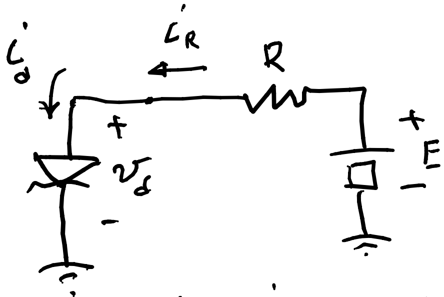
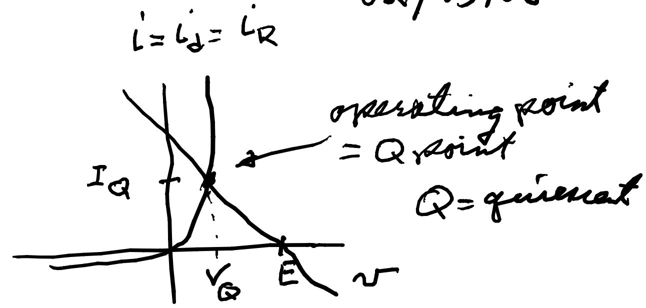
EE 303
02/05/08





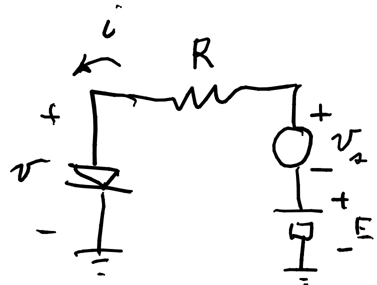
$i_R = i_d$ KCL

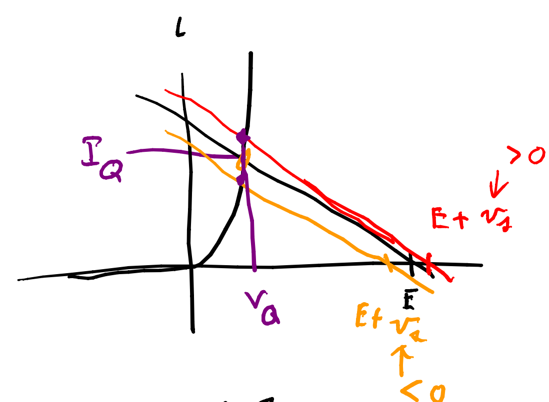
KVL: $v = v_d = E - Ri \Rightarrow i = \frac{1}{R}(E - v) = -Gv + GE$, $G = 1/R$

$i_d = I_S(e^{v_d/V_T} - 1) = -Gv + GE$ desire to solve

$= I_S(e^{v/V_T} - 1) = -Gv + GE$

$Gv + I_S e^{v/V_T} = GE + I_S$





$$i_D = f(v_D) = I_D + \frac{df(v_D)}{dv_D}\Big|_{V_Q}(v_D - V_Q) + \frac{1}{2}\frac{d^2 f(v_D)}{dv_D^2}\Big|_{Q}(v_D - V_Q)^2 + \dots$$

= Taylor series expansion about Q point

$$\approx I_D + \frac{df(v_d)}{dv_d}\Big|_{Q}(v_d - V_Q) \quad \text{if } |v_d - V_Q|^2 << |v_d - V_Q|$$

$\frac{df(v_d)}{dv_d}\Big|_Q$ = g = conductance

$i_d = i_D - I_D = g(v_D - V_Q) \Rightarrow \Delta i_d = g \Delta v_d$

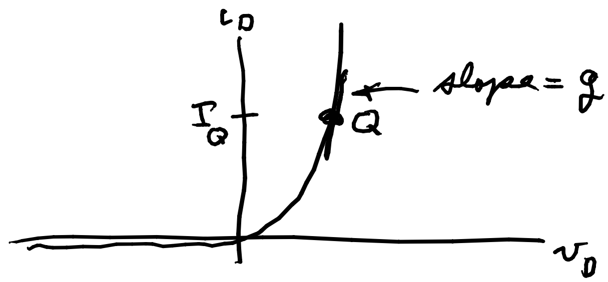
$= g v_d$

$i_D = I_S\left(e^{v_D/V_T} - 1\right)$;

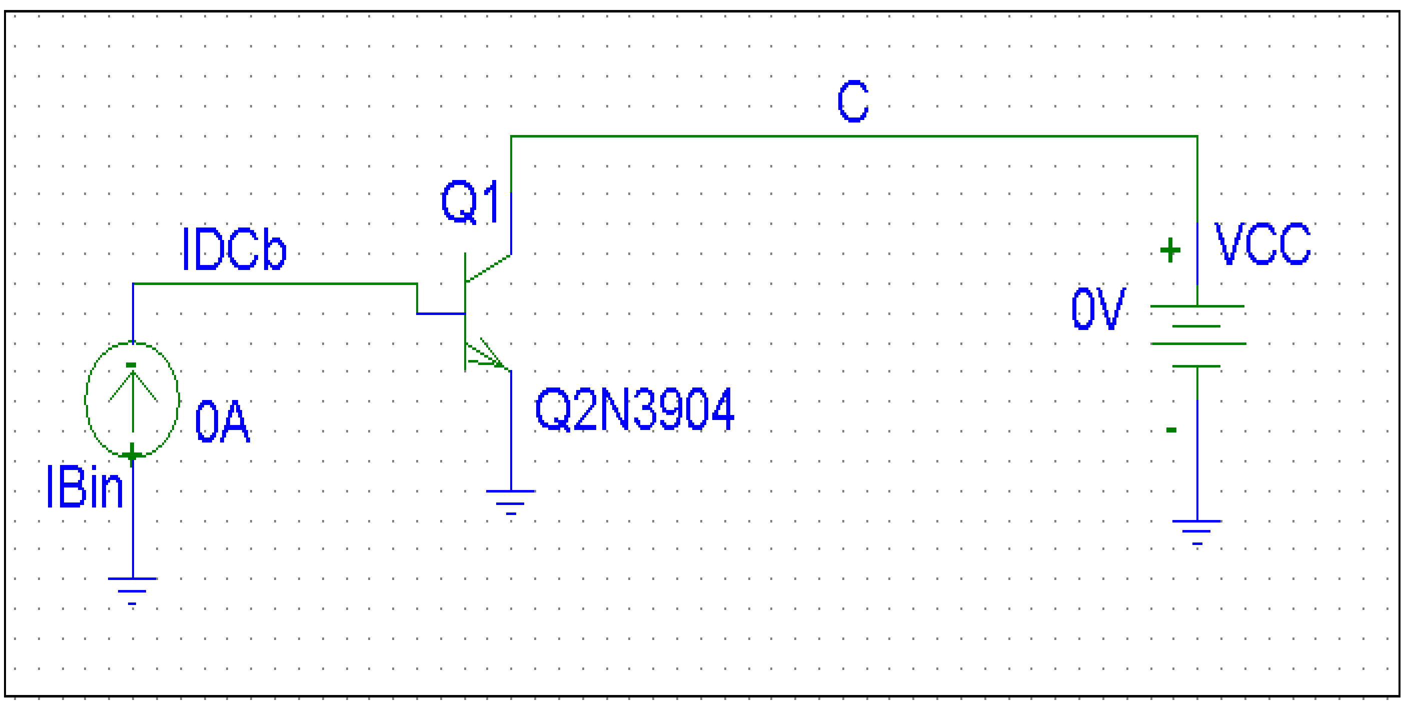
$$\left.\frac{di_D}{dv_D}\right|_{V_Q} = I_S \cdot \frac{1}{V_T} \cdot e^{v_D/V_T}\Big|_{V_Q} = \frac{I_S}{V_T} \cdot e^{v_D/V_T}$$

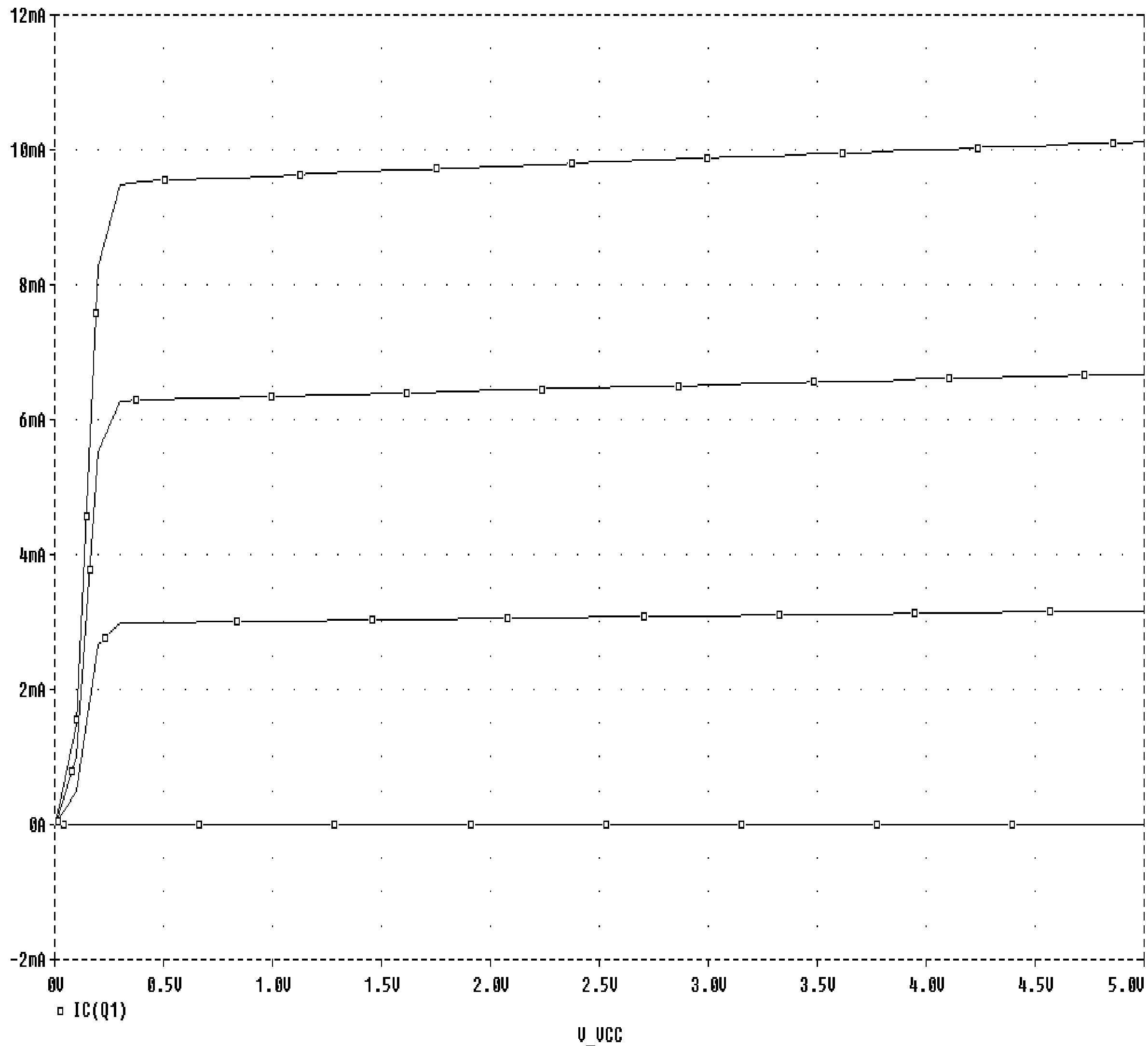
for $v_D > 0$, $i_D \approx I_S e^{v_D/V_T}$

$$\approx \frac{i_D}{V_T}\Big|_{V_Q} = \frac{I_Q}{V_T} = g$$



$V_T = \frac{kT}{|q|} \approx 25\,mV$ @ room T




12mA
10mA
8mA
6mA
4mA
2mA
0A
-2mA
0V
0.5V
1.0V
1.5V
2.0V
2.5V
3.0V
3.5V
4.0V
4.5V
5.0V
IC(Q1)
V_VCC