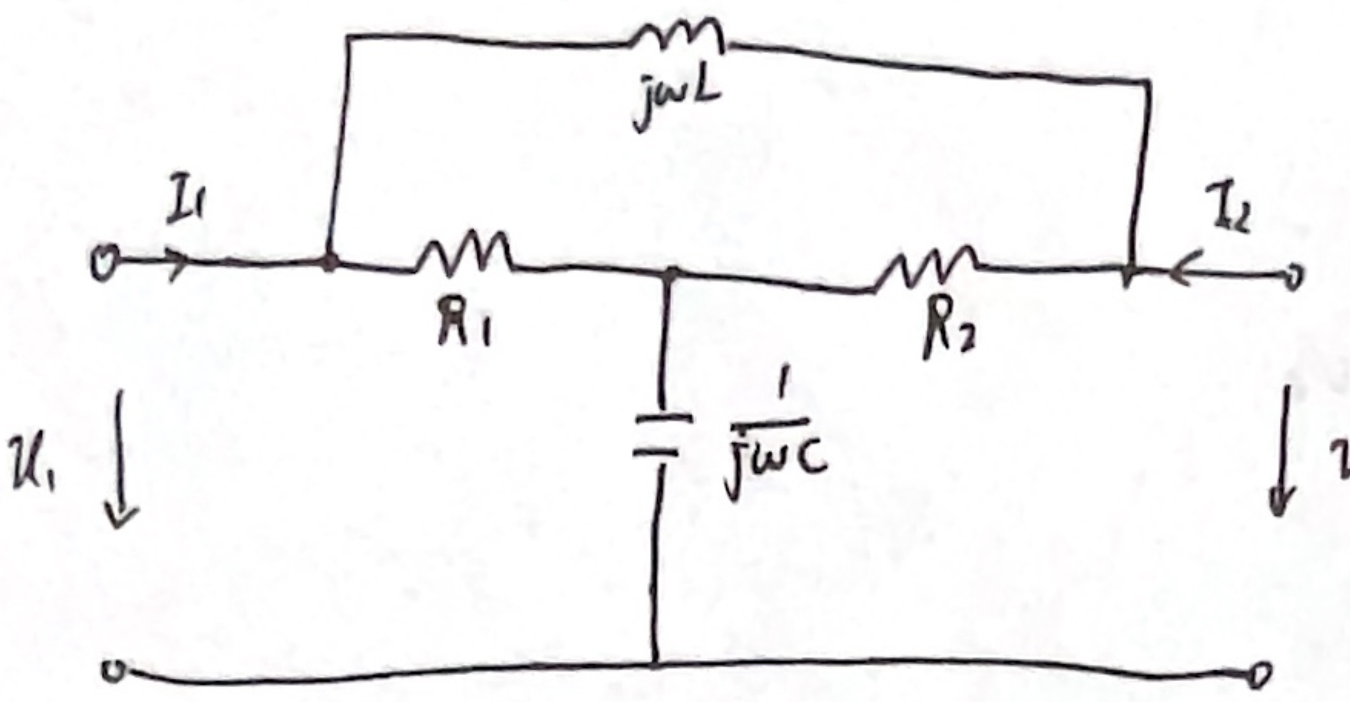
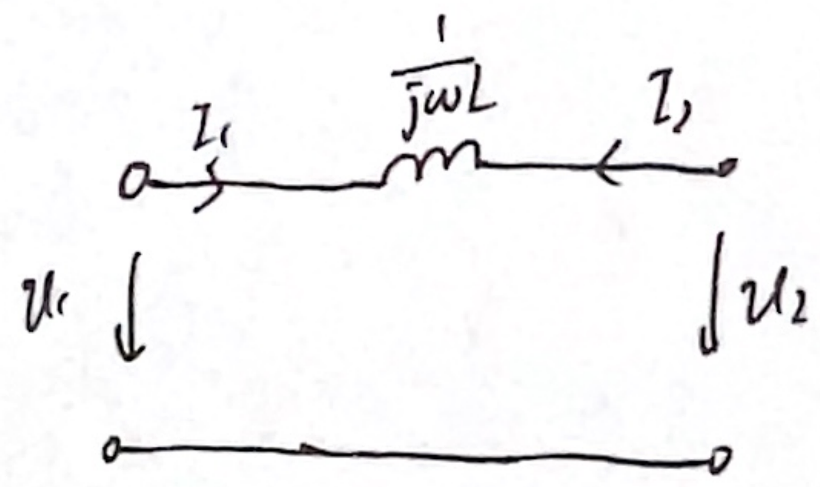
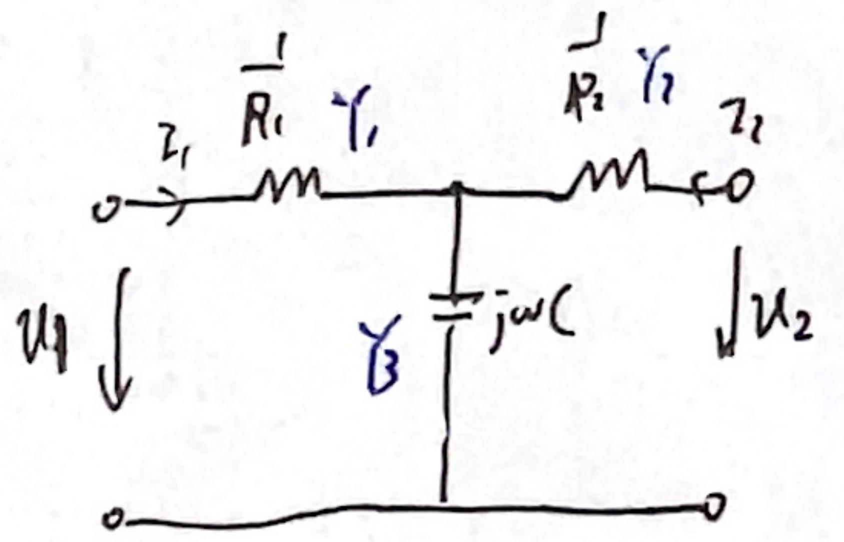
Zweitor



写出 $\underline{Y}$ 矩阵



$$\underline{Y} = \begin{pmatrix} Y & -Y \\ -Y & Y \end{pmatrix} \Rightarrow \underline{Y}_1 = \begin{pmatrix} \frac{1}{j\omega L} & -\frac{1}{j\omega L} \\ -\frac{1}{j\omega L} & \frac{1}{j\omega L} \end{pmatrix}$$



$$\underline{Y} = \frac{1}{N} \begin{pmatrix} Y_1(Y_2+Y_3) & -Y_1 Y_2 \\ -Y_1 Y_2 & Y_2(Y_1+Y_3) \end{pmatrix}$$

$$N = Y_1 + Y_2 + Y_3$$

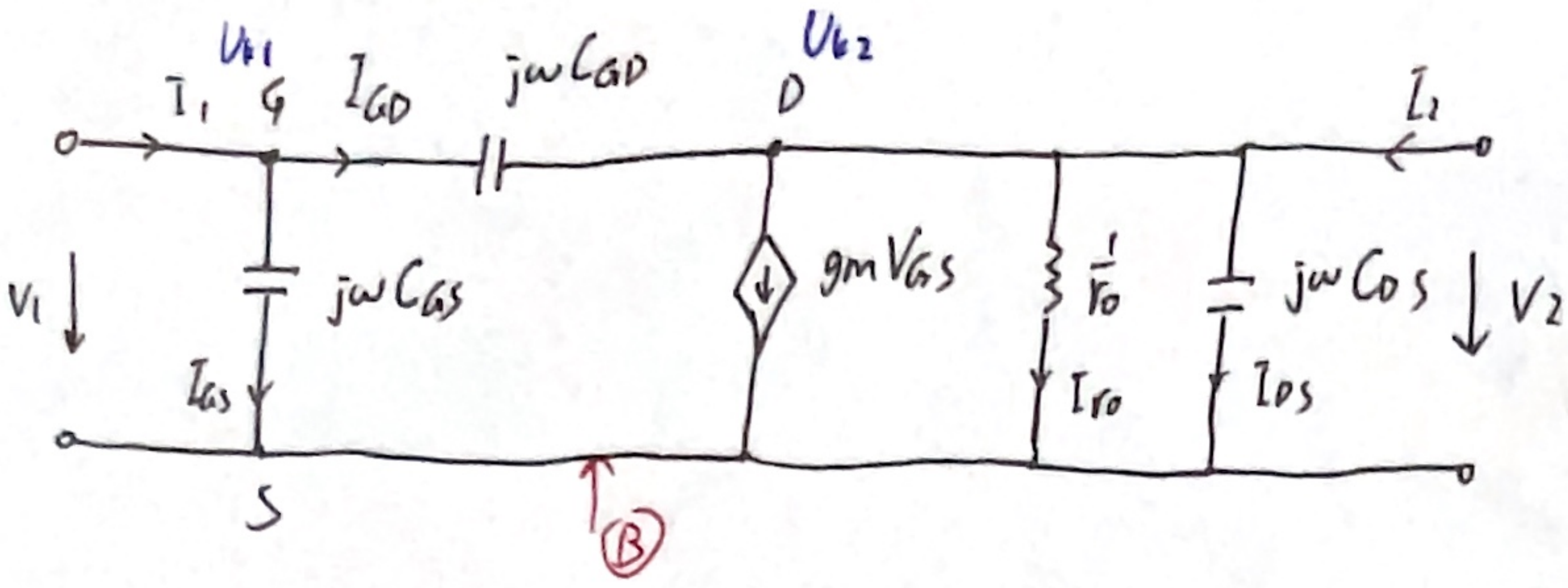
$$N = \frac{1}{R_1} + \frac{1}{R_2} + j\omega C$$

$$Y_{11} = \frac{1}{R_1}\left(\frac{1}{R_2} + j\omega C\right), \quad Y_{12} = Y_{21} = -\frac{1}{R_1 R_2}, \quad Y_{22} = \frac{1}{R_2}\left(\frac{1}{R_1} + j\omega C\right)$$

$$\underline{Y}_2 = \begin{pmatrix} \frac{1}{R_1}\left(\frac{1}{R_2}+j\omega C\right) & -\frac{1}{R_1 R_2} \\ -\frac{1}{R_1 R_2} & \frac{1}{R_2}\left(\frac{1}{R_1}+j\omega C\right) \end{pmatrix} \frac{1}{\frac{1}{R_1}+\frac{1}{R_2}+j\omega C}$$

$$\Rightarrow \underline{Y} = \underline{Y}_1 + \underline{Y}_2 = \begin{pmatrix} \frac{1}{j\omega L} + \frac{\frac{1}{R_1}\left(\frac{1}{R_2}+j\omega C\right)}{\frac{1}{R_1}+\frac{1}{R_2}+j\omega C} & -\frac{1}{j\omega L} - \frac{\frac{1}{R_1 R_2}}{\frac{1}{R_1}+\frac{1}{R_2}+j\omega C} \\ -\frac{1}{j\omega L} - \frac{\frac{1}{R_1 R_2}}{\frac{1}{R_1}+\frac{1}{R_2}+j\omega C} & \frac{1}{j\omega L} + \frac{\frac{1}{R_2}\left(\frac{1}{R_1}+j\omega C\right)}{\frac{1}{R_1}+\frac{1}{R_2}+j\omega C} \end{pmatrix}$$

mit gesteuert



写出 $\underline{Z}$ 矩阵，含受控源

① 对 G, D 列 KCL

$$\begin{cases} I_1 = I_{GD} + I_{GS} \\ I_{GD} = g_m V_{GS} + I_{r0} + I_{DS} - I_2 \end{cases} \Leftrightarrow \begin{cases} I_1 = I_{GD} + I_{GS} \\ I_2 = g_m V_{GS} + I_{r0} + I_{DS} - I_{GD} \end{cases}$$

② 找到 KCL 中的 UI 关系

$$\begin{cases} V_{GS} = V_1 \\ I_{GS} = j\omega C_{GS} \cdot V_{GS} = j\omega C_{GS} \cdot V_1 \\ I_{GD} = j\omega C_{GD} \cdot V_{GD} = j\omega C_{GD}(V_1 - V_2) \end{cases}$$

③ $\underline{Y} U = I$ ...

Knotenpotentialverfahren. 列节点

$Y_{11} = j\omega C_{GS} + j\omega C_{GD}$ } positiv

$Y_{22} = j\omega C_{GD} + \frac{1}{r_0} + j\omega C_{DS}$

$Y_{12} = j\omega C_{GD} = Y_{21}$ } negativ

$I_1 = I_1$

$I_2 = I_2 - g_m V_{GS}$

流入正
流出负

$$\begin{pmatrix} j\omega C_{GS} + j\omega C_{GD} & -j\omega C_{GD} \\ -j\omega C_{GD} & j\omega C_{GD} + \frac{1}{r_0} + j\omega C_{DS} \end{pmatrix} \begin{pmatrix} U_{k1} \\ U_{k2} \end{pmatrix} = \begin{pmatrix} I_1 \\ I_2 - g_m V_{GS} \end{pmatrix}$$

$$\begin{cases} U_{k1} = U_{GS} = V_1 \\ U_{k2} = U_{DS} = V_2 \\ V_{GS} = V_1 \end{cases}$$

$$\Rightarrow \begin{pmatrix} j\omega C_{GS} + j\omega C_{GD} & -j\omega C_{GD} \\ g_m - j\omega C_{GD} & j\omega C_{GD} + \frac{1}{r_0} + j\omega C_{DS} \end{pmatrix} \begin{pmatrix} V_1 \\ V_2 \end{pmatrix} = \begin{pmatrix} I_1 \\ I_2 \end{pmatrix}$$

$$Z_{11} = \frac{V_1}{I_1}\bigg|_{I_2=0} = \frac{\begin{vmatrix} I_1 & -j\omega C_{GD} \\ 0 & j\omega C_{GD} + \frac{1}{r_0} + j\omega C_{DS} \end{vmatrix}}{I_1 \det \underline{Y}}$$

$$\Rightarrow V_1 = \frac{\begin{vmatrix} I_1 & -j\omega C_{GD} \\ I_2 & j\omega C_{GD} + \frac{1}{r_0} + j\omega C_{DS} \end{vmatrix}}{\det \underline{Y}}, \quad V_2 = \frac{\begin{vmatrix} j\omega C_{GS} + j\omega C_{GD} & I_1 \\ g_m - j\omega C_{GD} & I_2 \end{vmatrix}}{\det \underline{Y}}$$

$$Z_{12} = \frac{V_1}{I_2}\bigg|_{I_1=0} = Z_{21}$$

$$Z_{22} = \frac{V_2}{I_2}\bigg|_{I_1=0} = \frac{\begin{vmatrix} j\omega C_{GS} + j\omega C_{GD} & 0 \\ g_m - j\omega C_{GD} & I_2 \end{vmatrix}}{I_2 \det \underline{Y}}$$