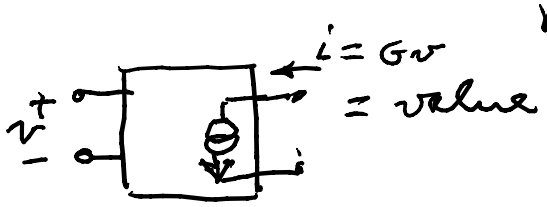
09/05/13
EE303H

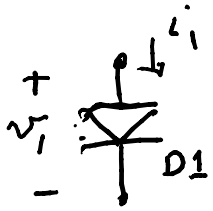
Note Title 9/5/2013

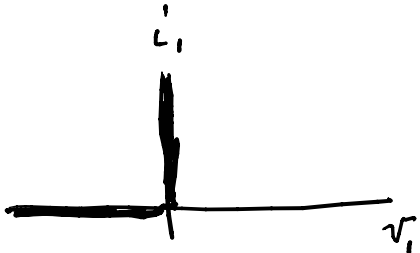
To study: diodes, biasing, see if can access PSpice, look for library files *.lib (have models)

Spice "index"
BJT → Q
diodes → D
MOS → M
voltage controlled current source → G
(that set the gain as a function) → G value
parameter → PARAM

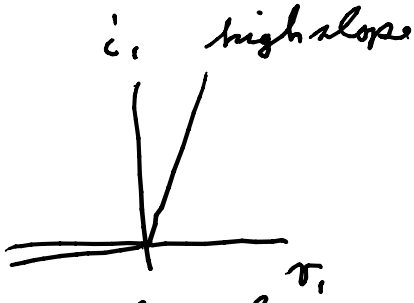


Diodes

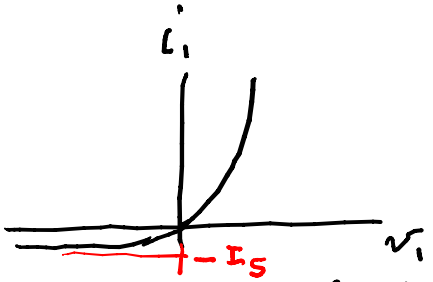




very ideal



2nd level

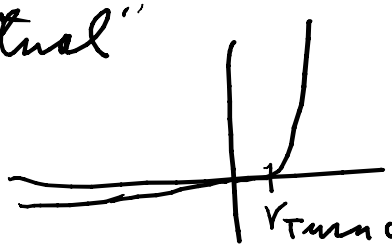


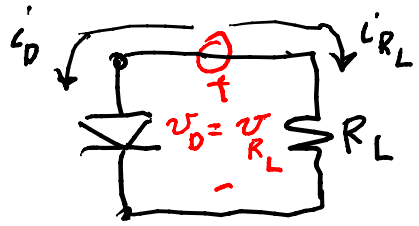
ideal junction diode

here $i_1 = I_S(e^{v_1/V_{TH}} - 1) \approx -I_S$ when $v_1 \to -\infty$

V_{TH} = thermal = $\frac{kT}{|q|} \approx 26\,mV$ @ rm T

"actual"





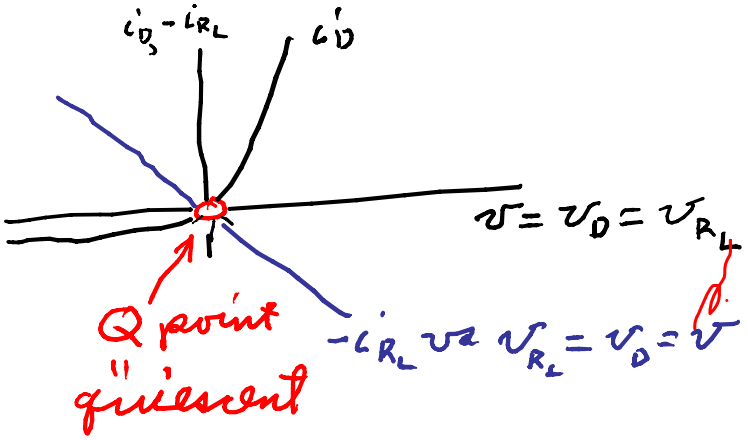
KCL: $0 = i_D + i_{R_L}$

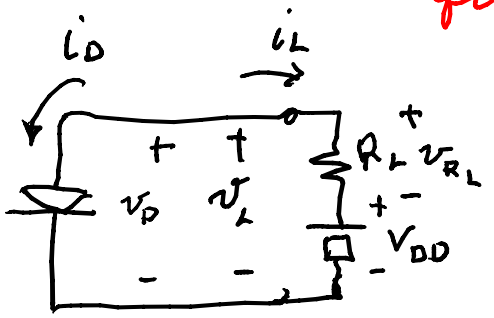
$\Rightarrow i_{R_L} = -i_D$

KVL $0 = v_D - v_{R_L} \Rightarrow v_{R_L} = v_D$

$v_{R_L} = R_L \cdot i_{R_L}$

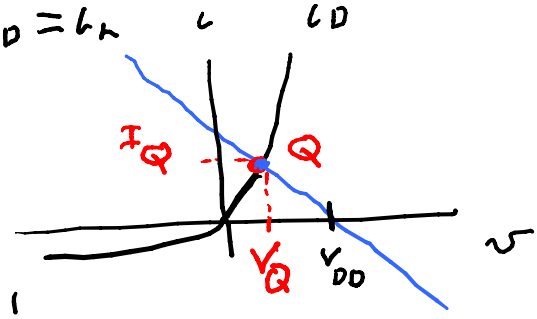
$-i_{R_L} = -\frac{1}{R_L} v$





$v_L = v_{R_L} + V_{DD} = v_D = v$

$-i_D = i_L$



$i_L = i_{R_L} = \frac{v_{R_L}}{R_L} = \frac{v - V_{DD}}{R_L}$

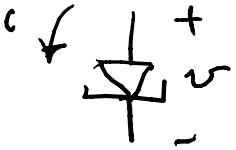
$= G_L(v - V_{DD})$, $G_L = \frac{1}{R_L}$

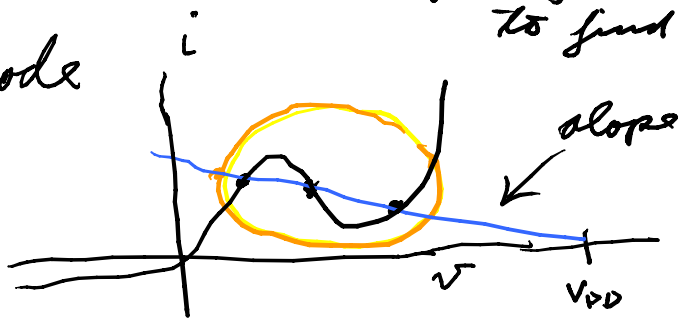
$= G_L v - G_L V_{DD}$

$-i_L = -G_L v + G_L V_{DD} \Rightarrow$ $i_D = I_S(e^{v/V_{th}} - 1) = -G_L v + G_L V_{DD}$

given I_S, V_{th}, G_L & V_{DD} then desire to find V_Q the solution for v

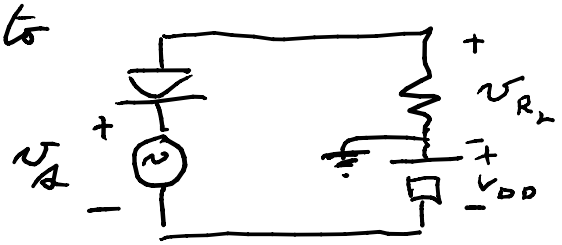
Tunnel diode





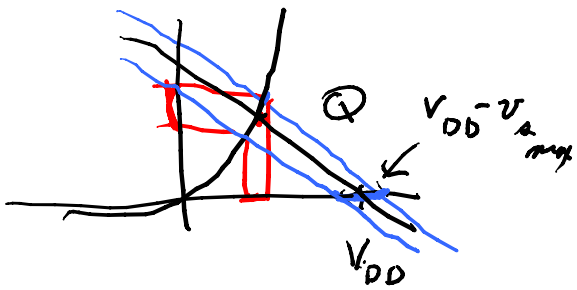
gives a cubic law

Generalize to

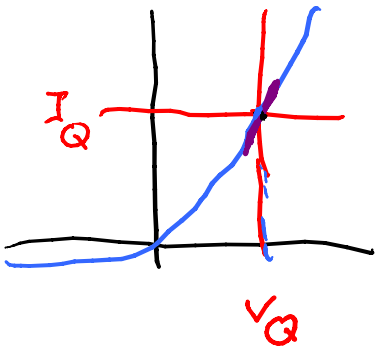


for i_D

v_D



For small signals can shift origin to Q



then use

$$x_y = X_y + x_y$$

↑ total ↑ Q pt value = DC ↑ signal value

Taylor series

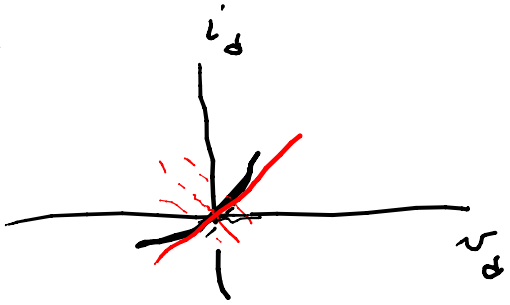
$$i_D = I_D + i_d \; ; \quad I_D = I_S\left(e^{V_Q/V_{th}} - 1\right) = I_Q$$

$$i_D = I_S\left(e^{v_d/V_{th}} - 1\right) = I_D + \left.\frac{d i_D}{d v_D}\right|_{V_Q} \underbrace{(v_D - V_D)}_{v_d} + \ldots$$

v_d signal; higher order (if $|v_d|$ small wrt V_D)

$$i_D = I_D + g_d(v_d)$$

$$\Rightarrow i_D - I_D = i_d = g_d v_d$$



Small signal equivalent circuit