Folder no. _____ Name: _____

ECE 2210 / 00
Fall 2018 Exam 2

Useful Information

$C = \frac{Q}{V}$ $\quad v_C = \frac{1}{C}\cdot\int_{-\infty}^{t} i_C\,dt = \frac{1}{C}\cdot\int_{0}^{t} i_C\,dt + v_C(0)$ (initial voltage) $\quad \Delta V_C = \frac{1}{C}\cdot\int_{t_1}^{t_2} i_C\,dt$

$\text{farad} = \frac{\text{coul}}{\text{volt}} = \frac{\text{amp}\cdot\text{sec}}{\text{volt}}$ $\quad i_C = C\cdot\frac{d}{dt}v_C$

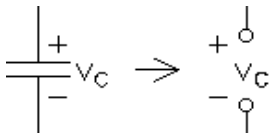
parallel: $C_{eq} = C_1 + C_2 + C_3 + \ldots$ $\quad$ **series:** $C_{eq} = \frac{1}{\frac{1}{C_1}+\frac{1}{C_2}+\frac{1}{C_3}+\ldots}$

$W_C = \frac{1}{2}\cdot C\cdot V_C^2$ Capacitor voltage **cannot** change instantaneously

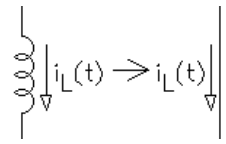
$\text{henry} = \frac{\text{volt}\cdot\text{sec}}{\text{amp}}$ $\quad i_L = \frac{1}{L}\cdot\int_{-\infty}^{t} v_L\,dt = \frac{1}{L}\cdot\int_{0}^{t} v_L\,dt + i_L(0)$ (initial current) $\quad \Delta I_L = \frac{1}{L}\cdot\int_{t_1}^{t_2} v_L\,dt$

$W_L = \frac{1}{2}\cdot L\cdot I_L^2$ $\quad v_L = L\cdot\frac{d}{dt}i_L$ Inductor current **cannot** change instantaneously

Final Conditions:



Replace capacitors with opens



Replace inductors with wires

For all first order transients: $x(t) = x(\infty) + (x(0) - x(\infty))\cdot e^{-\frac{t}{\tau}}$ $\quad \tau = R_{Th}\cdot C$ OR $\frac{L}{R_{Th}}$

Resonance: $\omega_o = \frac{1}{\sqrt{L_{eq}\cdot C_{eq}}}$

Steady-state sinusoidal AC Impedances: $Z_C = \frac{1}{j\cdot\omega\cdot C} = \frac{-j}{\omega\cdot C}$ $\quad Z_L = j\cdot\omega\cdot L$ $\quad \omega = 2\cdot\pi\cdot f$

$A = |\mathbf{A}| = \sqrt{a^2+b^2}$ $\quad \theta = \arg(\mathbf{A}) = \operatorname{atan}\left(\frac{b}{a}\right)$ $\quad a = A\cdot\cos(\theta)$ $\quad b = A\cdot\sin(\theta)$

October 18, 2018

Closed Book, Closed notes, Calculators OK

Show all work to receive credit

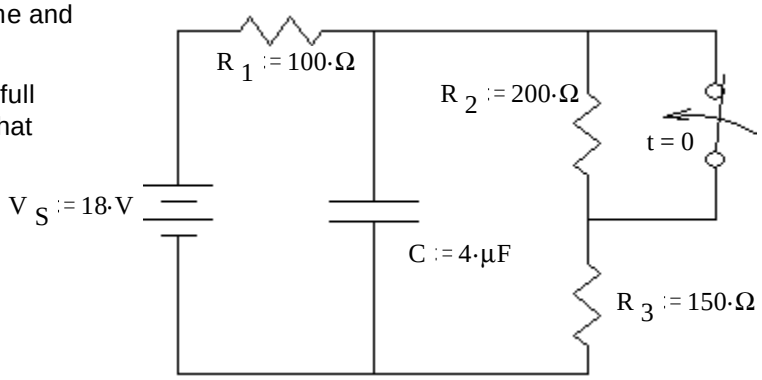
Circle answers, show units, and round off reasonably

ECE 2210/00 Exam 2 given: Fall 18

(The space between problems has been removed.)

1. (32 pts) a) The switch has been open for a long time and is closed (as shown) at time $t = 0$.

   a) Find the initial and final conditions and write the full expression for $v_C(t)$, including all the constants that you find.

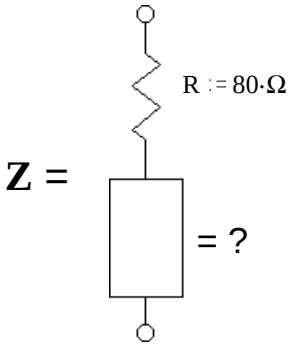


   b) What is v_C when $t = \tau$? $v_C(\tau) = ?$

   c) At time $t = 1\tau$ the switch is opened again. Find the complete expression for $v_C(t')$, where t' starts when the switch opens. Be sure to clearly show the time constant.

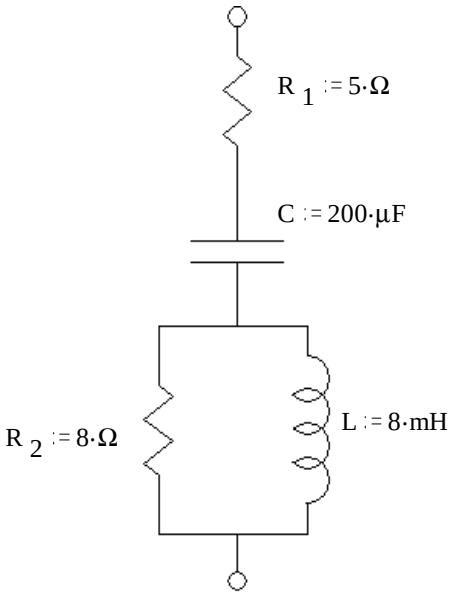
2. (9 pts) $\mathbf{Z} := |\mathbf{Z}| \cdot e^{j \cdot 30 \cdot deg}$ We don't know its magnitude, but its "phase" angle is $+30^o$.

   $\mathbf{Z}$ is made of a 80Ω resistor in series with one other part. What is the part? Give type and value. $\omega := 2000 \cdot \frac{rad}{sec}$



3. (18 pts) Find $\mathbf{Z_{eq}}$ in simple polar form (give me numbers).

   For partial credit, you must show work and/or intermediate results. $f := 79.577 \cdot Hz$

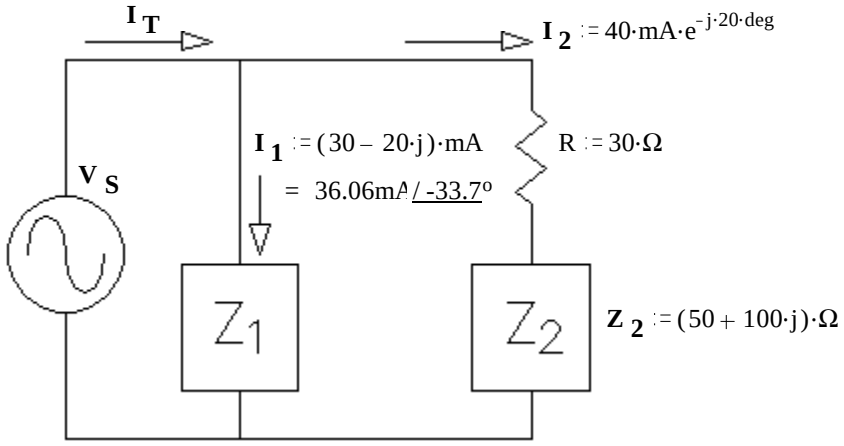


ECE 2210/00 Exam 2 Fall 18 p2

4. (23 pts) For partial credit, you must show work and/or intermediate results.
   a) Find $\mathbf{V_S}$ in polar form.

   b) Find $\mathbf{I_T}$

   c) Find $\mathbf{Z_1}$



   d) Circle 1: i) $\mathbf{I_1}$ lags $\mathbf{I_2}$ ii) $\mathbf{I_1}$ leads $\mathbf{I_2}$ e) By how much? I.E. what is the phase angle between $\mathbf{I_1}$ and $\mathbf{I_2}$?

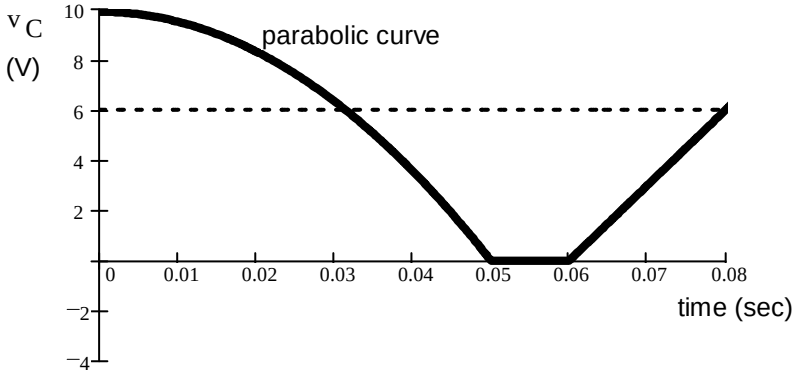
5. 18 pts) The voltage across a capacitor is shown below. Make an accurate drawing of the capacitor current. Make reasonable assumptions where necessary. Label your graph.

   Note: You will be graded on the accuracy of your plot at 0, 0.05, 0.06 and 0.08 sec, so calculate those values and plot or label them carefully. Between those points your plot must simply be the correct shape.

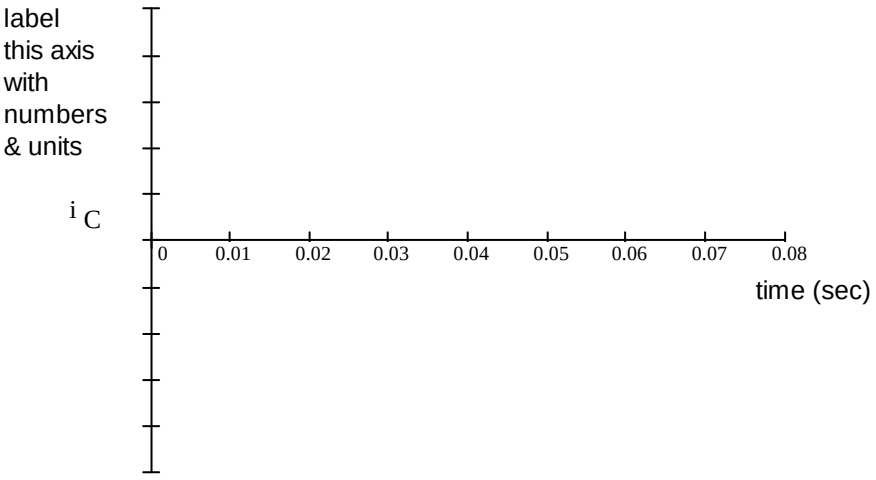
   You **MUST SHOW** how you calculate your values starting from the original relationships between voltage and current.

   That is: **Start** with the **interger** and/or **differential** equations for the capacitor!

$C := 10·\mu F$



label this axis with numbers & units

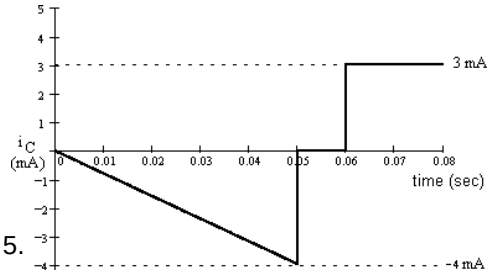


Answers

1. a) $10.8·V + 3.2·V·e^{-\frac{t}{240·\mu s}}$ b) $11.98·V$ c) $14·V – 2.02·V·e^{-\frac{t'}{311·\mu s}}$ 2. $23.1·mH$ Inductor

3. $9.48\ \Omega\ /\ -45.9^o$ 4. a) $5.12\ V\ /\ 31.34^o$ b) $75.5\ mA\ /\ -26.5^o$ c) $142\ \Omega\ /\ 65.0^o$

5.



d) i) e) $13.7·deg$