EE303
02/01/12

Note Title 2/1/2012

To look at

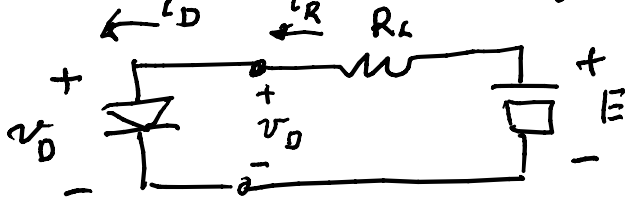
Diodes Chap. 3, p. 150 F. 3.13 & Eq. (3.40)
Chap. 4 pp. 174-175
load line p. 180, F. 4.11
small signal p. 184, F. 4.13 g_d eqs. (4.17-.18)

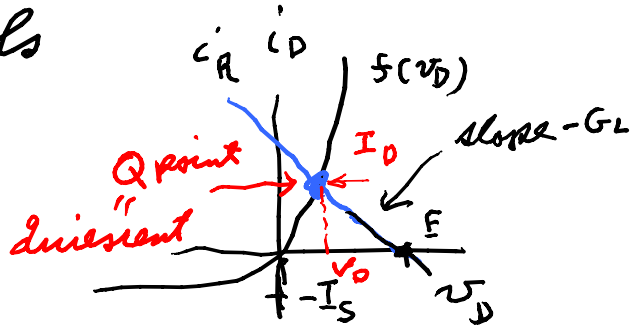
BJT Chap. 6 p. 374, F. 6.18
p. 376, F. 6.19

MOS Chap. 5 p. 249, table 5.1 (curves & eqs.)
p. 255 F. 5.17 (Early effect)

hybrid-π, p. 711, F. 9.2

Load line & small signals





$f(v_D) = i_D = I_S\left(e^{+v_D/V_T} - 1\right)$, V_T = thermal voltage $= kT/|q|$

$f(v_D) = i_D \simeq i_R = (E - v_D)/R_L = G_L(E - v_D)$

Desire to know the Q point

$I_S\left(e^{v_D/V_T} - 1\right) = G_L E - G_L v_D \Rightarrow$ solve for v_D

For small changes, expand in a series expansion around the Q point

$$i_R = G_L E - G_L v_D = f(v_D) \simeq f(V_D) + \left.\frac{\partial f}{\partial v_D}\right|_{@v_D = V_D}(v_D - V_D) + \frac{1}{2}\left.\frac{\partial^2 f(v_D)}{\partial v_D^2}\right|_{V_D}(v_D - V_D)^2 + \cdots$$

$v_D = V_D + v_d \quad \Rightarrow \quad G_L E - G_L(V_D + v_d) = f(V_D) + \left.\frac{\partial f}{\partial v_D}\right|_{V_D} \cdot v_d + (\text{ignore?})$

$\quad\;\; \| \quad\quad \| \quad\quad \|$

total bias signal

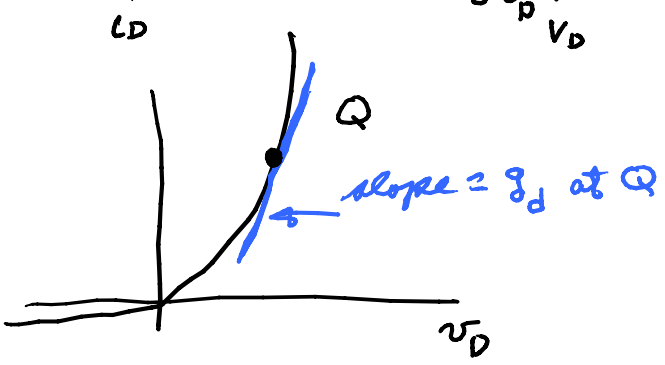
$G_L E - G_L V_D$: bias ; v_d : signal ; $f(V_D) = I_D$

$$-G_L v_d = \left.\frac{\partial f}{\partial v_D}\right|_{V_D} \cdot v_d$$

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

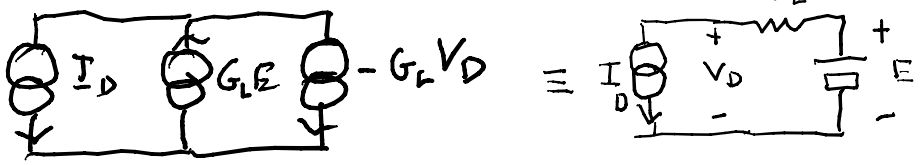
$$\frac{\partial i_D}{\partial v_D} = \left.\frac{\partial f}{\partial v_D}\right|_{V_D} = \left.\frac{I_S \cdot e^{v_D/V_T}}{V_T}\right|_{V_D} = \frac{I_D}{V_T} = g_d$$

= conductance of the diode at Q



bias: $G_L E - G_L V_D = I_D = I_S\left(e^{V_D/V_T} - 1\right) \approx I_S e^{V_D/V_T}$ if in forward region

redraw: bias



(small) signal