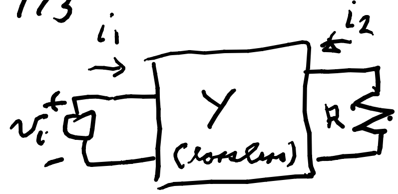
EE 303H
10/22/13

Note Title 10/22/2013

Plan for midterm on 11/05/13

$$\frac{v_0}{v_i} = \frac{A_0}{s^2+\sqrt{2}s+1}$$



$-i_2 = G v_0$

$$-Gv_2 = \begin{bmatrix} i_1 \\ i_2 \end{bmatrix} = \begin{bmatrix} y_{11} & y_{12} \\ y_{21} & y_{22} \end{bmatrix} \begin{bmatrix} v_1 \\ v_2 \end{bmatrix}, \quad v_2 = v_0$$

$$-G v_2 = y_{21} v_1 + y_{22} v_2 \Rightarrow -(G+y_{22}) v_0 = y_{21} v_i$$

$$\frac{v_0}{v_i} = \frac{-y_{21}}{G+y_{22}} = \frac{A_0}{s^2+\sqrt{2}s+1}$$

$D(s) = s^2+\sqrt{2}s+1$ is a Hurwitz polynomial

$$\Rightarrow \frac{A_0/(s^2+1)}{1+\sqrt{2}s/(s^2+1)}$$

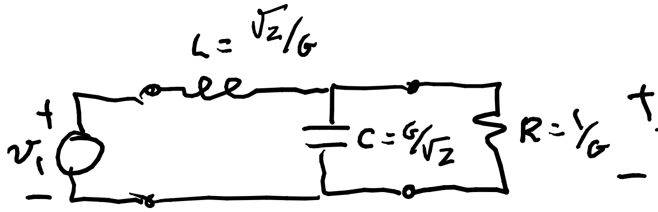
$$= \frac{-y_{21}/G}{1+y_{22}/G}$$

can choose $\dfrac{y_{22}}{G} = \dfrac{\sqrt{2}s}{s^2+1}$

$$= \frac{A_0/\sqrt{2}s}{1+\frac{(s^2+1)}{\sqrt{2}s}}$$

or $\dfrac{y_{22}}{G} = \dfrac{s^2+1}{\sqrt{2}s}$

1st choose $\Rightarrow$ $y_{22} = \dfrac{Gs^2+G}{\sqrt{2}s} = \dfrac{G}{\sqrt{2}}s + \dfrac{G}{\sqrt{2}s}$

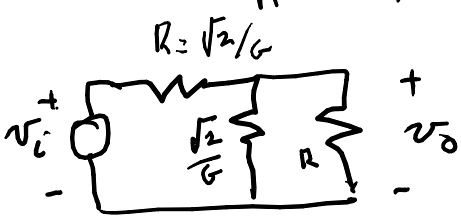


$$\Rightarrow \frac{v_0}{v_i}(s) = \frac{1}{s^2+\sqrt{2}s+1}$$

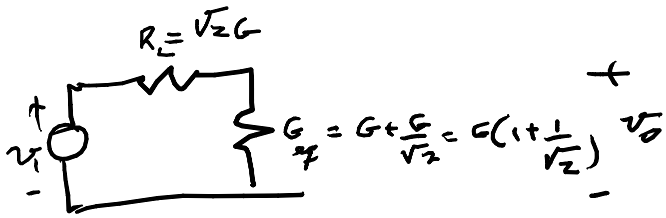
let $s = 1$

$z = \sqrt{2}/G = R_L$

$z = \dfrac{\sqrt{2}}{G \cdot 1} = R_C$



$G_c = \dfrac{G}{\sqrt{2}}$ $G_{load} = G$

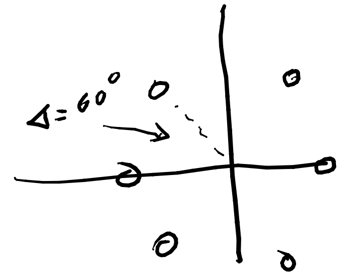


$$\frac{v_0}{v_i} = \frac{R_{eq}}{R_L+R_{eq}} = \frac{A_0}{2+\sqrt{2}}$$

$$\frac{v_o}{v_i}(1) = \frac{\frac{\sqrt{2}}{1+\sqrt{2}}\cdot\frac{1}{G}}{\frac{\sqrt{2}}{G}+\frac{\sqrt{2}}{1+\sqrt{2}}\frac{1}{G}} = \frac{1}{\frac{\sqrt{2}\times(1+\sqrt{2})}{\sqrt{2}}+1} = \frac{1}{2+\sqrt{2}} = \frac{A_0}{2+\sqrt{2}}$$

$A_0 = 1$

For degree 3, low-pass max flat



$$T(s) = \frac{1}{(s+1)(s+\cos 60^\circ - j\sin 60)\times(s+\cos 60^\circ + j\sin 60)}$$

$$= \frac{1}{(s+1)(s+\frac{1}{2}-j\frac{\sqrt{3}}{2})(s+\frac{1}{2}+j\frac{\sqrt{3}}{2})}$$

$$= \frac{1}{(s+1)(s^2+s+1)} = \frac{1}{s^3+2s^2+2s+1}$$

$$= \frac{1/(2s^2+1)}{1+\frac{s^3+2s}{2s^2+1}} = \frac{-y_{21}}{1+y_{22}}$$

$$y_{22} = \frac{s(s^2+2)}{2s^2+1} = \frac{s^3+2s}{2s^2+1}$$

$$= \frac{1}{2}s + \frac{1}{\frac{4}{3}s+\frac{1}{\frac{3}{2}s}}$$

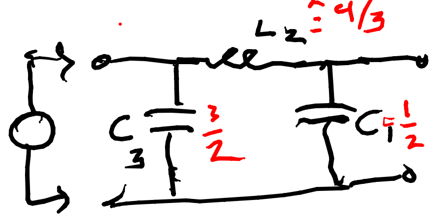
a continued fraction

∴ divide highest power of s into " " of s

$$\begin{array}{r|l} & \frac{1}{2}s \\ 2s^2+1 & s^3+2s \\ & s^3+\frac{1}{2}s \\ & \frac{3}{2}s \end{array}$$

$$\begin{array}{r|l} & \frac{4}{3}s \\ \frac{3}{2}s & 2s^2+1 \\ & 2s^2 \\ & 1 \end{array} \qquad \begin{array}{r|l} & \frac{3}{2}s \\ 1 & \frac{3}{2}s \end{array}$$

redo

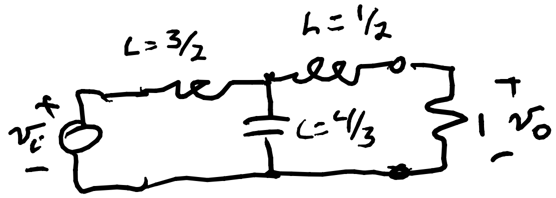


shorts C_3

redo by ÷ by odd

$$T(s) = \frac{1/(s^3+2s)}{1+\frac{2s^2+1}{s^3+2s}}$$

$$y_{22} = \frac{2s^2+1}{s^3+2s}$$



$$\frac{1}{y_{22}} = \frac{s^3 + 2s}{2s^2 + 1} = \cfrac{1}{\frac{1}{2}s + \cfrac{1}{\frac{4}{3}s + \cfrac{1}{\frac{3}{2}s}}}$$

$2s^2+1 \,\overline{\big)\, s^3 + 2s}$

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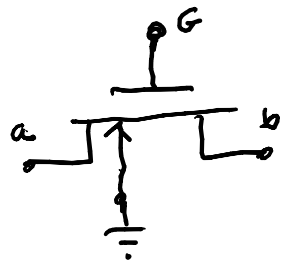
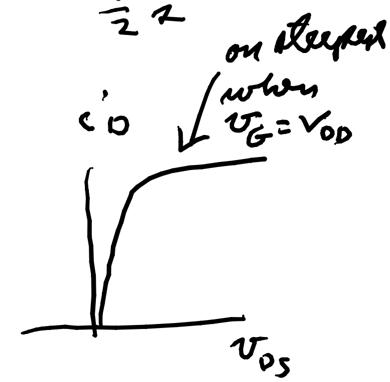
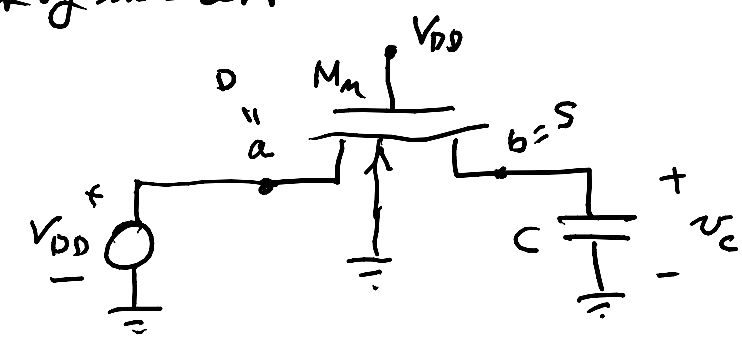
pass transistors





2 cases of interest



$v_c(0) = 0$

@ $t=0$, $v_S = 0$, $v_D = V_{DD} \Rightarrow v_{DS} = V_{DD}$

$v_G = V_{DD} \Rightarrow v_{GS} = V_{DD}$; $v_{GS} - v_{th} = V_{DD} - V_{TO} < v_{DS}$

$v_{th} = V_{TO}$

$\therefore$ M_n is in saturation @ $t=0$

$$i_c = C\frac{dv_c}{dt} = \frac{KP}{2}\frac{W}{L}\left(V_{DD} - v_c - v_{th}\right)^2\left(1 + \lambda(V_{DD} - v_o)\right)$$

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$$v_{th} = V_{TO} + \gamma\left(\sqrt{2\phi_f + v_{SB}} - \sqrt{2\phi_f}\right)$$

$$= V_{TO} + \gamma\left(\sqrt{2\phi_f + v_c(t)} - \sqrt{2\phi_f}\right)$$

$$C\frac{dv_c}{dt} = \frac{KP}{2}\frac{W}{L}\left(V_{DD} - v_c - V_{TO} - \gamma\left(\sqrt{2\phi_f + v_c} - \sqrt{2\phi_f}\right)\right)^2\left(1 + \lambda(V_{DD} - v_o)\right)$$

approximate: $\lambda \approx 0$, $v_c < 2\phi_f$

$$\sqrt{2\phi_f + v_c} \approx \sqrt{2\phi_f}\sqrt{1+\frac{v_c}{2\phi_f}} \approx \sqrt{2\phi_f}\left(1+\frac{v_c}{2\cdot 2\phi_f}\right)+\dots$$

$$C\frac{dv_c}{dt} = \frac{KP}{2}\frac{W}{L}\left(V_{DD}-V_{T0}-\gamma\cancel{\sqrt{2\phi_f}}-\gamma\sqrt{2\phi_f}\,\frac{v_c}{4\phi_f}+\cancel{\gamma\sqrt{2\phi_f}}-v_c\right)^2$$

$$\frac{dv_c}{dt} \approx \frac{k_n}{C}\left(V_{DD}-V_{T0}-\left(1+\frac{\gamma}{2\sqrt{2\phi_f}}\right)v_c\right)^2$$

$$= A\left(B-C\,v_c\right)^2 \qquad \text{a Riccati eq.}$$

$$\frac{dv_c}{(B-Cv_c)^2} = A\,dt \qquad d(B-Cv_c) = -C\,dv_c$$

$$\frac{-d(B-Cv_c)}{C(B-Cv_c)^2} = \frac{-dx}{Cx^2} = A\,dt \Rightarrow \frac{dx}{x^2} = -CA\,dt$$

$$\int_0^{x(t)} \frac{dx}{x^2} = -\frac{1}{x}\Bigg|_{x=0=B-Cv_c(0)}^{x(t)=B-Cv_c(t)} = -CA\Bigg|_0^t = -CAt$$

now find $v_c(t)$