1/15/26

Welcome to ECE 3050

Formatting Guide

* Engineering Notation

10^{-3} = milli [m]

10^{-6} = micro [μ]

10^{-9} = nano [n]

10^{-12} = pico [p]

10^{3} = kilo [k]

10^{6} = Mega [M]

10^{9} = Giga [G]

10^{12} = Tera [T]

$0.\cancel{001}$ A $= \boxed{1\,mA}$

$.\cancel{000000}002 = \boxed{2\,nF}$

* Final Answers

- Must be circled/boxed/double underline
- No fractions, answers in decimal form

Ex: $\cancel{\dfrac{22\times10^{-3}\,\epsilon}{5\times10^{-6}}}$ F

$$\boxed{\begin{array}{l}455.804\,nF \\ 0.456\,\mu F\end{array}}$$

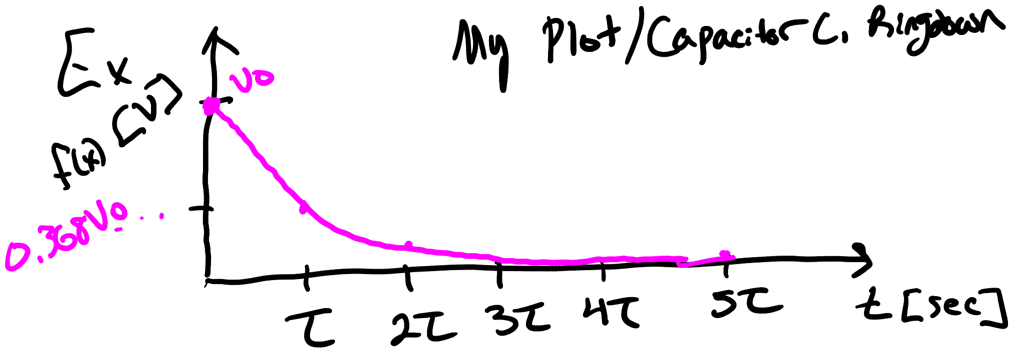
✓ ✓

* Plots

- All axis must be labeled with units
- Plots must title
- Minimum of 4 points

My Plot/Capacitor C. Ringdown

Ex



$f(x) = V_0 e^{-\frac{t}{\tau}}$

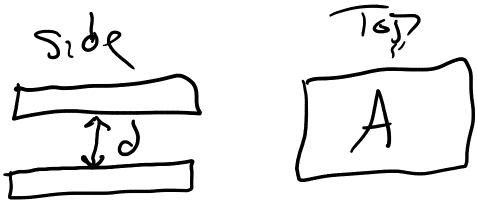
t	$f(x)$
0	V_0
τ	$0.368V_0$
2τ	$0.135V_0$
5τ	$0.007V_0$

* Review

Circuits
- → R => Resistance [Ω]
- → C => Capacitance [F]
- → L = Inductance [H]

* Energy Storage Elements

$$C = \frac{\varepsilon A}{d}$$



ε is dielectric constant/permittivity $\varepsilon = \varepsilon_r \varepsilon_0$ $\varepsilon_0 = 8.854 \times 10^{-12}$

* $Q = CV \Rightarrow i_c = C\frac{dV}{dt}$ $\frac{Q}{S}$ = current!!

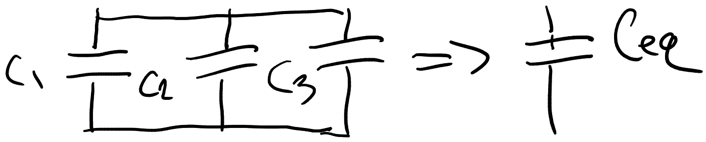
* $V(t) = \frac{1}{C}\int_{-\infty}^{t} i_c(\tau)d\tau = \underbrace{\frac{1}{C}\int_{-\infty}^{t_0} i_c(\tau)d\tau}_{\text{Initial Condition}} + \frac{1}{C}\int_{t_0}^{t} i(\tau)d\tau$

$$V(t) = V(t_0) + \frac{1}{C}\int_{t_0}^{t} i_c(\tau)d\tau$$

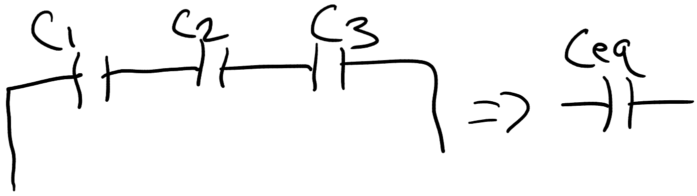
* Energy Storage in a Capacitor

$$W(t) = \frac{1}{2}CV(t)^2$$

* Series and parallel Capacitors



Parallel



Series

$$C_{eqp} = C_1 + C_2 + C_3 + \dots C_N$$

$$\frac{1}{C_{eqs}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \dots \frac{1}{C_N}$$

* Inductors

$$V(t) = L\frac{di_L}{dt} \quad \text{where} \quad L = \frac{\mu N^2 A}{\ell}$$

$N = \#$ of turns

$\mu =$ permeability

length "lower-case" cursive L

$$\mu = \mu_r \mu_0 \Rightarrow \mu_0 = 4\pi \times 10^{-7}$$

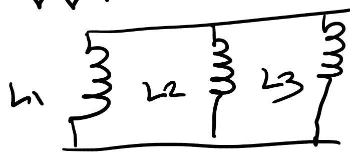
$$i(t) = i(t_0) + \frac{1}{L}\int_{t_0}^{\tau} V(\tau)\,d\tau$$

* Energy Storage in Inductor

$$W(t) = \frac{1}{2} L\, i(t)^2$$

* Series and parallel Inductors

Parallel



$$\frac{1}{L_{eq}} = \frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3} + \dots \frac{1}{L_N}$$

$$L_{eq} = L_1 + L_2 + L_3 + \dots + L_N$$

* First Order Response

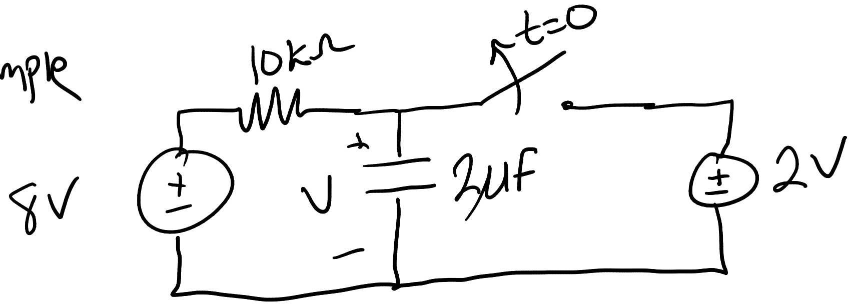
$$V_c(t) = V(\infty) + [V(0) - V(\infty)]\, e^{-\frac{t}{\tau}}$$

where $\tau = RC$

$$i_L(t) = i(\infty) + [i(0) - i(\infty)]\, e^{-\frac{t}{\tau}}$$

where $\tau = \frac{L}{R}$

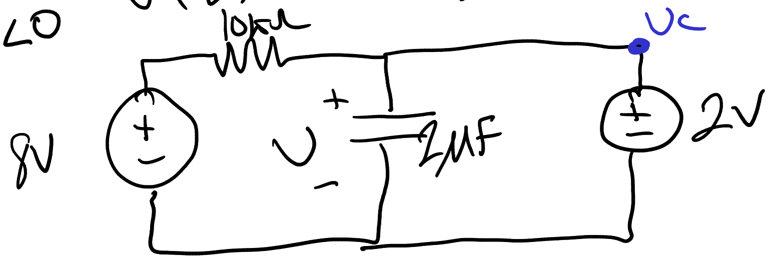
* Example



Plot the capacitor voltage as a function of time

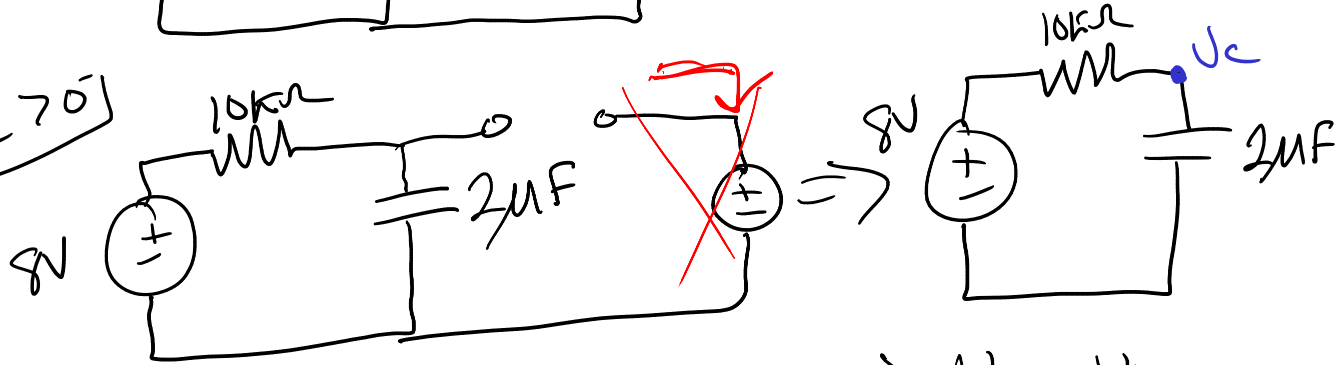
$$V(t) = V(\infty) + [V(0) - V(\infty)]e^{-\frac{t}{\tau}}$$

$t < 0^-$



From inspection, $V(0) = 2V$

$t > 0^-$



$$\tau = RC = (10\times10^3)(2\times10^{-6})$$
$$= 20mS$$

$$V(\infty) = V_{oc} = V_{th}$$
$$V(\infty) = 8V$$

$$V(t) = 8 + [2-8]e^{-\frac{t}{20\times10^{-3}}}$$
$$= 8 - 6e^{-\frac{t}{20\times10^{-3}}}$$

	t(ms)	V(t)
$-\tau =$	-20	2V
	0	2V
τ	20	5.793V
2τ	40	7.188V
3τ	60	7.701V
	⋮	
6τ	120	7.985V