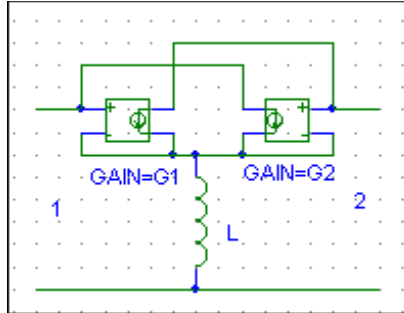


1. For the following 2-port find and draw its adjoint.



2. For the 2-port above, apply a voltage source to the left port and measure the output voltage across the right port. Find V_{out}/V_{in} . Then use two methods to calculate the change in V_{out}/V_{in} when L changes (by direct calculation and by using the adjoint circuit); repeat when $G1$ changes, and when $G1$ and $G2$ both change with a third parameter x (such as a ganged voltage control). Discuss a) what the frequency dependence means, b) for how large of variations these hold, and differences in the circuit behavior due to different parameter changes.

3. The 2-port above can be used to form Richards' functions. Give the resulting Richards' functions. Find the 2-port scattering matrix and use it for lossless synthesis via factorization of the input scattering matrix. Use this to synthesize

$$S(s) = \frac{s^2 - 5s + 6}{s^2 + 5s + 6} \quad (5-1)$$

4. The transfer scattering matrix of a 2-port is defined by

$$\begin{bmatrix} v_1^i \\ v_1^r \end{bmatrix} = \Theta \begin{bmatrix} v_2^r \\ v_2^i \end{bmatrix} \quad (5-2)$$

Find the transfer scattering matrix for the 2-port of 1. above. In terms of the transfer scattering matrix entries

$$\Theta = \begin{bmatrix} \Theta_{11} & \Theta_{12} \\ \Theta_{21} & \Theta_{22} \end{bmatrix} \quad (5-3)$$

Show that for a cascade connection the transfer scattering matrices multiply (in what order?). Find the input reflection coefficient, S_{in} , looking into the left port when the 2-port has a load S_L on the right port. How is the resulting formula related to the Richards' function and the corresponding result for the scattering matrix of the 2-port?