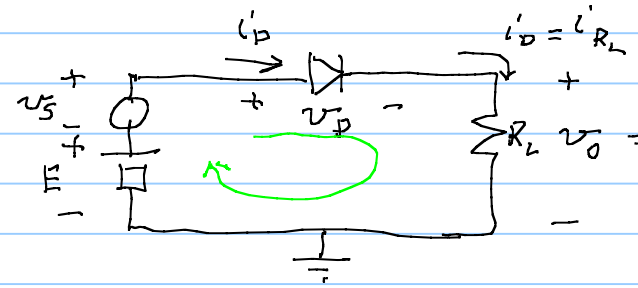
EE303H
09/08/16

Note Title 9/5/2016

Load lines, Q point, etc but go over chapter 5 on MOS, eq. (5.16) & (5.23)

Eq. for solid-state diode

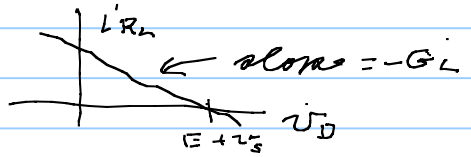
$$i_D = I_S\left(e^{v_D/V_T} - 1\right)$$

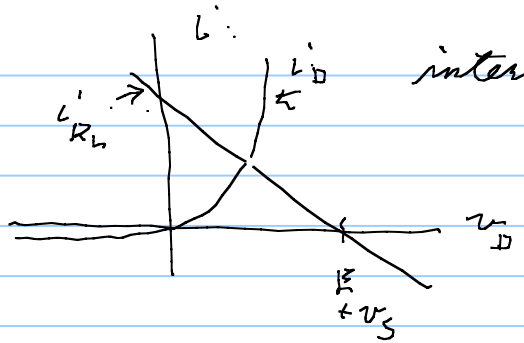


$+v_D + v_0 - E - v_S = 0$ by KVL

$v_D = E + v_S - v_0$

$$R_L: \quad i_{R_L} = G_L v_0 = G_L(E + v_S - v_D) = G_L(E + v_R) - G_L v_D$$





intersect @ $i_D = i_{R_L}$ ⇒ operating point

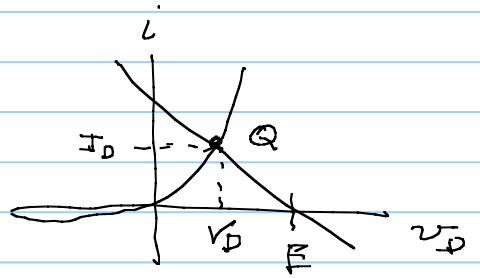
= Q point if $v_S = 0$

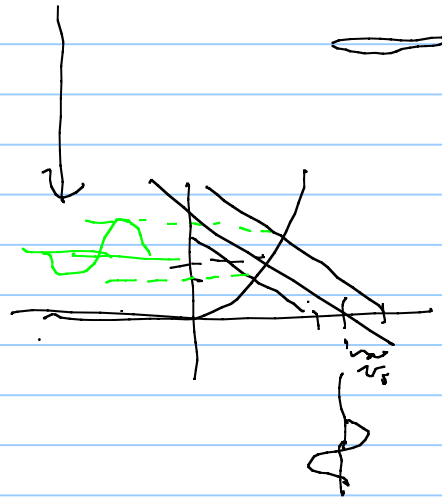
⇓

biasing

||

DC operation w/ no signal





If $|v_d|$ small use Taylor series

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

$$= f(V_D) + \left.\frac{df(v_D)}{dv_D}\right|_{v_D=V_D}(v_D - V_D) + \left.\frac{d^2 f(v_D)}{2\,dv_D^2}\right|_{v_D=V_D}(v_D - V_D)^2 + \cdots$$

$v_D = V_D$

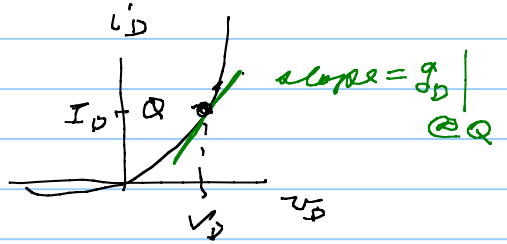
g_D $\quad$ v_d (= signal voltage)

DC response no signal Q pt current I_D

conductance of diode @ Q

ignore if $v_D - V_D = v_d$. max $|v_d|$ small

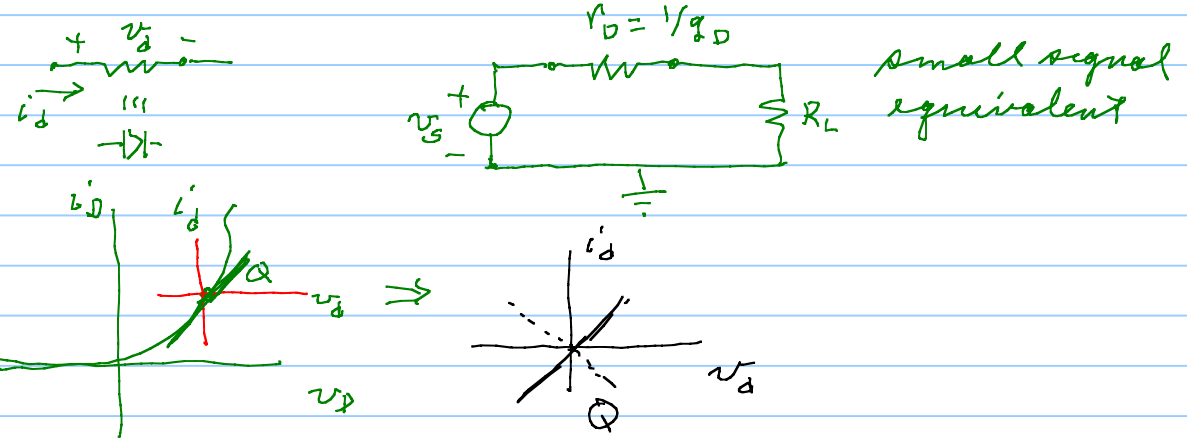
$I_D = f(V_D)$



$i_D - I_D = i_d$ = signal current = total current − bias current

$x_y = X_y - x_y$

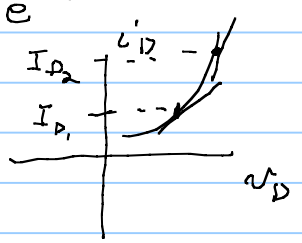
$i_d = i_D - I_D = g_D \cdot v_d$ (+ higher order terms ≈ 0 if $|v_d|$ small)

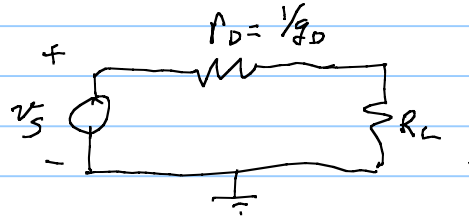


here: $i_D = I_S\left(e^{v_D/V_T} - 1\right)$; $\left.\dfrac{d i_D}{d v_D} = \dfrac{1}{V_T} \cdot I_S e^{v_D/V_T}\right|_{v_D = V_D}$

If $v_D > 0$ then $i_D = I_S(e^{v_D/V_T} - 1) \approx I_D = I_S e^{v_D/V_T}$

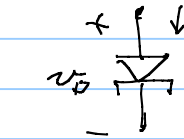
or $\left.\frac{d i_D}{d v_D}\right|_{v_D>0} = \frac{1}{V_T} I_D = g_D$



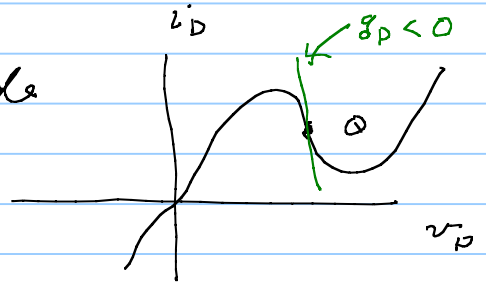


$v_0 = \frac{R_L}{R_L + r_D} \cdot v_i$; $i_d = \frac{1}{(r_d + R_L)} \cdot v_S$

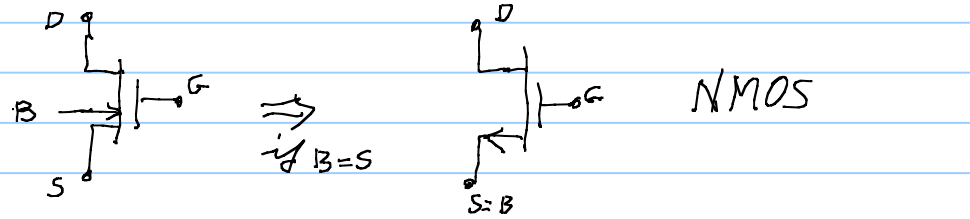
Tunnel diode



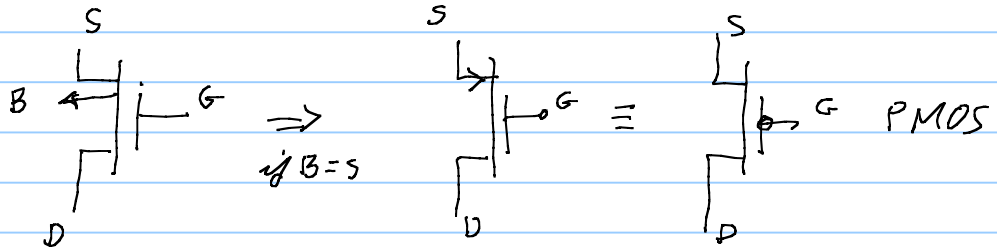
$i_D \cdot v_D$ = powers into the diode



MOS transistors: CMOS ⇒ PMOS with NMOS

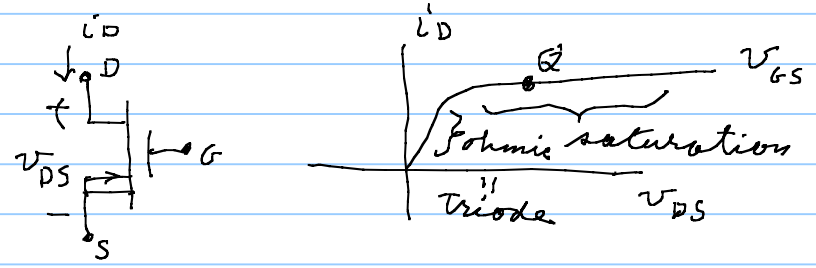


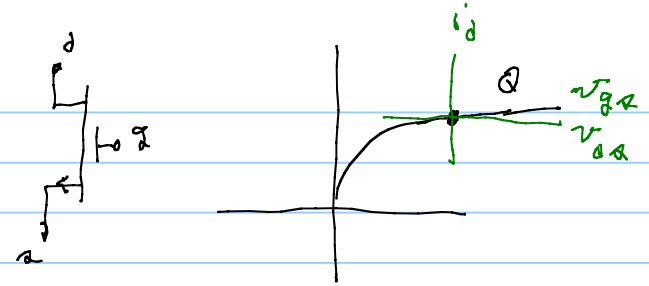
NMOS



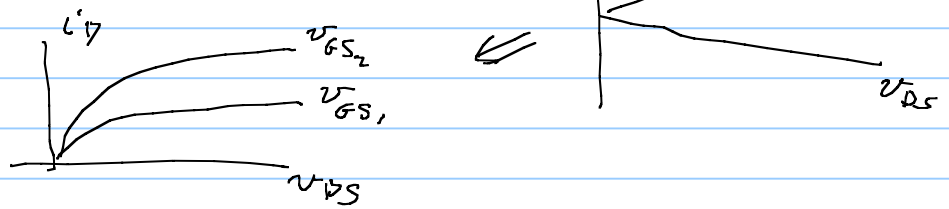
PMOS

for NMOS





here $i'_D = f(v_{DS}, v_{GS})$



$\Rightarrow$ admittance matrices