ELEN30009 - Electrical Network Analysis and Design Assignment 4

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Tuesday - 2:15 PM

1. (a) INSERT DIAGRAM HERE
   Using KVL in loop 1:

$$\begin{aligned}
&\Sigma V_{drops} = 0 \\
\implies &V_i + I_i R_i = 0 \\
\implies &V_i = I_i R_i
\end{aligned}$$

   Using KVL in loop 2:

$$\begin{aligned}
&\Sigma V_{drops} = 0 \\
\implies &-V_o + I_o R_o + A_{voc} V_i = 0 \\
\implies &-V_o + I_o R_o + A_{voc} I_i R_i = 0 \\
\implies &I_i = \frac{V_o - I_o R_o}{A_{voc} R_i} \\
\implies &V_i = \frac{V_o - I_o R_o}{A_{voc}}
\end{aligned}$$

   We know that for a two port network, the general matrix equation written in a parameters is:

$$\begin{bmatrix} V_i \\ I_i \end{bmatrix} = \begin{bmatrix} a_{11} & -a_{12} \\ a_{21} & -a_{22} \end{bmatrix} \begin{bmatrix} V_o \\ I_o \end{bmatrix}$$

   From the equation obtained before, we can re-write them in matrix form:

$$\begin{bmatrix} V_i \\ I_i \end{bmatrix} = \begin{bmatrix} \frac{1}{A_{voc}} & -\frac{R_o}{A_{voc}} \\ \frac{1}{A_{voc} R_i} & -\frac{R_o}{A_{voc} R_i} \end{bmatrix} \begin{bmatrix} V_o \\ I_o \end{bmatrix}$$

   Therefore, the A matrix of this voltage amplifier model is:

$$A = \begin{bmatrix} \frac{1}{A_{voc}} & -\frac{R_o}{A_{voc}} \\ \frac{1}{A_{voc} R_i} & -\frac{R_o}{A_{voc} R_i} \end{bmatrix}$$

   (b) This circuit can be thought of as 3 cascaded two port networks forming a single two port network with a loaded output and a voltage input with source impedance.
   To find the A parameter matrix of the single two port network, first find the A parameter matrices of each amplifier stage and matrix multiply them together to.

$$A_1 = \begin{bmatrix} \frac{1}{10} & -\frac{1\times10^3}{10} \\ \frac{1}{101\times10^6} & -\frac{1\times10^3}{101\times10^6} \end{bmatrix}$$
$$A_2 = \begin{bmatrix} \frac{1}{100} & -\frac{2\times10^3}{100} \\ \frac{1}{100200\times10^3} & -\frac{2\times10^3}{100200\times10^3} \end{bmatrix}$$
$$A_3 = \begin{bmatrix} \frac{1}{2} & -\frac{50\times10^3}{2} \\ \frac{1}{225\times10^3} & -\frac{50\times10^3}{225\times10^3} \end{bmatrix}$$
$$A = A_1 A_2 A_3$$
$$= \begin{bmatrix} 457\times10^{-6} & 22.885\ \Omega \\ 457\times10^{-12}\ \mho & 22.885\times10^{-6} \end{bmatrix}$$

2. (a) i. We know that in a Thevenin equivalent circuit, maximum power transfer to the load occurs when $Z_L = Z_{Th}^*$, or more simply for entirely resistive circuits, $R_L = R_{Th}$.
   ii.
   iii.
   (b)
3. (a)
   (b)
   (c)
4. i
   ii
   iii
5.