E2.2 Analogue electronics
Problem sheet 6 (Week 9)

Q1: Show that the impedance matrix of the "Tee" circuit (shown below) is:

$$Z_{TEE} = \begin{bmatrix} Z_1 + Z_C & Z_C \\ Z_C & Z_2 + Z_C \end{bmatrix}$$

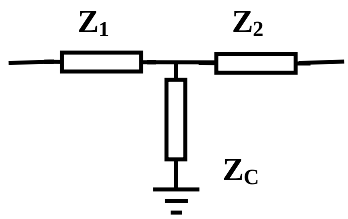

Figure for problem 3: The "tee" network

Q2: Show that the impedance matrix of a network consisting of a 2-port with impedance matrix $Z_0 = \begin{bmatrix} z_{11} & z_{12} \\ z_{21} & z_{22} \end{bmatrix}$ and a impedance Z_C along its common terminal connection is:

$$Z' = \begin{bmatrix} z_{11} + Z_C & z_{12} + Z_C \\ z_{21} + Z_C & z_{22} + Z_C \end{bmatrix}$$

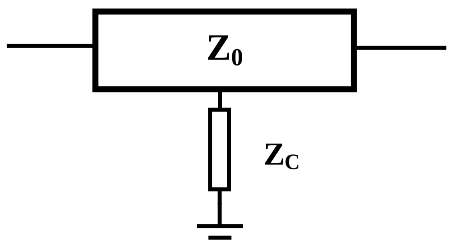

Figure for problem 4: Connecting an impedance along the common terminal of a 2-port.

Q3: Prove that the "Tee" and "Pi" networks are equivalent if:

$$Z_1 = \frac{Y_2}{Y_1Y_2 + Y_2Y_3 + Y_1Y_3} \;,\; Z_2 = \frac{Y_1}{Y_1Y_2 + Y_2Y_3 + Y_1Y_3} \;,\; Z_3 = \frac{Y_3}{Y_1Y_2 + Y_2Y_3 + Y_1Y_3}$$ or, equivalently, if

$$Y_1 = \frac{Z_2}{Z_1Z_2 + Z_2Z_3 + Z_1Z_3} \;,\; Y_2 = \frac{Z_1}{Z_1Z_2 + Z_2Z_3 + Z_1Z_3} \;,\; Y_3 = \frac{Z_3}{Z_1Z_2 + Z_2Z_3 + Z_1Z_3}$$

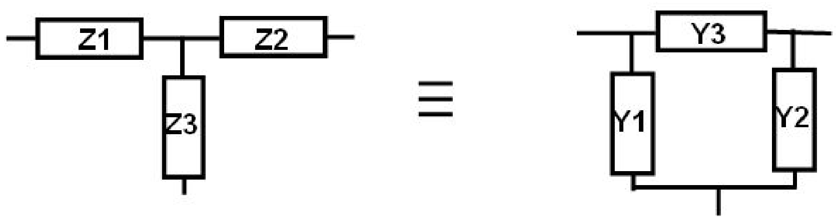

Figure for problem 5: Equivalence of Tee and Pi networks

Q4: Given the Y-matrix for a network calculate its G-matrix

Q5: Given the G-matrix for a network calculate its Y-matrix

Q6: Use the results of Q4 and Q5 above to discover the exact form of the parallel form of the Miller theorem (what was shown in class was approximate!). What are the conditions for the approximation to be good?