ENEE 610
11/12/20

Note Title 9/19/2020

presentations
solutions
sensitivity cont

state to Y

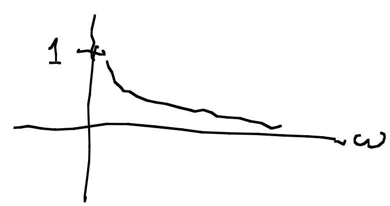
$$S_x^T = \frac{\partial T/\partial x}{T/x}$$

$$\frac{v_2}{v_1} = 1 + g/C\alpha$$

$$\text{Ex}: \; S_g^{v_2/v_1} = \frac{-1/C\alpha}{(1 + g/C\alpha)/g} = \frac{-g}{(g + C\alpha)} \approx \frac{-g/C}{\alpha + g/C}$$

$$-1/C\alpha = \frac{d\, v_2/v_1}{dg}$$

$$\text{Here} \quad |T(\alpha)|_{j\omega = \alpha} = \frac{+g/C}{\sqrt{\omega^2 + (g/C)^2}}$$



$$S_x^T = S_x^{|T(j\omega)|e^{j\phi}} = \frac{\frac{d|T|e^{j\phi}}{dx}}{\frac{|T|e^{j\phi}}{x}} = \frac{x\,(d|T|/dx)e^{j\phi} + x\,|T|\,de^{j\phi}/dx}{|T|e^{j\phi}} = \frac{d|T(j\omega)|/dx}{|T|/x} + \frac{j\,d\phi\,|T|e^{j\phi}}{|T|e^{j\phi}}$$

$$= S_x^{|T|} + j\cancel{\phi}$$

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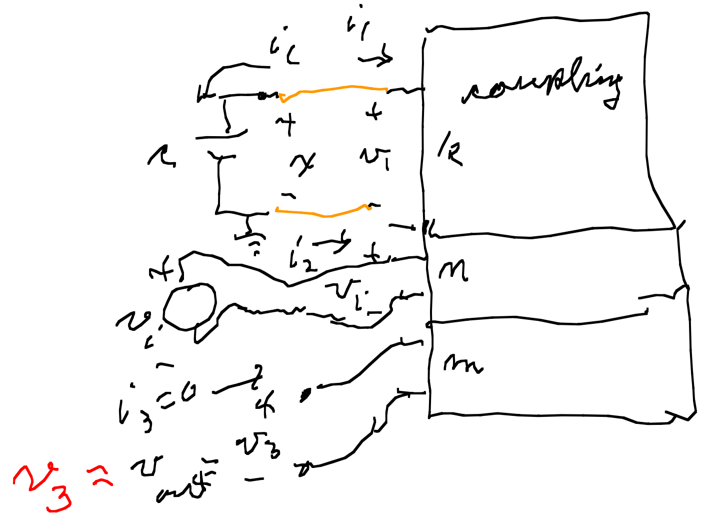
Realize the state eqs. by i's and admittance

$c\dot{x} = Ax + Bv_i$ $\Rightarrow$ $c\dot{x}$ = current into capacitors

dim of x = k

$v_{out} = v_3 = Cx + Dv_i$ dim of v_i = n, dim of v_o = m

$v_3 = C\left[s\,1_k - A\right]^{-1} B v_i + D v_i$ $T(s) = C\left[s\,1_k - A\right]^{-1} B + D$



$$i_1 = -i_c = -c\dot{x} = -Ax - Bv_i$$

$$-c\dot{x} = \begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{bmatrix} -A & -B & 0_{k\times m} \\ -Y_{m\times k} & X_{m\times m} & X_{m\times m} \\ -C & -D & \frac{1}{3} \end{bmatrix} \begin{bmatrix} v_1 \\ v_2 \\ v_3 \end{bmatrix} \begin{matrix} = x \\ = v_i \\ = v_{out} \end{matrix}$$

dim m

$0 =$

$= Y_c$

= constant admittance
can make with OTA

$X =$ don't care
can specify as desired

To make as passive as possible
choose x's to give gyrators which
are lossless & give low sensitivities (?)

∴ choose $Y_c = \begin{bmatrix} -A & -B & 0 \\ B^T & 0 & D^T \\ -C & -D & 1_3 \end{bmatrix}$ gives a $(k+n+m)$ port

can choose $c = 1_k$ for the capacitors

$$c\dot{x} = Ax + Bv_i$$
$$v_3 = Cx + Dv_i$$

we can transform these $c = 1_k$ by a transformer; $x = T\hat{x}$

$$T^T c T\dot{\hat{x}} = T^T A T\hat{x} + T^T B v_i \Rightarrow T^T c T = 1_k$$ if c is positive definite

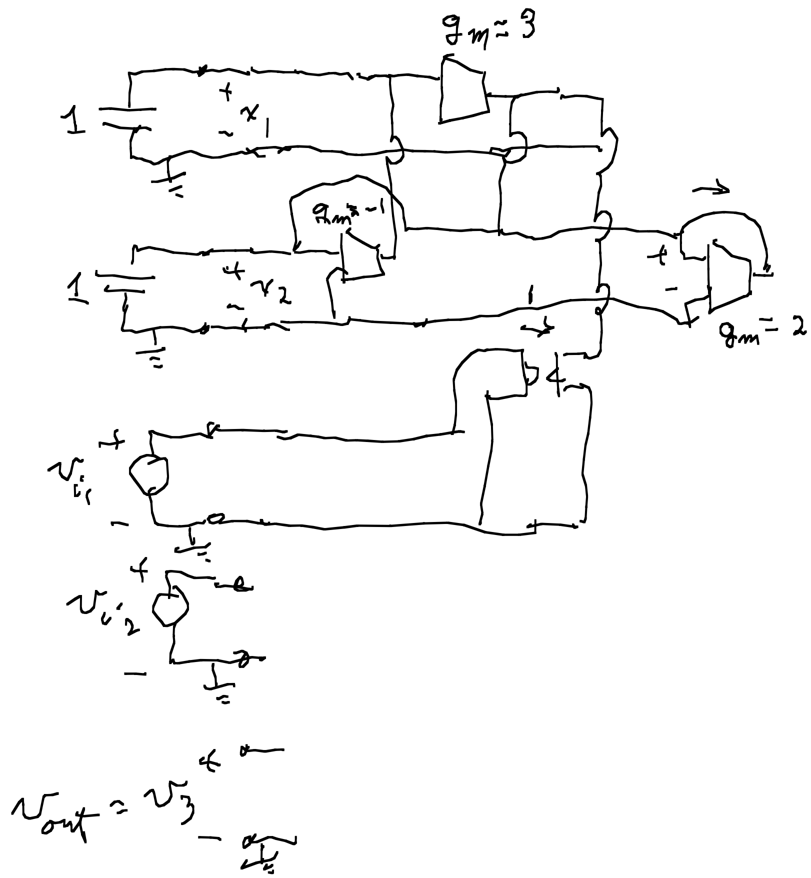
$$v_3 = CT\hat{x} + Dv_i$$

$$\hat{Y}_c = \begin{bmatrix} -T^T A T & -T^T B & 0 \\ B^T T & 0 & -D^T \\ C T & D & 1_m \end{bmatrix} = \begin{bmatrix} T^T & 0 & 0 \\ 0 & 1_n & 0 \\ 0 & 0 & 1_m \end{bmatrix}^T \begin{bmatrix} -A & -B & 0 \\ B^T & 0 & -D \\ C & D & 1_m \end{bmatrix} \begin{bmatrix} T & 0 & 0 \\ 0 & 1_n & 0 \\ 0 & 0 & 1_m \end{bmatrix}$$

Ex:

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -3 & -2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 1 & 0 \\ -1 & 2 \end{bmatrix} \begin{bmatrix} v_{i_1} \\ v_{i_2} \end{bmatrix} ; \quad v_3 = \begin{bmatrix} -1 & 2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 5 & 4 \end{bmatrix} \begin{bmatrix} v_{i_1} \\ v_{i_2} \end{bmatrix}$$

$$Y_c = \begin{bmatrix} 0 & -1 & -1 & 0 & 0 \\ 3 & 2 & 1 & -2 & 0 \\ 1 & -1 & 0 & 0 & -5 \\ 0 & 2 & 0 & 0 & -4 \\ -1 & 2 & 5 & 4 & 1 \end{bmatrix} ; \quad T(s) = [5, 4] + [-1, 2] \begin{bmatrix} s & -1 \\ 3 & s+2 \end{bmatrix}^{-1} \begin{bmatrix} 1 & 0 \\ -1 & 2 \end{bmatrix}$$



+ 2 more OTA's & 4 gyrators