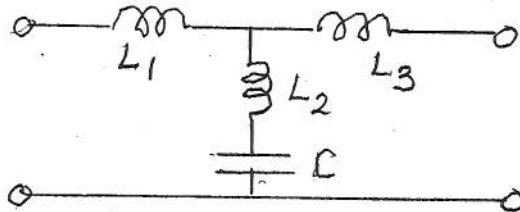


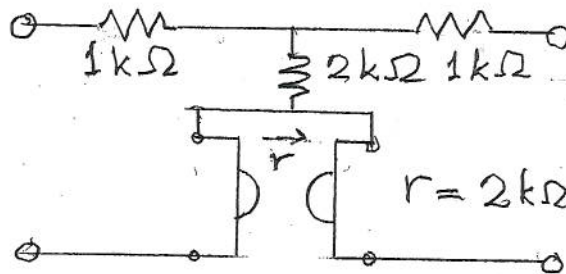
FINAL EXAMINATION
Dec.6, 2007, 9:30 - 11:20 am

ECE 580
Prof. Gabor C. Temes

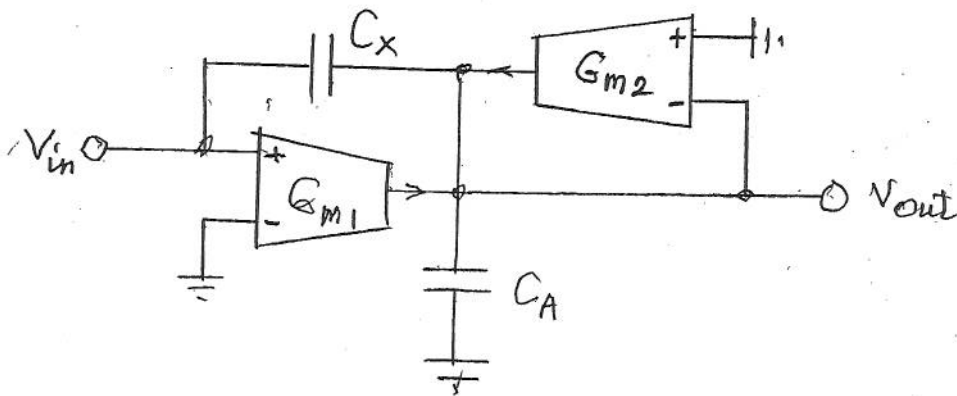
1. For the two-port shown, $y_{11} = y_{22} = \frac{7s^2 + 1}{16s^3 + 4s}$. Find the element values.



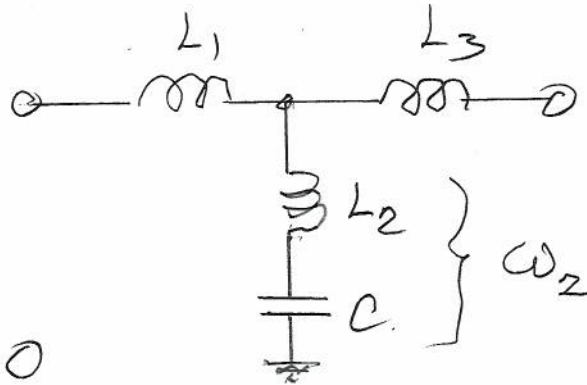
2. Find the open-circuit impedance parameters of the two-port shown below.



3. Find the input impedance and the output (Thevenin) impedance of the linear Gm-C section shown.



1.

For $s = 0$

$$y_{11}^{-1} = y_{22}^{-1} = s(L_1 + L_3) \Rightarrow L_1 + L_3 = 4 \text{ H}$$

For $s = j\omega_2$

$$y_{11}^{-1} = y_{22}^{-1} = j\omega_2 L_1 = j\omega_2 L_3 \Rightarrow L_1 = L_3 = 2 \text{ H}$$

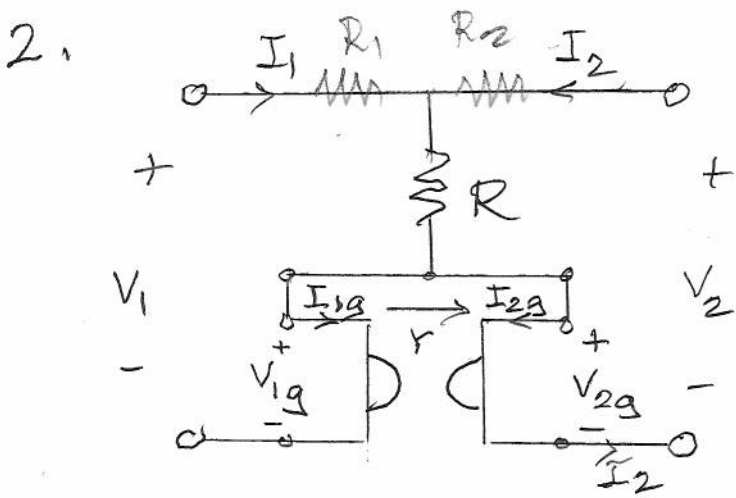
For $s \rightarrow \infty$

$$y_{11}^{-1} \rightarrow sL_1 + s \frac{L_1 L_2}{L_1 + L_2} = sL_1 \left(1 + \frac{L_2}{L_1 + L_2} \right) = s \frac{16}{7}$$

$$L_1/L_2 = 6, \quad L_2 = 1/3 \text{ H}$$

$$y_{11}^{-1} - sL_1 = \frac{16s^3 + 4s}{7s^2 + 1} - s2 = \frac{2s^3 + 2s}{7s^2 + 1}$$

$$\text{Hence, } \omega_2 = \pm 1, \quad C_2 = 1/L_2 = 3 \text{ F}$$



Note: the series two-port conditions always hold!

$$V_{1g} = -r I_{2g} \quad V_{2g} = r I_{1g} \quad \underline{\underline{Z_g}} = \begin{bmatrix} 0 & -r \\ r & 0 \end{bmatrix}$$

$$z_{11} : I_2 = I_{2g} = 0 \Rightarrow V_{1g} = 0$$

$$z_{11} = R$$

$$z_{22} : I_{1g} = 0 \Rightarrow V_{2g} = 0, \quad z_{22} = R$$

$$z_{21} : I_{1g} = 1A, \quad I_{2g} = 0$$

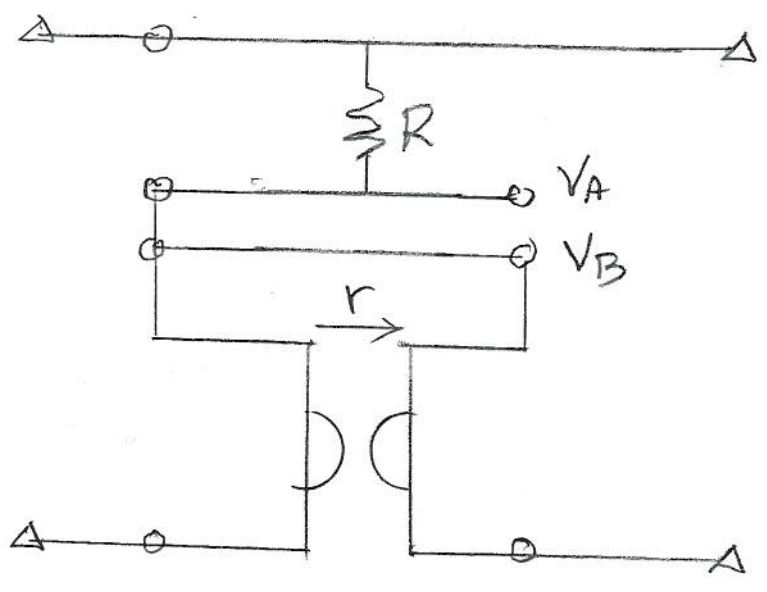
$$V_{1g} = 0, \quad V_{2g} = r$$

$$V_2 = I_1 R + V_{2g} = R + r = z_{21}$$

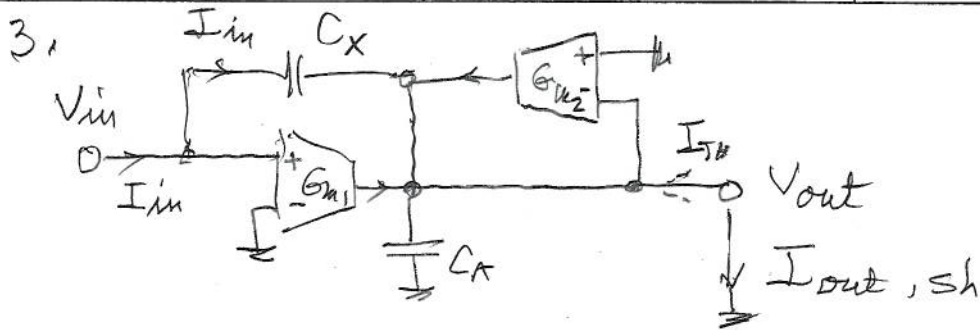
$$z_{12} : V_1 = I_2 R + V_{1g} = R - r = z_{12}$$

$$\underline{\underline{Z}} = \begin{bmatrix} R_1 + R & R - r \\ R + r & R_2 + R \end{bmatrix}$$

The two-ports are in series!



$$V_A = V_B$$



$$V_{out} = H(s) V_{in}$$

$$I_{in} = sC_X [V_{in} - H(s) V_{in}]$$

$$\frac{I_{in}}{V_{in}} = \frac{1}{Z_{in}} = sC_X [1 - H(s)]$$

$$\rightarrow Y_{in} = sC_X \frac{sC_A + G_{m2} - G_{m1}}{s(C_X + C_A) + G_{m2}}$$

$$I_{out, sh} = V_{in} (sC_X + G_{m1})$$

$$\rightarrow Z_{out} = \frac{V_{out}}{I_{out, sh}} = \frac{1}{s(C_X + C_A) + G_{m2}}$$

Check: let $V_{in} = 0$, $V_{out} = 1V$

$$I_{TH} = [s(C_X + C_A) - (-G_{m2})] V_{out} \quad \checkmark$$