EE6322 12/3/2018

$t_d = \frac{CV_{dd}}{2I_p}$	Single stage delay
$T_0 = \frac{MCV_{dd}}{I_p}$	Oscillation period
$f_0 = \frac{2I_p}{MCV_{dd}}$	Oscillation frequency
$P_1 = CV_{dd}^2 f_0$	Power dissipation per stage
$P_d = MCV_{dd}^2 f_0$	Total power dissipation
$I_d = MCV_{dd} f_0$	Total current drawn from V_{dd}

$$S_0 = \frac{8}{3} kT g_m$$ g_m ill defined, but still . . .

$$= \frac{16}{3} kT \frac{I_p}{V_{GS} - V_T}$$ $V_{GS} - V_T$ not fixed, but still . . .

$$\sigma^2_{\Delta td} = \frac{8}{3} \frac{kTCV_{dd}}{(V_{GS} - V_T) I_p^2}$$ Variance of stage delay

$$\sigma^2_{\tau 0} = \frac{16}{3} \frac{kTMCV_{dd}}{(V_{GS} - V_T) I_p^2}$$ Period jitter

$$S_{\tau 0}(f) = \frac{32}{3} \frac{kTMCV_{dd}}{(V_{GS} - V_T) I_p^2 f_0}$$ Spectral density of period jitter

$$S_\phi(f) = \frac{32}{3} \frac{kT}{(V_{GS} - V_T) I_p} \frac{f_0^2}{f^2}$$ Spectral density of phase

(double-sided)

$$S_\phi(f) = \frac{32}{3}\frac{kT}{(V_{GS}-V_T)I_p}\frac{f_0^2}{f^2}$$ Spectral density of phase

$$\mathcal{L}(f) = \frac{32}{3}\frac{kT}{(V_{GS}-V_T)I_p}\frac{f_0^2}{f^2}$$ Phase noise, $f > 0$

$$\text{FoM} = \frac{3}{32}\frac{1}{kT}\frac{V_{GS}-V_T}{V_{dd}}10^{-3}$$ Figure of merit

144 dB

10^{18}

$V_{GS} - V_T = \frac{1}{4} \cdot V_{DD}$

$+5\,dB$ $\quad \frac{3}{8} \cdot \frac{1}{4 \cdot 10^{-21}} \cdot \frac{1}{4} \cdot 10^{-3}$

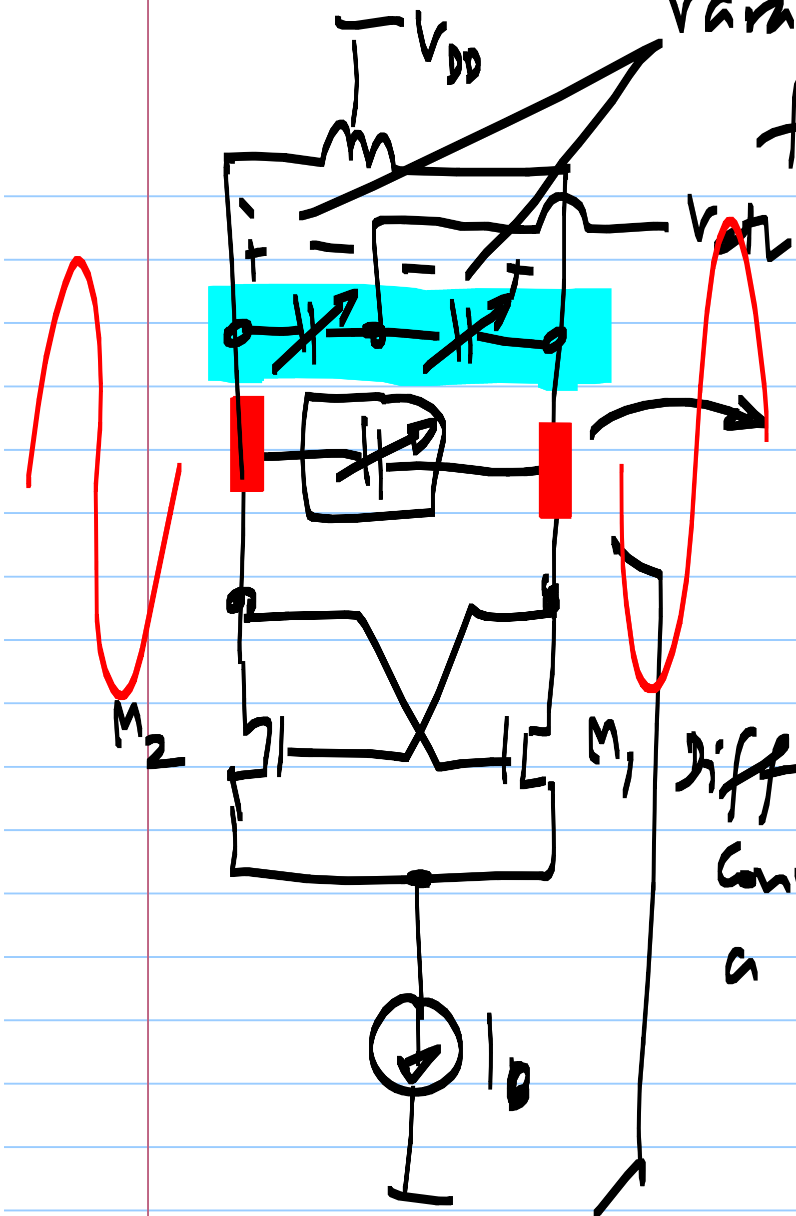
$\frac{3}{128} \cdot 10^{18}$

$-21\,dB$ $\quad 128$ $\quad 180\,dB$

164 dB

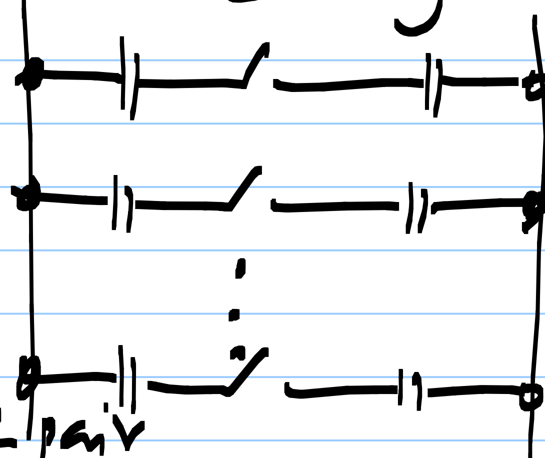
Varactors [capacitance depends on the dc voltage across them]

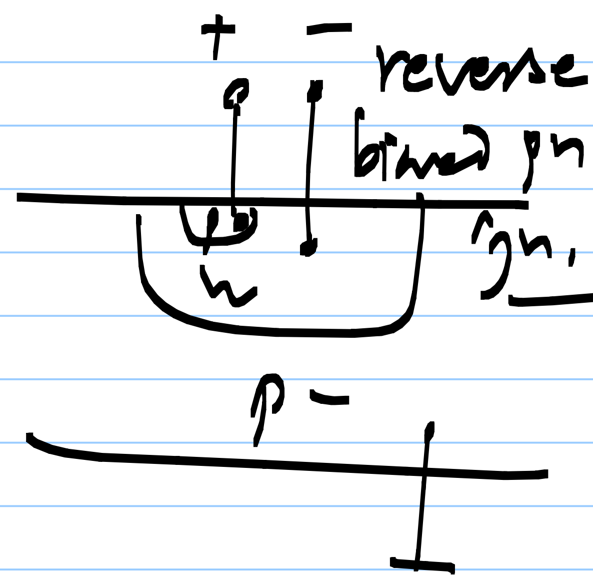
fine tuning.



Diff pair connected on a -ve resistance

Coarse tuning

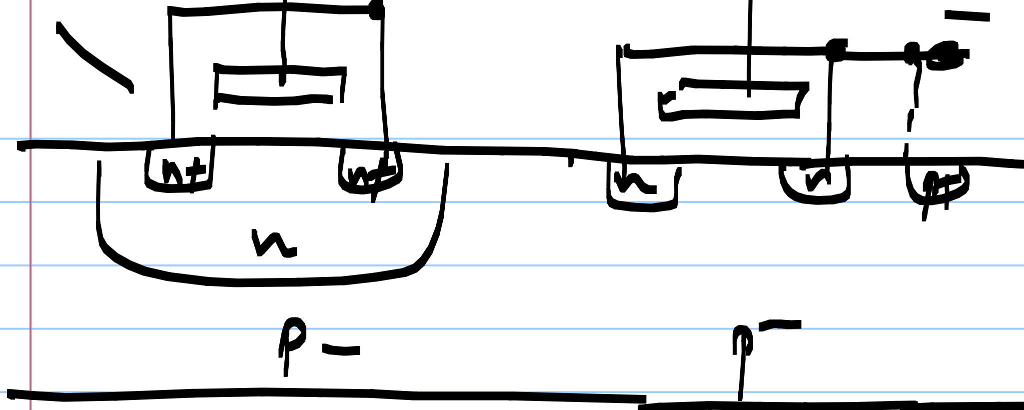


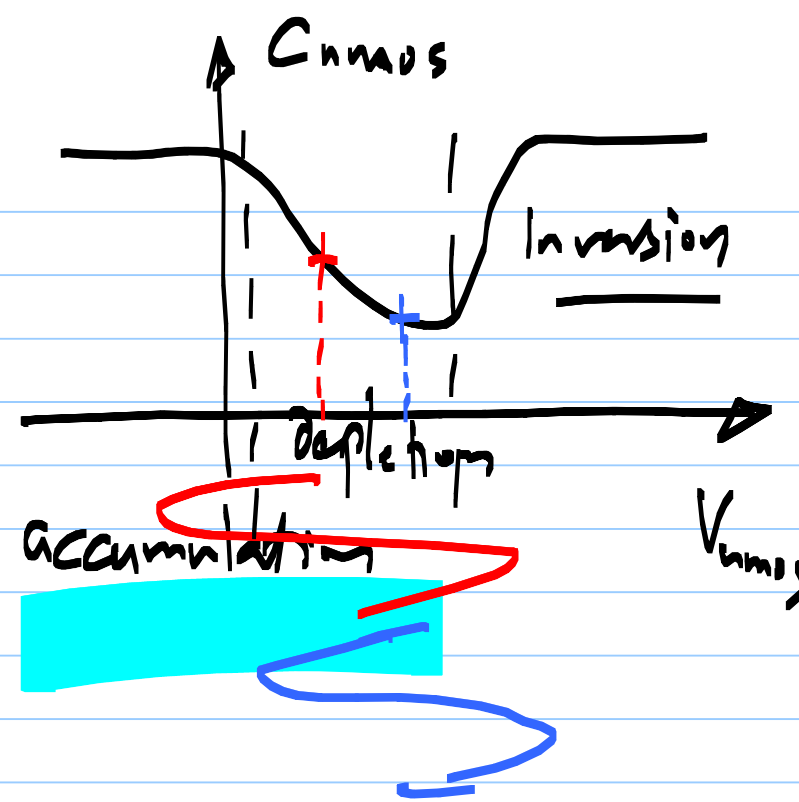


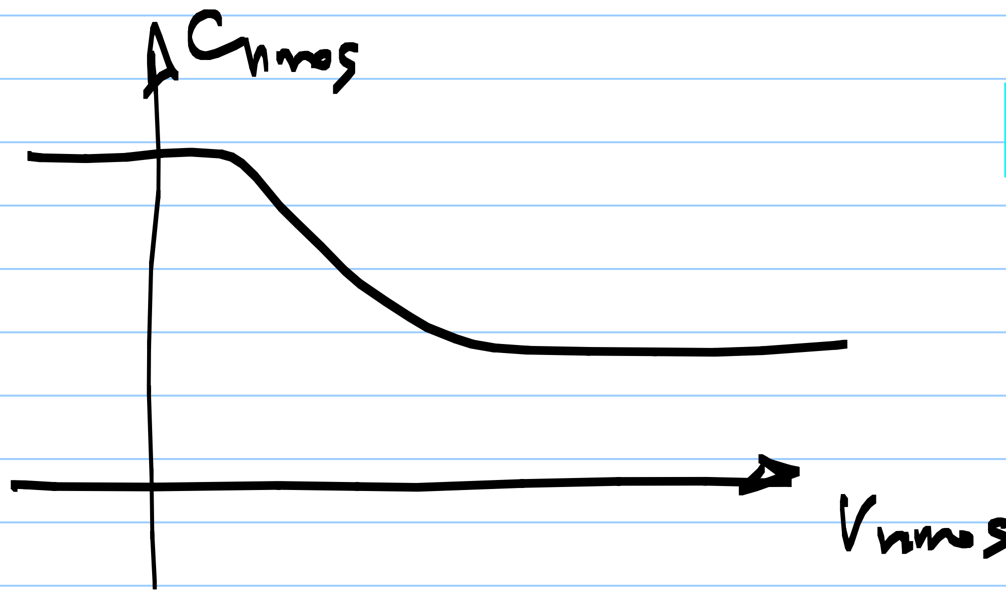
reverse biased pn jn.

p-n junction varactor

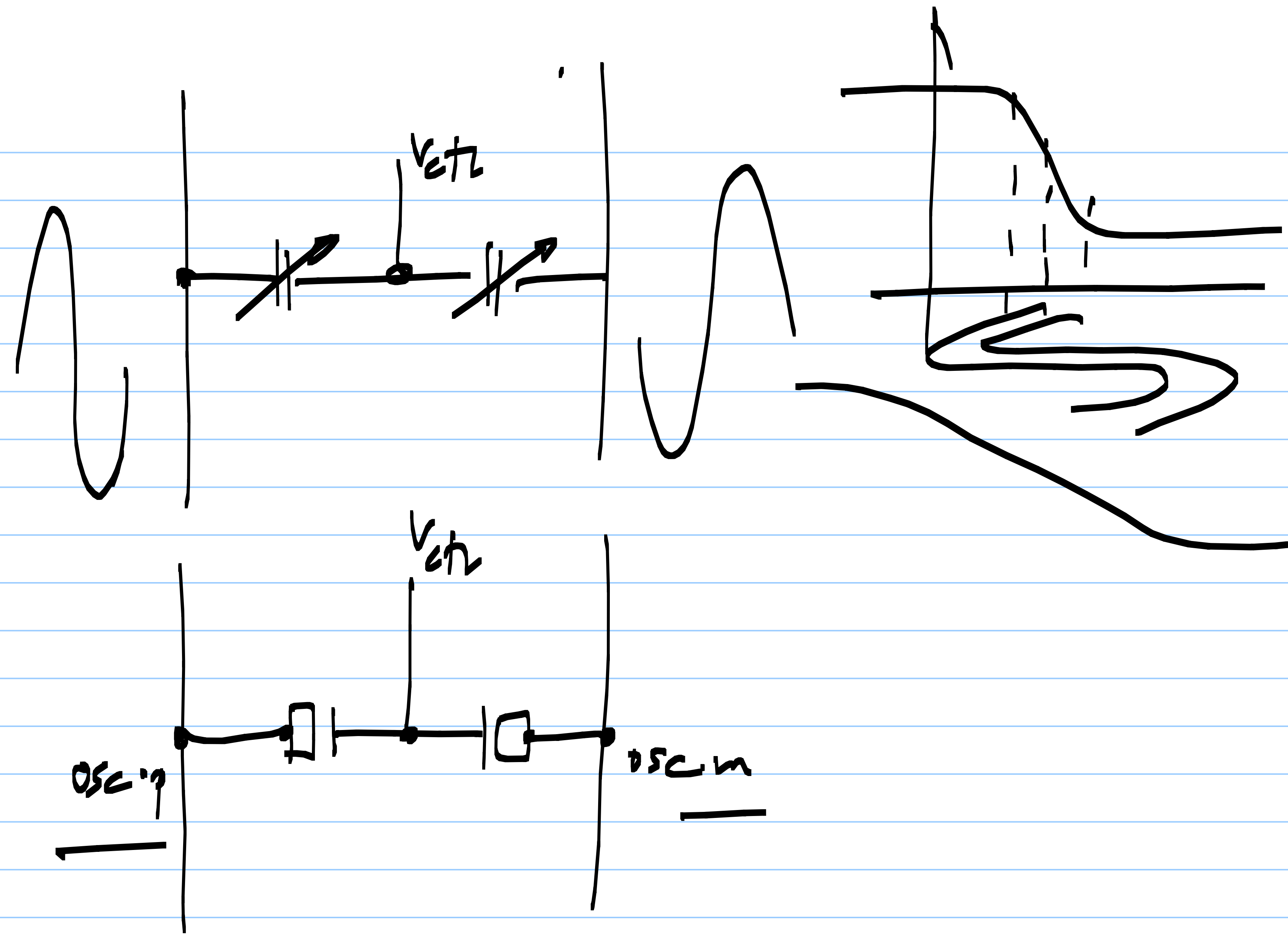
nMOS in n-well



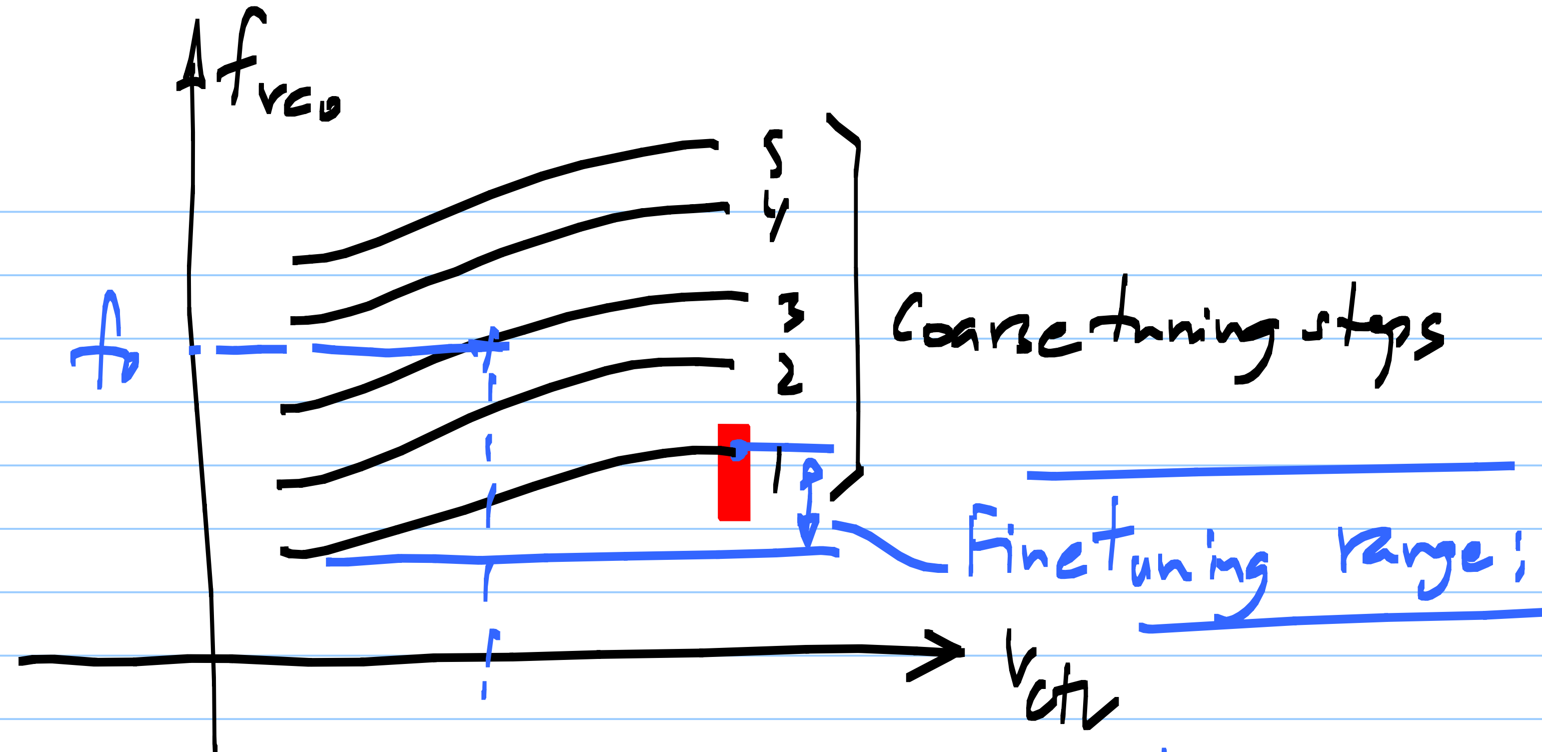




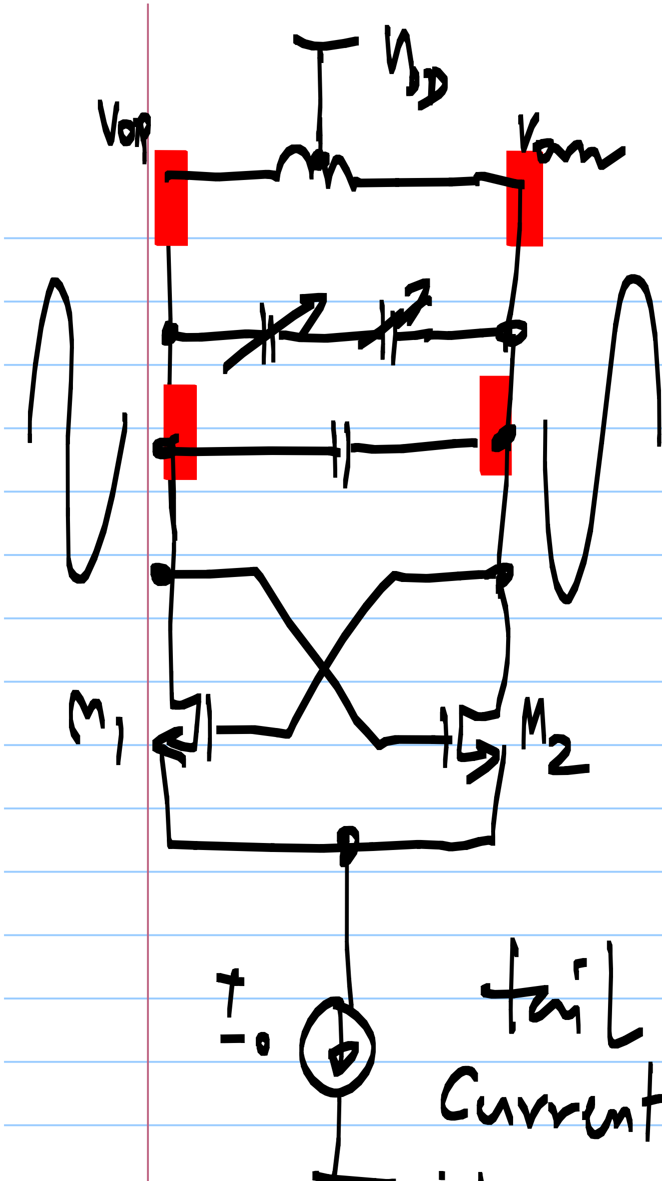
nMOS in nwell



Vctl
Vctl
osc_p
osc_m

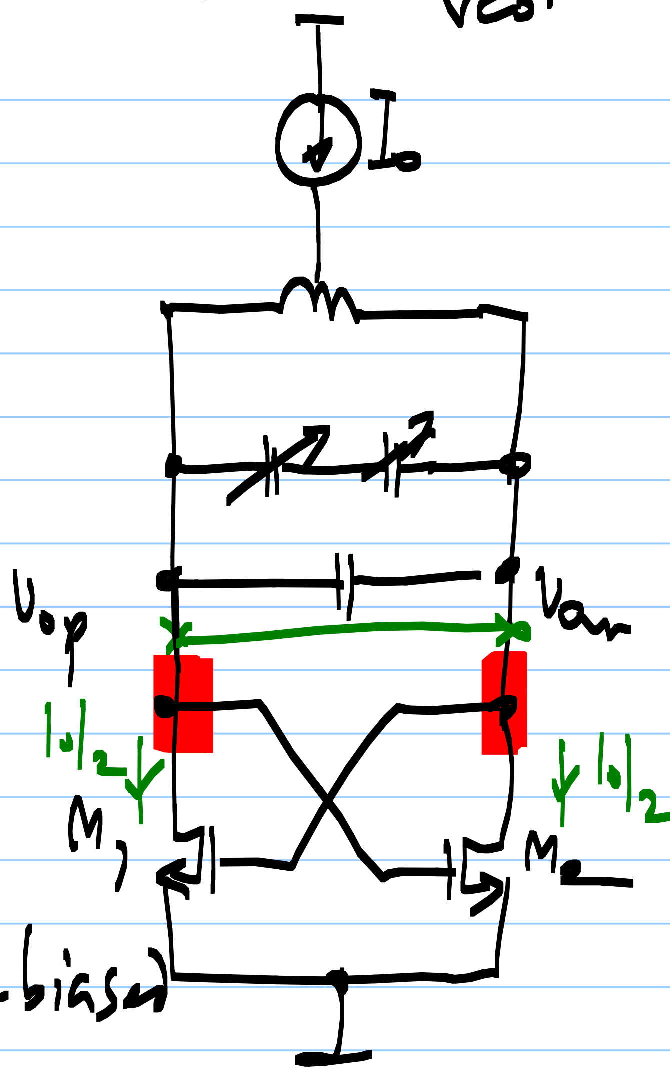


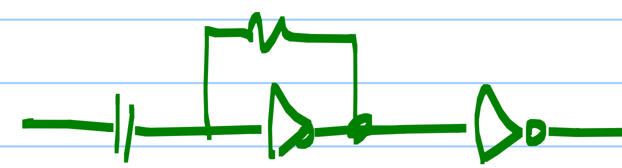
* There should be overlap between tuning curves of successive coarse steps.



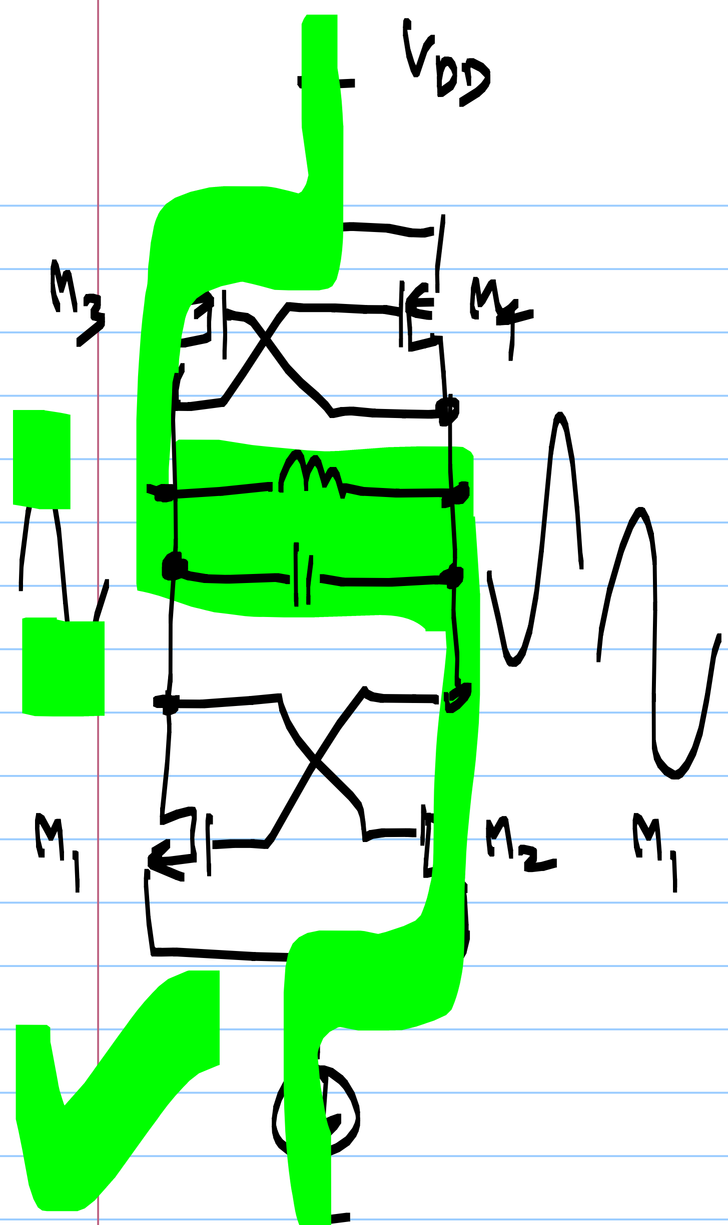
tail Current-biased VCO

Top current biased VCO.

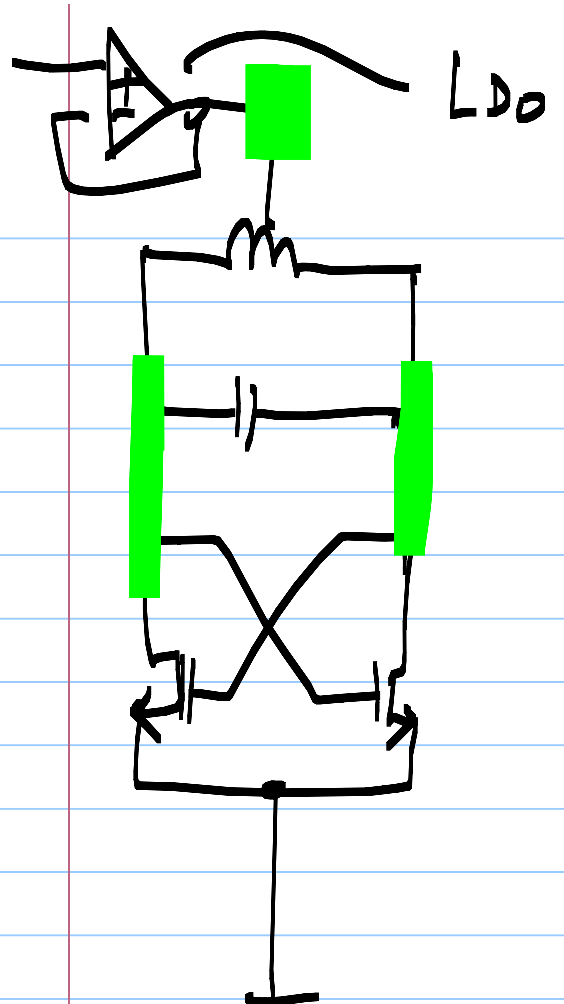




$$V_{GS M_1}\Big|_{\frac{I_0}{2}} =$$

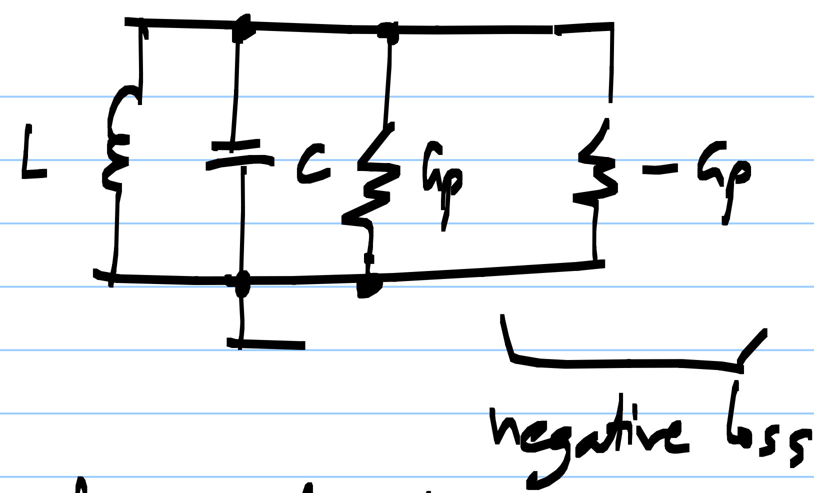

VDD
M3
M4
M1
M2

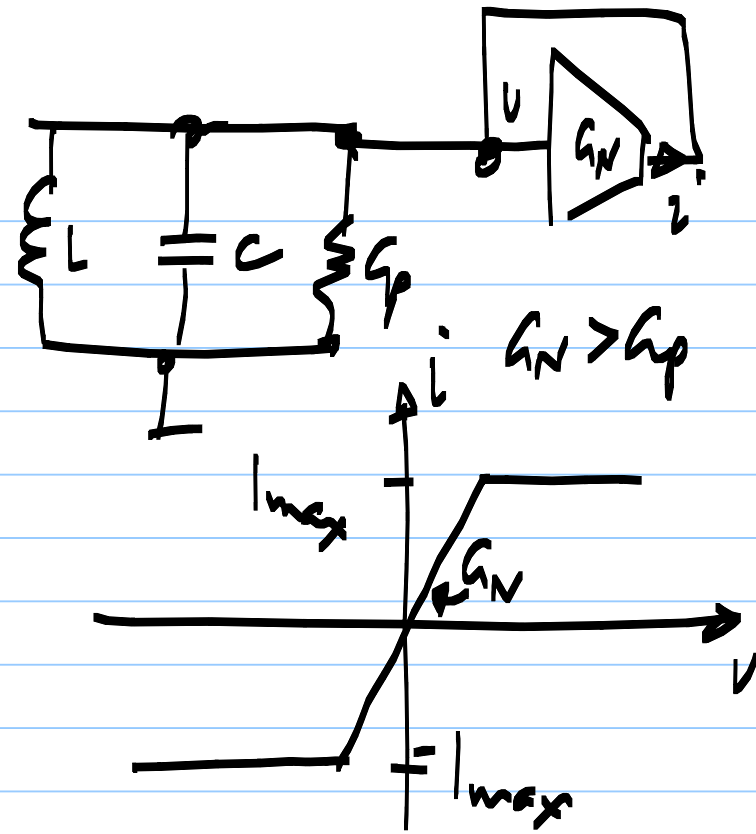

VDD
M1
M2



Voltage biased VCO
no current source

Ideal linear LC oscillator





Leeson's phase model