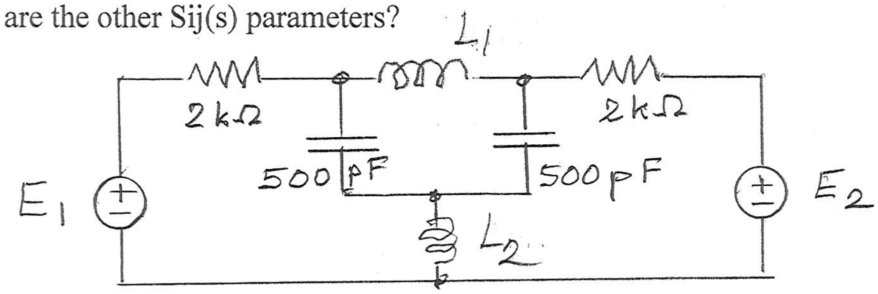
FINAL EXAMINATION
December 6, 2006, 12 - 1:50 pm

ECE 580
Prof. G.C. Temes

1. In the circuit shown, $S11(s) = 0$ for all $s = j\omega$.

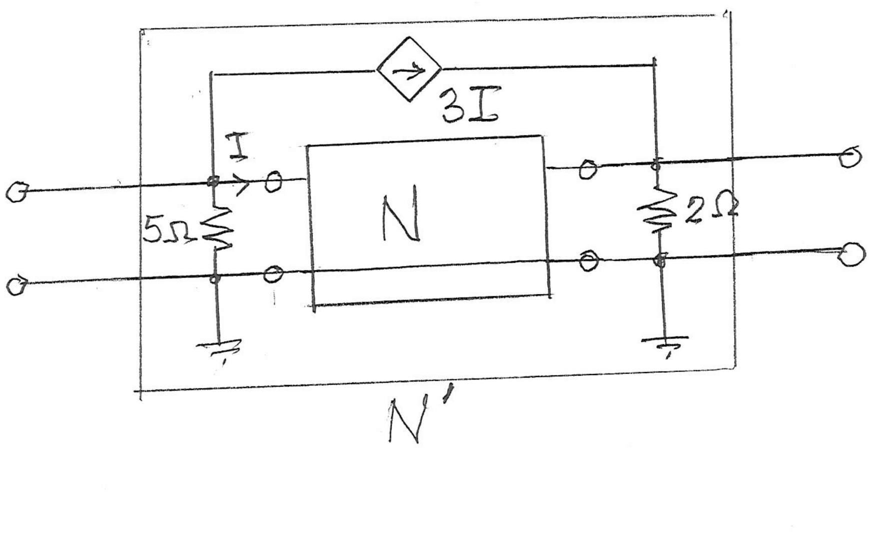
a. Find the missing element values.

b. What are the other $Sij(s)$ parameters?



2. Find the adjoint of an ideal transformer. What is the change in the output voltage or current of a linear circuit containing it, if the turns ratio n changes by Δn?

3. Find the admittance matrix of the twoport N'. The admittance parameters of the embedded twoport N are y11 = 2 S, y12 = -4 S, y21 = 8 S, and y22 = 10 S.



12/5.

1. a. For $I_1 = 1$ A

$$V_1 = Z_1 = z_{11}I_1 + z_{12}I_2 = z_{11} - z_{12}V_2/R$$

$$V_2 = z_{21}I_1 + z_{22}I_2 = z_{12} - z_{22}V_2/R$$

$$V_2 = \frac{z_{12}}{1 + z_{22}/R}$$

$$Z_1 = z_{11} - \frac{z_{12}^2/R}{1 + z_{22}/R} = \frac{z_{11}R + \det \underset{\sim}{z}}{R + z_{22}}$$

For $Z_1 = R$, $z_{11} = z_{22}$

$$R^2 + \cancel{z_{11}R} = \cancel{z_{11}R} + z_{11}^2 - z_{12}^2$$

$$z_{11} = sL_2 + \frac{1}{sC} - \frac{1/sC}{s^2L_1C + 2}$$

$$z_{12} = sL_2 + \frac{1/sC}{s^2L_1C + 2}$$

$$(z_{11} + z_{12})(z_{11} - z_{12}) = \left(2sL_2 + \frac{1}{sC}\right)\left(\frac{1}{sC} - \frac{2/sC}{s^2L_1C + 2}\right)$$

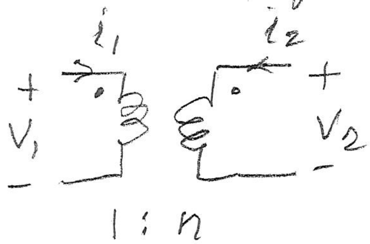
$$= \frac{L_1}{C}\,\frac{2s^2L_2C + 1}{s^2L_1C + 2} = R^2$$

$$2L_1L_2Cs^2 + L_1 = R^2L_1C^2s^2 + 2R^2C$$

$$L_1 = 2R^2C = 2 \times 4 \times 10^6 \times 5 \times 10^{-10} = 4 \text{ mH}$$

$$L_2 = \frac{4 \times 10^6 \times 5 \times 10^{-10}}{2} = 1 \text{ mH} = \frac{R^2C}{2}$$

2. Ideal transformer



$$V_2 = n V_1 \qquad \begin{bmatrix} V_2 \\ i_1 \end{bmatrix} = \begin{bmatrix} n & 0 \\ 0 & -n \end{bmatrix} \begin{bmatrix} V_1 \\ i_2 \end{bmatrix}$$

$$i_1 = -n i_2 \qquad \underset{\sim}{y} = \underset{\sim}{H}\, \underset{\sim}{x}$$

$$\Delta \underset{\sim}{y} \cong \underset{\sim}{H}\, \Delta \underset{\sim}{x} + \Delta \underset{\sim}{H}\, \underset{\sim}{x}$$

$$\hat{\underset{\sim}{y}} = \hat{\underset{\sim}{H}}\, \hat{x}$$

Branch sens. $\hat i_1 \Delta v_1 - \hat V_1 \Delta i_1 + \hat i_2 \Delta V_2 - \hat V_2 \Delta i_2 =$

$$\Delta_B = \hat i_1 \Delta V_1 - \hat V_1(-n \Delta i_2 - \Delta n \cdot i_2) + \hat i_2 (\Delta n \cdot V_1 + n \cdot \Delta V_1)$$

$$- \hat V_2 \Delta i_2$$

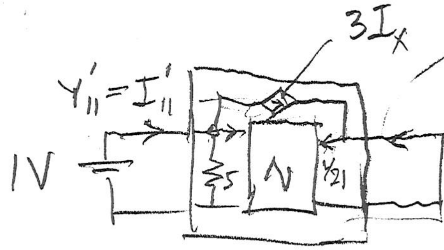
To eliminate ΔV_1, $\hat i_1 \doteq -n \hat i_2$] same as in N

— " — Δi_2, $n \hat V_1 = \hat V_2$

Then, sens.

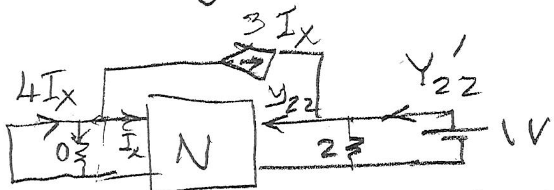
$$+\hat V_1 i_2 \Delta n + \hat i_2 V_1 \Delta n \rightarrow \frac{\partial\, out}{\partial n} = \hat V_1 i_2 + \hat i_2 V_1$$

3.



$I_1 = Y_{11}' V_1 + Y_{12}' V_2$
$I_2 = Y_{21}' V_1 + Y_{22}' V_2$

$$Y_{11}' = I_{11}' = \frac{1}{5} + \overset{y_{11}}{2} + \overset{3y_{11}}{6} = 8.2\ \mho$$



$$Y_{22}' = \frac{1}{2} - 3 \times \overset{y_{12} = I_x}{(-4)} + \overset{y_{22}}{10} = 22.5\ \mho$$

$I_1 = y_{11} V_1 + y_{12} V_2$
$I_2 = y_{21} V_1$

$$Y_{12}' = 4 y_{12} = -16\ \mho$$

$$y_{21}' = y_{21} - 3I_x = Y_{21} - 3y_{11} = 8 - 6 = 2\ \mho$$

$$\underset{\sim}{Y}' = \begin{bmatrix} 8.2 & -16 \\ 2 & 22.5 \end{bmatrix} \mho$$