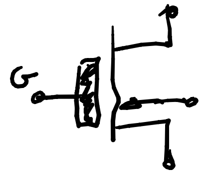
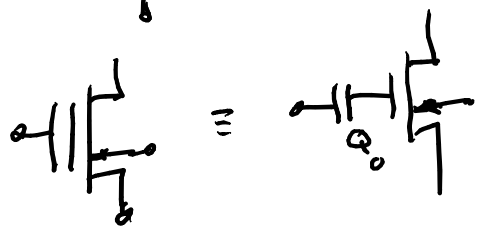
EE303H
10/20/11

Depletion mode MOS

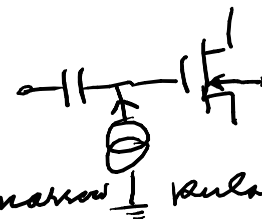


$VTO_n < 0$

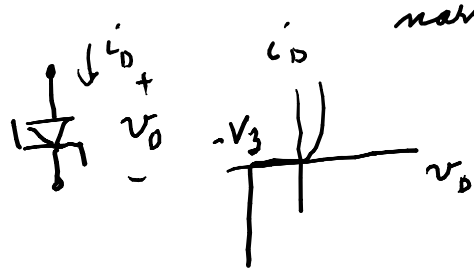
Floating gate MOS



in Spice

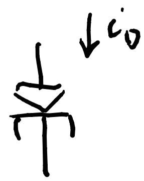


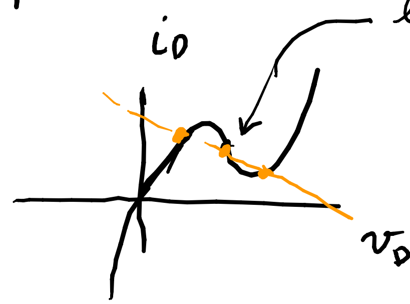
Zener diode



see p. 190

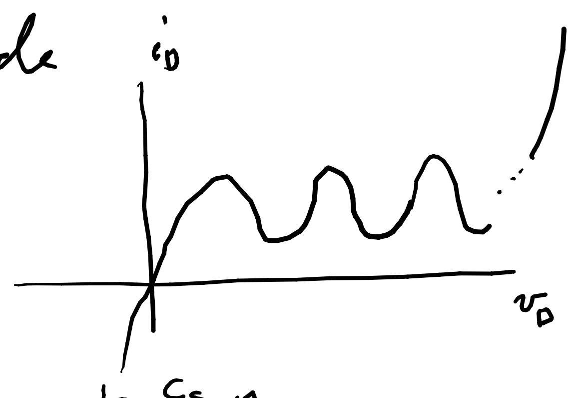
Tunnel diode (Esaki)



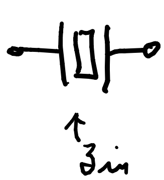


looks cubic around this bias

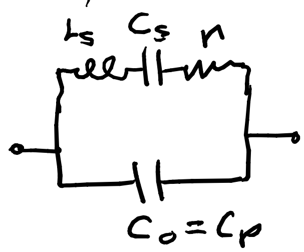
Resonant tunnel diode



Quartz Crystal



⇒



r = small
⇒ high Q
has a precise resonant frequency

see Pierce oscillator, p. 1355

$$z_{in} = \frac{1}{y_{in}} \Rightarrow y_{in}(s) = C_0 s + \frac{1}{L_s s + \frac{1}{C_s s} + r} = C_0 s + \frac{C_s s}{L_s C_s s^2 + r C_s s + 1}$$

$$= C_0 s + \frac{\frac{1}{L_s} s}{s^2 + \frac{r}{L_s} s + \frac{1}{L_s C_s}} = C_0 s + \frac{\frac{1}{L_s} s}{s^2 + \frac{\omega_0}{Q} s + \omega_0^2}$$

$$\omega_0^2 = \frac{1}{L_s C_s}$$

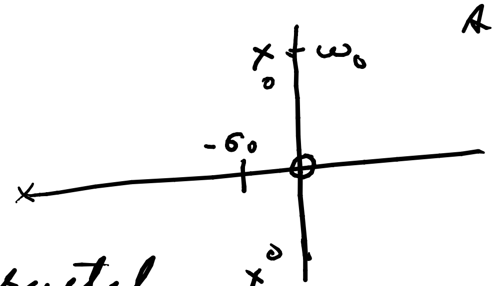
$$\frac{r}{L_s} = \frac{\omega_0}{Q} \Rightarrow Q = \frac{\omega_0 \cdot L_s}{r} = \frac{1}{r} \cdot \sqrt{L_s / C_s} \Rightarrow \text{if } r = 0,\ Q = \infty$$

$y_{in}(s) \Rightarrow$ has a zero @ $s = 0$

$\Rightarrow$ poles near zeros of $s^2 + \omega_0^2 \Rightarrow s = \pm j\omega_0$

$s = \sigma + j\omega$

if $r \neq 0$, $s = \sigma_0 \pm j\omega_0$



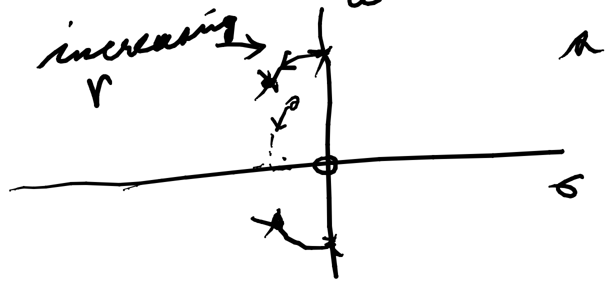
actual poles of y_{in} of the crystal are zeros of $s^2 + \frac{\omega_0}{Q} s + \omega_0^2 = D(s)$

$$s_{1,2} = -\frac{\omega_0}{2Q} \pm \frac{1}{2}\sqrt{\left(\frac{\omega_0}{Q}\right)^2 - 4\omega_0^2} = \frac{\omega_0}{2Q}\left[-1 \pm \sqrt{1 - 4Q^2}\right],\quad Q \neq 0$$

if Q is high then $s_{1,2} = \frac{\omega_0}{2Q}(1 \pm 2jQ)$

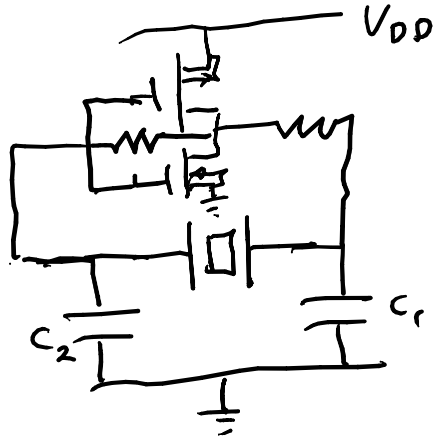
$$= \frac{\omega_0}{2Q} \pm j\omega_0$$

$$= \frac{r}{2L_s} \pm j\sqrt{\frac{1}{L_s C_s}}$$

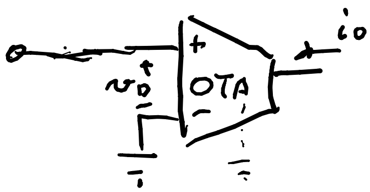


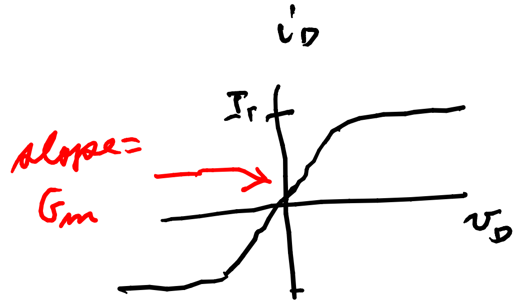
Pierce oscillator

Fig 17.16



How to get a negative R

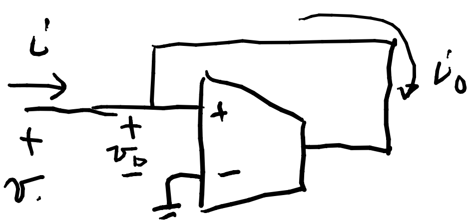


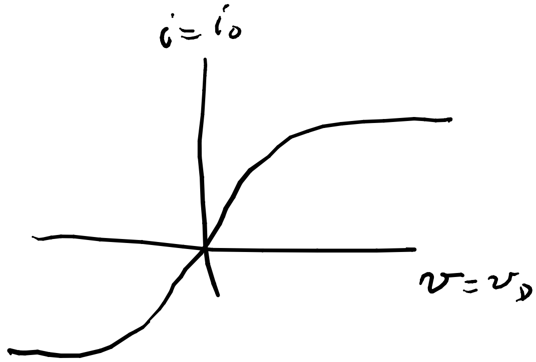


from 10/04/11 $\quad i_o = \beta v_D \sqrt{\frac{2I_T}{\beta} - v_D^2}$ for $|v_D| \le \frac{I_T}{\beta}$

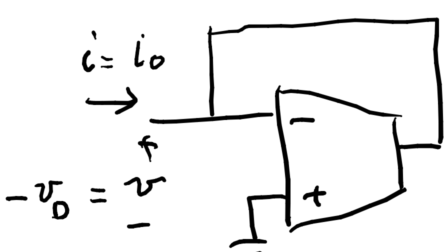
for $|v_D|$ small $\quad i_o \sim \beta v_D \sqrt{\frac{2I_T}{\beta}} = \underbrace{\sqrt{2\beta I_T}}_{G_m} \cdot v_D$

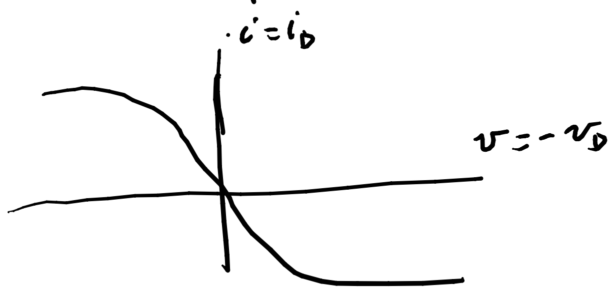
$\beta = \frac{KP}{2} \cdot \frac{W}{L}$ of differential pair transistors





R_{in} near $v = 0$, $R_{in} = \frac{1}{G_m} >$





slope < 0 ⇒ a negative R

for hysteresis from last time

$$\text{slope} = 1 + \frac{G_1}{G_2} = \frac{V_{DD}}{V_{D_2}} \Rightarrow 1 + \frac{G_1}{2} = \frac{V_{DD}}{-\frac{G_1}{G_2}\left(\frac{1}{1+\frac{G_1}{G_2}}\right)V_{i_2}}$$ ← voltage input to hysteresis for the jump down

$$-V_{d_2} = \frac{G_1}{G_2} \times \frac{1}{1+\frac{G_1}{G_2}} V_{i_2}$$

same for V_{i_1} do the same on the other side:

$$V_{i_2} = -\frac{G_1}{G_2} V_{DD} \; ; \; V_{i_1} = \frac{G_1}{V_2}(-V_{SS}) = \frac{G_1}{G_2} V_{DD}$$

width: $V_{i_1} - V_{i_2} = 2\frac{G_1}{G_2} \cdot V_{DD}$