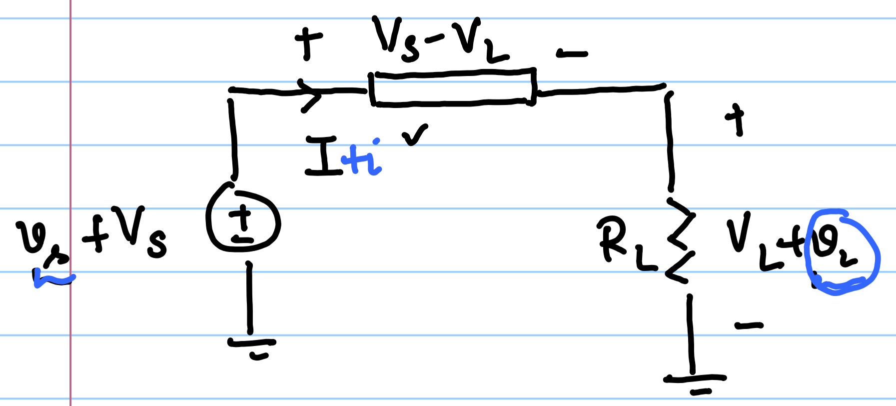
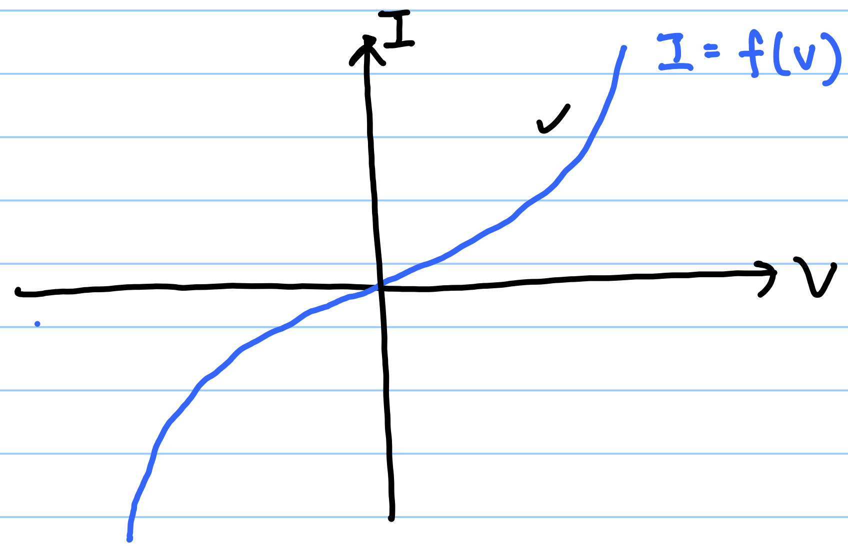
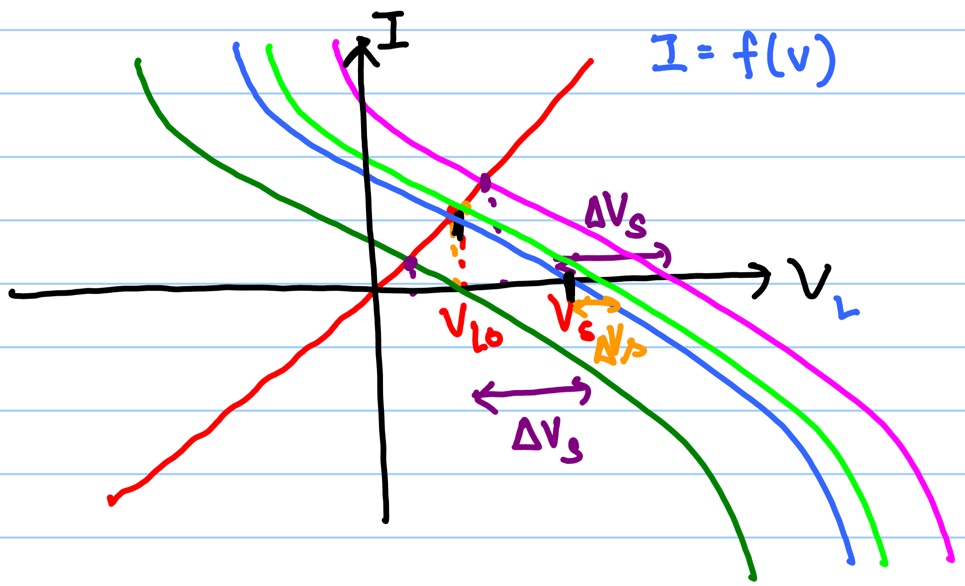
Note Title 05-08-2021

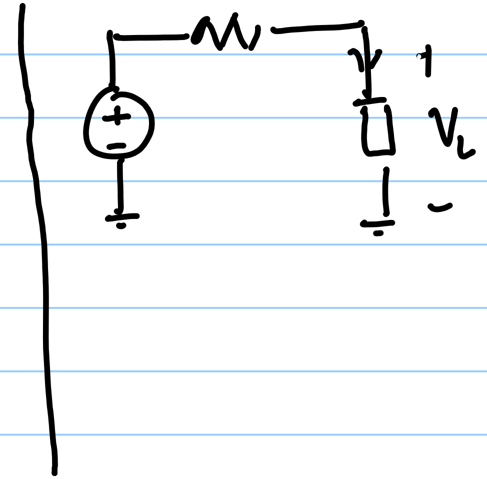
Lecture # 02







$$I = f(V_s - V_L) = \frac{V_L}{R_L}$$



$$I_0 = f(V_s - V_L) = f(V_{s0} - V_{L0}) = \frac{V_{L0}}{R_L}$$

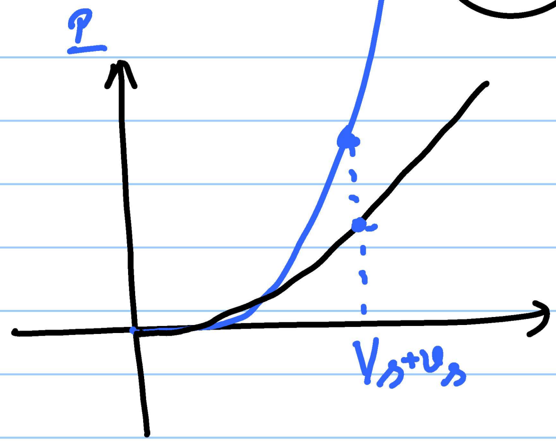
$V_s : V_{s0} \rightarrow V_{s0} + v_s \longrightarrow V_L : V_{L0} \rightarrow V_{L0} + v_L$

$$I = f(V_{s0} + v_s - V_{L0} - v_L) = f(\underline{V_{s0} - V_{L0}} + \underline{v_s - v_L})$$

$$I_0 + i = f(V_{s0} - V_{L0}) + f'(V_{s0} - V_{L0})(v_s - v_L) + f''(V_{s0} - V_{L0}) \cdot \frac{(v_s - v_L)^2}{2!} + \dots$$

$$\frac{v_L}{R_L} = i = f'(V_{s0} - V_{L0})(v_s - v_L) + f''(V_{s0} - V_{L0}) \frac{(v_s - v_L)^2}{2!} + f'''(\quad) \frac{(\quad)^3}{3!} + \dots$$

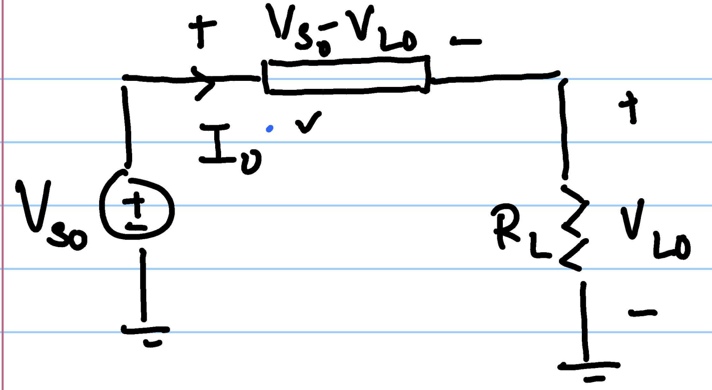
$$\text{If. } \sum_{k \geq 2} f^k(V_{s0} - V_{L0}) \frac{(v_s - v_L)^k}{k!} \ll f'(V_{s0} - V_{L0})(v_s - v_L)$$



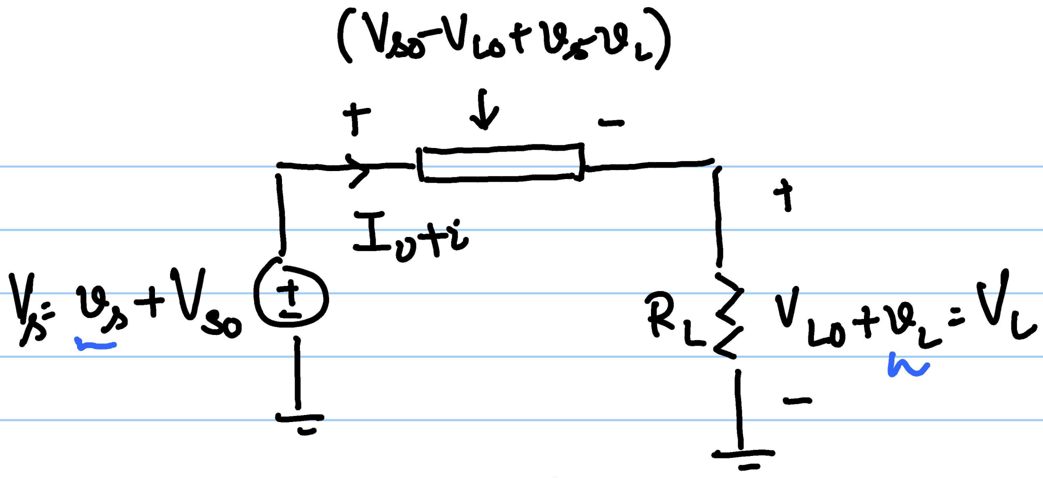
$$i = \frac{v_L}{R_L} \approx f'(V_{s0} - V_{L0})(v_s - v_L)$$

$$\frac{v_L}{R_L} = \frac{v_s - v_L}{\underbrace{1 / f'(V_{s0} - V_{L0})}} = \frac{v_s - v_L}{R_n}$$

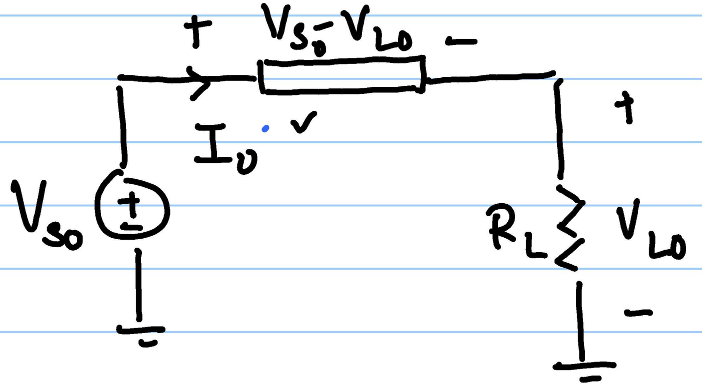
$$\Rightarrow \boxed{v_L = \frac{R_L}{R_L + R_n} v_s} \quad \text{for } V_s = V_{s0},\ V_L = V_{L0}$$



#1



#2



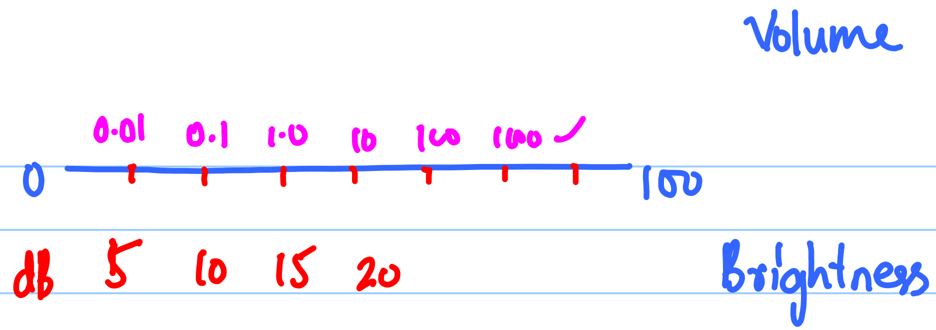
Non-linear Analysis

+

linear Ckt. Analysis

$$R_n = \frac{1}{f'(V_{so} - V_{Lo})}$$

v ~~x =~~ mV



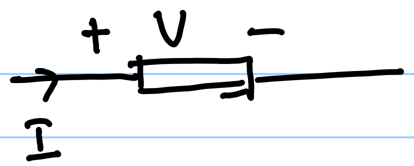
- Small changes in i/p at given operating condition.
- V_{so} , V_{Lo} : operating points
  bias condition.

- v_s, v_L, i are small signals

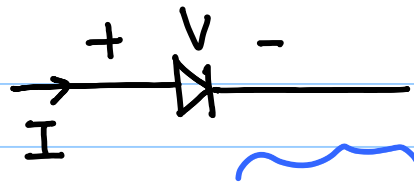
Given a non-linear element

- Non-linear analysis to get operating points (V, I)
- linearise non-linear elements using first derivative for I-V relationship. Eg: $I = f(v) = a_1 v + a_2 v^2 + \ldots$
- Replace non-linear element with their linear counterpart.
- Analyze new ckt. for small changes in the i/p.

"Diode"



$I = f(V)$



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