Christian Garcia

Pr. Zecevic

ELEN 100 Lab

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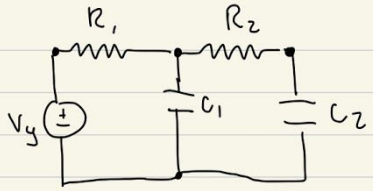
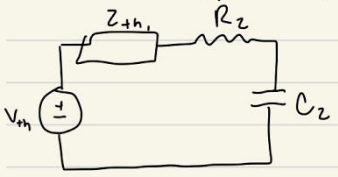
Project 1



1. $H(j\omega) = \frac{\vec{V}_{C_2}}{\vec{V}_g}$

$$V_{th} = \frac{C_1}{R_1 + C_1} V_g = \frac{\frac{1}{j\omega C_1}}{R_1 + \frac{1}{j\omega C_1}} = \frac{1}{j\omega C_1 R_1 + 1}$$

$$Z_{th_1} = \frac{C_1 R_1}{R + C_1} = \frac{\frac{1}{j\omega C_1} R_1}{R_1 + \frac{1}{j\omega C_1}} = \frac{R_1}{j\omega C_1 R_1 + 1}$$



$$Z_{th_2} = Z_{th_1} + R_2 = \frac{R_1}{j\omega C_1 R_1 + 1} + R_2$$

$$V_{C_2} = \frac{C_2}{Z_{th_2} + C_2} V_{th} = \frac{\frac{1}{j\omega C_2}}{\left(\frac{R_1}{j\omega C_1 R_1 + 1} + R_2\right) + \frac{1}{j\omega C_2}} \frac{1}{j\omega C_1 R_1 + 1} = H(j\omega)$$

$$H(j\omega) = \frac{\frac{1}{j\omega C_2}}{R_1 + R_2(j\omega C_1 R_1 + 1) + \frac{1}{j\omega C_2}(j\omega C_1 R_1 + 1)}$$

$$H(j\omega) = \frac{\frac{1}{j\omega C_2}}{R_1 + j\omega C_1 R_1 R_2 + R_2 + \frac{C_1 R_1}{C_2} + \frac{1}{j\omega C_2}}$$

$$H(j\omega) = \frac{1}{R_1 C_2 j\omega + R_1 R_2 C_1 C_2 (j\omega)^2 + R_2 C_2 j\omega + C_1 R_1 j\omega + 1}$$

$$H(j\omega) = \frac{1}{(j\omega)^2 R_1 R_2 C_1 C_2 + j\omega(R_1 C_2 + R_2 C_2 + C_1 R_1) + 1}$$

2. $\frac{1}{ab} = R_1 R_2 C_1 C_2 \qquad \frac{a+b}{ab} = R_1 C_2 + R_2 C_2 + C_1 R_1$

$C_1 = C_2 = 0.1\,nF$ In Matlab...

$a = 3000$

$b = 20000$

$R_1 = 1.25$ & $R_2 = 1.33$

or

$R_1 = 0.667$ & $R_2 = 2.5$

So we chose $R_1 = 1.3\,K\Omega$ & $R_2 = 1.3\,K\Omega$

3. $i_{vg} + i_{R_1} = 0$

$-i_{R_1} + i_{C_1} + i_{R_2} = 0$

$-i_{R_2} + i_{C_2} = 0$

$i_{vg} = ?$

$i_{R_1} = (V_1 - V_2)/R_1$

$i_{R_2} = (V_2 - V_3)/R_2$

$i_{C_1} = V_2\, j\omega C_1$

$i_{C_2} = V_3\, j\omega C_2$

$V_1 = V_g = 1$

$(V_2 - V_1)/R_1 + V_2\, j\omega C_1 + (V_2 - V_3)/R_2 = 0 \rightarrow V_1(-\frac{1}{R}) + V_2(\frac{2}{R} + j\omega C) + V_3(-\frac{1}{R}) = 0$

$(V_3 - V_2)/R_2 + V_3\, j\omega C_2 = 0 \rightarrow V_2(-\frac{1}{R}) + V_3(\frac{1}{R} + j\omega C) = 0$

$$\begin{bmatrix} 1 & 0 & 0 \\ -1/R & \frac{2}{R} + j\omega C & -1/R \\ 0 & -1/R & \frac{1}{R} + j\omega C \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix}$$

$$G_1 = \begin{bmatrix} 1 & 0 & 0 \\ -1/R & 2/R & -1/R \\ 0 & -1/R & 1/R \end{bmatrix} \quad G_2 = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

$$G_3 = \begin{bmatrix} 0 & 0 & 0 \\ 0 & C & 0 \\ 0 & 0 & C \end{bmatrix} \quad B = \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix}$$