Class Notes - 4/14/2015

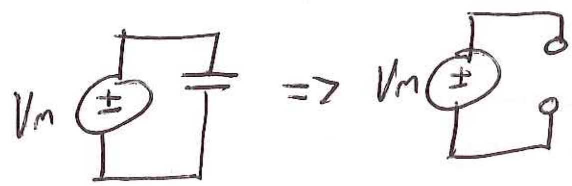
# Exam 3 Review

- 20MCQ - fill in every answer. Do not leave any blanks!
- 3 3.5"x5" note cards for crib sheets
- No calculators or other materials, bring ~~Poly~~ NYU ID

## Chapter 7

Capacitors $i = C\dfrac{dv}{dt}$ C measured in Farads

DC voltage across a capacitor results in zero current flow (Open Circuit)




A steady state circuit w/ DC source, capacitor acts like open circuit.

Voltage across a capacitor can NOT change instantaneously!

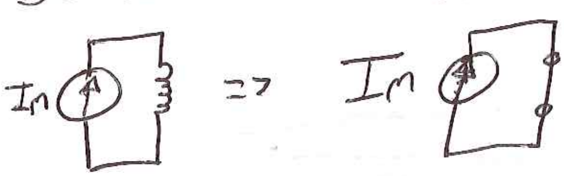
Current through a capacitor can change instantaneously

$$dv = \frac{1}{C} i(t)\,dt \qquad \boxed{v(t) = \frac{1}{C}\int_{t_0}^{t} i(t')\,dt' + v(t_0)}$$

Energy: $\boxed{w_C(t) = \frac{1}{2}C\left\{[v(t)]^2 - [V(t_0)]^2\right\} + w_C(t_0)}$

Inductor $v = L\dfrac{di}{dt}$ L measured in Henrys

DC current flow through an inductor results in zero voltage potential (short circuit)




A steady state circuit w/ DC source, Inductor acts like a short circuit

Current through an Inductor can NOT change instantaneously!

Voltage across an Inductor can change instantaneously!

Current through (or Voltage across) a Resistor ~~can~~ ~~change~~ can change instantaneously!

$$di = \frac{1}{L} v\,dt \qquad \boxed{i(t) = \frac{1}{L}\int_{t_0}^{t} v\,dt' + i(t_0)}$$

Energy: $\boxed{w_L(t) = \frac{1}{2} L \left\{ [i(t)]^2 - [i(t_0)]^2 \right\} + w_L(t_0)}$

Series Inductors: $L_{eq} = L_1 + L_2 + \cdots + L_N$

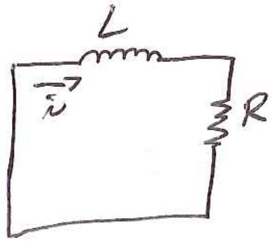
Parallel Inductors: $L_{eq} = \dfrac{1}{1/L_1 + 1/L_2 + \cdots + 1/L_N}$

Series Capacitors: $C_{eq} = \dfrac{1}{1/C_1 + 1/C_2 + \cdots + 1/C_N}$

Parallel Inductors: $C_{eq} = C_1 + C_2 + \cdots + C_N$

## Chapter 8

RL circuit => Source Free




$$0 = Ri + L\frac{di}{dt}$$

$$i(t) = I_0 e^{-Rt/L}$$

$$i_L = I_0 e^{-Rt/L}$$

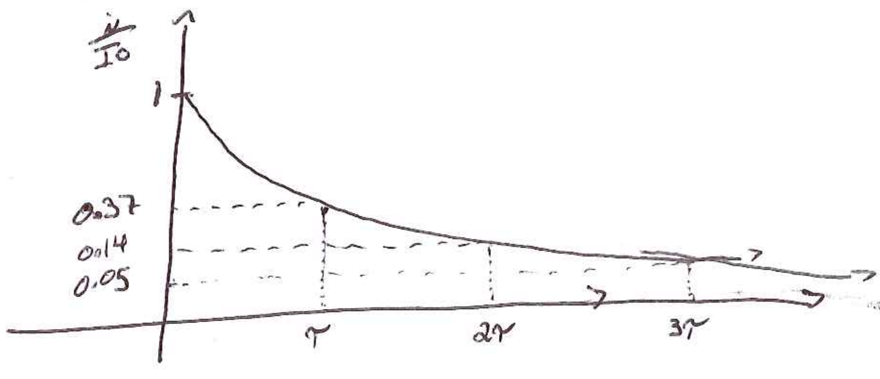
Source Free w/ some initial current $I_0$

$\tau = \frac{L}{R}$ in seconds

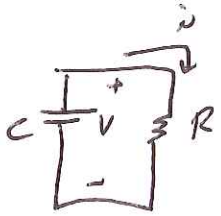
$V = IR$

$P = V \cdot I$

$P_R = \frac{V^2}{R} = I^2 R$




RC Circuit =>

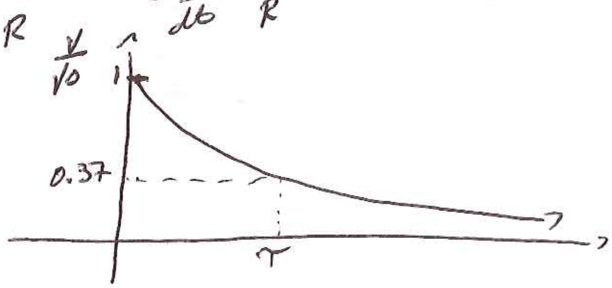



$$C\frac{dv}{dt} + \frac{V}{R} = 0$$

$$v(t) = V_0 e^{-t/RC}$$

Source Free w/ some initial voltage $V_0$

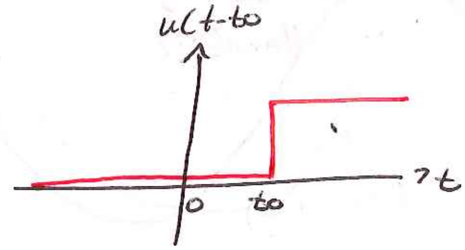
$\tau = RC$ in seconds



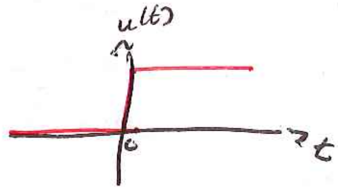
$\tau = \frac{L_{eq}}{R_{eq}}$ $\tau = R_{eq} C_{eq}$

Determine $\tau$ during the transient state

unit step function $u(t-t_0) = \begin{cases} 0 & t < t_0 \\ 1 & t > t_0 \end{cases}$




$u(t) = \begin{cases} 0 & t < 0 \\ 1 & t > 0 \end{cases}$




Natural + Forced Response

↳ similar to source free

↳ adding a new source to the circuit

Complete Response = Natural Response + Forced Response

$v = v_N + v_F$

Determine based ~~on~~ on initial + final conditions

$i_L(0^-) = i_L(0^+)$ , $i_L(\infty)$

$v_C(0^-) = v_C(0^+)$ ; $v_C(\infty)$

$f(0^+) = f(\infty) + A$; $f(t) = f(\infty) + [f(0^+) - f(\infty)]e^{-t/\tau}$

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

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

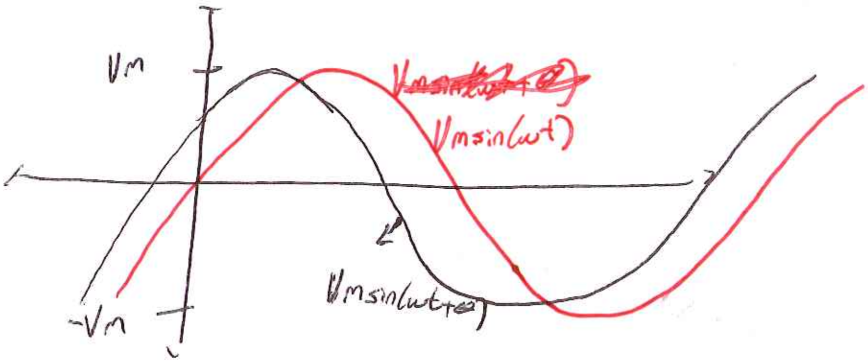
# Chapter 10

$v(t) = V_m \sin(\omega t)$

$f = \frac{1}{T}$

$\omega T = 2\pi$

$\omega = 2\pi f$




$V_m \sin(\omega t)$ lags $V_m \sin(\omega t + \theta)$ by $\theta$ rads

$-\sin \omega t = \sin(\omega t \pm 180°)$

$-\cos \omega t = \cos(\omega t \pm 180°)$

$\sin(\omega t) = \cos(\omega t - 90°)$

$\cos(\omega t) = \sin(\omega t + 90°)$

Can combine terms w/ common frequencies.

$$e^{j\theta} = \cos\theta + j\sin\theta$$

Phasors   Practice 10.6   $\omega = 2000$ rads/sec   Find instantaneous current at $t = 1ms$ for

a) $j10A = 10\angle 90° \rightarrow i(0.001) = 10\cos\left(2000 \times 0.001 + \frac{\pi}{2}\right)$

b) $20 + j10A \rightarrow 20\cos(2000 \times 0.001) +$

or $\sqrt{20^2 + 10^2} \measuredangle \tan^{-1}\left(\frac{10}{20}\right) = 22.36 \angle 0.4636$ rads

$= 22.36 \angle 26.56$

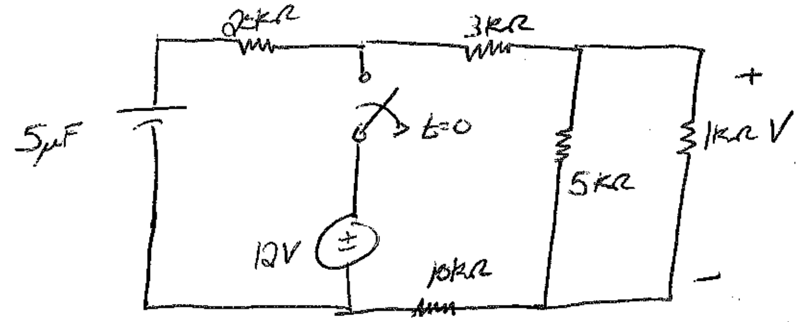
$\rightarrow 22.36 \times \cos(2000 \times 0.001 + 0.4636) +$ ~~22.36 sin (2000 x 0.001 + 0.4636)~~

c) $20 + 10\angle 20° = 10\cos(20°) + j\sin(20°)$

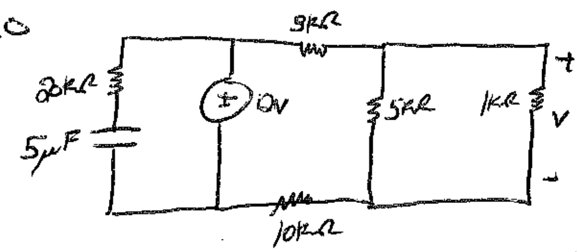
$\boxed{j^2 = -1}$

Impedance
$Z_R = R$
$Z_L = j\omega L$
$Z_C = \frac{1}{j\omega C}$

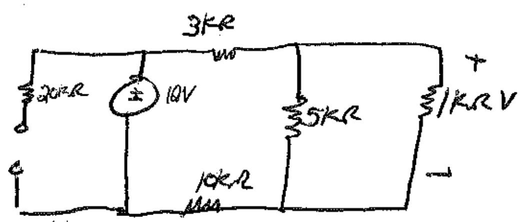
# Chapter 8 Exercise 22




For $t<0$



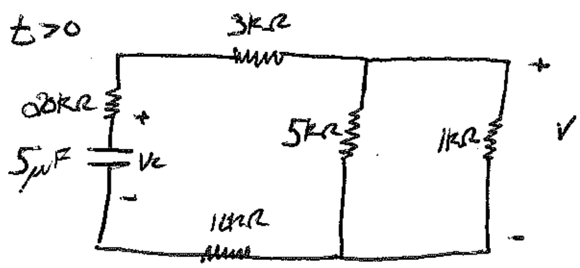

$\Rightarrow$



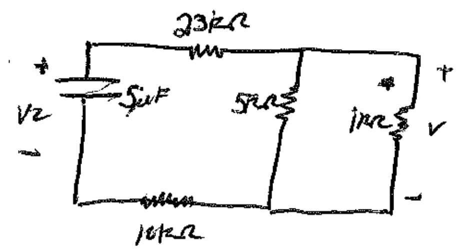

$$V(0^-) = 12 \times \frac{5\|1}{5\|1+3+10}$$

$$V_c(0^-) = 12V = V_c(0^+)$$

$t>0$




$\Rightarrow$




$\tau = R_{eq}C$

$R_{eq} = 23k + 5k\|1k + 10k\Omega = 33.83k\Omega$

$\tau = 33.833\times10^3 \times 5\times10^{-6} = \boxed{169.2ms = \tau}$

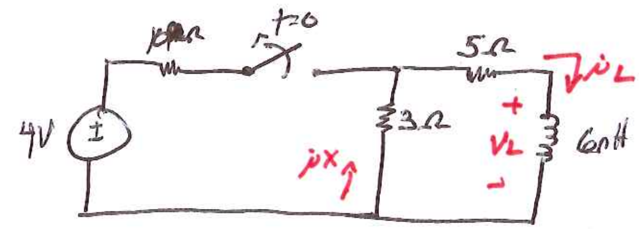
$$V(0^+) = 12 \times \frac{5\|1}{23+5\|1+10} = 12\times\frac{5/6}{23+10+5/6}$$

$= 0.2956$

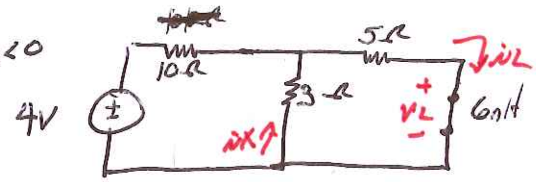
$\therefore V(t)$

For $t>0$ $= 0.2956\, e^{-t/.1692}\ V$

Chapter 8 Exercise 27.




$t<0$




$\boxed{V_L(0^-) = 0V}$

$3 \| 5 = \frac{15}{8}$

$-i_x + i_L = \frac{4}{10 + \frac{15}{8}} = 0.3368$

$i_L = \frac{3}{8} \times 0.3368 = \boxed{0.1263 = i_L(0^-) = i_L(0^+)}$

$\cancel{i_x} = 0.1263 - 0.3368 = \boxed{i_x(0^-) = -0.2105}$

$i_x(0^+) = i_L(0^+) = \boxed{0.1263 = i_x(0^+)}$

$V_L(0^+) = -0.1263 \times 8 = \boxed{-1.0104V = V_L(0^+)}$

[redacted]

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