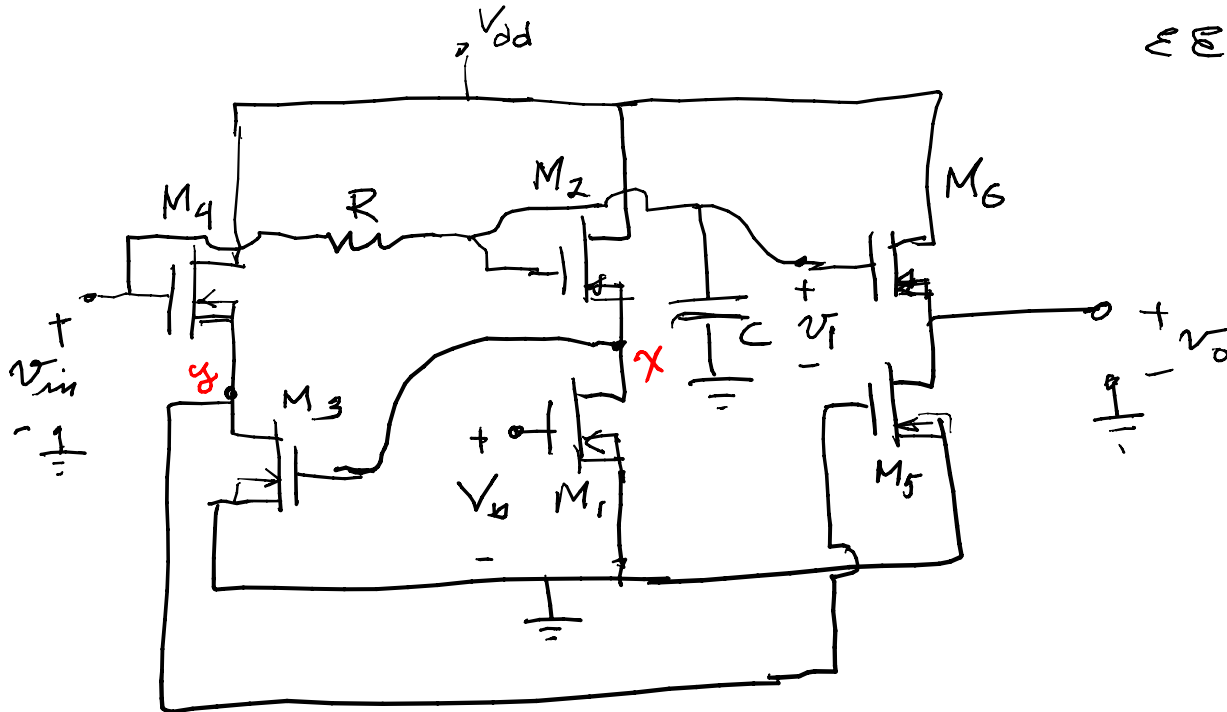
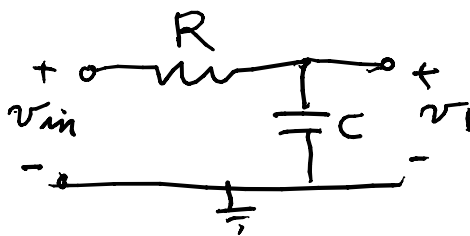


09/27/06
EE 610



B. J. Maundy & P. Aronhime, "A Novel First-order all-Pass Filter," *Int. J. of Electronics*, 2002, Vol. 89, #9, pp. 739-743



$$V_1 = \frac{\frac{1}{sC}}{R + \frac{1}{sC}} V_{in}$$

$$= \frac{1}{1 + sRC} V_{in}$$

$$\text{if } V_o = 2V_1 - V_{in}$$

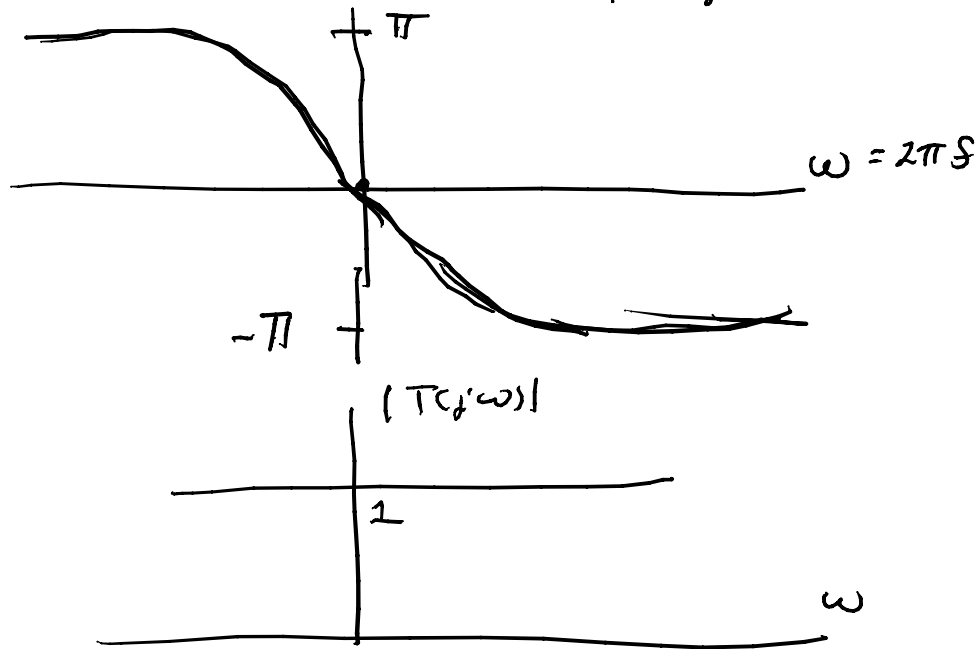
$$\approx \left(\frac{2}{1 + sRC} - 1 \right) V_{in} = \left(\frac{1 - sRC}{1 + sRC} \right) V_{in} \Rightarrow \text{all-pass}$$

$$T(s) = \frac{1 - sRC}{1 + sRC} \quad ; \quad \text{for } s = j\omega = \frac{1 - jRC\omega}{1 + jRC\omega}$$

$$\phi_{\text{num}} = \arctan\left(\frac{-RC\omega}{1}\right), \quad \phi_{\text{den}} = \arctan\left(\frac{RC\omega}{1}\right)$$

$$\phi_{\text{total}} = \text{phase of } T(j\omega) = -2 \arctan(RC\omega)$$

$$|T(j\omega)|$$



see if $v_o = 2v_i - v_{in}$?

for M_6 & M_5 for same drain current

$$v_{GS6} = v_{GS5} = v_i - v_o = v_y$$

$$\text{for } M_4 \text{ \& } M_3 \quad v_{GS4} = v_{GS3} = v_{in} - v_y = v_x$$

$$\Rightarrow v_o = v_i - v_y = v_i - (v_{in} - v_x)$$

$$\text{for } M_2 \text{ \& } M_1 \quad v_{GS2} = v_{GS1} = v_i - v_x = V_b \Rightarrow v_x = v_i - V_b$$

$$v_o = v_i - (v_{in} - [v_i - V_b]) = 2v_i - v_{in} - V_b$$

$$v_{o \text{ signal}} = (2v_i - v_{in})_{\text{signal}}$$

$$\therefore \text{for } \left(\frac{v_i}{v_{in}} \right)_{\text{signal}} = T_1(s) = \frac{1}{1+sRC}$$

more general:

$$v_o = 2v_i - v_{in}, \quad v_i = T_1(s) v_{in}$$

$$= (2T_1 - 1)v_{in}$$

$$\text{if all pass } T(s) = 2T_1(s) - 1 = \frac{D(-s)}{D(s)} = \frac{v_o}{v_{in}}$$

$$\text{let } T_1(s) = \frac{N_1(s)}{D(s)} = \frac{\text{polynomial}}{\text{polynomial}}$$

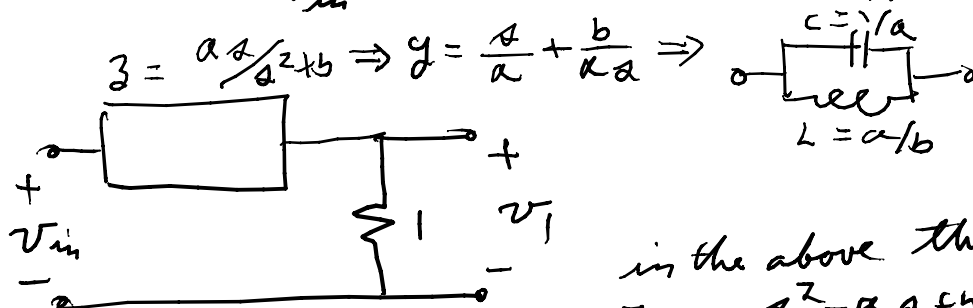
$$\frac{2N_1(s) - D(s)}{D(s)} = \frac{D(-s)}{D(s)} \Rightarrow N_1(s) = \frac{D(s) + D(-s)}{2} = E_v(D(s))$$

$$\text{Ex: } D(s) = s^2 + as + b, \quad a, b > 0$$

$$D(-s) = s^2 - as + b$$

$$E_v[D(s)] = s^2 + b = N(s)$$

$$\text{create } T_1(s) = \frac{v_i}{v_{in}} = \frac{s^2 + b}{s^2 + as + b} = \frac{1}{1 + \frac{as}{s^2 + b}}$$

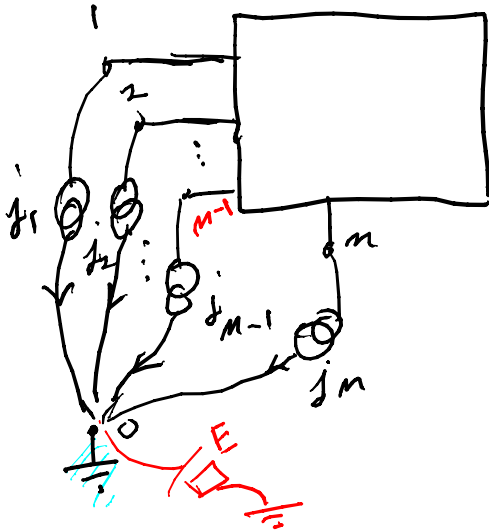


in the above this gives

$$\frac{v_o}{v_{in}} = \frac{s^2 - as + b}{s^2 + as + b}$$

$$\angle T(j\omega) = -2 \arctan\left(\frac{a\omega}{b-\omega^2}\right)$$

indefinite admittance
assume n terminals



$$\text{here } \sum_{i=1}^n j_i = 0$$

$$-j = Y_{ind} v_{node} = Y_{ind} (v_{node} + \frac{E}{-})$$

" indefinite

$$\begin{aligned} \text{Ex: } -j_1 &= y_{1,1} E + y_{1,2} E + \dots + y_{1,m} E + (y_{1, \text{row}} v_{node}) \\ &= [y_{1,1} + y_{1,2} + \dots + y_{1,m}]_{node} E + (j_1) \end{aligned}$$

$$\Rightarrow 0$$

means entries in the row sum to zero

true for any row.

$$\begin{aligned} 0 &= \sum_{i=1}^n j_i = \sum_i y_{iJ} v_J \\ &= \left(\sum_i y_{iJ} \right) v_J \\ &\quad \parallel \\ &\quad 0 \end{aligned}$$

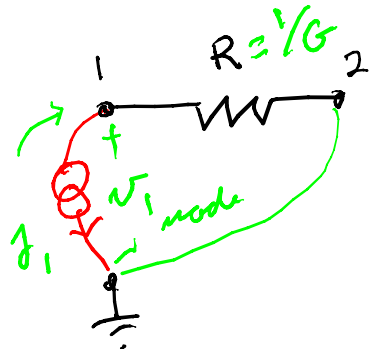
choose all other $v_{j'2} = 0$

$$v_{node} = \begin{bmatrix} 0 \\ \vdots \\ 0 \\ v_J \\ 0 \\ \vdots \\ 0 \end{bmatrix}$$

∴ the sum of all entries in a column (J) is zero

∴ in Y_{ind} in each row the entries sum to 0 & in column.

Ex:



$$Y_{ind} = \begin{bmatrix} G & -G \\ -G & G \end{bmatrix}$$

gives all other entries

If we move the ground onto the circuit the node voltage of the ground is zero; or can scratch out that column & can scratch out the row as that row's current is the sum of all the other currents.

This gives the "nodal" admittance.