2013.

一.解：端口电流电压关系：

$$u(t)=\frac{1}{C}\int_{t_0}^{t} i(t)\,dt - \frac{2}{C}(t-t_0)$$

设输入为 $v(t)=u(t)$，输出 $y(t)=i(t)$.

则端口输入-输出关系：$D(v,y)=v-\frac{1}{C}\int_{t_0}^{t} y\,dt+\frac{2}{C}(t-t_0)=0$

则对于 $\hat{v},\hat{y}$：$D(\hat{v},\hat{y})=\hat{v}-\frac{1}{C}\int_{t_0}^{t}\hat{y}\,dt+\frac{2}{C}(t-t_0)=0$

而对于 $v+\hat{v}$, $y+\hat{y}$：$D(v+\hat{v},y+\hat{y})=v+\hat{v}-\frac{1}{C}\int_{t_0}^{t}(y+\hat{y})\,dt+\frac{2}{C}(t-t_0)\neq 0$

不满足可加性，故非端口型线性网络.

二.解. ① VCCS对原始不定导纳矩阵贡献为：

$$\begin{array}{c|cc} & 5 & 3 \\ \hline 4 & g_m & -g_m \\ 3 & -g_m & g_m \end{array} = \begin{array}{c|cc} & 3 & 5 \\ \hline 3 & g_m & -g_m \\ 4 & -g_m & g_m \end{array}$$

② 回转器对不定导纳矩阵的贡献：

$$\begin{array}{c|cccc} & 5 & 3 & 2 & 3' \\ \hline 5 & 0 & 0 & g & -g \\ 3 & 0 & 0 & -g & g \\ 2 & -g & g & 0 & 0 \\ 3' & g & -g & 0 & 0 \end{array} = \begin{array}{c|ccc} & 5 & 3 & 2 \\ \hline 5 & 0 & -g & g \\ 3 & g & 0 & -g \\ 2 & -g & g & 0 \end{array} = \begin{array}{c|ccc} & 2 & 3 & 5 \\ \hline 2 & 0 & g & -g \\ 3 & -g & 0 & g \\ 5 & g & -g & 0 \end{array}$$

原始不定导纳矩阵：

$$Y_i(s)=\begin{array}{c|ccccc} & 1 & 2 & 3 & 4 & 5 \\ \hline & \frac{1}{R_1} & 0 & 0 & -\frac{1}{R_1} & 0 \\ & 0 & 0 & g & 0 & -g \\ & 0 & -g & g_m & 0 & g-g_m \\ & -\frac{1}{R_1} & 0 & -g_m & \frac{1}{R_1}+sC_2 & g_m-sC_2 \\ & 0 & g & -g & -sC_2 & sC_2 \end{array}$$

以节点3为参考节点，得定导纳矩阵：

$$Y_d(s)=\begin{bmatrix} \frac{1}{R_1} & 0 & -\frac{1}{R_1} & 0 \\ 0 & 0 & 0 & -g \\ -\frac{1}{R_1} & 0 & \frac{1}{R_1}+sC_2 & g_m-sC_2 \\ 0 & g & -sC_2 & sC_2 \end{bmatrix}$$

消节点⑤：

$$\begin{bmatrix} \frac{1}{R_1} & 0 & -\frac{1}{R_1} \\ 0 & \frac{g^2}{sC_2} & -g \\ -\frac{1}{R_1} & \frac{g(sC_2-g_m)}{sC_2} & \frac{1}{R_1}+g_m \end{bmatrix}$$

消节点④：

$$Y_{sc(11)}=\frac{1}{R_1}-\frac{1}{R_1^2}\times\frac{R_1}{1+R_1g_m}=\frac{g_m}{1+R_1g_m}$$

$$Y_{sc(21)}=-\frac{g}{R_1}\times\frac{R_1}{1+R_1g_m}=-\frac{g}{1+R_1g_m}$$

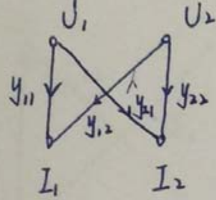
$$Y_{sc(12)} = \frac{1}{R_1} \times \frac{g(sC_2-g_m)}{sC_2} \times \frac{R_1}{1+R_1 g_m} = \frac{g(sC_2-g_m)}{sC_2(1+R_1 g_m)}$$

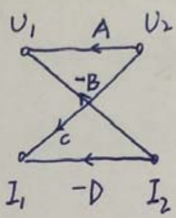
$$Y_{sc(22)} = \frac{g^2}{sC_2} + \frac{g^2(sC_2-g_m)}{sC_2} \times \frac{R_1}{1+R_1 g_m} = \frac{g^2(1+R_1 sC_2)}{sC_2(1+R_1 g_m)}$$

短路导纳矩阵: $Y_{sc}(s) = \begin{bmatrix} \frac{g_m}{1+R_1 g_m} & \frac{g(sC_2-g_m)}{sC_2(1+R_1 g_m)} \\ \frac{-g}{1+R_1 g_m} & \frac{g^2(1+R_1 sC_2)}{sC_2(1+R_1 g_m)} \end{bmatrix}$

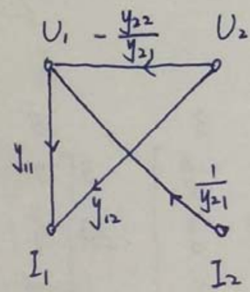
四解: (1) 短路导纳矩阵:

SFG:

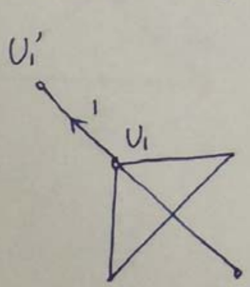


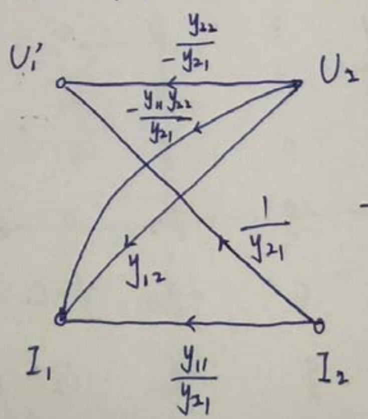


将 $U_1 I_2$ 倒向:



I_1 与 I_2 缺少支路、$U_1 I_1$ 多一条支路. 建立新节点 U_1', 消去 U_1





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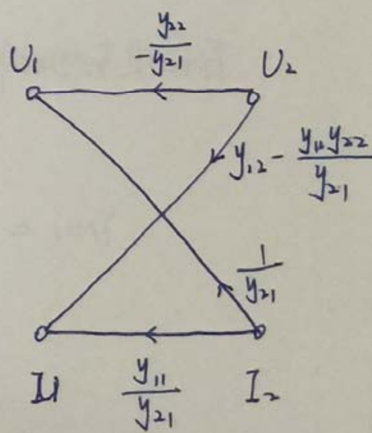


$$A = -\frac{y_{22}}{y_{21}}$$

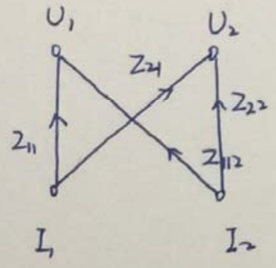
$$B = \frac{-1}{y_{21}}$$

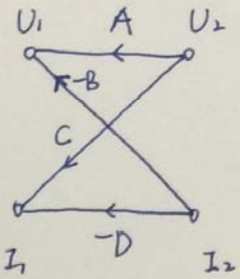
$$C = y_{12} - \frac{y_{11}y_{22}}{y_{21}}$$

$$D = -\frac{y_{11}}{y_{21}}$$

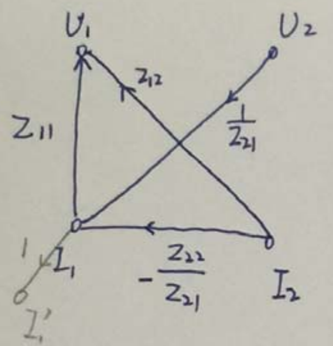
(2) 开路阻抗矩阵:

SFG:





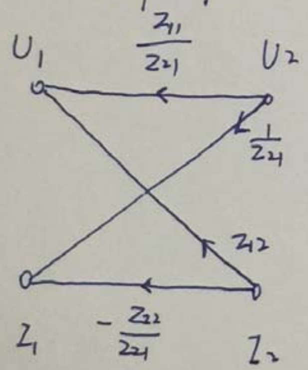
U_1I_1倒向:



U_1U_2少一条

U_1I_1多一条

新建I_1'，消掉I_1节点:



$A=\frac{Z_{11}}{Z_{21}}$

$B=-Z_{12}$

$C=\frac{1}{Z_{21}}$

$D=\frac{Z_{22}}{Z_{21}}$