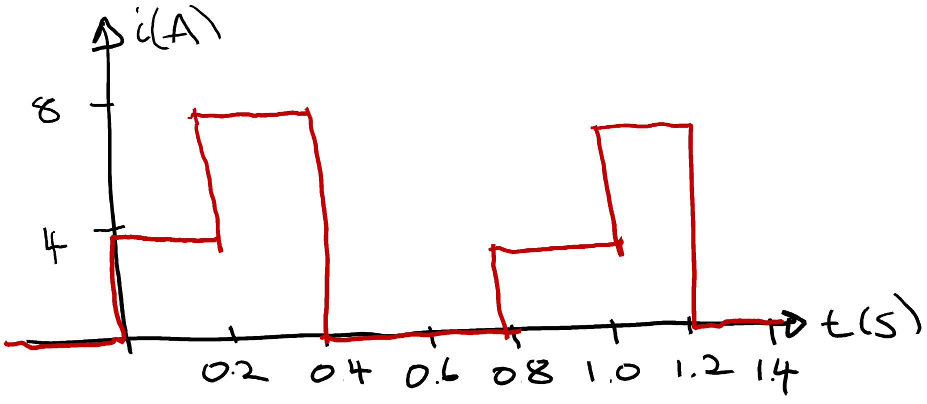
Conservation of energy.

For power absorbed problems you can also try Ex. 22.

Chapter 7, Ex 11a: Capacitors

The current flowing through a 33 mF capacitor is shown graphically below.

a) Assuming the passive sign convention, sketch the resulting voltage waveform across the device.



Q11a) $C = 33\,mF$

$$v = \frac{1}{C}\int_{t_0}^{t} i(\tau)\,d\tau + v(t_0)$$

⇒ integral of a horizontal straight line (ie. a constant) is a constant slope straight line. If find the end-points can just join them.

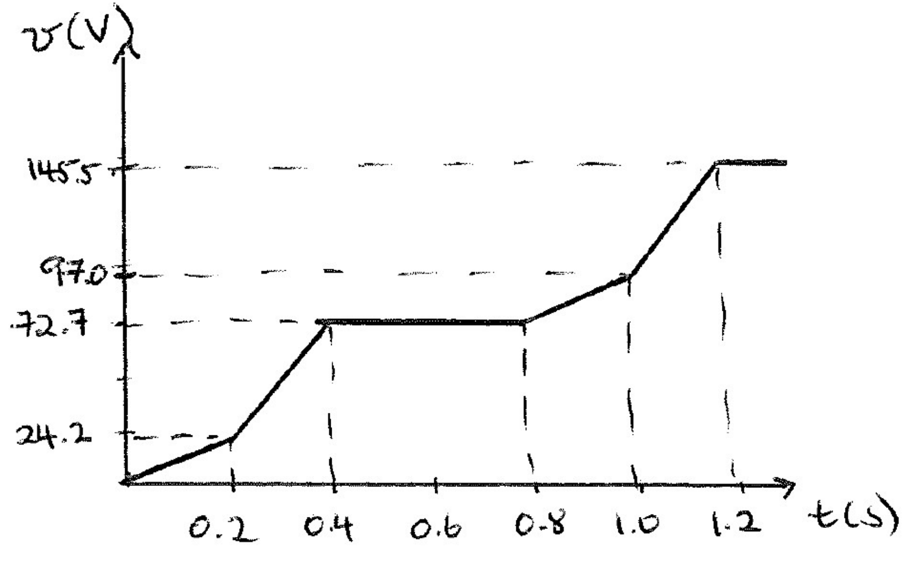
@ $t = 0.2$:
$$v = \frac{1}{33\times10^{-3}}\int_0^{0.2} 4\,dt + 0$$
$$= \frac{4}{33\times10^{-3}}\left[t\right]_0^{0.2}$$
$$= \frac{4\times0.2}{33\times10^{-3}}$$
$$= 24.2V$$

@ $t = 0.4$:
$$v = \frac{1}{33\times10^{-3}}\int_{0.2}^{0.4} 8\,dt + 24.2$$
$$= \frac{8}{33\times10^{-3}}\left[t\right]_{0.2}^{0.4} + 24.2$$
$$= \frac{8\times(0.4-0.2)}{33\times10^{-3}} + 24.2$$
$$= 72.7V$$

@ $t = 0.8$:
$$v = \frac{1}{33\times10^{-3}}\int_{0.4}^{0.8} 0 \, dt + 72.7$$
$$= 72.7V$$
(or by inspection)

@ $t = 1$:
$$v = \frac{1}{33\times10^{-3}}\int_{0.8}^{1} 4 \, dt + 72.7$$
$$= \frac{4}{33\times10^{-3}}[t]_{0.8}^{1} + 72.7$$
$$= 97.0V$$

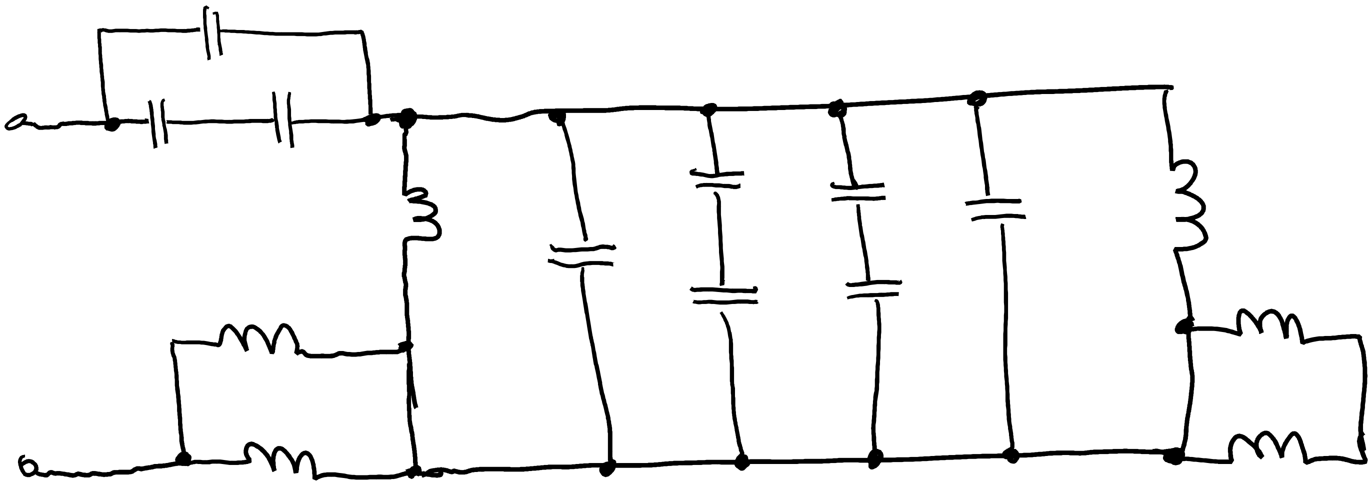
@ $t = 1.2$:
$$v = \frac{1}{33\times10^{-3}}\int_{1}^{1.2} 8 \, dt + 97$$
$$= \frac{8}{33\times10^{-3}}[t]_{1}^{1.2} + 97$$
$$= 145.5 V$$

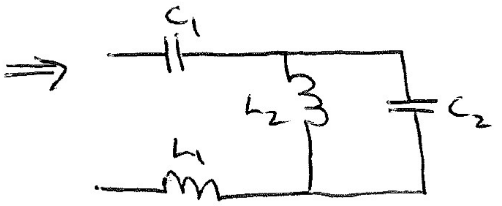


At Tutorial 4 – Marked Question (3rd May 2019)

Chapter 7, Ex 41: Equivalent capacitance/inductance

Reduce the network below to the smallest possible number of components if each inductor is 1 nH and each capacitor is 1 mF.





$$C_1 = \frac{(1\times10^{-3})^2}{1\times10^{-3}+1\times10^{-3}} + 1\times10^{-3}$$

$$= 1.5\times10^{-3}\ F$$

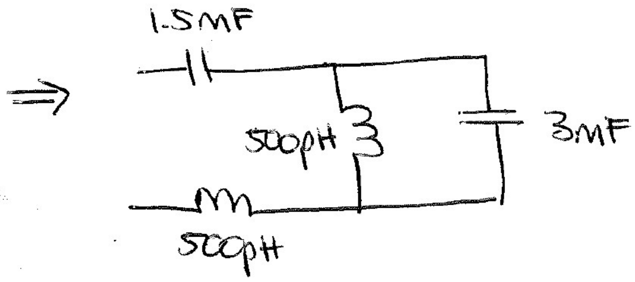
$$C_2 = \left(\frac{(1\times10^{-3})^2}{2\times10^{-3}}\right)\times2 + 2\times10^{-3}$$

$$= 3mF$$

$$L_2 = 500\times10^{-12}H$$

$$L_1 = \frac{(1\times10^{-9})^2}{1\times10^{-9}\times2}$$

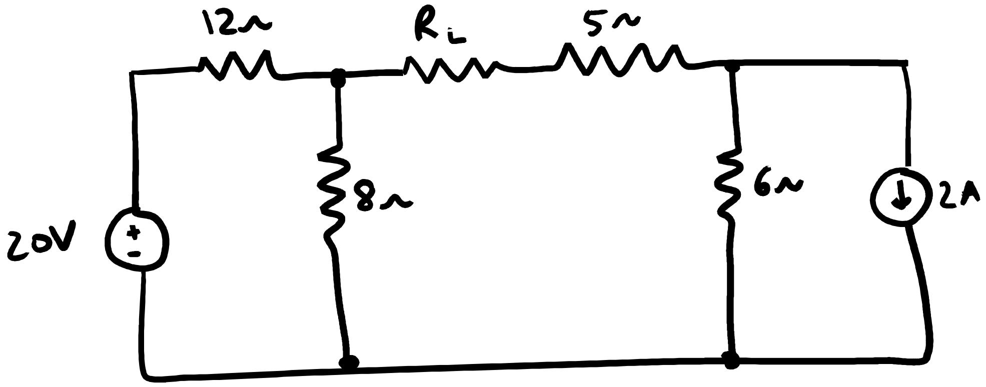
$$= 500\times10^{-12}\ H$$



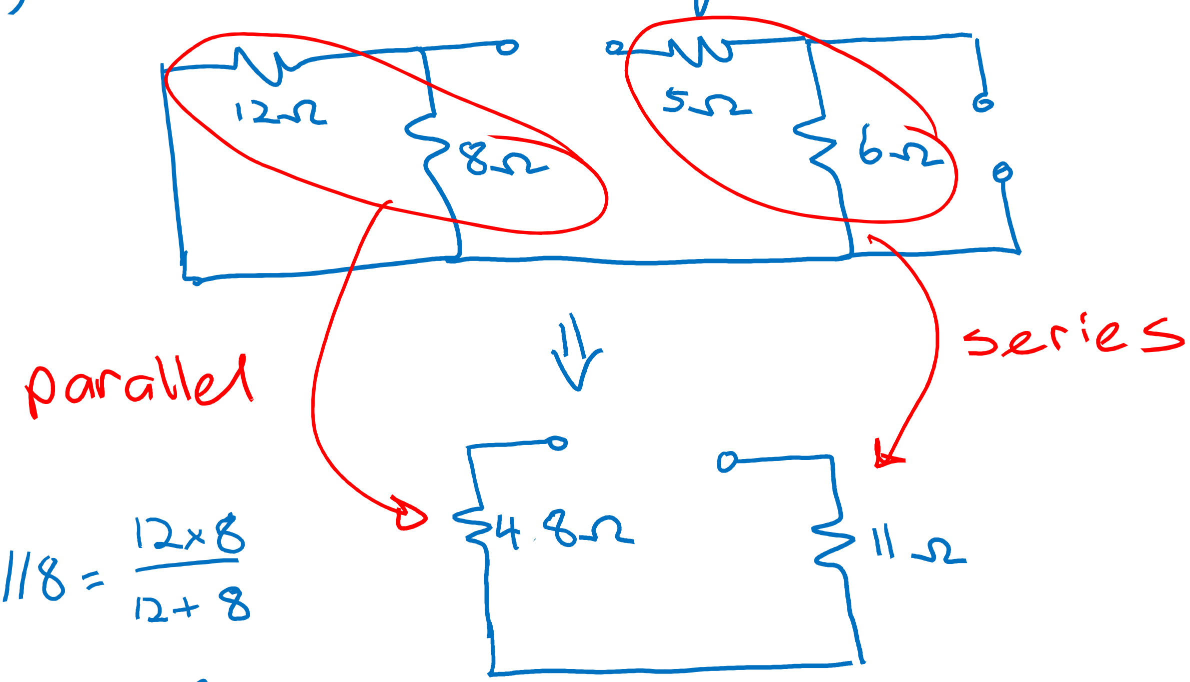
At Tutorial 4 – Unmarked Questions (3rd May 2019)

Ch 5 ex 61: Maximum power transfer

Given you can select any value of R_L, what is the maximum power that could be delivered to R_L?



1) Find Thévenin equivalent resistance:



$$12 // 8 = \frac{12 \times 8}{12 + 8}$$

$$= 4.8\Omega$$

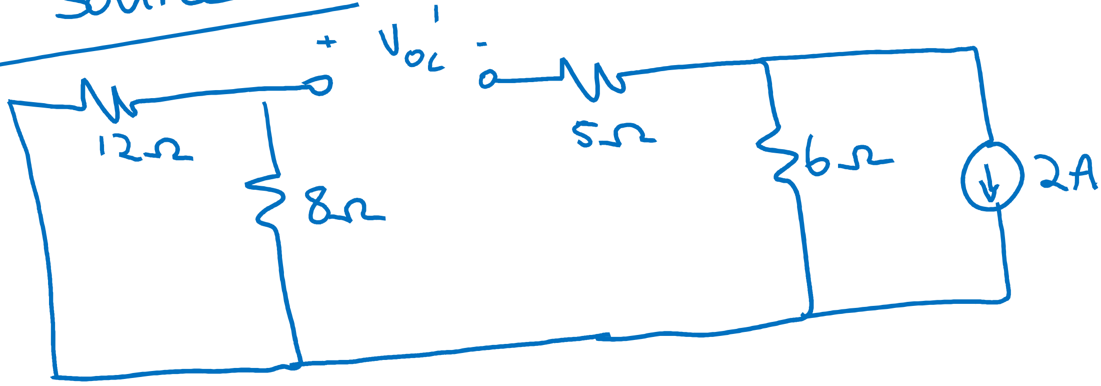
$$R_{TH} = 11 + 4.8$$

$$= 15.8\Omega$$

For Max pwr transfer, $R_L = R_{TH}$

2) Find V_{oc} using superposition:

20V source off

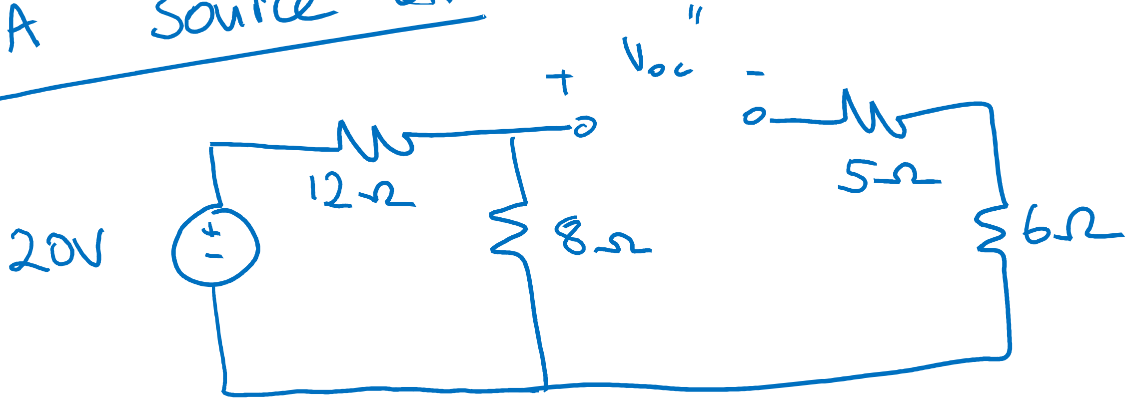


⇓

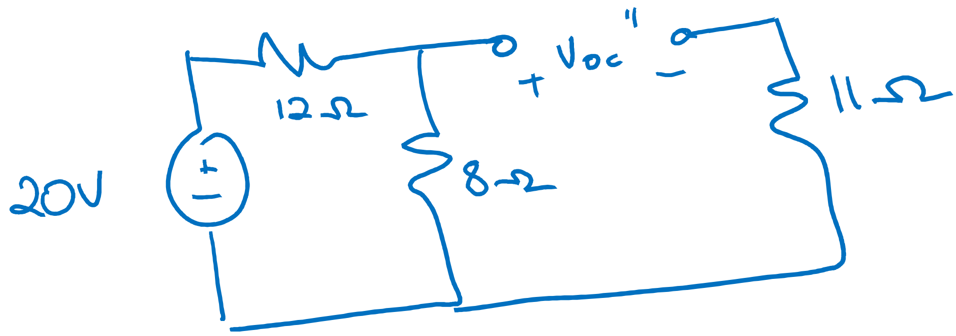
All current goes through 6Ω resistor,

$\therefore \; V_{oc}' = 6 \times 2 = 12V$

2A source off

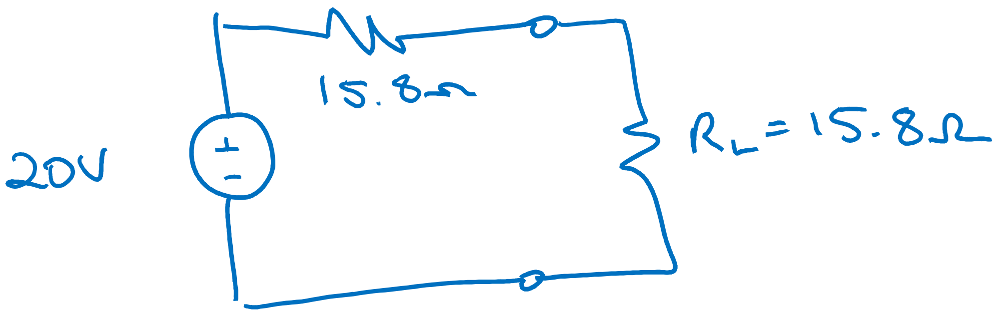


$\Downarrow$



$$V_{8\Omega} = V_{oc}'' = \frac{20 \times 8}{12+8} = 8V$$

$$\therefore \quad V_{oc} = V_{oc}' + V_{oc}'' = 12 + 8$$
$$= 20V$$



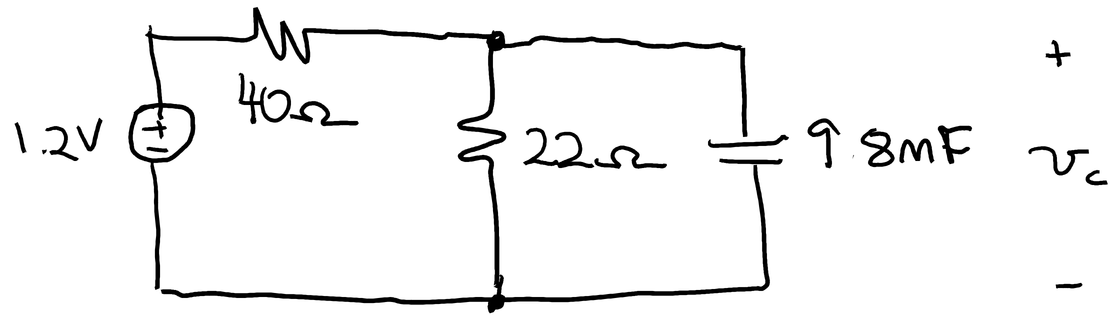
$$P = V^2/R = (20/2)^2/15.8$$

$$= 6.33\ W$$

Chapter 7, Ex 14: Power

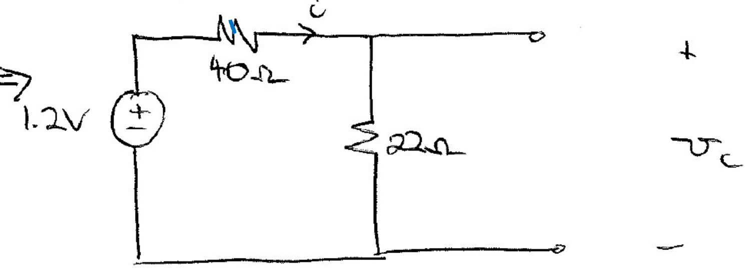
Assume the circuits below have been connected for a long time. Calculate the power dissipated in the 40 Ω resistor and the voltage labeled v_C in the circuits below:

a)



capacitor acts as an open circuit to DC

∴ circuit is ⟹

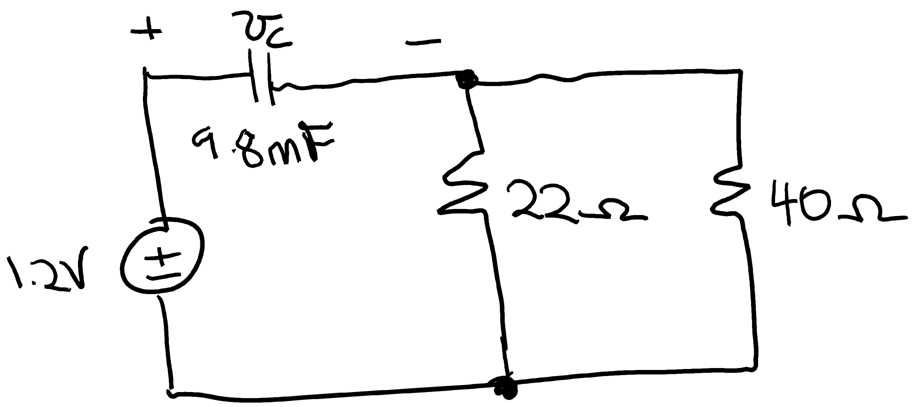


$$i = \frac{1.2}{(40+22)} = 19mA$$

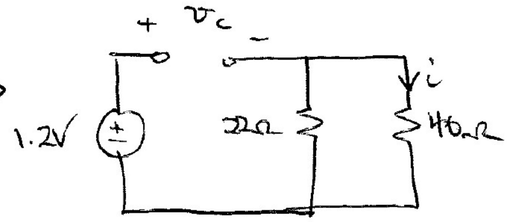
$$P_{40\Omega} = i^2 R = (19 \times 10^{-3})^2 \times 40 = 14.98mW$$

$$v_c = iR = 19 \times 10^{-3} \times 22 = 0.43V$$

b)



as above. ∴ circuit becomes ⇒



$P_{40\Omega} = 0W$ $\quad (i = 0A)$

$v_c = 1.2V$

Chapter 7, Ex 27: Inductors

Determine the amount of energy stored in a 33 mH inductor at t = 1 ms as a result of a current i_L given by:

a) 7 A

$i = 7A$

$w_L = \frac{1}{2}Li^2$

$= \frac{1}{2} \times 33 \times 10^{-3} \times 7^2$

$= 808.5 \text{ mJ}$

b) 3 - $9e^{-10^3 t}$ mA

$$i = 3 - 9e^{-10^3 t} \text{ mA}$$

$$w_L = \frac{1}{2} L i^2$$

$$= \frac{1}{2} \times 33\times10^{-3} \times (3\times10^{-3} - 9e^{-10^3 t} \times 10^{-3})^2$$

$$= 16.5\times10^{-3} (3\times10^{-3} - 3.3\times10^{-3})^2$$

$$= 16.5\times10^{-3} \times 96.67\times10^{-9}$$

$$= 1.595 \text{ nJ}$$

Chapter 7, Ex 25: Inductors

The voltage across a 2 H inductor is given by v_L = 4.3t, -0.1 s ≤ t ≤ 50 ms. Knowing that i_L (-0.1) = 100 µA, calculate the current (assuming it is defined consistent with the passive sign convention) as t equal to:

a) 0
b) 1.5 ms
c) 45ms

$$i(t) = \frac{1}{L} \int_{t_0}^{t} v(\tau)\, d\tau + i(t_0)$$

$$= \frac{1}{2} \left[\int_{-0.1}^{t} 4.3\tau\, d\tau \right] + 100\times10^{-6}$$

$$= \frac{1}{2} \times 4.3 \int_{-0.1}^{t} \tau\, d\tau + 100\times10^{-6}$$

$$= 2.15 \left[\frac{1}{2} \tau^2 \right]_{-0.1}^{t} + 100\times10^{-6}$$

$$= 2.15 \left(\frac{1}{2} t^2 - 5\times10^{-3} \right) + 100\times10^{-6}$$

a) $i(0) = -2.15 \times 5\times10^{-3} + 100\times10^{-6} = -10.65 \text{ mA}$

b) $i(1.5\text{ms}) = 2.15(1/2 \times (1.5\times10^{-3})^2 - 5\times10^{-3}) + 100\times10^{-6}$

$= -10.65 \text{ mA}$

c) $i(45\text{ms}) = 2.15(\frac{1}{2}(45\times10^{-3})^2 - 5\times10^{-3}) + 100\times10^{-6}$

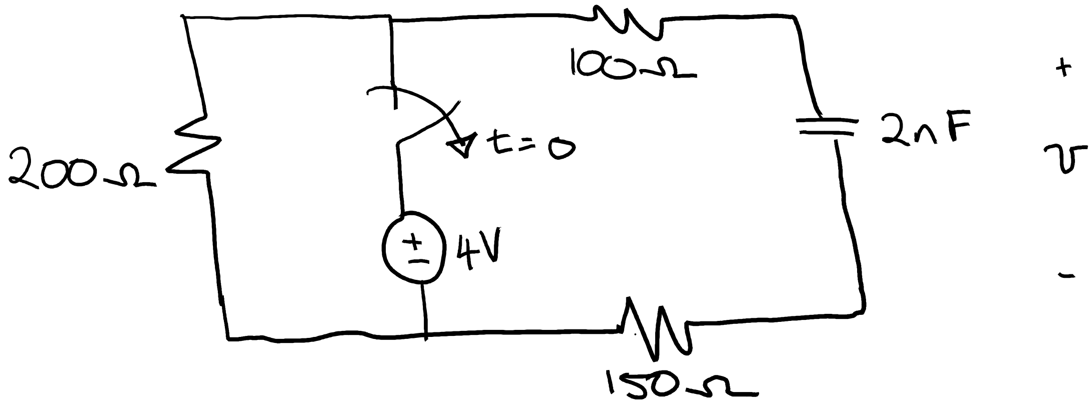
$= -8.47 \text{ mA}$

Name: Student ID:

Pre-tutorial 5 Questions (to be attempted before class on May 17th, 2019)

Chapter 8, Ex 20: Source-free RC circuit

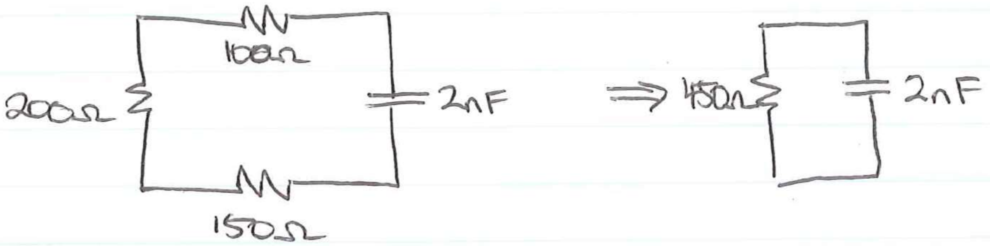
The switch drawn in the circuit below has been closed for such a long time that any transients which might have arisen from first connecting the voltage source have disappeared.



a) Determine the circuit time constant

$\tau = RC$

For $t > 0$ circuit is:

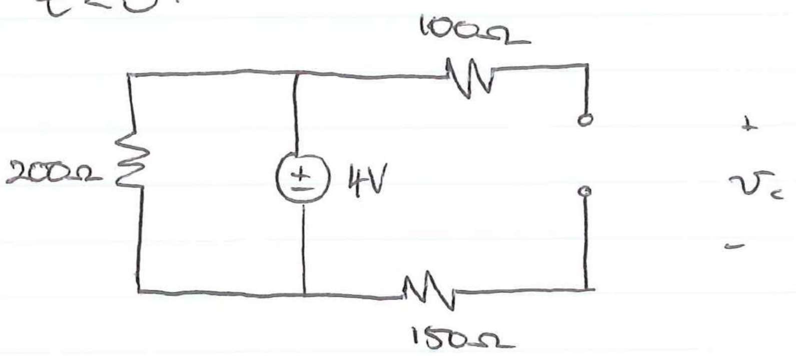


$RC = 450 \times 2 \times 10^{-9}$

$= 900ns$

b) Calculate the voltage $v(t)$ at $t = \tau, 2\tau,$ and 5τ

$t<0$:



$v_c(0^-) = 4V$

$v_c(0^-) = v_c(0^+) = 4V$

For $t>0$: $v(t) = Ae^{-t/\tau}$

$= Ae^{-t/900\times10^{9}}$

$= Ae^{-1.11\times10^{6}t}$

$v(0) = A\cancel{e^{-1.11\times10^{6}\times 0}}^{\,1} = 4$

$A = 4$

$\therefore v(t) = 4e^{-1.11\times10^{6}t}$ V $\quad t>0$

$v(\tau) = 4e^{-1}$

$= 1.47$ V

$v(2\tau) = 4e^{-2}$

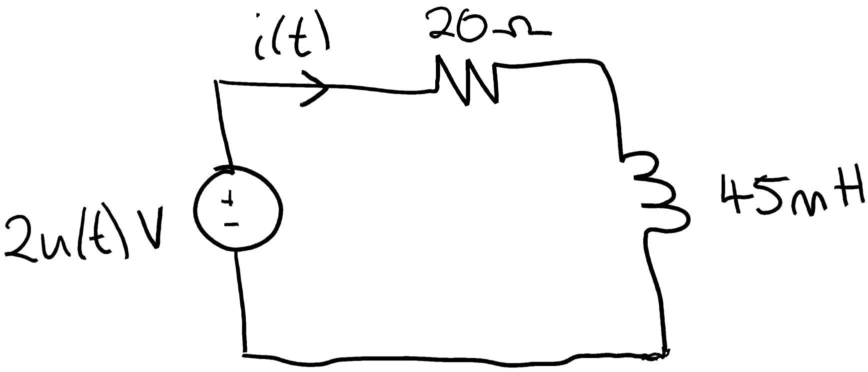
$= 0.54V$

$v(5\tau) = 4e^{-5}$

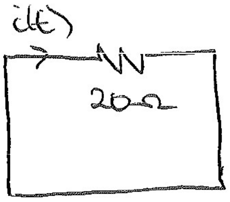
$= 0.027$ V

Chapter 8, Ex 49: Driven RL circuit

The circuit shown below is powered by a source which is inactive for t < 0. Obtain an expression for i(t) valid for all t.

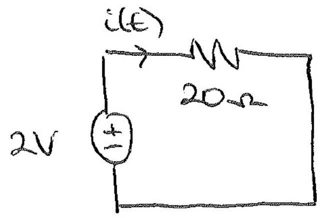


For $t<0$:



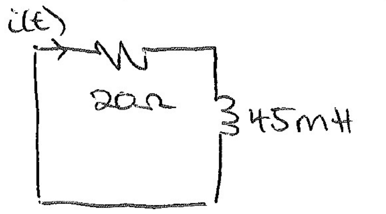
$i(t) = 0 \text{ A}$

For $t>0$, forcing function circuit:



$$i_F(t) = \frac{2}{20} = 0.1 \text{ A}$$

For $t>0$, natural function circuit:



$$i_n(t) = I_o e^{-t/\tau}$$

$$\tau = \frac{L}{R} = \frac{45\times10^{-3}}{20} = 2.25\times10^{-3} \text{ s}$$

$$1/\tau = 444.4 \text{ s}^{-1}$$

$$i_n(t) = I_o e^{-444.4t}$$

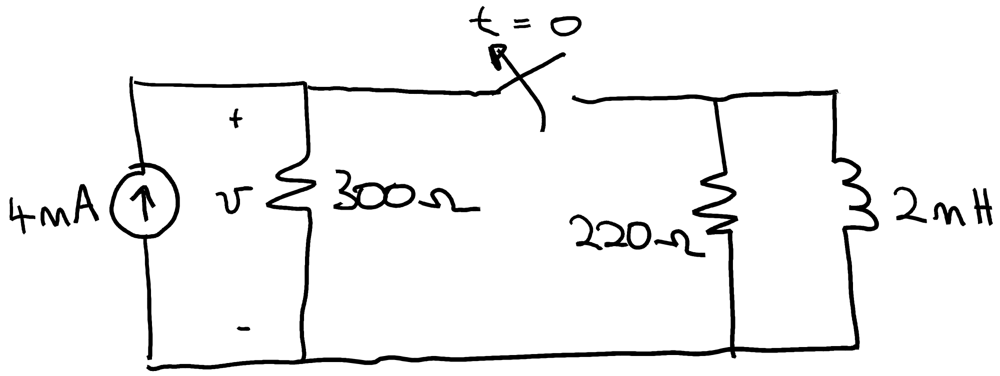
$$i(t) = i_F(t) + i_n(t) \quad t>0$$
$$= 0.1 + I_o e^{-444.4t}$$

$$i(0^-) = i(0^+) = 0 \qquad i(0) = 0.1 + I_o = 0$$
$$I_o = -0.1$$

$$i(t) = 0.1 - 0.1e^{-444.4t} \text{ A} \quad t>0$$
$$= 0.1\left(1 - e^{-444.4t}\right)u(t) \text{ A}$$

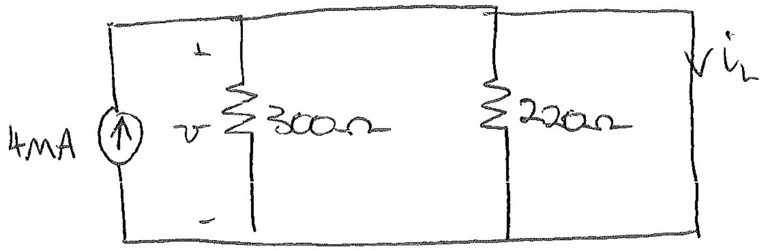
At Tutorial 5 – Marked Question (17th May 2019)

Chapter 8, Ex 8: Source-free RL circuit



The switch in the circuit above has been closed a very long time. Calculate the voltage v as well as the energy stored in the inductor at:

a) The instant just prior to the switch being thrown open

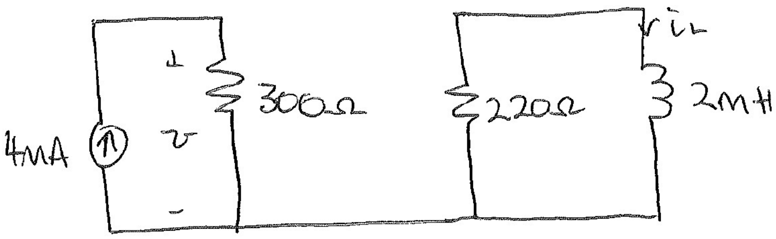


$i_L(0^-) = 4mA$

$v(0^-) = 0V$

$$w(0^-) = \frac{1}{2} L i^2$$
$$= \frac{1}{2} \times 2\times10^{-3} \times (4\times10^{-3})^2$$
$$= 16\times10^{-9}\ J$$

b) The instant just after the switch is opened



$$v(0^+) = 4\times10^{-3} \times 300$$
$$= 1.2V$$

$i_L(0^+) = i_L(0^-) = 4mA$

$$w_L(0^+) = \frac{1}{2} \times 2\times10^{-3} \times (4\times10^{-3})^2$$
$$= 16\times10^{-9}\ J$$

c) t = 8 μs

$$v(8\mu s) = v(0^+) = 1.2V$$

$$i = I_o e^{-t/\tau}$$
$$= 4\times10^{-3} e^{-110\times10^{3}t}$$

$$\frac{1}{\tau} = \frac{R}{L}$$
$$= \frac{220}{2\times10^{-3}}$$
$$= 110\times10^{3}$$

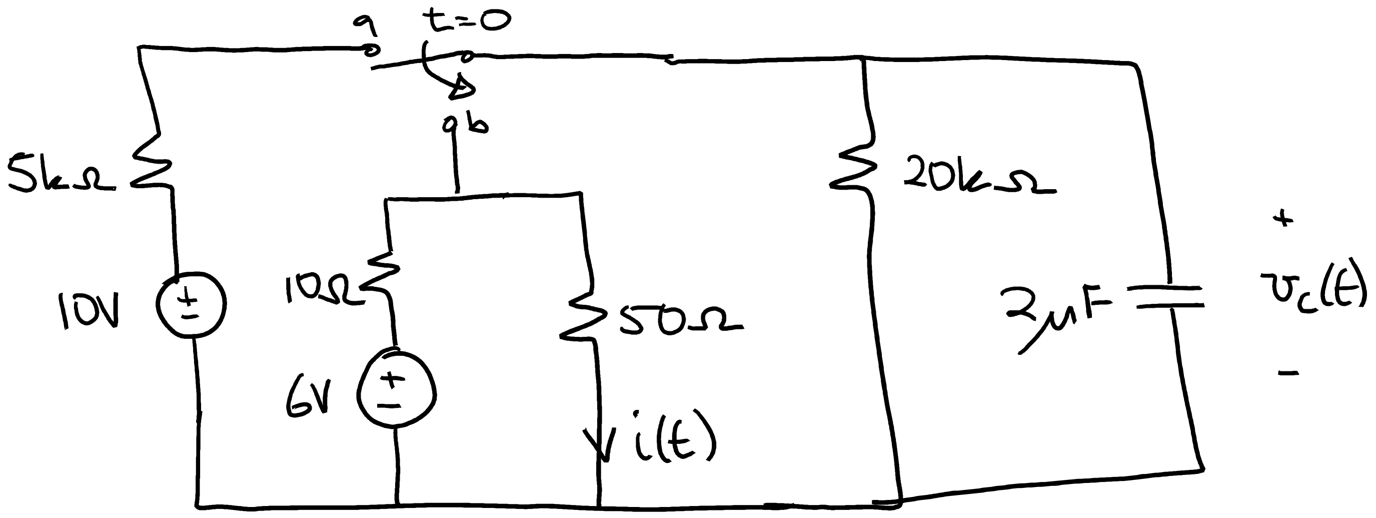
$$i(8\mu s) = 4\times10^{-3} e^{-110\times10^{3}\times8\times10^{-6}}$$
$$= 1.66\ mA$$

$$\omega(8\mu s) = \frac{1}{2}\times2\times10^{-3}\times(1.66\times10^{-3})^2$$
$$= 2.7\times10^{-9}\ J$$

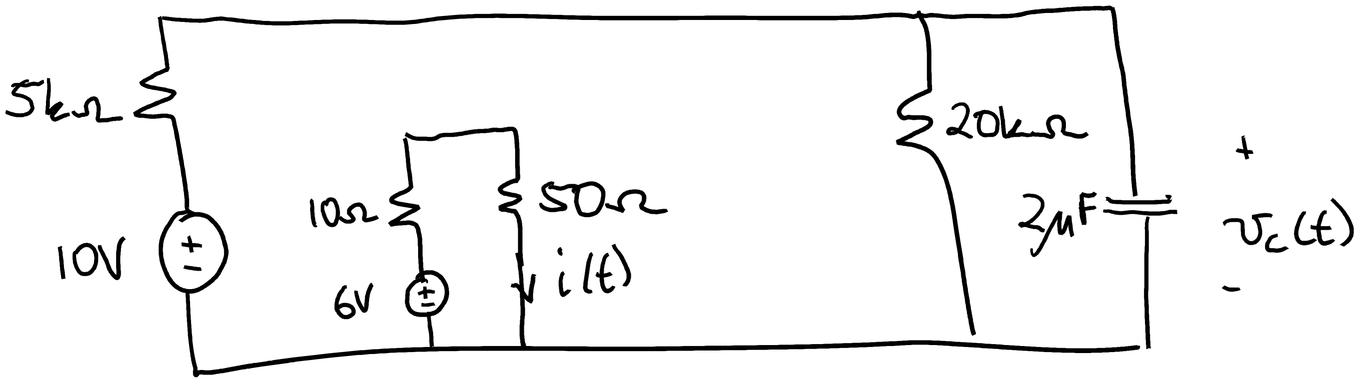
At Tutorial 5 – Unmarked Questions (17th May 2019)

Chapter 8, Ex 60: Driven RC circuit

The switch shown in the circuit below has been in position *a* since the original Battlestar Galactica aired on TV. It is moved to position *b* at time t = 0. Obtain expressions for $i(t)$ and $v_c(t)$ valid for all values of t.



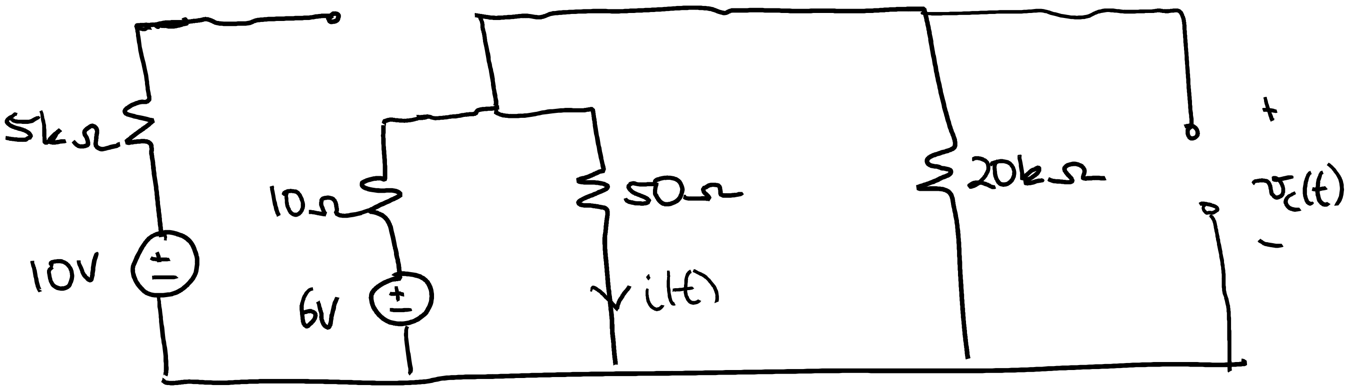
t<0:

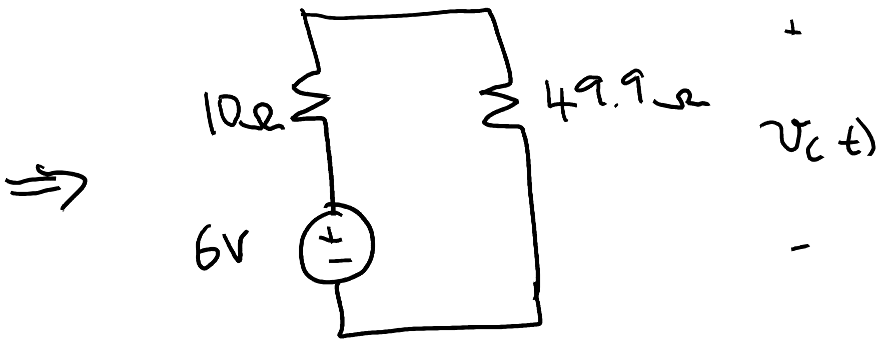


$i(0^-) = 6/60$
$= 0.1\,A$

$v_c(0^-) = 10 \times \frac{20}{25}$ (voltage divider)
$= 8V$

t > 0 (forced):





$$R_{eq} = \frac{50 \times 20k}{50 + 20k}$$

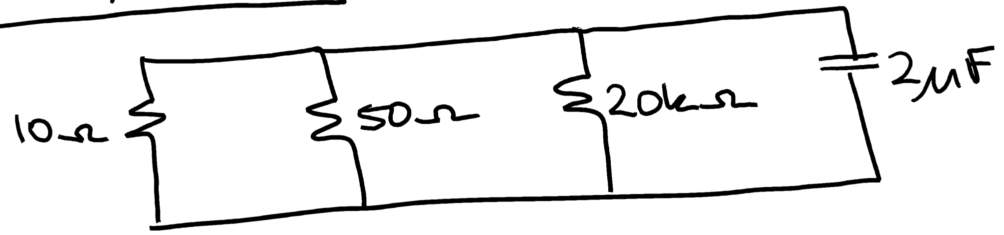
$$= 49.9\,\Omega$$

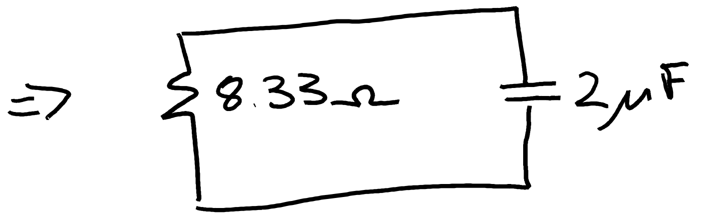
$$v_{c,F} = 6 \times \frac{49.9}{59.9} \text{ (voltage divider)}$$

$$= 5\,V$$

$$i_F = 5/50 = 0.1\,A$$

<u>$t > 0$, natural:</u>





$$\frac{1}{R_{eq}} = \frac{1}{10} + \frac{1}{50} + \frac{1}{20k}$$

$$R_{eq} = 8.33\,\Omega$$

$$v_{c,n} = V_0 e^{-t/\tau}$$

$$\tau = RC$$

$$\frac{1}{\tau} = \frac{1}{8.33 \times 2\mu}$$

$$= 60 \times 10^3\ s^{-1}$$

$$v_{c,n} = V_0 e^{-60 \times 10^3 t}$$

$$v_c = v_{c,F} + v_{c,n} \qquad t > 0$$

$$= 5 + V_0 e^{-60 \times 10^3 t}$$

$$v_c(0^-) = v_c(0^+) = 8$$

$$v_c(0) = 5 + V_o = 8$$

$$V_o = 3$$

$$v_c = \begin{cases} 8\ \text{V} & t \leq 0 \\ 5 + 3e^{-60\times10^3 t} & t > 0 \end{cases}$$

$$= 8 - 3\left(1 - e^{-60\times10^3 t}\right)u(t)\ \text{V}$$

$$i(t) = v/R$$

$$= \frac{5 + 3e^{-60\times10^3 t}}{50} \quad t > 0$$

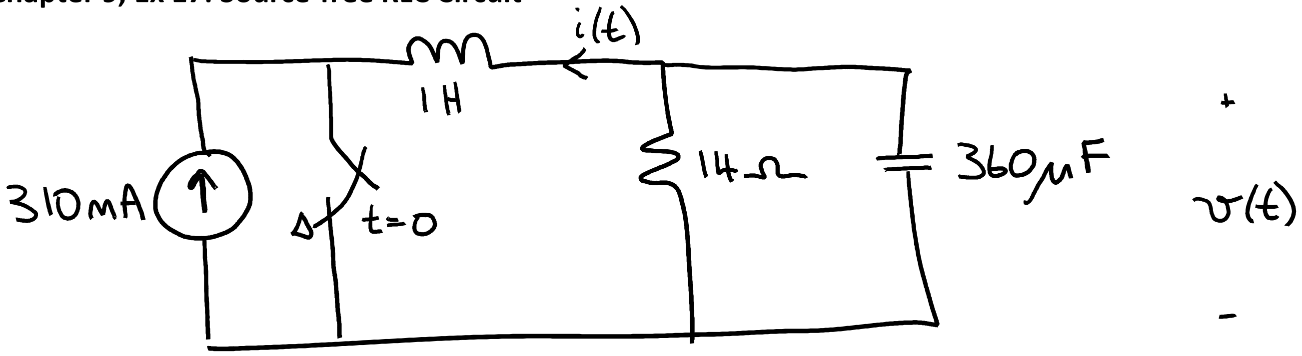
$$= 0.1 + 0.06e^{-60\times10^3 t}\ \text{A} \quad t > 0$$

$$= \begin{cases} 0.1\ \text{A} & t \leq 0 \\ 0.1 + 0.06e^{-60\times10^{3t}}\ \text{A} & t > 0 \end{cases}$$

Name: Student ID:

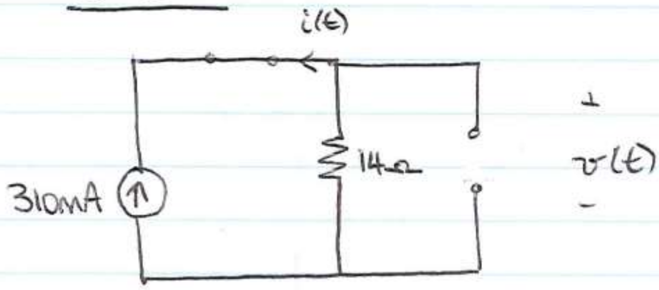
Pre-tutorial 6 Questions (to be attempted before class on May 31st, 2019)

Chapter 9, Ex 17: Source-free RLC Circuit



Obtain expressions for the current i(t) and voltage v(t) as labelled in the circuit above, which are valid for all t > 0.

$t < 0:$

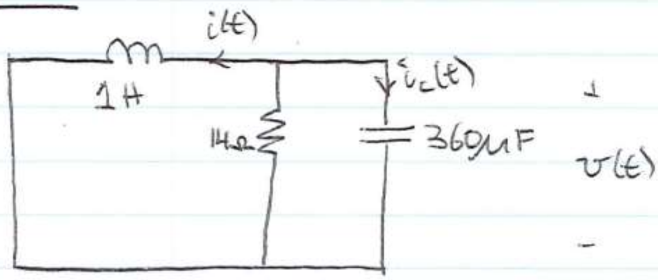


$i(0^-) = -310\text{mA}$

$v(0^-) = 310 \times 10^{-3} \times 14$

$= 4.34\text{V}$

$t > 0:$



$$\alpha = \frac{1}{2RC} = \frac{1}{2 \times 14 \times 360 \times 10^{-6}} = 99.2 \ s^{-1}$$

$$\omega_0 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{1 \times 360 \times 10^{-6}}} = 52.7 \text{ rad/s}$$

$\alpha > \omega_0$ ∴ overdamped

$\Rightarrow v(t) = A_1 e^{s_1 t} + A_2 e^{s_2 t}$

$$s_1, s_2 = -\alpha \pm \sqrt{\alpha^2 - \omega_0^2}$$
$$= -99.2 \pm \sqrt{99.2^2 - 52.7^2}$$
$$= -15.16, -183.24$$

$$v(t) = A_1 e^{-15.16t} + A_2 e^{-183.24t}$$

$$v(0^+) = v(0^-) = 4.34 = A_1 + A_2$$
$$i(0^-) = i(0^+) = -310\times10^{-3}$$

$$i_c = C\frac{dv}{dt}$$

$$= 360\times10^{-6}\,(-15.16A_1 e^{-15.16t} - 183.24A_2 e^{-183.24t})$$
$$i_c(0^+) = 360\times10^{-6}\,(-15.16A_1 - 183.24A_2) = -5.46\times10^{-3}A_1 - 0.066A_2$$

$$i(t) + \frac{v(t)}{14} + i_c(t) = 0$$

@ $t=0$: $\quad -310\times10^{-3} + \frac{4.34}{14} - 5.46\times10^{-3}A_1 - 0.066A_2 = 0$

$$-5.46\times10^{-3}A_1 - 0.066A_2 = 0$$
$A_1 + A_2 = 4.34$ (from previous page)

$$-5.46\times10^{-3}(4.34 - A_2) - 0.066A_2 = 0$$
$$-0.06A_2 = 0.0237$$
$$A_2 = -0.391$$

$$A_1 = 4.34 - (-0.391)$$
$$= 4.73$$

$$v(t) = 4.73e^{-15.16t} - 0.391e^{-183.24t}\ \text{V} \quad t>0$$

$$i(t) = \frac{-v(t)}{14} - i_c(t)$$
$$= -0.34e^{-15.16t} + 0.028e^{-183.24t} - \left[-5.46\times10^{-3}\times4.73e^{-15.16t}\right.$$
$$\left. - 0.066\times(-0.391)e^{-183.24t}\right]$$
$$= -0.31e^{-15.16t} + 0.002e^{-183.24t}\ \text{A} \quad t>0$$

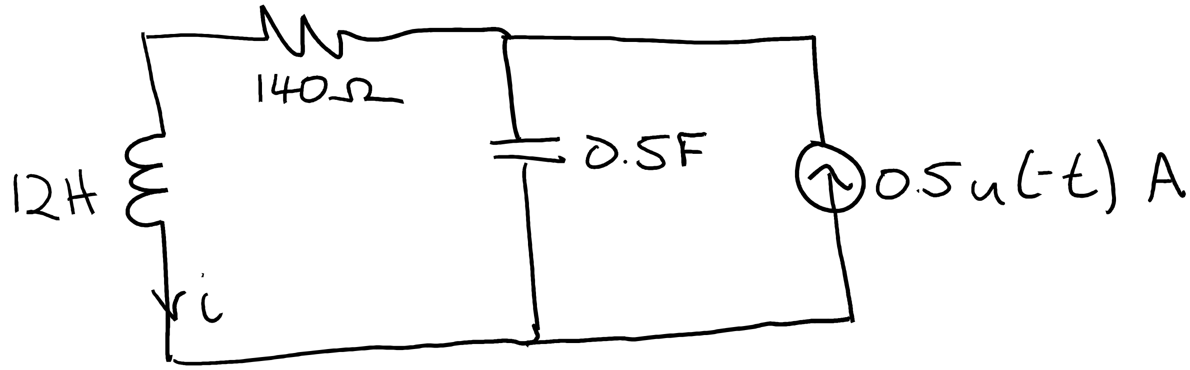
OR $i_L = \frac{1}{L}\int_0^t v(\tau)\,d\tau + i_L(0)$

$$i(t) = \int_0^t \left[4.73e^{-15.16\tau} - 0.391e^{-183.24\tau}\right] d\tau - 310\times10^{-3}$$

$$= -0.31e^{-15.16t} + 0.002e^{-183.24t} - (-0.312+0.002) - 310\times10^{-3}$$

$$= -0.31e^{-15.16t} + 0.002e^{-183.24t} \text{ A} \quad t>0$$

Chapter 9, Ex 46: Source-free RLC Circuit



With reference to the circuit above, calculate a) α; b) ω_0; c) $i(0^+)$; d) $\left.\frac{di}{dt}\right|_{0^+}$

a) $\alpha = \frac{R}{2L}$

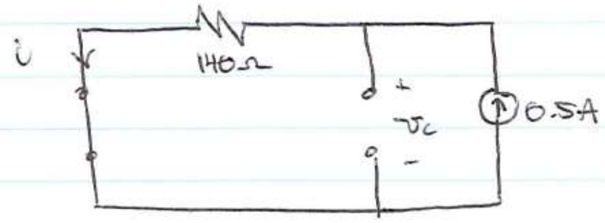
$= \frac{140}{2 \times 12}$

$= 5.83 \ s^{-1}$

b) $\omega_0 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{12 \times 0.5}}$

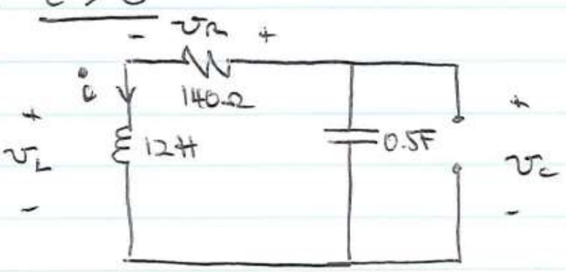
$= 0.41$ rad/s

c) <u>$t<0$:</u>



$i(0^-) = 0.5A = i(0^+)$

d) <u>$t>0$:</u>



$v_L = L\frac{di}{dt} = 12\frac{di}{dt}$

$$v_L(0^+) - v_c(0^+) + v_R(0^+) = 0$$

$$v_c(0^+) = v_c(0^-) = v_R(0^-) = 0.5 \times 140$$
$$= 70V$$

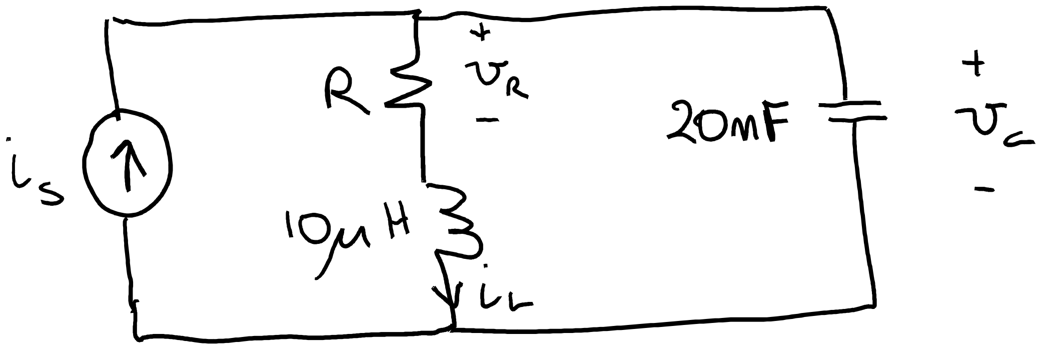
$$v_R(0^+) = iR$$
$$= 0.5 \times 140$$
$$= 70V$$

$$12 \left.\frac{di}{dt}\right|_{t=0} - 70 + 70 = 0$$

$$\left.\frac{di}{dt}\right|_{t=0} = 0$$

At Tutorial 6 – Marked Question (31st May 2019)

Chapter 9, Ex 50: Driven RLC Circuit



In the series circuit above, set R = 1 Ω. a) Compute α and ω₀. b) If $i_s = 3u(-t) + 2u(t)$ mA, determine $v_R(0^-)$, $i_L(0^-)$, $v_c(0^-)$, $v_R(0^+)$, $i_L(0^+)$, $v_C(0^+)$, $i_L(\infty)$, and $v_c(\infty)$.

a) $\alpha = \frac{R}{2L}$

$= \frac{1}{2 \times 10 \times 10^{-6}}$

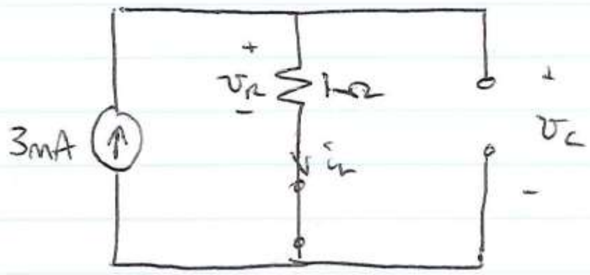
$= 50 \times 10^3 \ s^{-1}$

$\omega_0 = \frac{1}{\sqrt{LC}}$

$= \frac{1}{\sqrt{10 \times 10^{-6} \times 20 \times 10^{-3}}}$

$= 2.236 \times 10^3$ rad/s

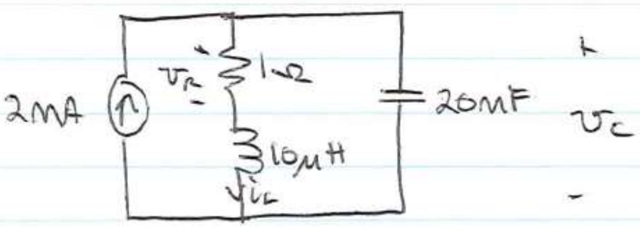
b) $\underline{t < 0:}$



$v_R = 3 \times 10^{-3} \times 1$
$= 3mV$

$i_L(0^-) = 3mA$
$v_c(0^-) = v_R(0^-) = 3mV$

$\underline{t > 0}$ (complete):

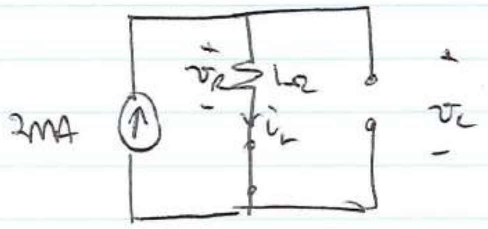


$i_L(0^-) = i_L(0^+) = 3mA$

$v_R(0^+) = 3 \times 10^{-3} \times 1$
$= 3mV$

$v_c(0^+) = v_c(0^-) = 3mV$

At $t=\infty$, only the forced response is left, as the natural response $\rightarrow 0$ as $t \rightarrow \infty$:



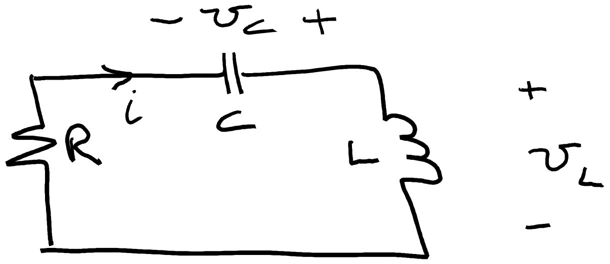
$i_L(\infty) = 2mA$

$v_C(\infty) = 2 \times 10^{-3} \times 1$
$= 2mV$

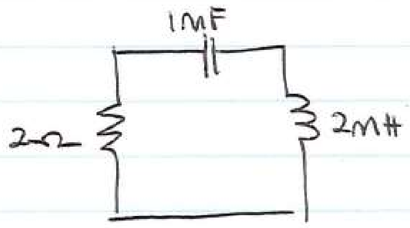
circuit for $t>0$, forced response

At Tutorial 6 – Unmarked Questions (31st May 2019)

Chapter 9, Ex 42: Source-free RLC Circuit



Component values of R = 2 Ω, C = 1 mF, and L = 2 mH are used to construct the circuit represented above. If $v_c(0^-)$ = 1 V and no current initially flows through the inductor, calculate $i(t)$ at t = 1 ms, 2ms, and 3ms.



$$\alpha = \frac{R}{2L} = \frac{2}{2\times2\times10^{-3}} = 500\ s^{-1}$$

$$\omega_0 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{2\times10^{-3}\times1\times10^{-3}}} = 707\ \text{rad/s}$$

$\alpha < \omega_0$ $\therefore$ underdamped

$$\Rightarrow i(t) = e^{-\alpha t}(B_1 \cos\omega_d t + B_2 \sin\omega_d t)$$
$$= e^{-500t}(B_1 \cos 500t + B_2 \sin 500t)$$

$$\omega_d = \sqrt{\omega_0^2 - \alpha^2} = \sqrt{707^2 - 500^2} = 500\ \text{rad/s}$$

$$i(0^+) = i(0^-) = 0 = B_1$$

$$\Rightarrow i(t) = B_2 e^{-500t}\sin 500t$$

$$v_C(0^-) = v_C(0^+) = 1V$$

$$v_L = L\frac{di}{dt}$$
$$= 2\times10^{-3}(-500B_2e^{-500t}\sin 500t + 500B_2e^{-500t}\cos 500t)$$

$$v_L(0) = 2\times10^{-3}(500B_2)$$
$$= B_2$$

$$v_L - v_R - v_C = 0$$

$$B_2 - 0 - 1 = 0$$

$$B_2 = 1$$

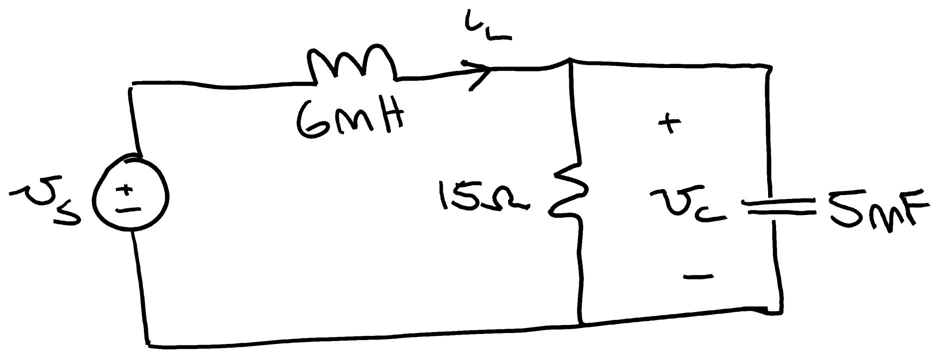
$$i(t) = e^{-500t} \sin 500t \text{ A} \quad t > 0$$

$$i(1ms) = 0.291 \text{ A}$$

$$i(2ms) = 0.310 \text{ A}$$

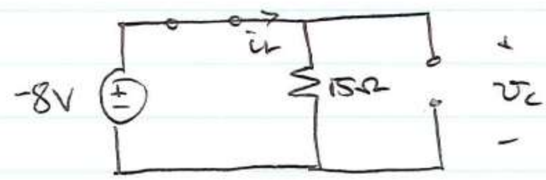
$$i(3ms) = 0.223 \text{ A}$$

Chapter 9, Ex 52: Forced RLC Circuit



Consider the circuit depicted above. If $v_S(t) = -8 + 2u(t)$ V, determine:

a) $v_C(0^+)$



$v_c(0^+) = v_c(0^-) = -8V$

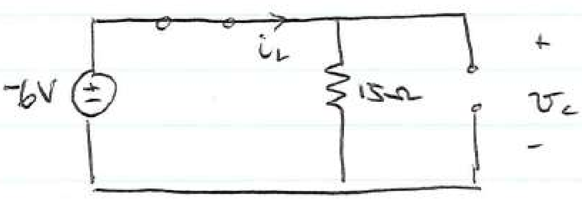
b) $i_L(0^+)$

$i_L(0^+) = i_L(0^-) = -8/15$

$= -0.53$ A

c) $v_c(\infty)$

forced response, $t > 0$:



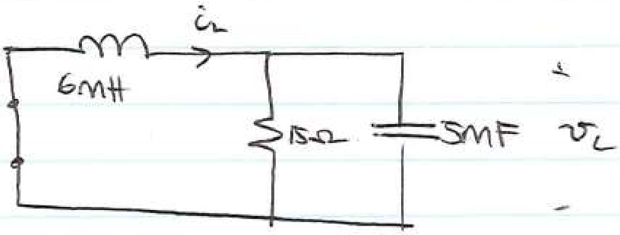
$v_c(\infty) \Rightarrow$ forced response only

$= -6V$

d) $v_C(t = 150\text{ms})$

$v_C(150ms) \Rightarrow$ need complete response

natural response, $t>0$:



$\alpha = \frac{1}{2RC}$

$= \frac{1}{2 \times 15 \times 5 \times 10^{-3}}$

$= 6.67 \ s^{-1}$

$\omega_0 = \frac{1}{\sqrt{LC}}$

$= \frac{1}{\sqrt{6\times10^{-3} \times 5\times10^{-3}}}$

$= 182.6 \ rad/s$

$\Rightarrow \alpha < \omega_0$

$\therefore$ underdamped

$\therefore v_{c,n} = e^{-\alpha t}(B_1 \cos \omega_d t + B_2 \sin \omega_d t)$

$\omega_d = \sqrt{\omega_0^2 - \alpha^2}$

$= \sqrt{182.6^2 - 6.67^2}$

$= 182.5 \ rad/s$

$v_{c,n} = e^{-6.67t}(B_1 \cos 182.5t + B_2 \sin 182.5t)$

$v_C(t) = v_{c,p} + v_{c,n}$

$= -6 + e^{-6.67}(B_1 \cos 182.5t + B_2 \sin 182.5t)$

$v_C(0) = -6 + B_1 = -8$

$B_1 = -2$

$\frac{dv_C}{dt} = -6.67e^{-6.67t}(-2\cos 182.5t + B_2 \sin 182.5t)$

$+ e^{-6.67}(-365 \sin 182.5t + 182.5B_2 \cos 182.5t)$

$\left.\frac{dv_C}{dt}\right|_{t=0} = -6.67 \times -2 + 182.5B_2$

$= 182.5B_2 + 13.33$

$i_c = C\frac{dv}{dt}$

$i_c + i_R - i_L = 0$

at $t=0$:

$5\times10^{-3}(182.5B_2 + 13.33) + \left(\frac{-8}{15}\right) - (-0.53) = 0$

$0.9125B_2 + 0.067 - 0.53 + 0.53 = 0$

$B_2 = -0.07$

$v_c(t) = -6 + e^{-6.67t}(-2\cos 182.5t - 0.07\sin 182.5t)$ V $t>0$

$v_c(150ms) = -5.56V$