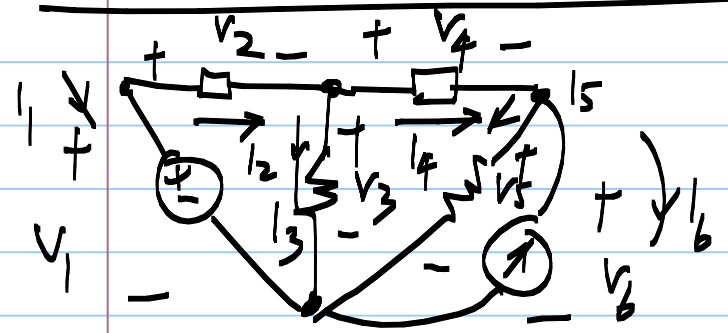
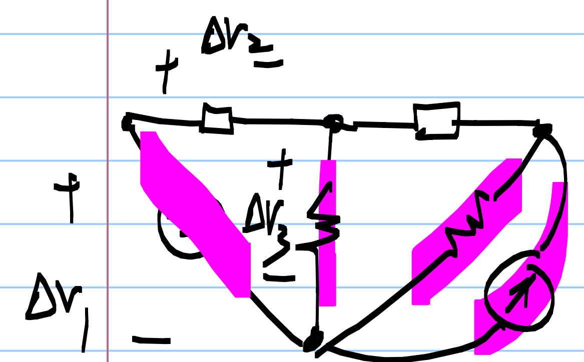
EC 1010: Lecture 19





$$\frac{v_k}{i_k} = R_k$$

$$\frac{\Delta v_k}{\Delta i_k} = R_k$$

Newton-Raphson / Fixed point iteration / Bisection

* Nodal analysis / MNA : Nonlinear equations (circuit analysis)

$$[G]\,\underline{v} = \underline{I}_s + \underline{\Delta I_s}$$

$$\underline{h}(\underline{v}) = \underline{I}_s + \underline{\Delta I_s}$$

Solve nonlinear equations

Solution: V_{k_0}, I_{k_0} operating point

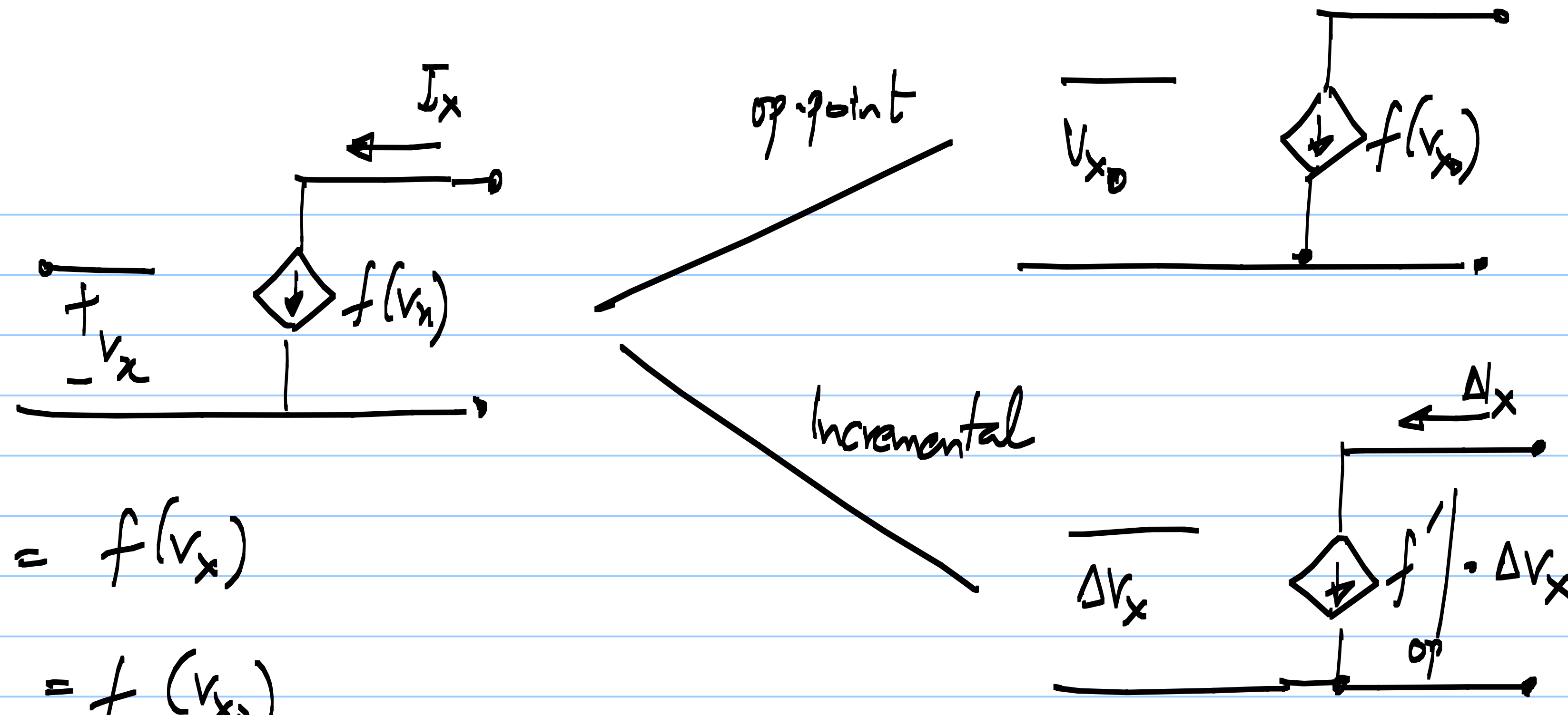
* Changed input $V_k = V_{k_0} + \Delta v_k$

$i_k = i_{k_0} + \Delta i_k$

* **Incremental equivalent circuit**: circuit with the same graph as the original. Branch voltages: ΔV_k
currents: ΔI_k

- Linear elements: remain the same
- Independent sources: replaced by source of the same type & value = change in value
- Nonlinear elements: For small increments, relationship (between ΔV_k & ΔI_k is linear → replaced by resistances) $\Delta I_k = f'\big|_{V_0} \cdot \Delta V_k$

$I = f(V)$

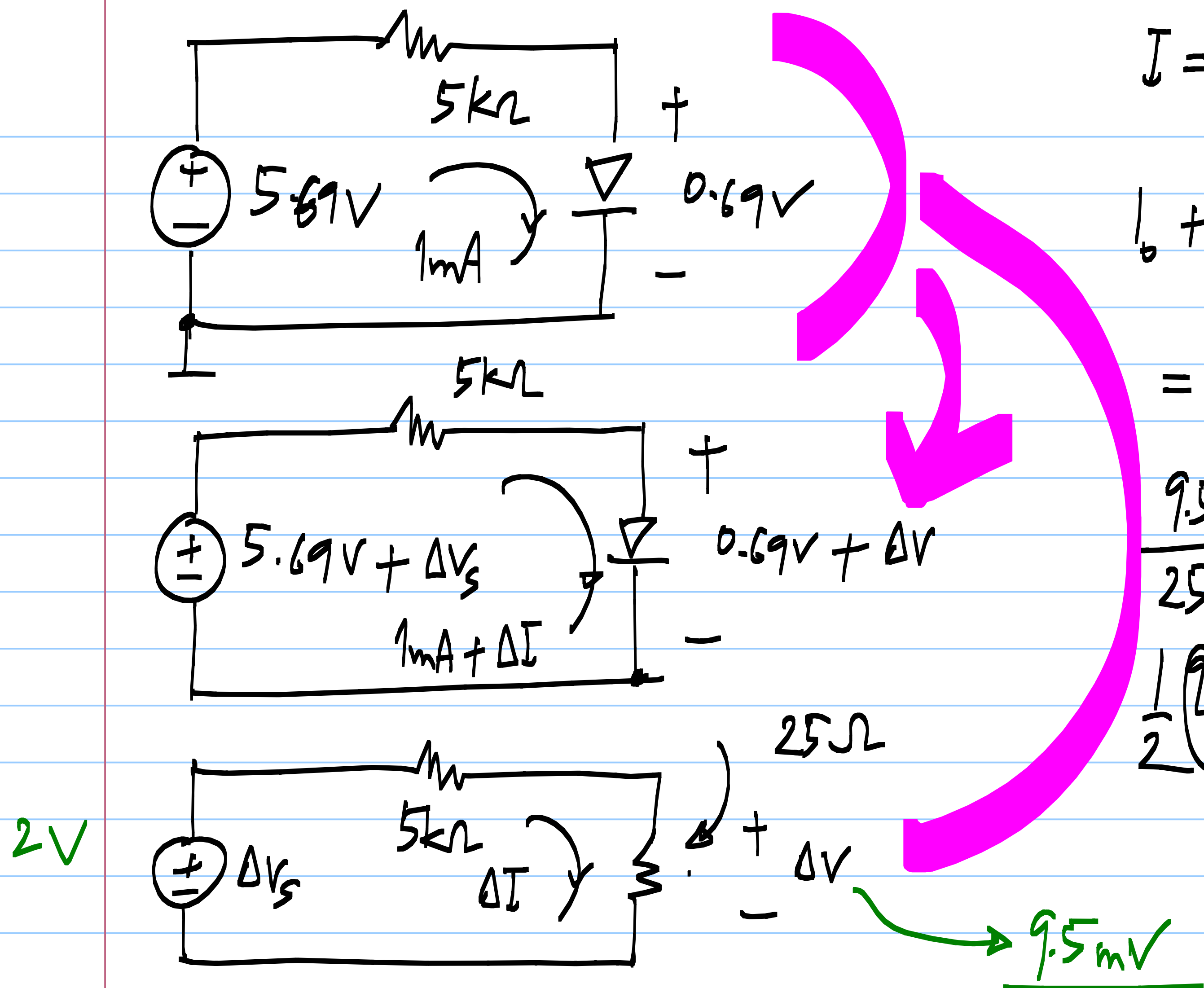


$$I_x = f(v_x)$$

$$I_{x_0} = f(V_{x_0})$$

$$I_{x_0} + \Delta I_x = f(V_{x_0} + \Delta v_x)$$

$$\simeq f(V_{x_0}) + f'\big|_{V_{x_0}} \cdot \Delta v_x + \ldots$$



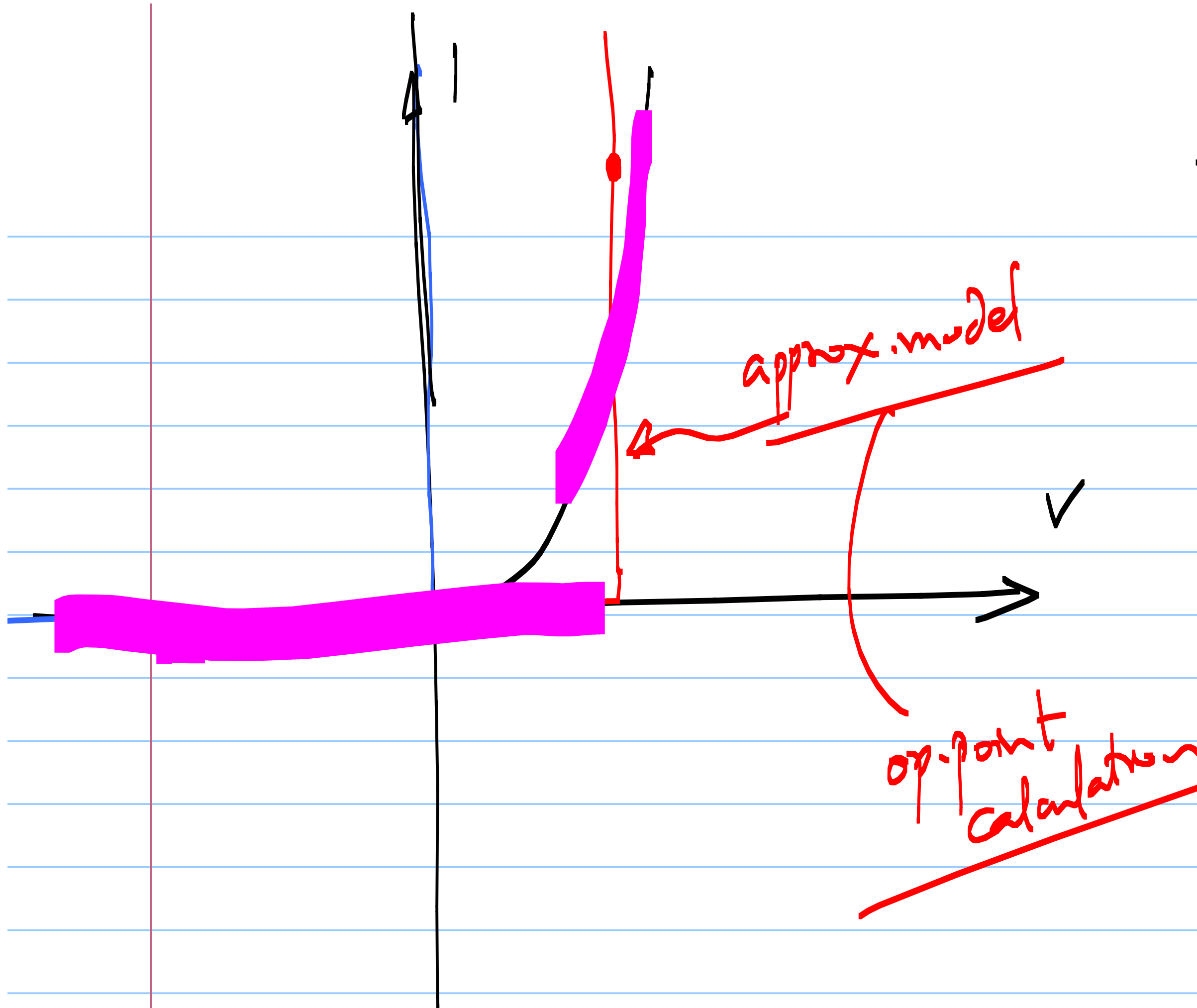
$$I = I_s \exp\left(\frac{V}{V_t}\right)$$

$$I_0 + \Delta I = I_s \exp\left(\frac{V_0 + \Delta V}{V_t}\right)$$

$$= I_s \exp\left(\frac{V_0}{V_t}\right)\left[1 + \frac{\Delta V}{V_t} + \frac{1}{2!}\left(\frac{\Delta V}{V_t}\right)^2 + \frac{1}{3!}\left(\frac{\Delta V}{V_t}\right)^3 + \ldots\right]$$

$$\frac{9.5}{25}$$

$$\frac{1}{2}\left(\frac{9.5}{25}\right)^2$$



$I_s = 10^{-15} A$

I	V
100μA	630mV ✓
1mA	690mV ✓
10mA	750mV ✓

≃ 0.7V