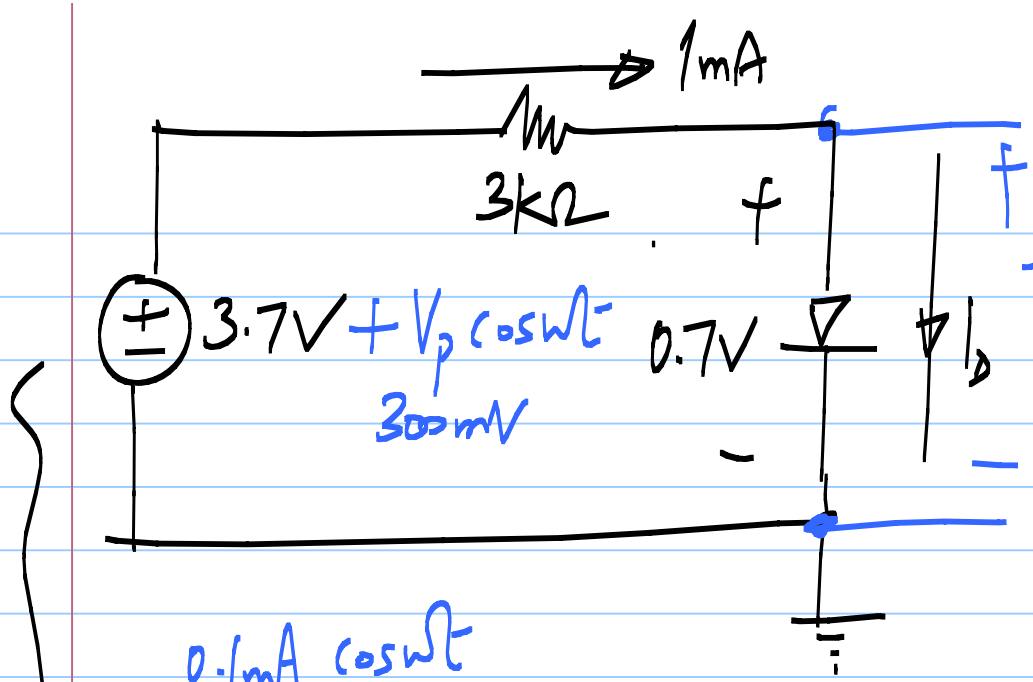
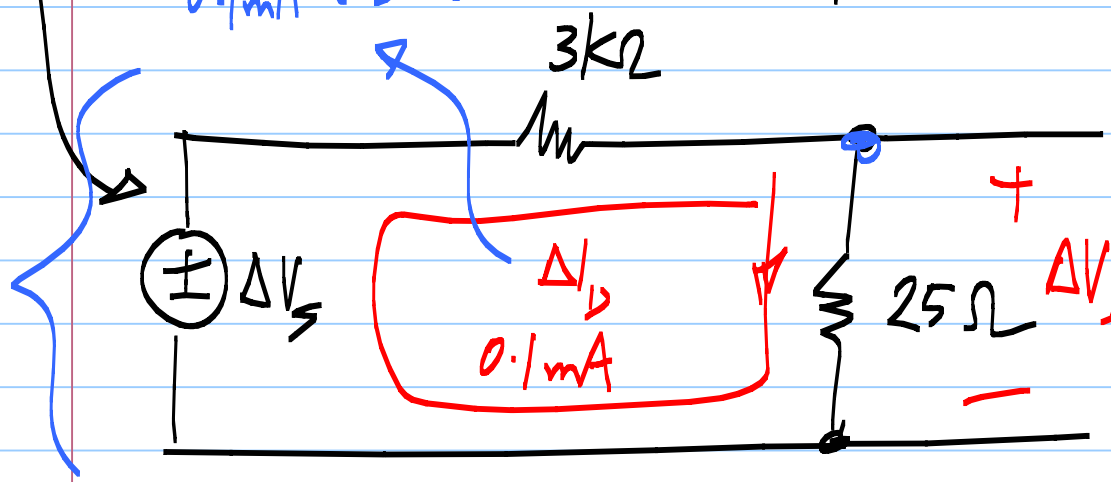


$$V_D = \frac{V_t}{I_S \exp\left(\frac{V_D}{V_t}\right)} = \frac{V_t}{I_D}$$

$700\,mV + 2.5\,mV\cos\omega t$

$$I_D = I_S\left[\exp\left(\frac{V_D}{V_t}\right) - 1\right]$$

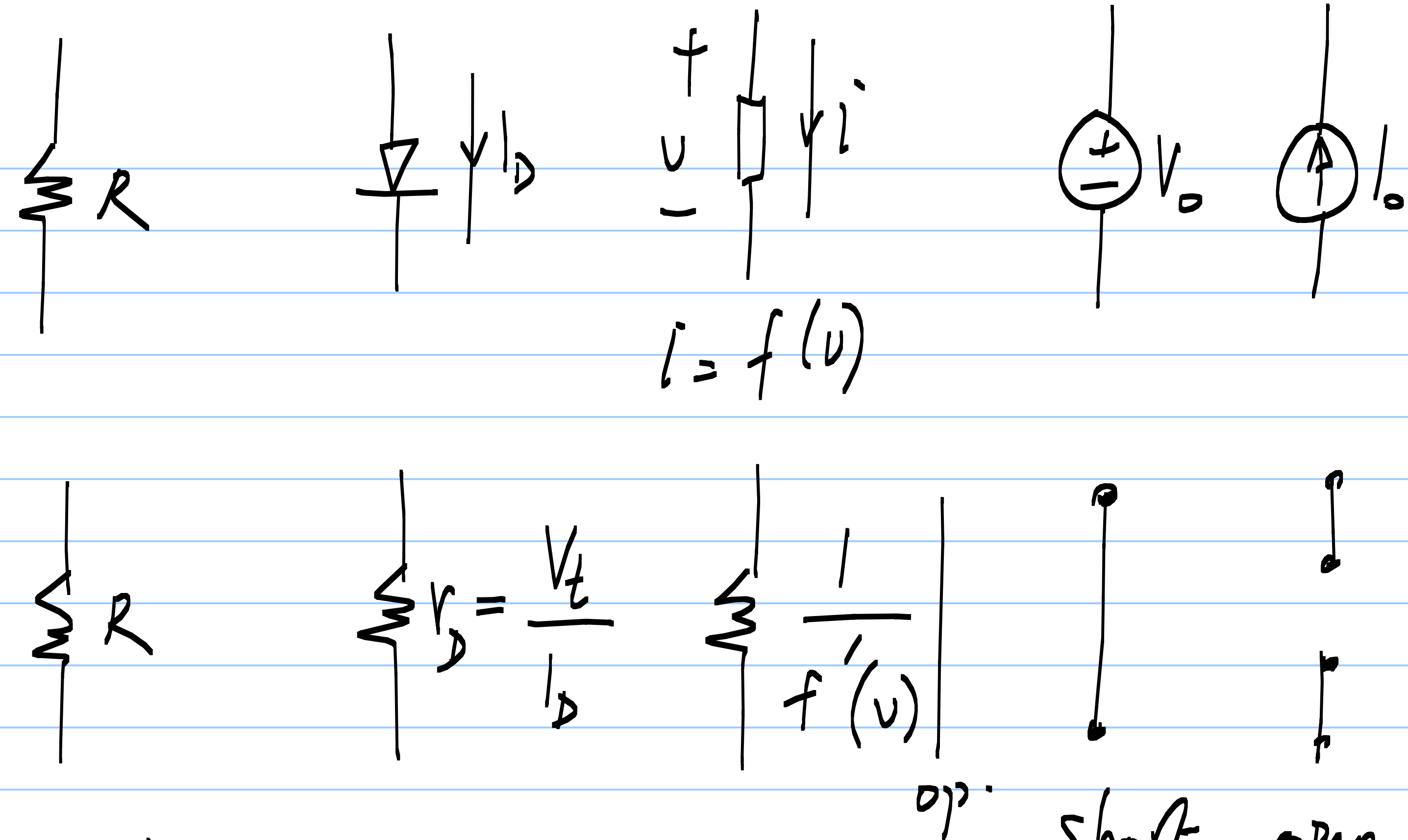


$$300\,mV \cdot \frac{25\,\Omega}{3025\,\Omega} \approx 3000\,\Omega$$

$2.5\,mV\cos\omega t$

Element

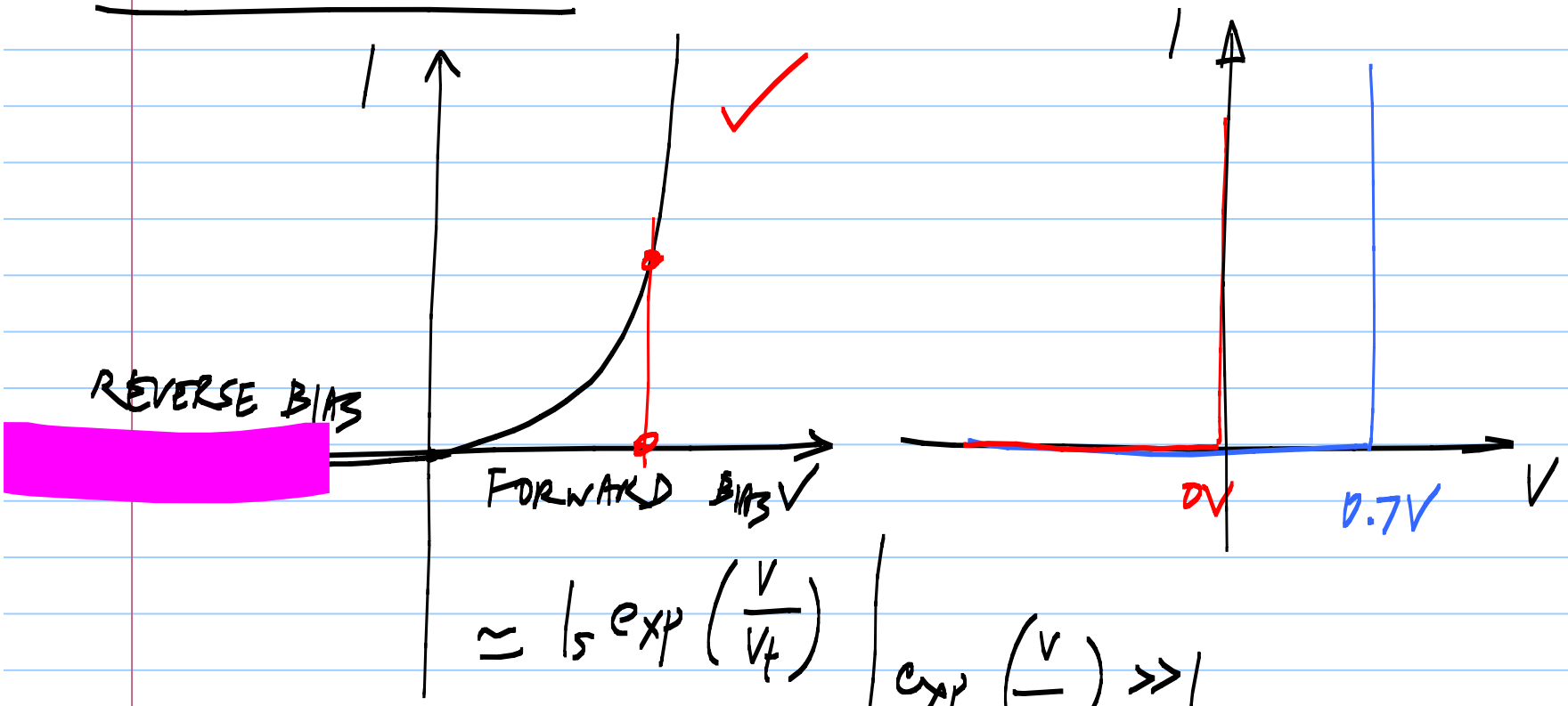
Incr. eq. circuit



operating pt. ≡ bias point

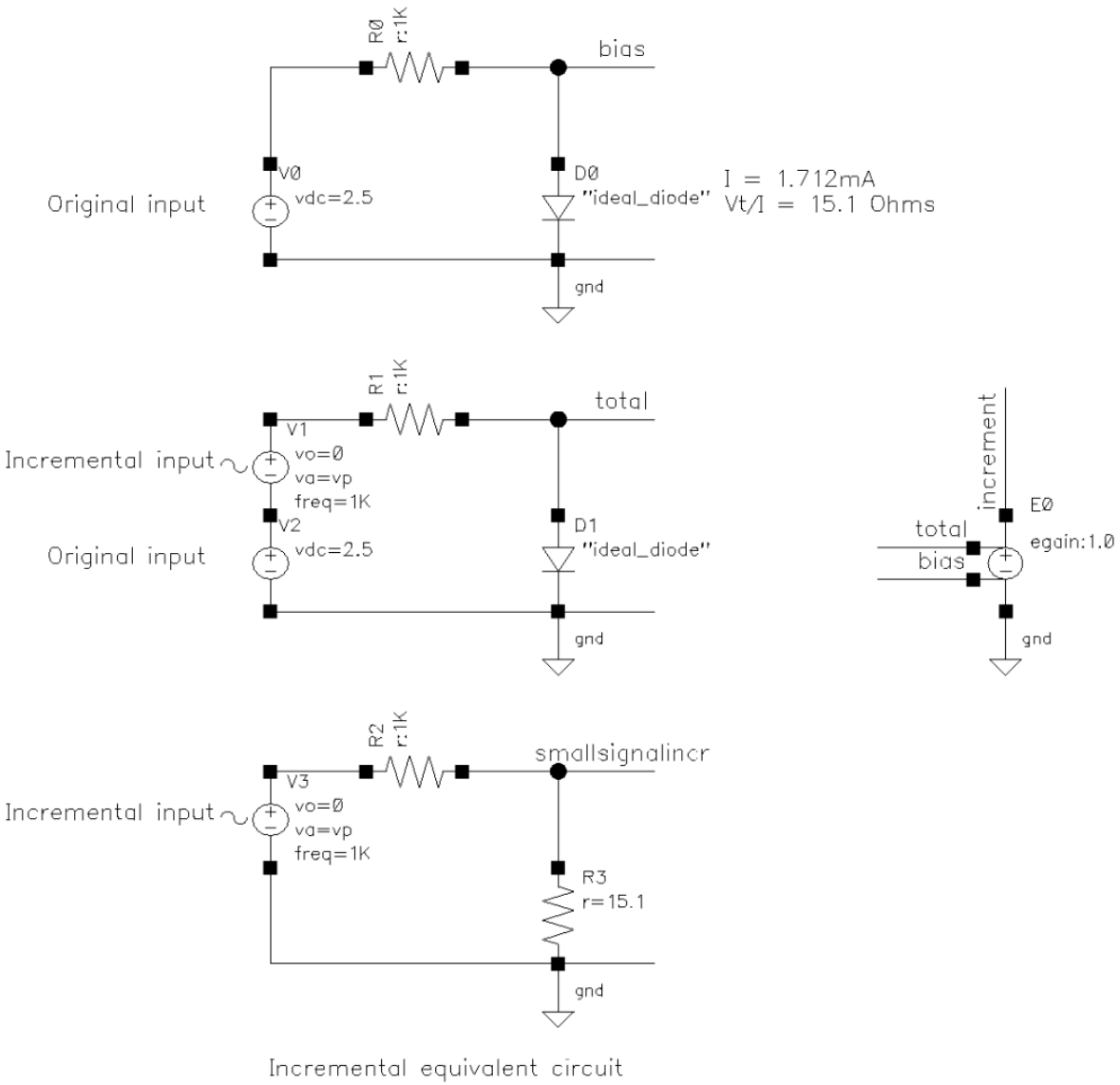
Diode model

$V = 0.7V$



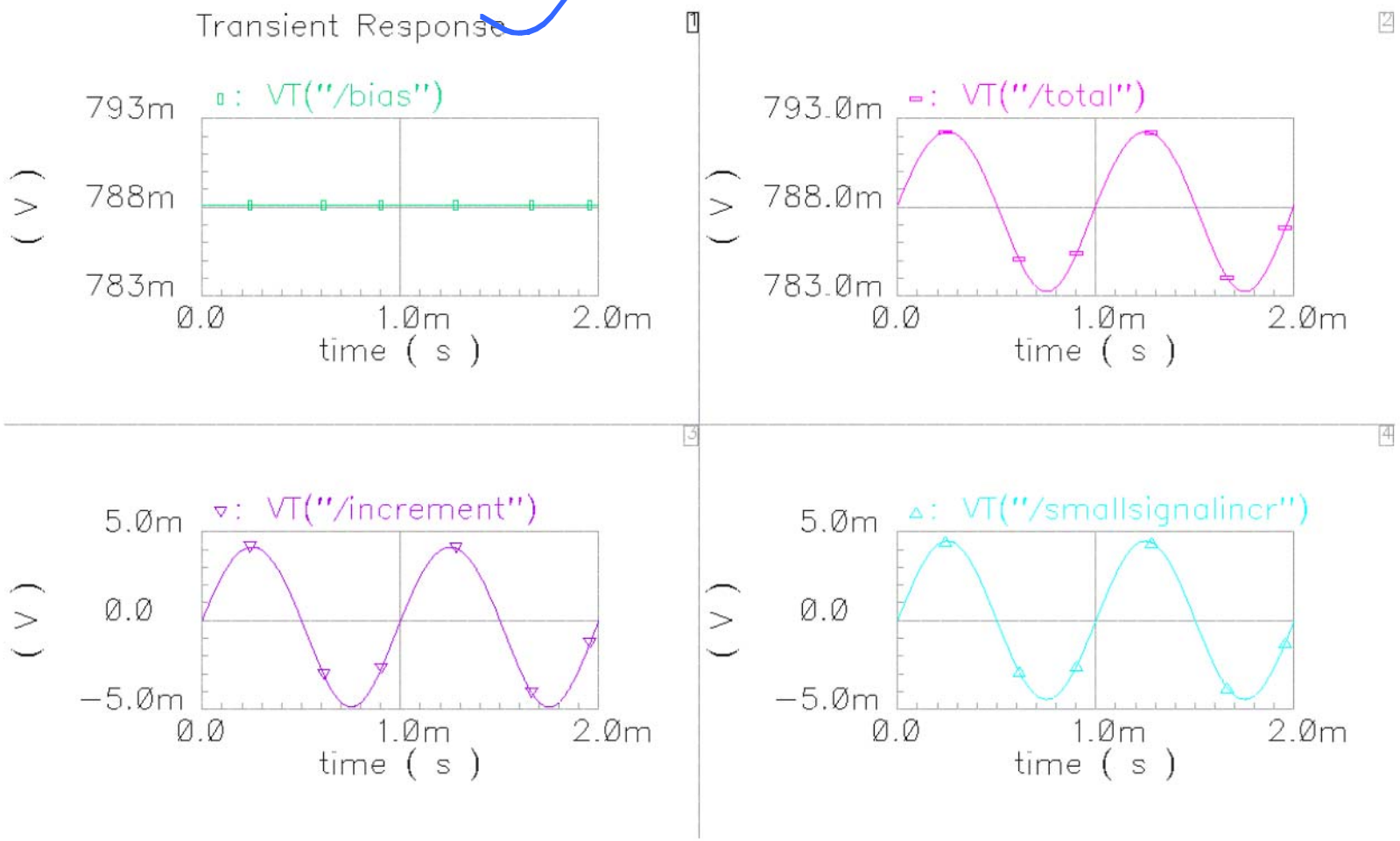
$$I = I_S\left[\exp\left(\frac{V}{V_t}\right) - 1\right]$$

$$\simeq I_S \exp\left(\frac{V}{V_t}\right) \quad \left| \exp\left(\frac{V}{V_t}\right) \gg 1 \right.$$

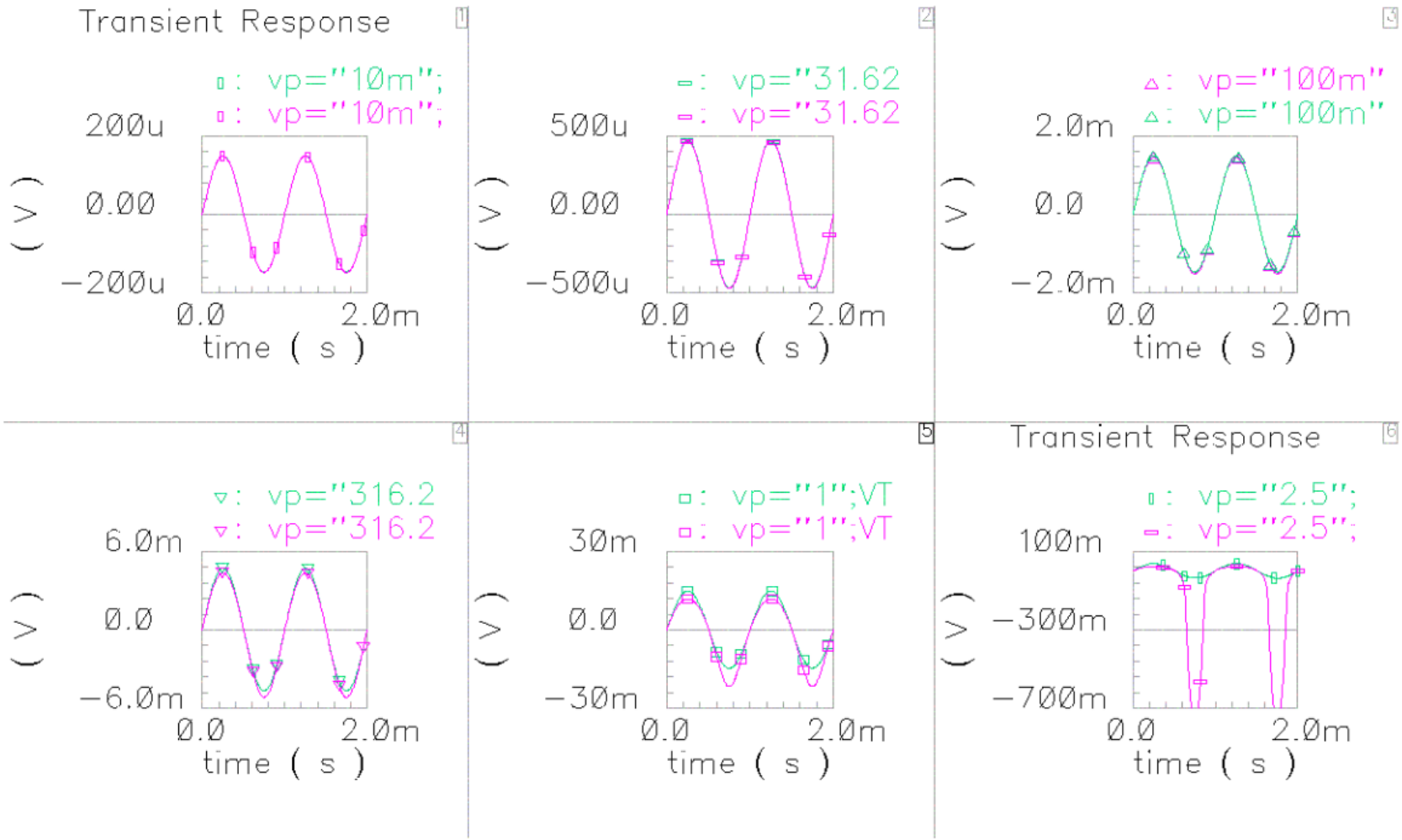


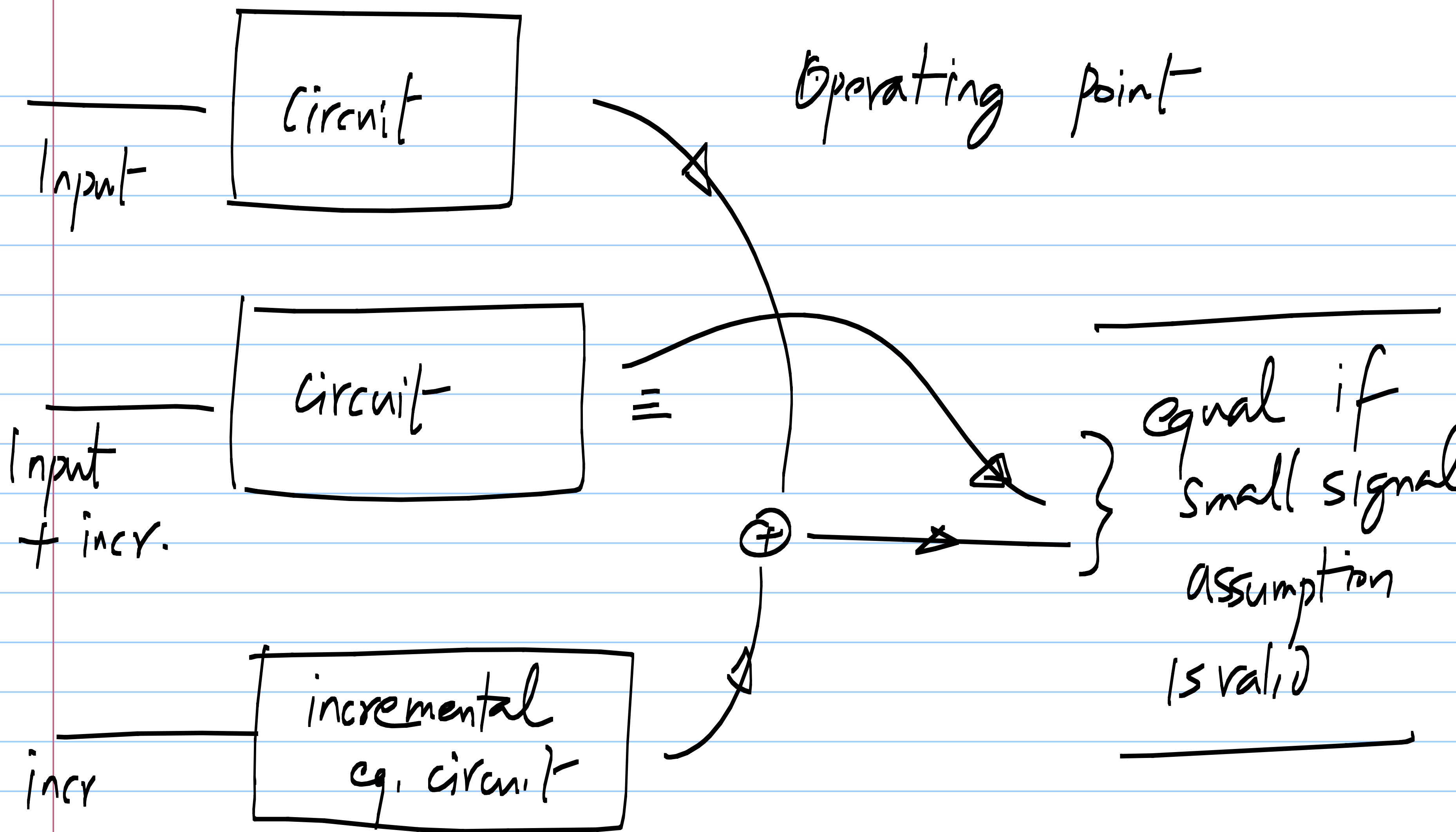
Incremental equivalent circuit

300mV increment in the input source

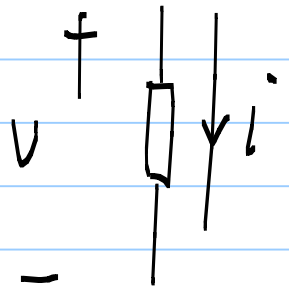


nkec201 smallsignaltest schematic : Overlaid Results

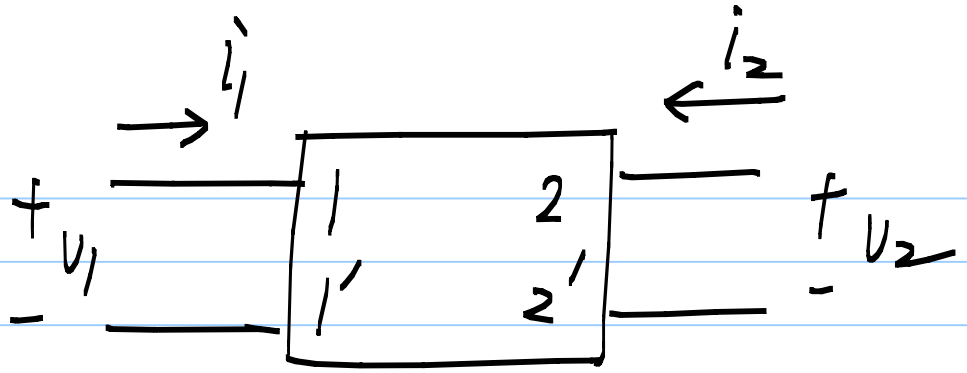




Input
Circuit
Operating point
Input + incr.
Circuit
≡
incr
incremental eq. circuit
+
equal if small signal assumption is valid



$i = f(v)$



$$i_1 = y_{11} v_1 + y_{12} v_2$$

$$i_2 = y_{21} v_1 + y_{22} v_2$$

$$i_1 = f_1(v_1, v_2)$$

$$i_2 = f_2(v_1, v_2)$$

$$I_1 = f_1(V_1, V_2) \;\Rightarrow\; \cancel{I_1} + \Delta I_1 = f_1(V_1 + \Delta V_1,\ V_2 + \Delta V_2)$$

$$I_2 = f_2(V_1, V_2) \;\Rightarrow\; \cancel{I_2} + \Delta I_2 = f_2(V_1 + \Delta V_1,\ V_2 + \Delta V_2)$$

$$\cancel{f_1(V_1, V_2)} + \left.\frac{\partial f_1}{\partial V_1}\right|_{op} \cdot \Delta V_1 + \left.\frac{\partial f_1}{\partial V_2}\right|_{op} \Delta V_2 + \text{higher order terms}$$

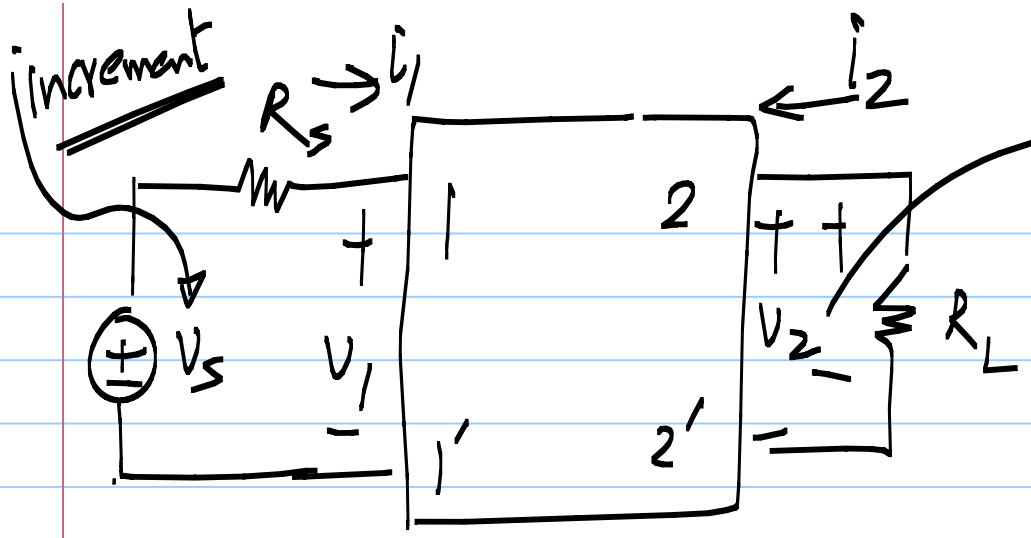
$$\cancel{f_2(V_1, V_2)} + \left.\frac{\partial f_2}{\partial V_1}\right|_{op} \Delta V_1 + \left.\frac{\partial f_2}{\partial V_2}\right|_{op} \Delta V_2 + \text{higher order terms}$$

$$\Delta I_1 = \left\{ \frac{\partial f_1}{\partial V_1}\bigg|_{op} \right\} \cdot \Delta V_1 + \frac{\partial f_1}{\partial V_2}\bigg|_{op} \Delta V_2$$

$$\Delta I_2 = \frac{\partial f_2}{\partial V_1}\bigg|_{op} \cdot \Delta V_1 + \frac{\partial f_2}{\partial V_2}\bigg|_{op} \cdot \Delta V_2$$

Incremental y-parameters of the nonlinear 2-port

$$y_{11} = \frac{\partial f_1}{\partial V_1}\bigg|_{op} \cdot \quad y_{12} = \frac{\partial f_1}{\partial V_2}\bigg|_{op} \cdot \quad y_{21} = \frac{\partial f_2}{\partial V_1}\bigg|_{op} \cdot \quad y_{22} = \frac{\partial f_2}{\partial V_2}\bigg|_{op} \cdot$$



incr. y parameters

$$\begin{bmatrix} y_{11} & y_{12} \\ y_{21} & y_{22} \end{bmatrix}$$

$$i_1 = y_{11} v_1 + y_{12} v_2$$

$$i_2 = y_{21} v_1 + y_{22} v_2$$

$$v_s = i_1 R_s + v_1$$

$$v_2 = -i_2 R_L$$