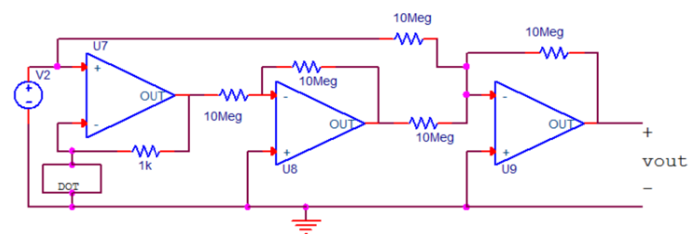
Note Title 9/19/2020

ENEE 610
10/27/20=>10/28

Choice of denominator for y22

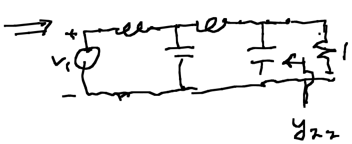
Curve tracing theory
Curve tracing op-amp circuit
Partial pole remaival
Constant R lattice



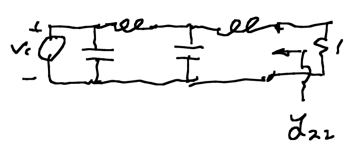
$$\frac{V_2}{V_1} = \frac{-y_{21}}{1+y_{22}} = \frac{k}{s^4+s^3+10s^2+4s+9} = \frac{k/(s^3+4s)}{1+\left(\frac{s^4+10s^2+9}{s^3+4s}\right)}$$

$$= \frac{k/(s^4+10s^2+9)}{1+\frac{s^3+4s}{s^4+10s^2+9}}$$

$$y_{22a} = \frac{s^4+10s^2+9}{s^3+4s} \Longrightarrow$$



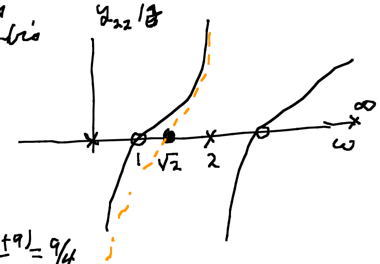
$$y_{22b} = \frac{s^3+4s}{s^4+10s^2+9}$$



y_{21} no degree 3
so not for $\frac{V_2}{V_1}$

$$\frac{V_2}{V_1} = \frac{k(s^2+2)}{s^4+s^3+10s^2+4s+9}$$

zeros 2 @ ∞
2 others
on $j\omega$ axis



choose $y_{22_a} = \dfrac{s^4+10s^2+9}{s^3+4s}$

$$= \frac{(s^2+1)(s^2+9)}{s(s^2+4)}$$

$y_{22_a} = \dfrac{k_0}{s} + k_\infty s + \dfrac{2k_1 s}{s^2+4}$; $k_0 = s\,y(s)\Big|_{s=0} = \dfrac{(0+1)(0+9)}{(0+4)} = 9/4$

$k_\infty = 1$

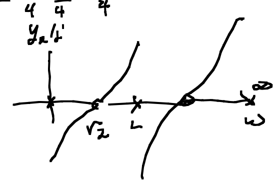
$2k_1 = \dfrac{s^2+4}{s}\cdot y(s)\Big|_{s^2=-4} = \dfrac{(-4+1)(-4+9)}{-4} = \dfrac{(-3)\cdot 5}{-4} = 15/4$

$$= \frac{9/4}{s} + s + \frac{\frac{15}{4}s}{s^2+4}$$

$\left(y_{22} - \dfrac{\hat{k}s}{s^2+4}\right)\Big|_{s^2=-2} = 0 = \left(\dfrac{9/4}{s} + s + \dfrac{\frac{15}{4}s}{s^2+4} - \dfrac{\hat{k}s}{s^2+4}\right)\Big|_{s^2=-2} = \dfrac{s}{s^2+4}\left(\dfrac{9}{4}\left(\dfrac{s^2+4}{s^2}\right) + (s^2+4) + \dfrac{15}{4} - \hat{k}\right)\Big|_{s^2=-2} = 0$

$$= \frac{s}{s^2+4}\left(\frac{9}{4}\left(\frac{2}{-2}\right) + (-2+4) + \frac{15}{4} - \hat{k}\right)$$

$$\Rightarrow \hat{k} = -\frac{9}{4} + 2 + \frac{15}{4} = \frac{6}{4} + \frac{8}{4} = \frac{14}{4} = 7/2$$

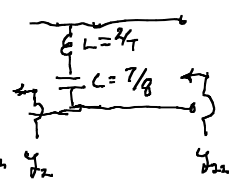


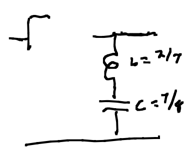
desire to pull out $\dfrac{\frac{7}{2}s}{s^2+4} = y_1$

$y_2 = y_{22_a} - \dfrac{\frac{7}{2}s}{s^2+4}$

$$= \left(\frac{9/4}{s} + s + \frac{15/4\,s}{s^2+4}\right) - \frac{\frac{14}{4}s}{s^2+4}$$

$$= \frac{9/4}{s} + s + \frac{1/4\,s}{s^2+4} = \frac{\frac{9}{4}(s^2+4) + s^2(s^2+4) + \frac{1}{4}s^2}{s(s^2+4)}$$





$$z_2 = \frac{1}{y_2} = \frac{s(s^2+4)}{s^4 + (\frac{9}{4} + 4 + \frac{1}{4})s^2 + 9} = \frac{s^3+4s}{s^4 + \frac{24}{4}s^2 + 9} = \frac{s^3+4s}{(s^2+2)(\frac{18}{4}s^2+9)}$$

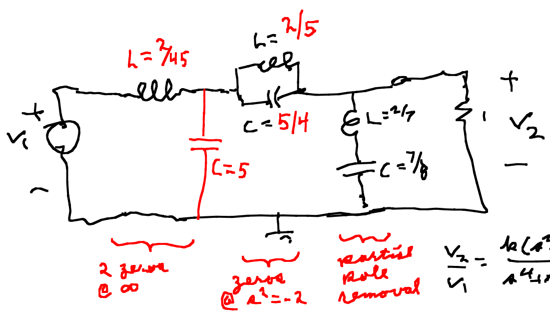
$$s^2+2 \,\overline{\big)\, s^4 + \tfrac{26}{4}s^2 + 9}\quad = s^2 + 9/2$$
$$s^4 + 2s^2$$
$$\tfrac{18}{4}s^2 + 9$$

$$z_2 = \frac{s^3+4s}{(s^2+2)\cdot(s^2+9/2)}$$

$$= \frac{(s^3+4s)}{(s^2+2)(s^2+9/2)} = \frac{2k_2 s}{s^2+2} + \frac{2k_{9/2} s}{s^2+9/2}$$

$$= \frac{4s/5}{s^2+2} + \frac{s/5}{s^2+9/2}$$

Remove the pole @ $s^2=-2$ (which gives the 0 of transmission (s^2+2)) and then 1st Cauer for the other two



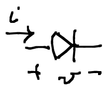
gain k for $\frac{V_2}{V_1}$

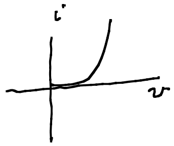
$$\frac{V_2}{V_1} = \left.\frac{k(s^2+2)}{s^4+s^3+10s^2+6s+9}\right|_{s=0} = \frac{2k}{9} = 1 \Rightarrow k = \frac{9}{2}$$

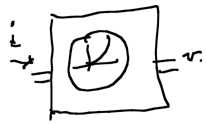
Note uses 6 reactive elements

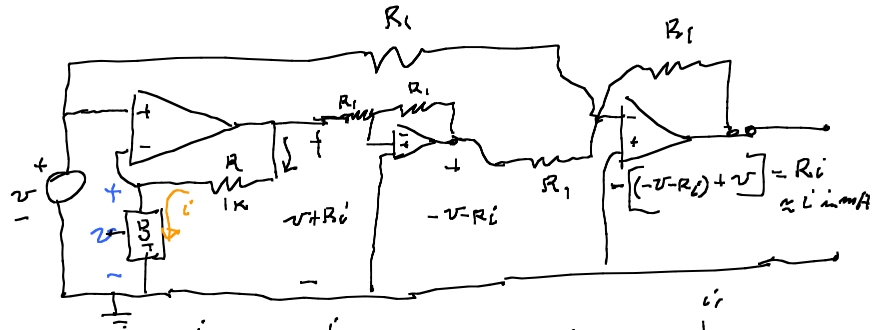
$6 > \delta[V_2/V_1] = 4$

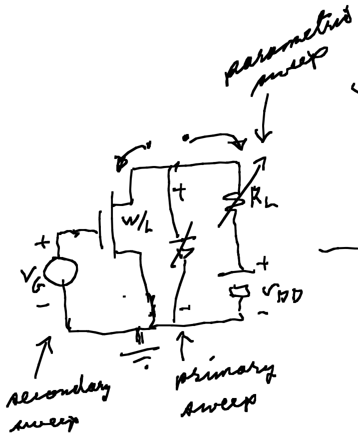
Curve tracing

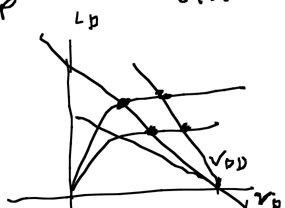












can do in Spice

For transistor