EE210: Analog Electronics - Quiz 3

NAME (in capital)	Roll No

Time: 15 minutes

1) : Consider the circuit in Fig. 1. $V_{DC} = 5\,V$. A three terminal non-linear element has been used, whose terminals are defined in the inset. The element has the following characteristics. $I_D = I_S = \alpha V_{GS}^2$ for $V_{GS} \geq 0$ and $V_{DS} \geq 0$. $I_D = I_S = 0$ otherwise.

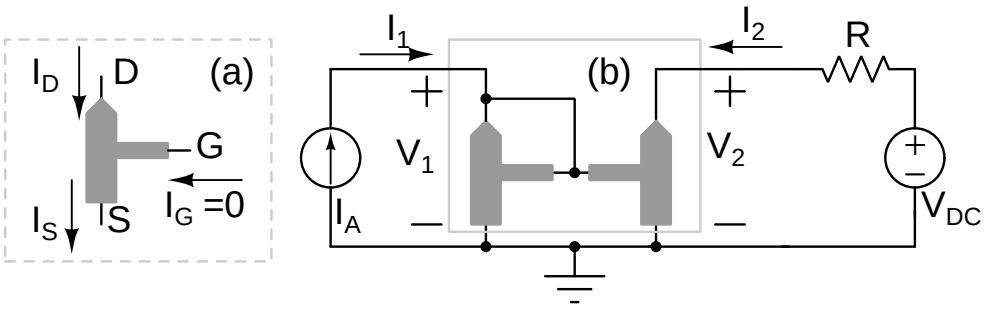


Fig. 1. Problem 1

a) : Assume $I_A = 1\,mA, \alpha = 1\,mA/V^2$ and $R1 = 1k\Omega$. Find the small-signal two-port y-parameters of the network within the box (in Fig. 1(b)) and sketch the small-signal two-port network. **[6]**

$I_1 = \alpha V_1^2 \Rightarrow V_1 = 1V$

$I_2 = \alpha V_1^2 \Rightarrow I_2 = 1mA \qquad V_2 = V_{DC} - I_2 R = 4V$

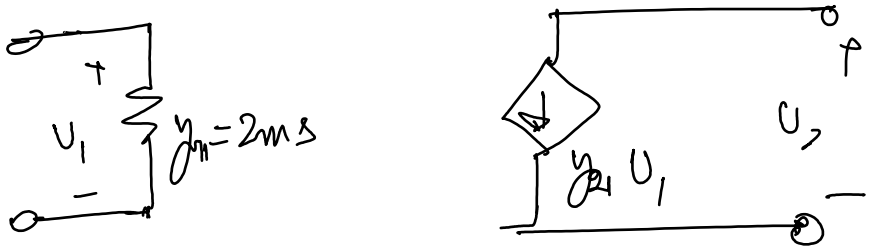
$\therefore \quad y_{11} = \left.\frac{\partial I_1}{\partial V_1}\right|_{\substack{V_1 = 1V \\ V_2 = 4V}} = 2\alpha V_1 = 2mS$

$y_{12} = \frac{\partial I_1}{\partial V_2} = 0$

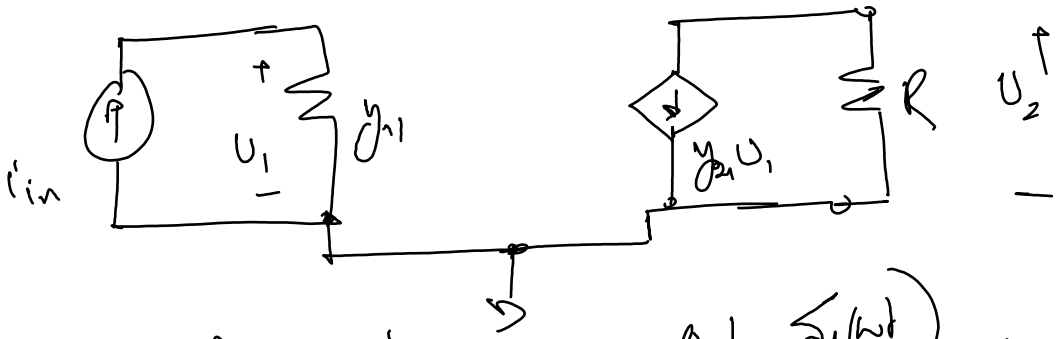
$y_{21} = \frac{\partial I_2}{\partial V_1} = 2\alpha V_1 = 2mS$

$y_{22} = \frac{\partial I_2}{\partial V_2} = 0$

..contd..



b) : If $I_A = 1\,mA + 0.1mA\sin(\omega t)$, find the small signal voltage across V_1 and V_2. **[4]**



Be mindful of connecting the two ports through the shunt

$$V_1 = \frac{i_{in}}{y_{11}} = \frac{0.1m\sin(\omega t)}{0.2m} = 500mV\sin(\omega t)$$

$$V_2 = -y_{21}V_1R = -0.2m \times 0.5k\sin(\omega t)$$

$$= -0.1V\sin(\omega t)$$

Be mindful of the -ve sign in V_2