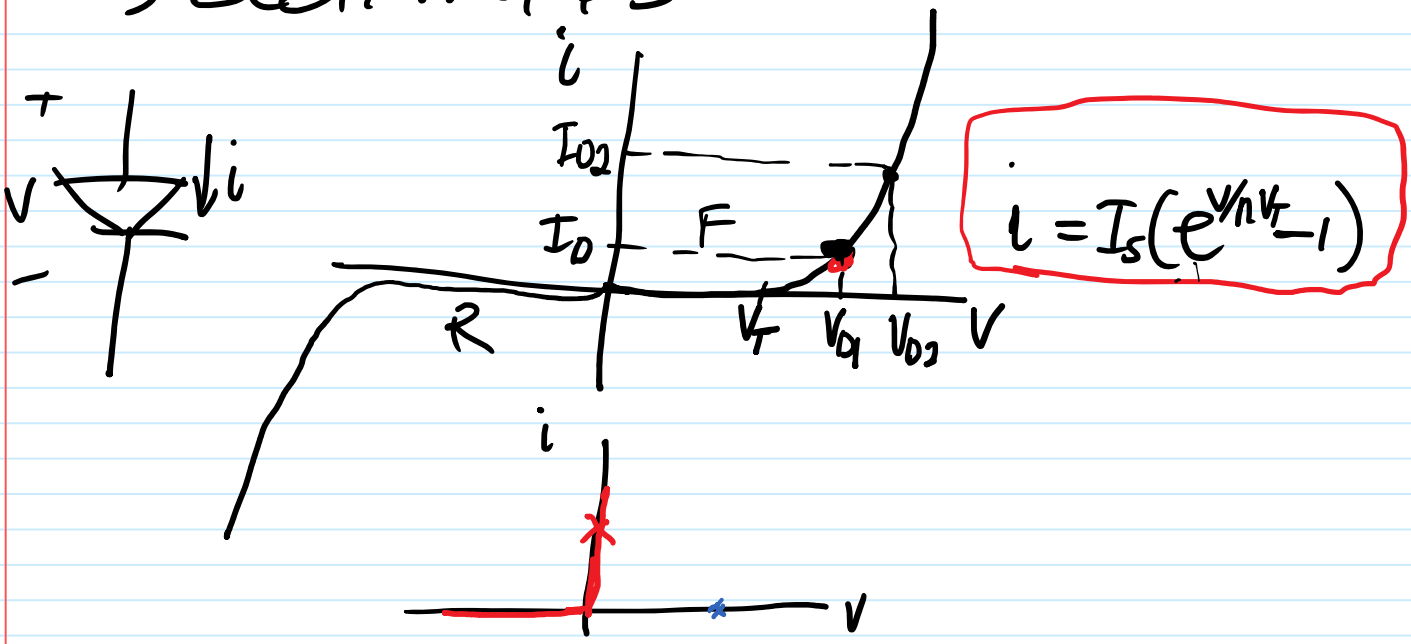
Real Diode Analysis

Wednesday, March 20, 2024 4:09 PM

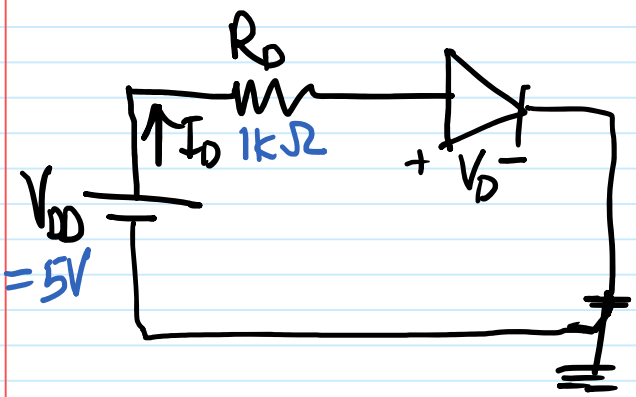
Exam II is on Friday March 29 in class.

→ Section 4 & 5



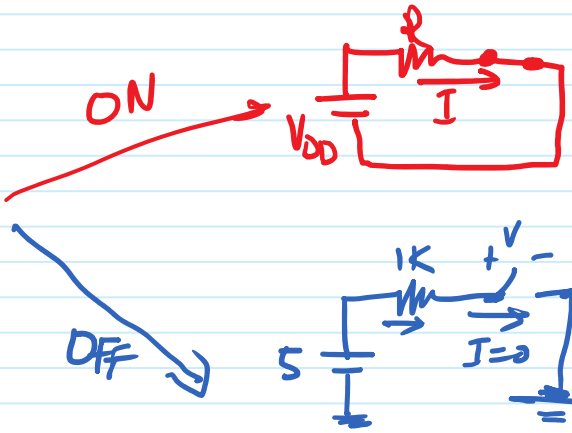
$$i = I_S\left(e^{V/nV_T} - 1\right)$$

$$V_2 - V_1 = nV_T \ln\left(I_2/I_1\right)$$



$$I_{D1} = \frac{V_{DD} - V_{D1}}{R_D} \quad - (1)$$

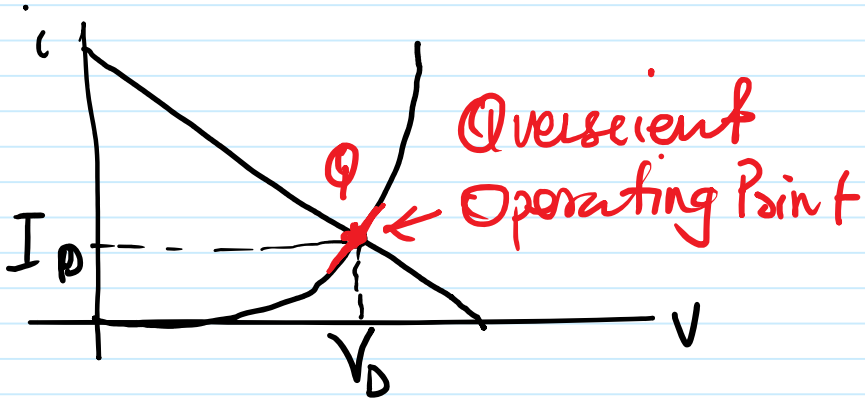
$I = \frac{5-0}{1k} = 5mA$ ≈ ✓ OK



$V = 5 - 0 = 5V$

NOT OK

$V_{D2} - V_{D1} = nV_T \ln\left(I_{D2}/I_{D1}\right)$



Iterative analysis

→ Start with a point on the I-V curve
→ Iterate through I_D and V_D solutions
→ Stop when I_D, V_D stop changing
→ Always use 3 decimal places.

Apply

$I_D, V_D = 1mA, 0.7V$ (1mA diode)

$$I_{D1} = \frac{V_{DD} - V_{D1}}{R_D} = \frac{5 - 0.7}{1K} = 4.300mA.$$

$$V_{D2} = V_{D1} + V_T \ln\left(\frac{I_{D2}}{I_D}\right) = 0.7 + 0.025 \ln\left(\frac{4.3m}{1m}\right)$$

$V_{D2} = 0.7 + 0.036 = 0.736V$

$I_{D2} = 5 - 0.736 = 4.264mA$

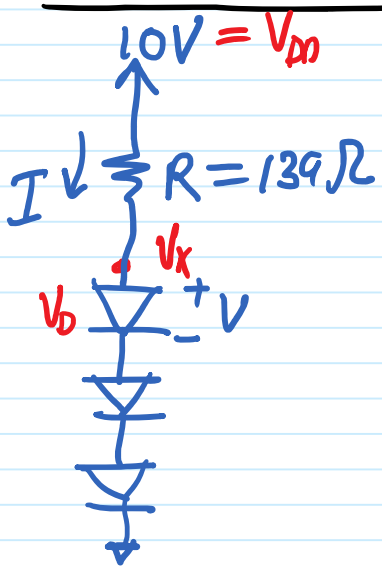
$$I_{D2} = \frac{5 - 0.736}{1K} = 4.264mA$$

$$V_{D3} = 0.7 + 0.025\ln\left(\frac{4.264}{1}\right) = 0.736V$$ Stop!

$$\boxed{I_D, V_D \equiv 4.264mA, 0.736V}$$

Another Example

(1mA, 0.7V)



$$V_2 - V_1 = nV_T\ln(I_2/I_1) \quad (1)$$

$$I = \frac{V_{DD} - V_X}{R} = \frac{V_{DD} - 3V_D}{R}$$

$$I = \frac{10 - 3\times 0.7}{139} = 56.830mA$$

$$V_2 = 0.7 + 0.025\ln\left(\frac{56830}{1}\right) = 0.801V$$

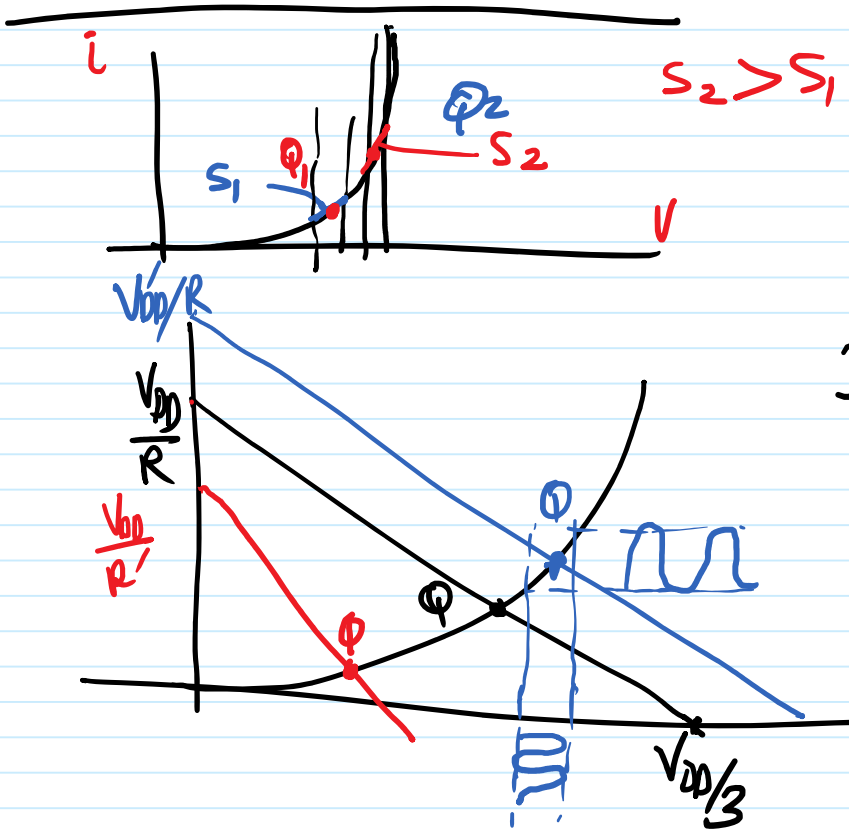
$$I_2 = \frac{10 - 3\times 0.801}{139} = 54.650mA$$

$$V_3 = 0.7 + 0.025\ln\left(\frac{54165}{1}\right) = 0.800V$$

$$I_3 = \frac{10 - 3\times 0.8}{135} = 54.680mA$$

$V_4 = 0.7 + 0.025 \ln(54.68) = 0.800\,V$ = stop

Linearization



$$I = \frac{V_{DD} - 3V_D}{R}$$