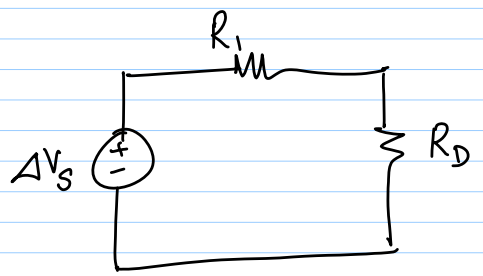
24/2/15

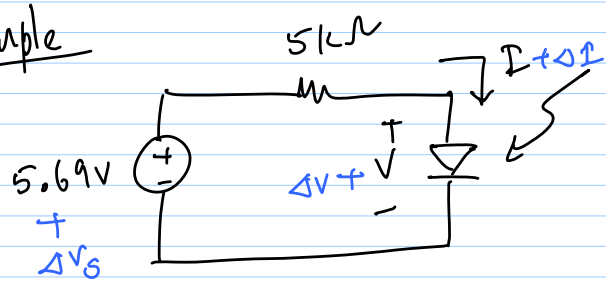
lec 19



Incremental equivalent ckt

$$R_D = \frac{1}{f'(v)\Big|_{V_0}}$$

example



$I_S = 10^{-15} A$

$T = 300K$

$V = 0.69V$

$I = 1mA$

I	V
100μA	630mV
1mA	690mV
10mA	750mV

$$R_D = \frac{1}{f'(v)\Big|_{V_0}}$$

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

$$I_0 = I_S\left[\exp\left(\frac{V_0}{V_t}\right) - 1\right] \simeq I_S \exp\left(\frac{V_0}{V_t}\right)$$

$$f'(V) = \frac{I_S}{V_t}\exp\left(\frac{V}{V_t}\right)$$

$$R_D = \frac{1}{f'\Big|_{V_0}} = \frac{V_t}{I_S \exp\left(\frac{V_0}{V_t}\right)} \simeq \frac{V_t}{I_0}$$

$$\boxed{R_D = \frac{V_t}{I_0}}$$

here $R_D = \frac{25mV}{1mA} = 25\Omega$

$$\Delta I = \frac{\Delta V_S}{5.025k\Omega}$$

$$\Delta V = \Delta I \cdot 25$$

"incremental" or "small-signal" analysis

* Incremental Ckt

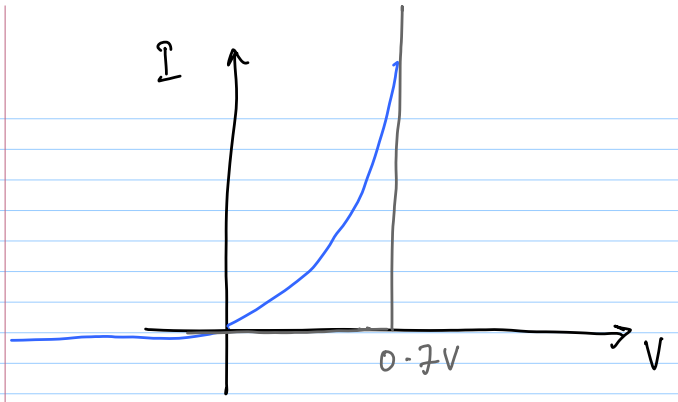
→ has the same graph as orig. ckt

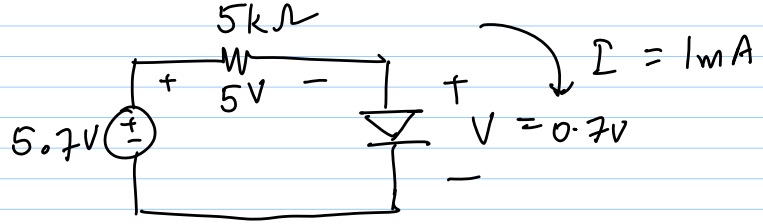
→ branch voltages $= \Delta V_k$
branch currents $= \Delta I_k$

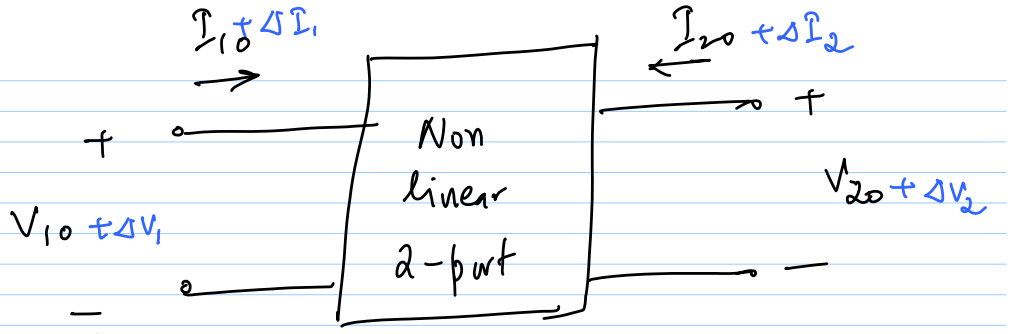
→ Linear elements remain the same

→ independent sources replaced with source of same type;
value = increment/change in value

→ Nonlinear elements: replace with resistance of value $r = \frac{1}{f'(v)}$
$\{\Delta V_k = r\Delta I_k\}$







Incremental y-parameters

$$I_1 = f_1(V_1, V_2); \quad I_2 = f_2(V_1, V_2)$$

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

$$+\Delta I_2 = \left.\frac{\partial f_2}{\partial V_1}\right|_{Op} \cdot \Delta V_1 + \left.\frac{\partial f_2}{\partial V_2}\right|_{Op} \cdot \Delta V_2$$

$$\Delta I_1 = y_{11} \Delta V_1 + y_{12} \Delta V_2$$

$$\Delta I_2 = y_{21} \Delta V_1 + y_{22} \Delta V_2$$