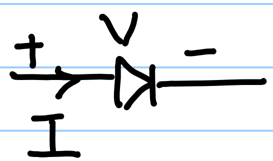
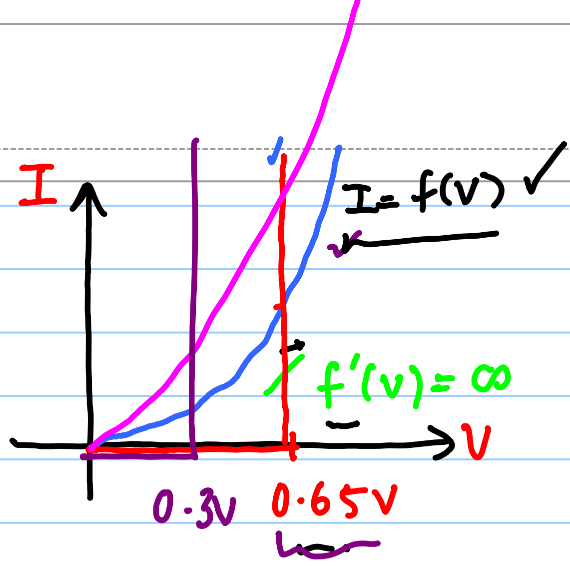
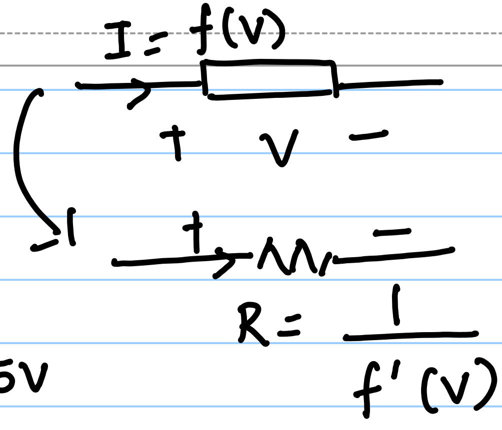
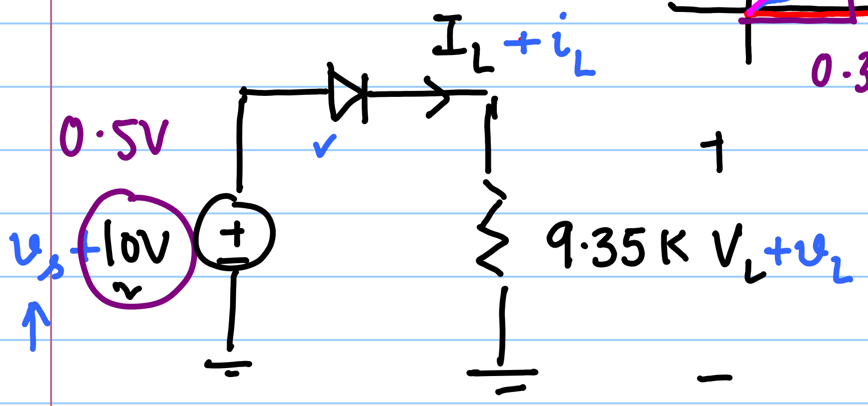
Note Title — 10-08-2021

Lecture # 04

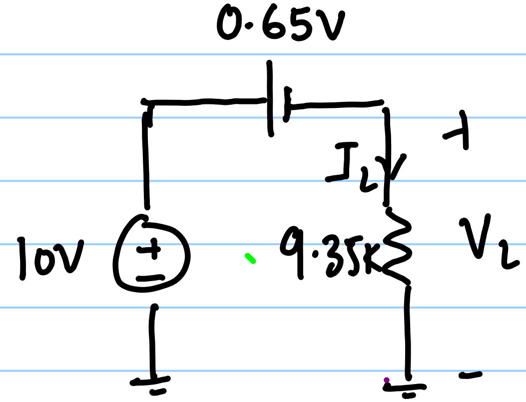








$\Rightarrow$



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

$$V_L = 9.35V$$

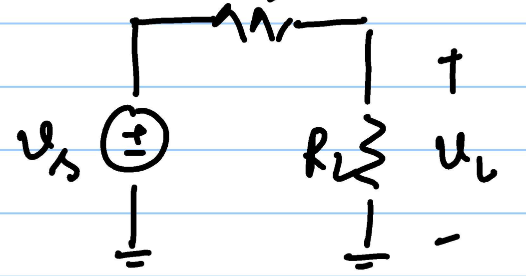
$$I_L = \frac{9.35V}{9.35K} = 1mA$$

$$f'(V) = \frac{dI}{dV} = \frac{I_s \exp\left(\frac{V}{V_T}\right)}{V_T}$$

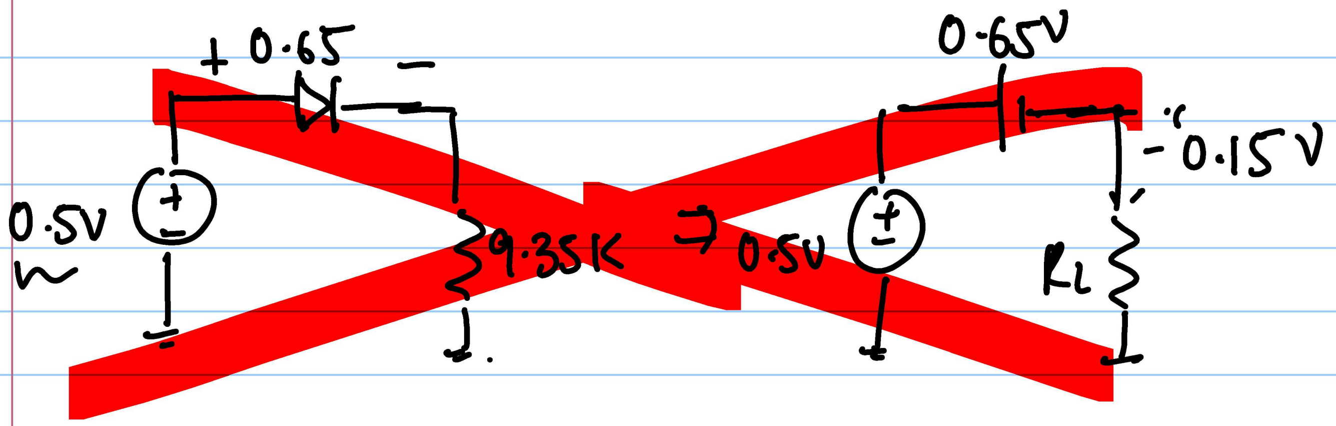
$$f'(V) = \frac{I_s \exp(V/V_T)}{V_T} = \frac{I + I_s}{V_T} \approx \frac{I}{V_T}$$

$$f'(V) = \frac{I}{V_T} = \frac{1mA}{25mV} = \frac{1}{25}$$

$R_D = 1/f'(v) = 25\Omega$

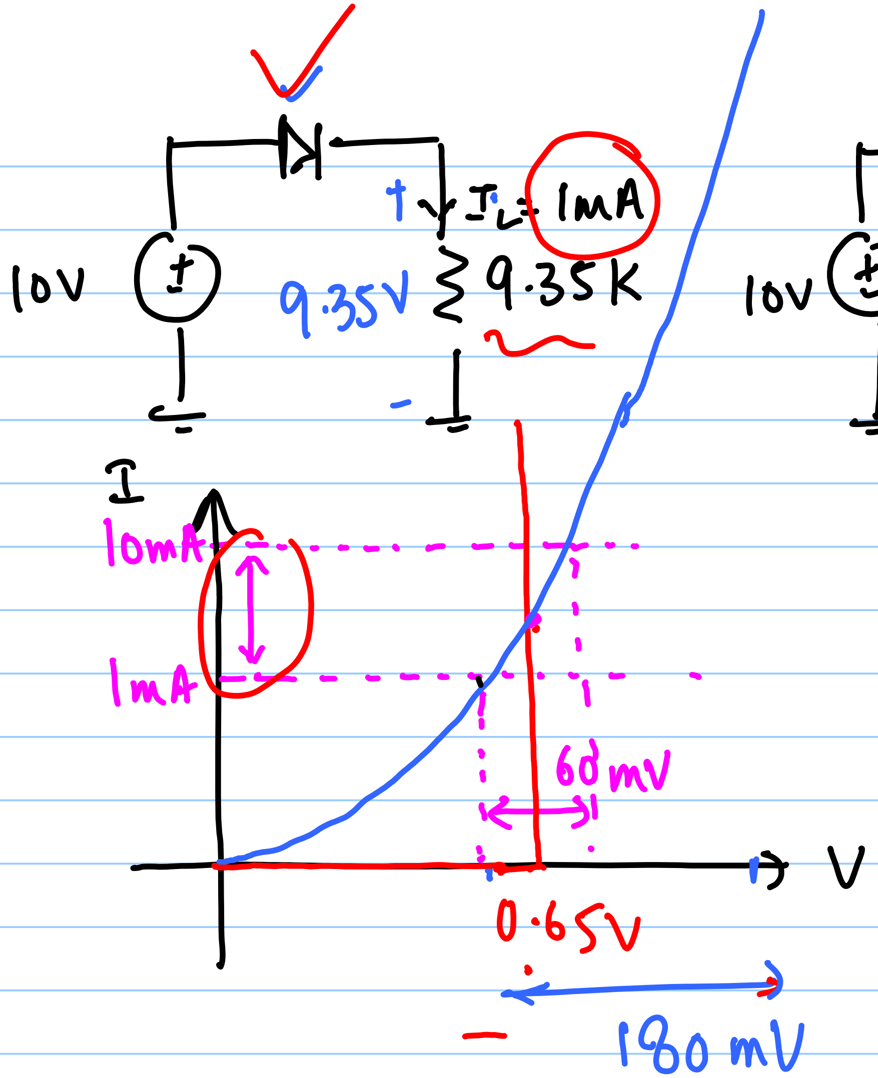


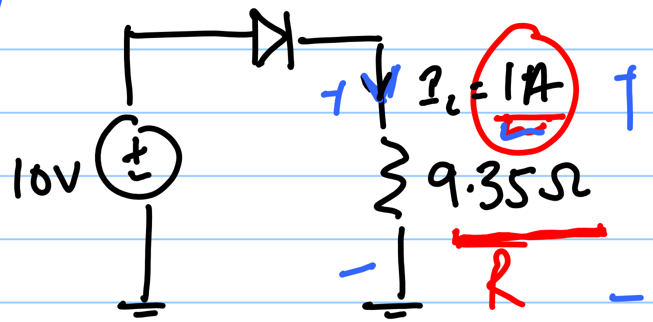
$$\frac{v_L}{v_s} = \frac{R_L}{R_L + R_D} = \frac{9.35K}{9.35K + 25\Omega} \approx 1$$



- If zeroth-order approx. is valid at 0.65V, don't use it when input voltage is lesser than 0.65V.
- Diodes in different technology can have different potential drop across them for zeroth-order approx.

$V = V_T \ln\left(\frac{I}{I_S}\right)$





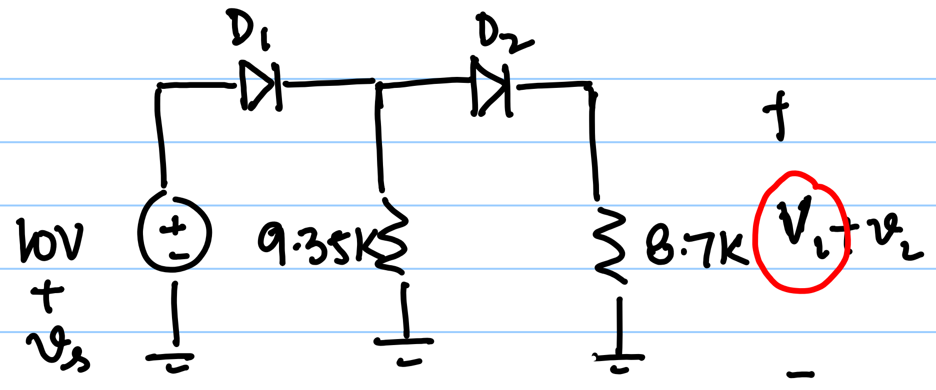
10mA → 100mA → 1A

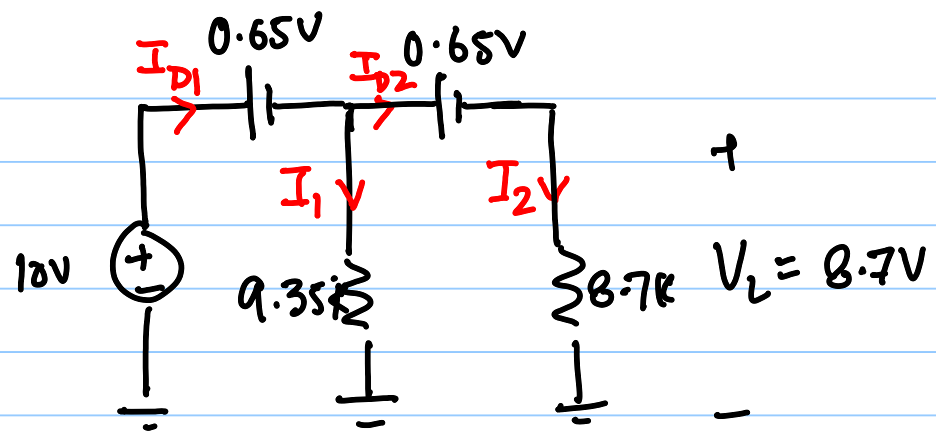
60mV 60mV.

60mV @ 9.35V

180 mV @ 9.35V

- To calculate operating point, use zeroth-order approx.
- To calculate small-signal mode, use actual I Vs V relationship.

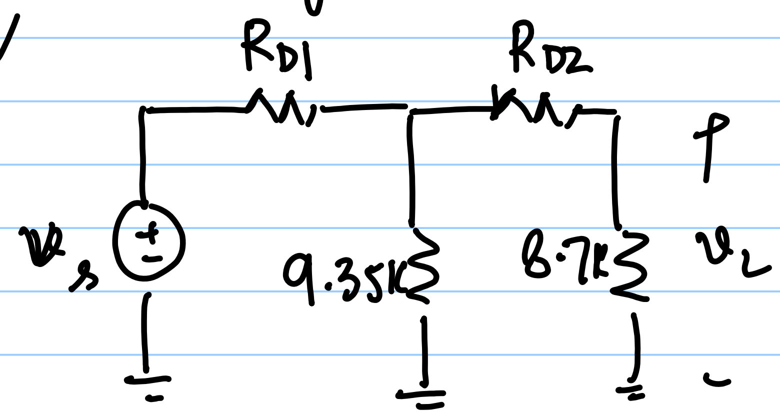




$I_1 = I_2 = 1mA$ ✓

$I_{D2} = I_2 = 1mA$, $I_{D1} = I_1 + I_{D2} = 2mA$ ✓

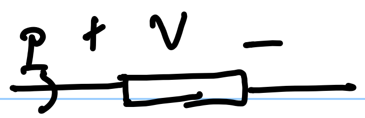
Small-signal Circuit ✓



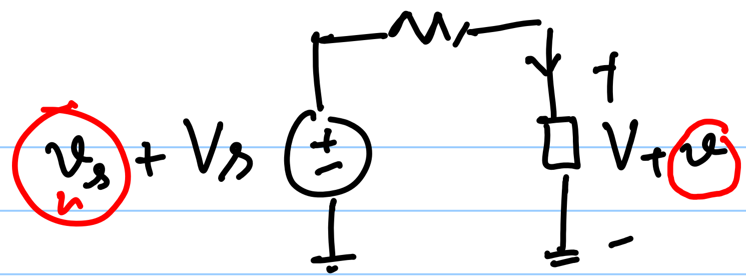
$R_{D1} = \frac{1}{f'(V)} = \frac{25mV}{2mA} = 12.5\Omega$ ✓

$R_{D2} = \frac{25mV}{1mA} = 25\Omega$ ✓

$\frac{v_L}{v_s} =$



$I = f(V)$



$$I + i = f(V + v)$$

$$I + i = f(V) + f'(V)\, v + f''(V) \frac{v^2}{2!} + \ldots$$

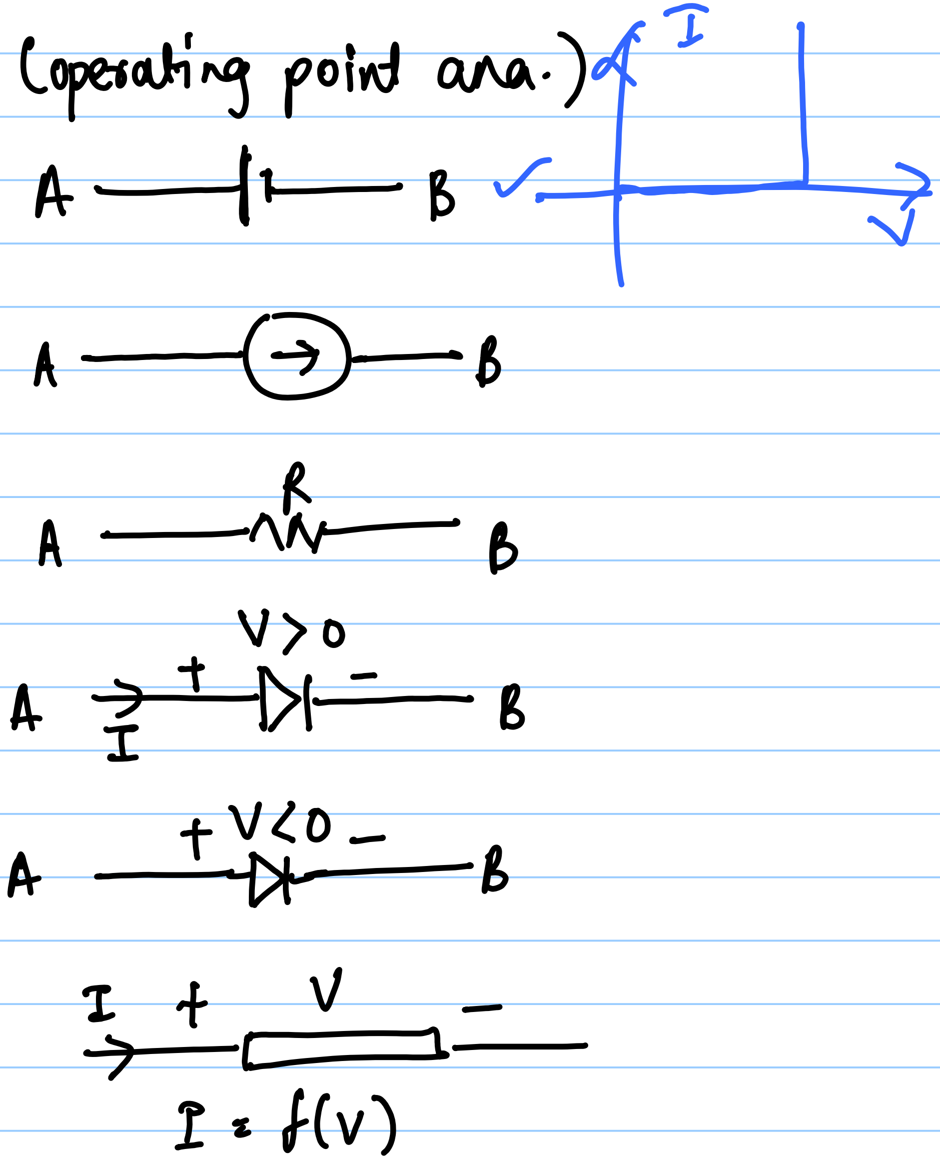
$$i = f'(V)\, v + f''(V) \frac{v^2}{2!} + \ldots$$

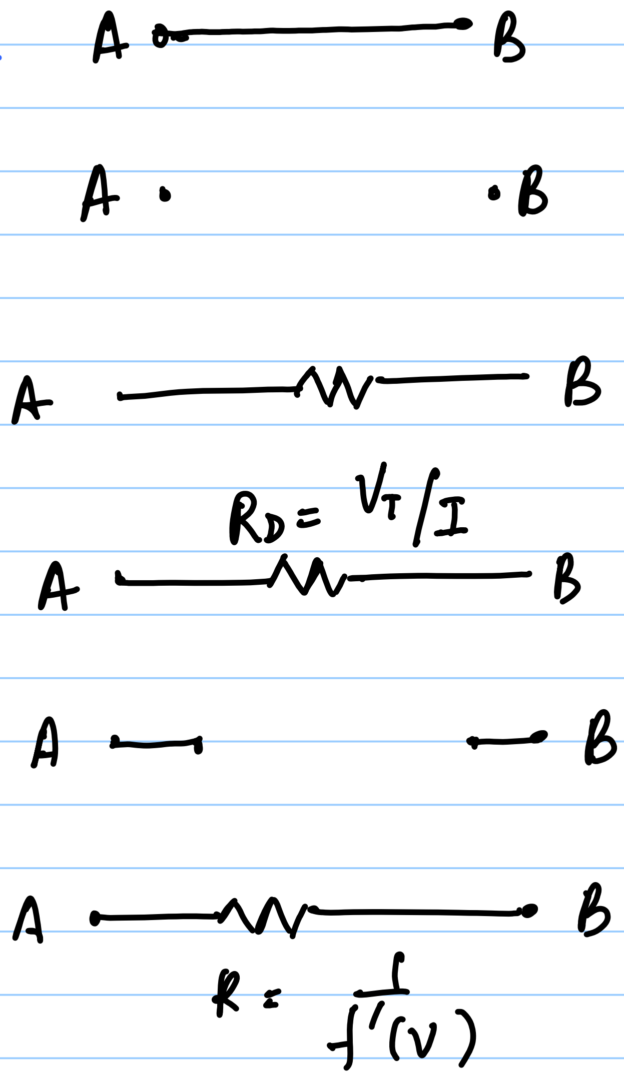
$$i \approx f'(V)\, v$$

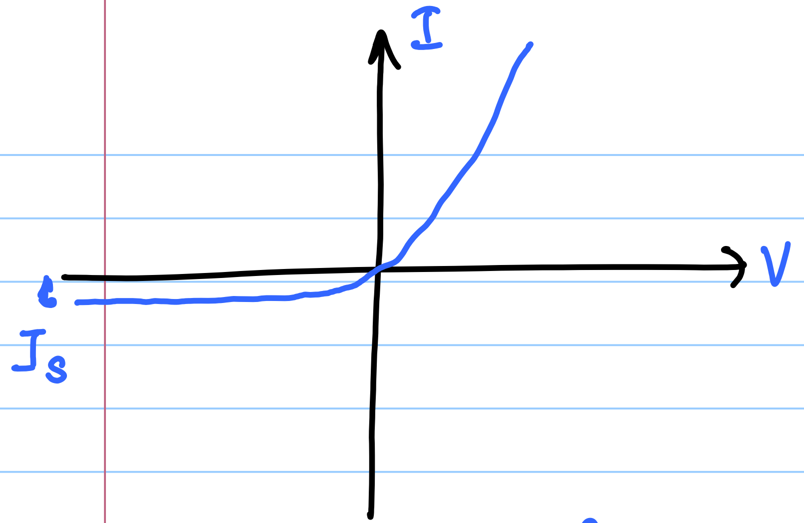
$$\ll f'(V) \cdot v$$

Element in Non-Linear Circuit (operating point ana.)

Circuit for small-signal ana.







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

$I = -I_s$ in reverse bias.