Node Suppression

\[ Y_N = \begin{bmatrix} W_{11} & W_{12} \\ W_{21} & W_{22} \end{bmatrix} \Rightarrow Y = W_{11} - W_{12}W_{22}^{-1}W_{21} \]

Two-Port Networks

\[ Y = \begin{bmatrix} y_{11} & y_{12} \\ y_{21} & y_{22} \end{bmatrix} \quad Z = \begin{bmatrix} z_{11} & z_{12} \\ z_{21} & z_{22} \end{bmatrix} \]

\[ I_1 = y_{11}V_1 + y_{12}V_2 \]
\[ I_2 = y_{21}V_1 + y_{22}V_2 \]
\[ V_1 = z_{11}I_1 + z_{12}I_2 \]
\[ V_2 = z_{21}I_1 + z_{22}I_2 \]
\[ Z = Y^{-1} \]

\[ H = \begin{bmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \end{bmatrix} \quad G = \begin{bmatrix} g_{11} & g_{12} \\ g_{21} & g_{22} \end{bmatrix} \]

\[ V_1 = h_{11}I_1 + h_{12}V_2 \]
\[ I_1 = g_{11}V_1 + g_{12}I_2 \]
\[ I_2 = h_{21}I_1 + h_{22}V_2 \]
\[ V_2 = g_{21}I_1 + g_{22}I_2 \]
\[ G = H^{-1} \]

\[ T = \begin{bmatrix} A & B \\ C & D \end{bmatrix} \]

\[ V_1 = AV_2 - BI_2 \]
\[ I_1 = CV_2 - DI_2 \]

\[ T_{\text{series}} = \begin{bmatrix} 1 & Z_{\text{series}} \\ 0 & 1 \end{bmatrix} \quad T_{\text{parallel}} = \begin{bmatrix} Y_{\text{parallel}}^{-1} & 0 \\ 1 & 1 \end{bmatrix} \]
Problem 1 (8 points)

Consider the following network.

(a) Write the state equations for the following network and put them in the form $\dot{x} = Ax + Bu$ where $x = [v_C(t) \ i_L(t)]^T$ and $u = [v_s(t) \ i_s(t)]^T$.

(b) Find the natural frequencies of the network if $R = 1\ \Omega$, $L = \frac{1}{4}\ \text{H}$ and $C = \frac{1}{5}\ \text{F}$.
Problem 1 (continued)
Problem 2 (7 points)
Find $y_{11}$ and $y_{21}$ for the following network by direct calculation.

![Network Diagram]

\[ I_1 \quad R_1 \quad C \quad v_C \quad g_m v_C \quad I_2 \]
\[ V_1 \quad R_2 \quad + \quad - \quad V_2 \]
\[ V_1 \quad R_3 \quad + \quad - \]
Problem 2 (continued)
Problem 3 (7 points)
Find the \( Y \)-parameters for the following network.
Problem 3 (continued)
Problem 4 (8 points)
(a) Find the transmission parameters (also called ABCD- or T-parameters) for the following network.
(b) Determine $\frac{V_2}{V_1}|_{I_2=0}$ for the network.

```
+---+   +---+   +---+   +---+
|   |   |   |   |   |
|I_1| L | R_1| R_2| I_2|
+---+   +---+   +---+   +---+
       C

V_1    V_2
```
Problem 4 (continued)