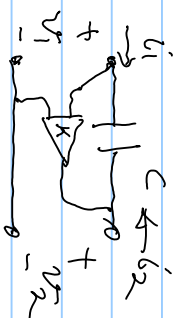


EE307
08/13/17

3/12/2017

Miller effect



$$v_2 = k v_1$$

$$k v_2 - g_m R_L < 0$$

$$i_1 = C(v_1 - v_2), \quad i_2 = C(v_2 - v_1)$$

$$= C(v_1 - k v_1) = C(v_2 - \frac{1}{k} v_2) = C(1 - \frac{1}{k}) \cdot v_2$$

$$= C[1 - k] v_1$$

$C_{\text{middle}} = C(1 - k) \Rightarrow$ larger if $k < 0$; can be negative if $k > 0$

C inside a circuit



$$i_C = C \frac{dv_C}{dt}$$

$$v_{\text{cap}} = -R_{\text{th}} \cdot i_C + v_{\text{th}} \Rightarrow i_C = -\frac{1}{R_{\text{th}}} v_{\text{cap}} + v_{\text{th}} / R_{\text{th}}$$

$$C \frac{dV_{cap}}{dt} + \frac{1}{R_{unc}}, V_{cap} = \frac{V_{unc}}{R_{unc}} \Rightarrow \frac{dV_{cap}}{dt} + \frac{1}{R_{unc}C} V_{cap} = \frac{V_{unc}}{R_{unc}}$$

of interest is the time constant $1/(R_{unc}C)$

$$\left(1 + \frac{1}{R_{unc}C}\right) V_{cap} = V_{unc} \Rightarrow V_{cap} = \frac{V_{unc}}{1 + \omega_0}$$

$$\omega_0 = 1/R_{unc}C$$

if $V_{unc} = V e^{at}$, $-\infty < t < \infty$

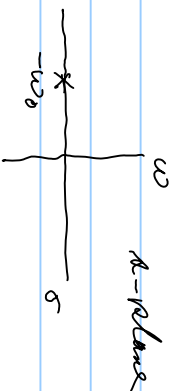
$$\frac{dV_{cap}}{dt} + \omega_0 V_{cap} = V_{unc} \Rightarrow \frac{dV_{cap}}{dt} + \omega_0 V_{cap} = V e^{at}$$

note: $V_{cap} = V_{cap} e^{at}$ substitute $V_{cap} \cdot a e^{at} + \omega_0 V_{cap} e^{at} = V e^{at}$

as $e^{at} \neq 0$, can cancel $a V_{cap} + \omega_0 V_{cap} = V$

$$V_{cap} = \frac{V}{a + \omega_0}$$

$$\Rightarrow -\omega_0 = \text{pole of } V_{cap}/V \quad a = \sigma + j\omega$$



$$T(s) = \frac{V_{out}}{V} = \frac{1}{R + \omega_0} \quad \text{here for } \left[\frac{C}{R} \right]_R \quad \omega_0 = 1/(RC)$$

for one capacitor

$$\text{for many} = T(s) = \frac{N(s)}{D(s)}$$

$D(s)$ is polynomial in $s \Rightarrow$ poles, assume all real &

$$D(s) = \prod_{i=1}^n (s + \omega_i) = R^n + \left(\sum_{i=1}^n \omega_i \right) s^{n-1} + \dots$$

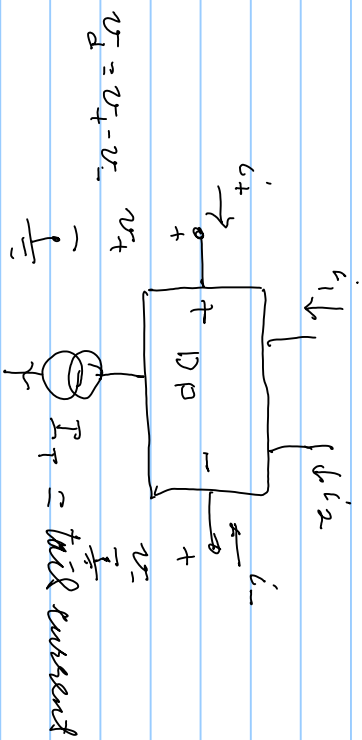
distinct

$\omega_i = 1/R_i C_i$ & found by $\omega_i = 0$ for if $C_i \Rightarrow C_i = \infty \Rightarrow$ short circuit
all other capacitors

$$D(s) = R^{n-1} \left(R + \sum_{i=1}^n \omega_i \right) + \dots$$

dominant term $\Rightarrow$ dominant pole $\omega_1 = -\sum \frac{1}{R_i C_i}$

differential pairs



DP = differential pairs

if $i_1' = i_2' = 0$
 then $i_1 + i_2 = I_T$
 by KCL

if look at $i_1' - i_2' = i_{out} = i_o$

