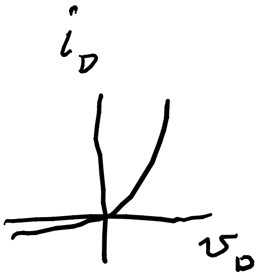
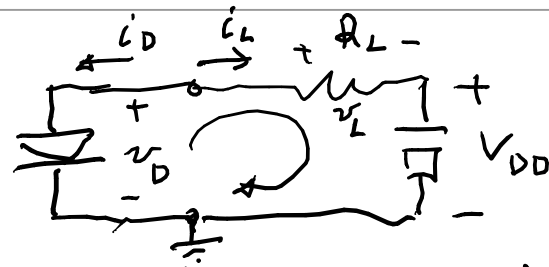
EE303H
09/08/11

Note Title 9/8/2011

Biasing





$i_L = -i_D$ by KCL $\quad 0 = \sum i_{\text{in a closed surface}} = -i_D - i_L$

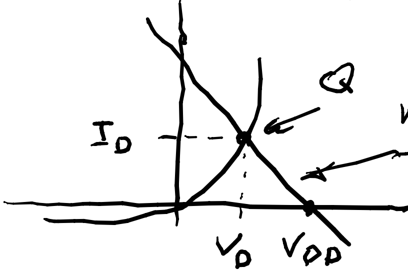
KVL $\quad -v_D + v_L + V_{DD} = 0$

laws of elements

R: $v_L = R_L i_L$, D: use the curve

$-i_L \quad i_D \quad -v_D + R_L i_L + V_{DD} = 0 \quad \Rightarrow -i_L = -\dfrac{v_D + V_{DD}}{R_L} = G_L(V_{DD} - v_D)$

$+i_D = i_L = G_L(-v_D + V_{DD})$



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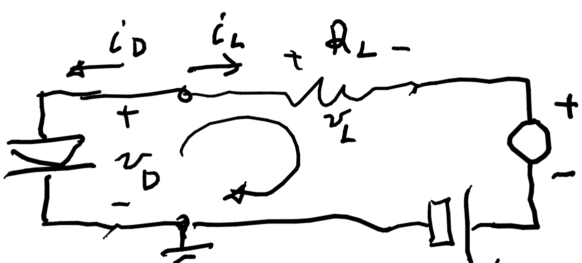
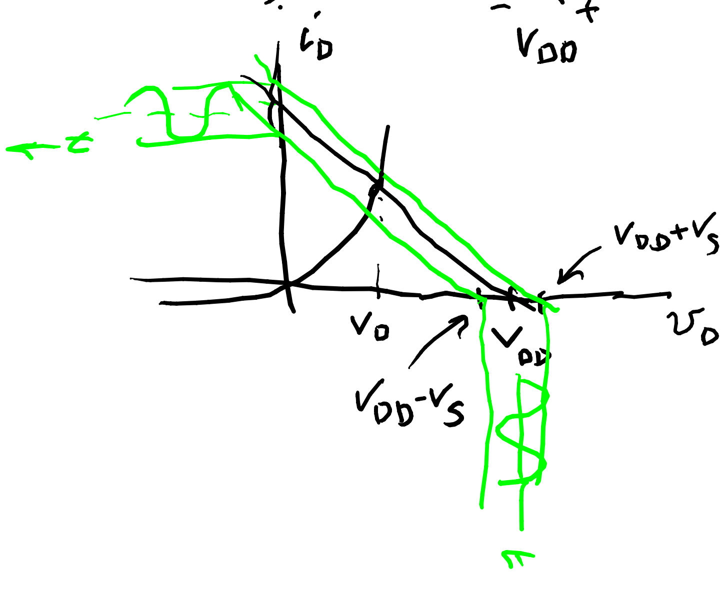
slope $= -G_L = -1/R_L$

Q = bias point, at bias $v_D = V_D$, $i_D = I_D$



$v_s = V_s \sin \omega_0 t$

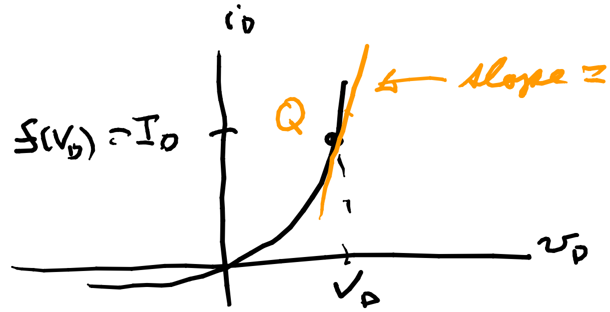


$i_D = f(v_D)$ = diode law

$= I_S(e^{v_D/V_T} - 1)$

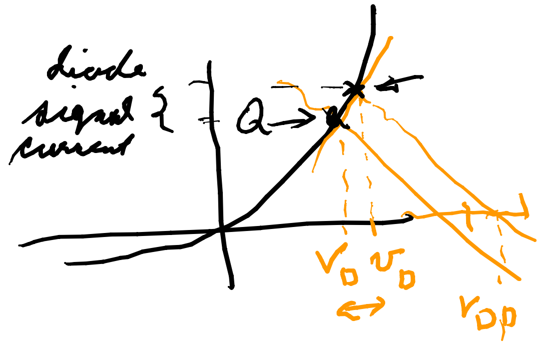
$= f(V_D) + \left.\dfrac{\partial f(v_D)}{\partial v_D}\right|_{V_D} (-V_D + v_D)$

$+ \dfrac{1}{2} \left.\dfrac{\partial^2 f(v_D)}{\partial v_D}\right|_{V_D} (V_D - v_D)^2 + \cdots$



$$\text{slope} = \left.\frac{\partial i_D}{\partial v_D}\right|_{V_D} = g_D \leftarrow \text{diode conductance}$$

$$i_D = I_D + g_D\,(\underbrace{-V_D + v_D}_{v_d}) + \text{higher order}$$



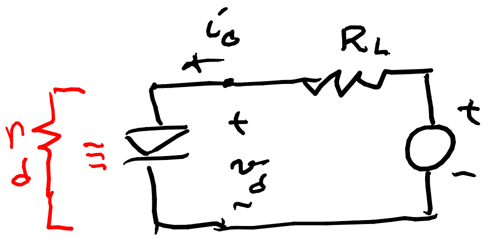
$$i_D - I_D = i_d = \text{signal}$$

i_D ↑ total, I_D ↑ bias

$$i_d = i_D - I_D = g_d\,(v_D - V_D) + \cdots$$

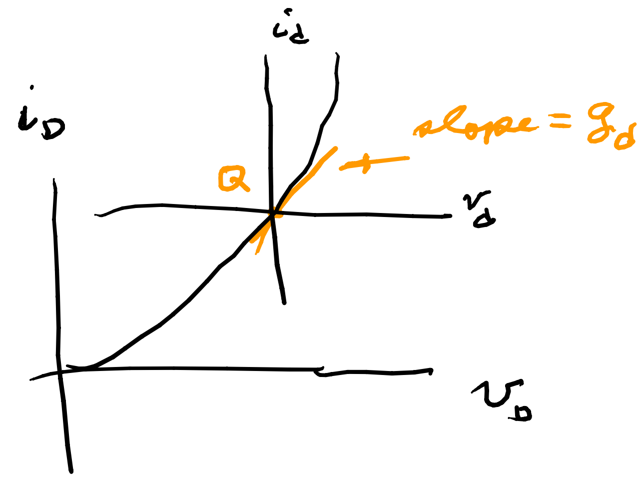
$$= g_d\, v_d \quad (\text{ignore } + \cdots)$$

signal eq



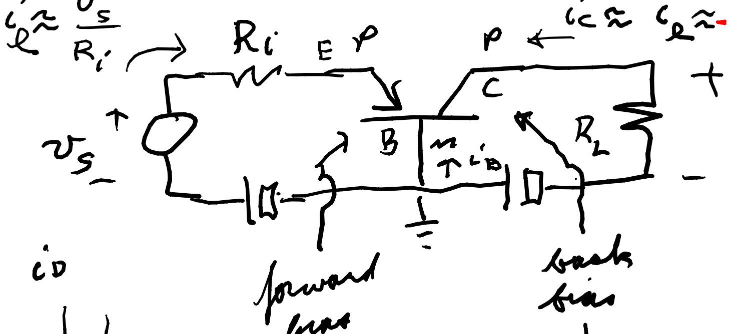
$v_s = V_s \sin \omega_0 t$, $V_s << V_{DD}$

small signal equivalent circuit linear



transistor = transfer resistor

$i_e \approx \frac{v_s}{R_i}$ → ; $i_c \approx i_e \approx -i_c$; $i_c = -\alpha i_e$, $0 < \alpha < 1$

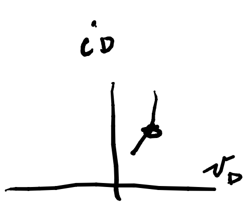


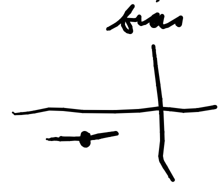
$$i_b + i_c + i_e = 0$$

$$i_b - \alpha i_e + i_e = 0$$

$$i_b = (\alpha - 1)\, i_e$$

$$i_c = -\alpha i_e = \frac{-\alpha}{\alpha - 1} \cdot i_b$$





large resistance ≈ 10 MEG Ω

$i_c = \frac{\alpha}{1-\alpha} \cdot i_b = \beta \cdot i_b$ β = beta = $h_{fe} = \frac{i_c}{i_b}$

↑ hybrid h parameters
f = forward, e = grounded emitter