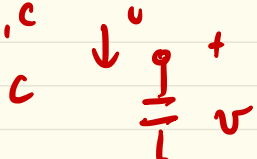
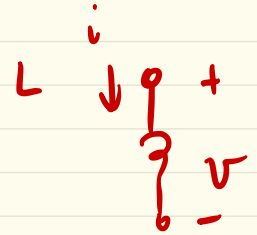
5/13/2019 (mon)

- L, C



$i = C\frac{dv}{dt}$ $= \underline{\quad}$ $E = \frac{1}{2}Cv^2$

	series	shunt
	$C_{eq} = \frac{1}{\sum \frac{1}{C_i}}$	$C_{eq} = \sum C_i$



$v = L\frac{di}{dt}$ $E = \frac{1}{2}Li^2$

	series	shunt
	$L_{eq} = \sum L_i$	$L_{eq} = \frac{1}{\sum L_i}$

- RL, RC first-order

General response

$x(t) = x_f + (x_0 - x_f)\cdot e^{-(t-t_0)/\tau}$

x_f : final value ($x(t)$ when $t \to \infty$), x_0 : initial value ($x(t)$ when $t = t_0$)

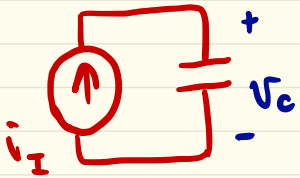
1) homogeneous sol (Ae^{st})

2) particular sol

Total response = 1) + 2)

$\tau = RC$ or L/R (time constant)

- only L or C



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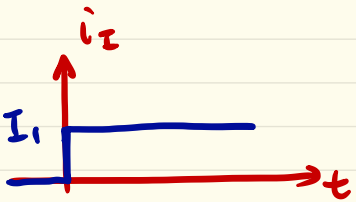
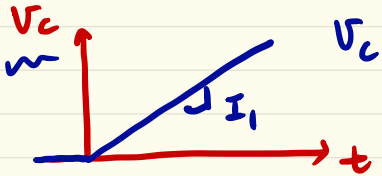
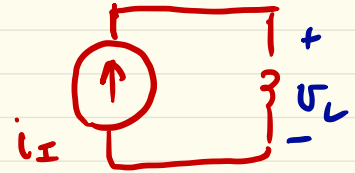




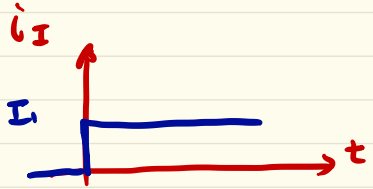
$$v_C = \frac{1}{C}\int i(\tau)\,d\tau$$



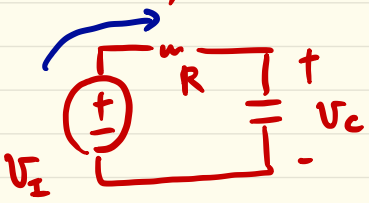
step

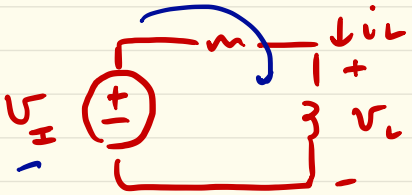
impulse

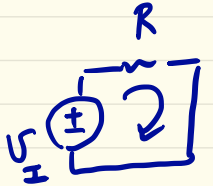
ramp.



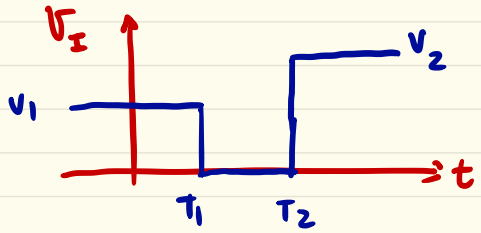
- RC , RL

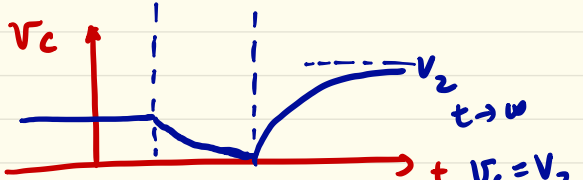


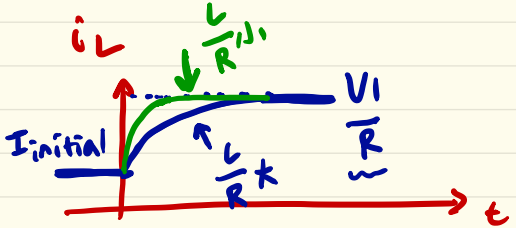




$$i = \frac{V_1}{R}$$





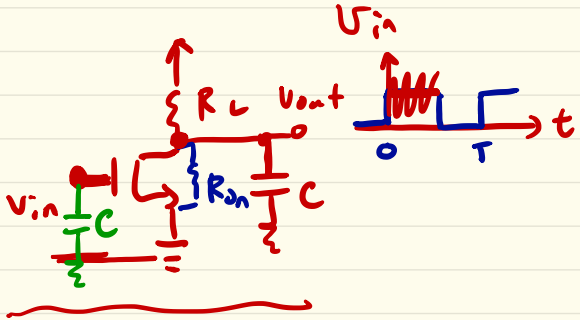


$$i_L = \frac{V_I}{R}\left(1 - e^{-R/L \cdot t}\right)$$

$$V_L = V_I \cdot e^{-R/L \cdot t}$$

- Energy, power
  (Joule) (watt)

$$E = \int_T p\,dt$$



P_{static} : static current from power supply.

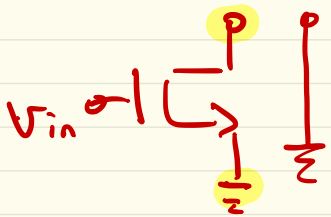
$P_{dynamic}$: charging/discharging

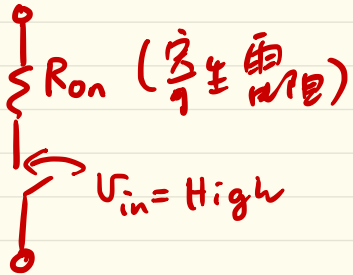
$$P = \frac{V_s^2}{2(R_L + R_{on})} \cdot t$$

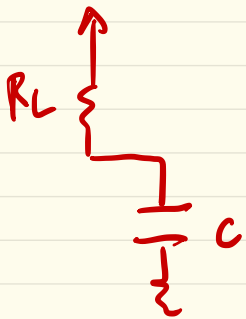
static

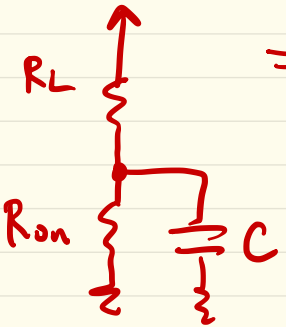
$$C V_s^2 \cdot f \cdot \frac{R_L^2}{(R_L + R_{on})^2}$$

dynamic

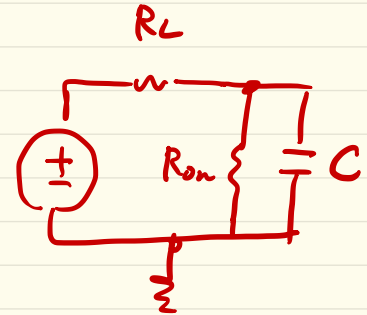

P
V_{in}


R_{on} (寄生電阻)
V_{in} = High

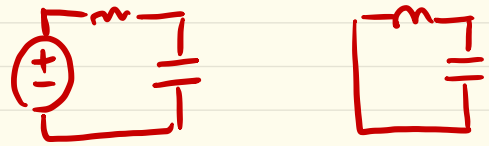

R_L
C


R_L
R_{on}
C

⇒


R_L
R_{on}
C

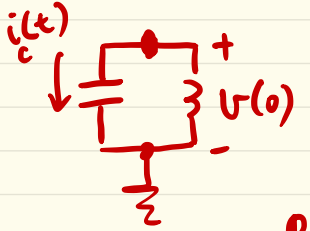
- 2nd-order circuits (only L C)



1) • Homogeneous sol (Ae^{st})

2) • Particular sol $A_1 e^{s_1 t} + A_2 e^{s_2 t}$

3) Total = 1) + 2)



Given $v(0)$, $\frac{dv(0)}{dt} = 0$

Particular sol = 0

$$\frac{d^2v(t)}{dt^2} + \frac{1}{LC}v(t) = 0$$

Assume $v(t) = Ae^{st} \Rightarrow s^2 + \frac{1}{LC} = 0 \Rightarrow s = \pm j\omega_0$, $\omega_0 = \frac{1}{\sqrt{LC}}$

$$\Rightarrow v(t) = A_1 e^{j\omega_0 t} + A_2 e^{-j\omega_0 t} = v(0)\cdot\cos\omega_0 t$$

$$i_c(t) = -\sqrt{\frac{C}{L}}\cdot v(0)\cdot\sin\omega_0 t$$

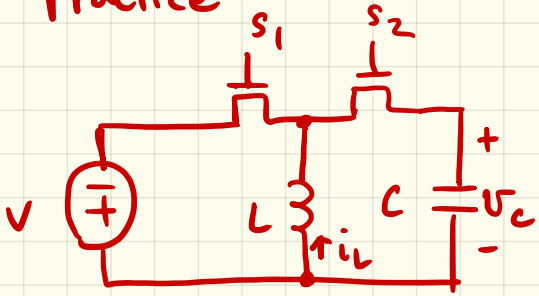
$\frac{v_{peak}}{i_{peak}} = \sqrt{\frac{L}{C}}$: characteristic impedance

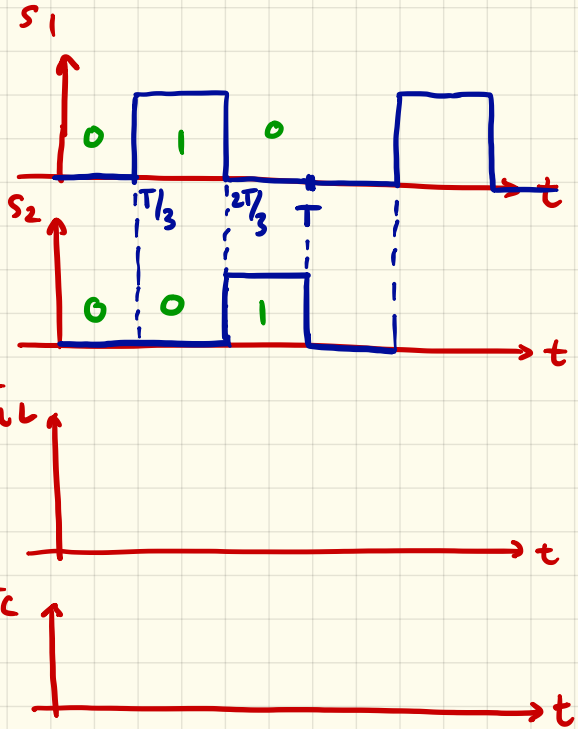
$\frac{\omega_0}{2\pi} = \frac{1}{2\pi\sqrt{LC}}$: oscillation frequency, $\sqrt{LC}$: time constant

Summary :

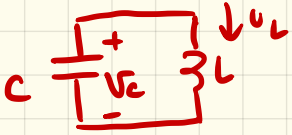
1) $v(t)$ and $i(t)$ are both sinewave, with $\frac{\pi}{2}$ phase difference
2) Initial conditions affect only their amplitude and absolute phase.

Practice 1





Practice 2



$C = 1\,\mu F$, $L = 100\,\mu H$,

$i_L(t=0^-) = 0A$, $v_c(t=0^-) = 1v$.

Find i_L and v_c.