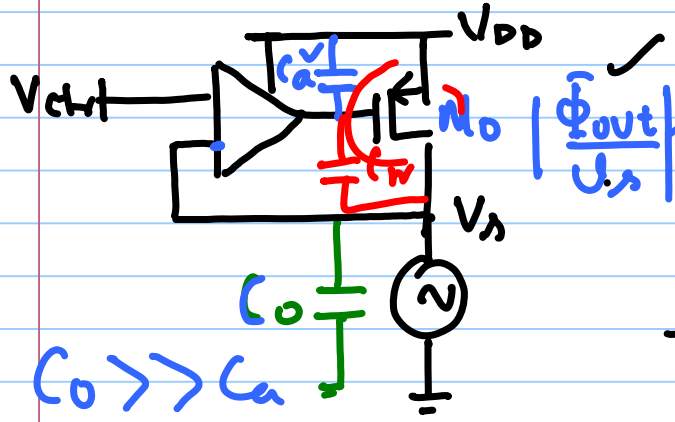
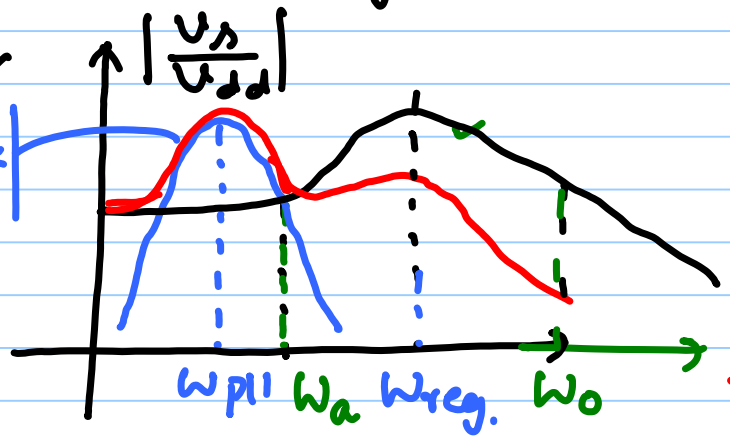
Lecture # 37

Note Title 12-10-2017

Power Supply Regulation for ring oscillators.



$C_o >> C_a$



$$\frac{V_s}{V_{dd}} = \frac{S_{vdd}}{(1+LG_{reg})\left(1+\frac{s}{\omega_o}\right)}$$

$$\frac{\Phi_{out}}{V_{dd}} = \frac{V_s}{V_{dd}} \times \frac{\Phi_{out}}{V_s}$$

$\omega_{reg} > \omega_{pll}$

$$\omega_o = \frac{1}{(r_{vco} \| r_{ds}) C_o}$$

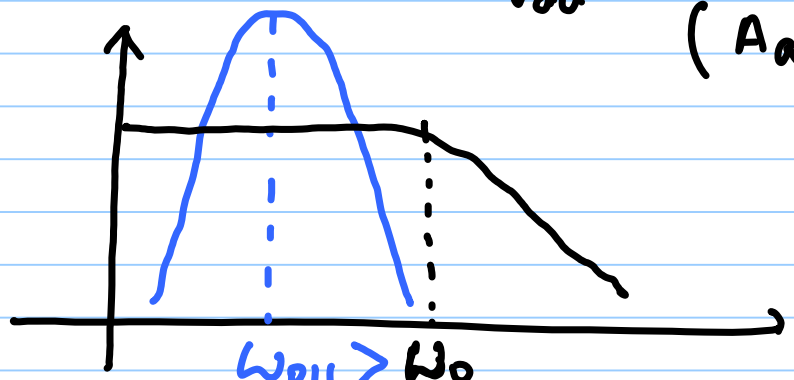
$\omega_a < \omega_o$ ✓

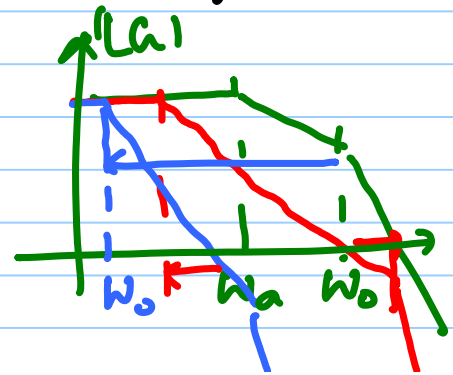
$\omega_a' \ll \omega_o'$

$\omega_a > \omega_o$

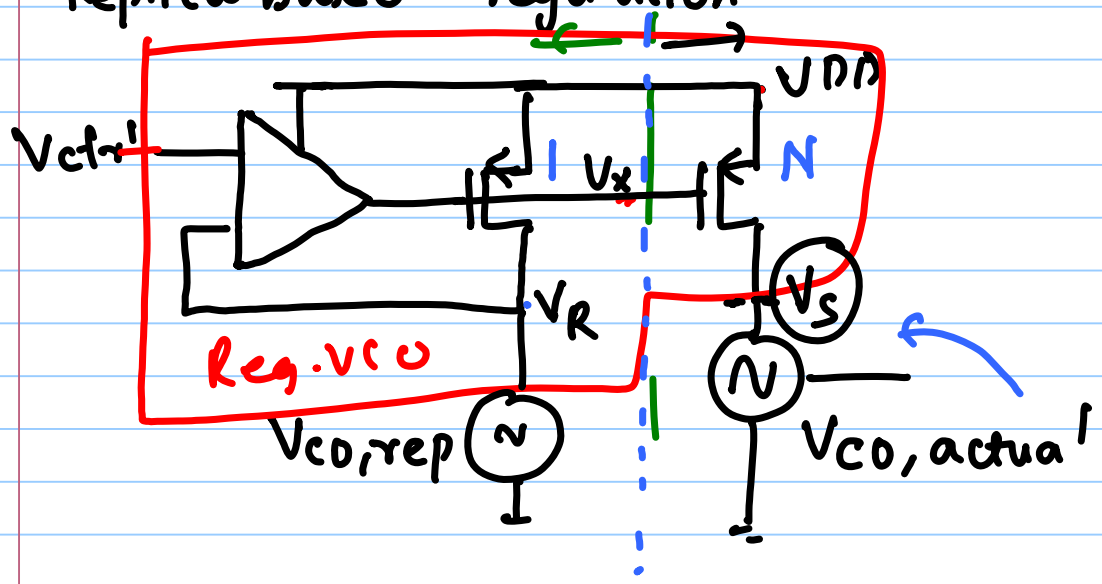
$\frac{V_s}{V_{ctrl}}$

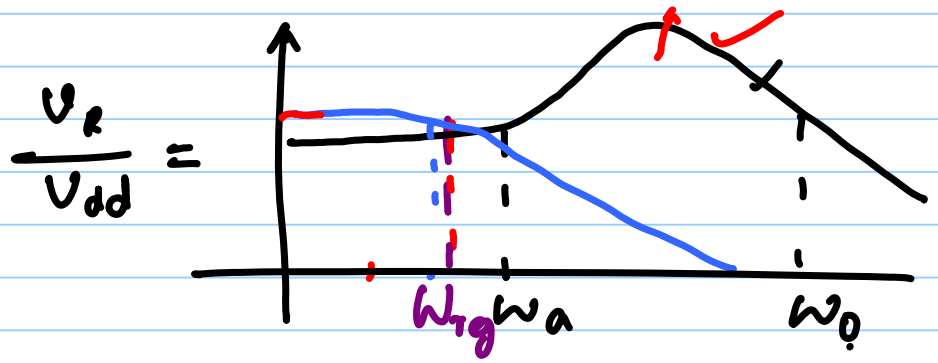
$$\frac{V_s}{V_{dd}} = \frac{S_{vdd}\ (1+s/\omega_a)}{\left(A_a A_o + \left(1+\frac{s}{\omega_a}\right)\left(1+\frac{s}{\omega_o}\right)\right)}$$





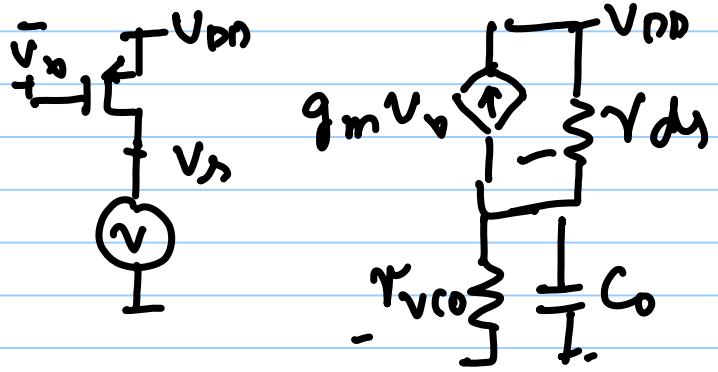
Replica-based regulation



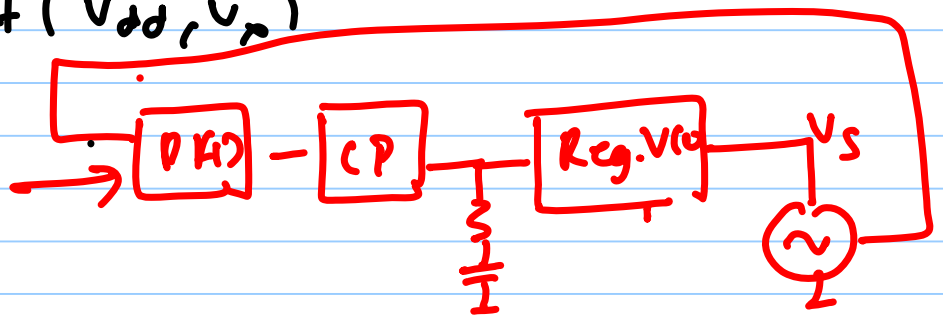


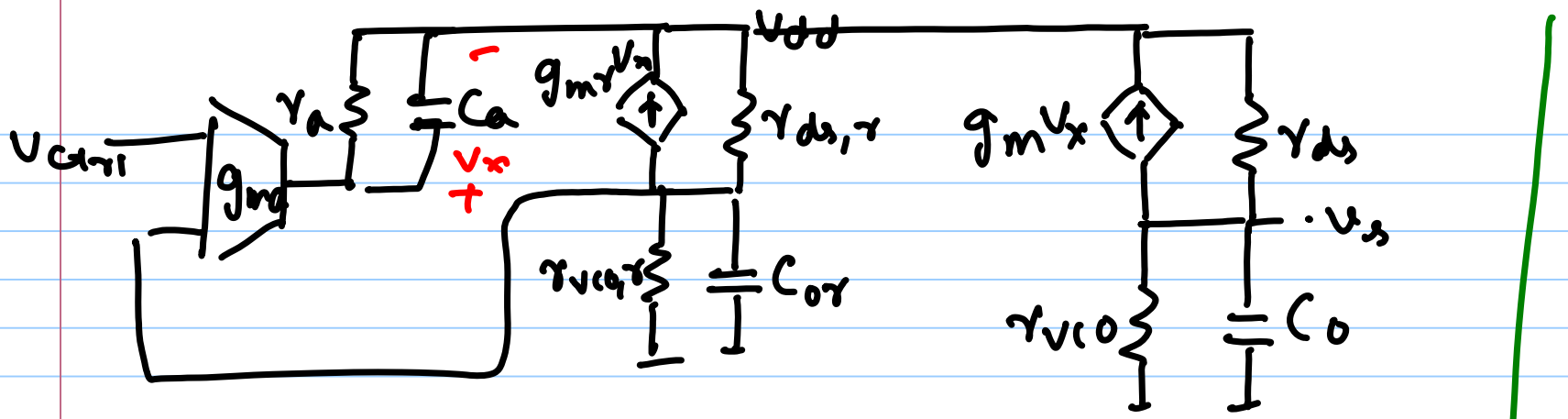
$$\omega_0' = \frac{1}{(r_{vco} \| r_{ds})\, C_0}$$

$$\frac{V_S}{V_{dd}} =$$



$$V_S = f(V_{dd}, V_x)$$

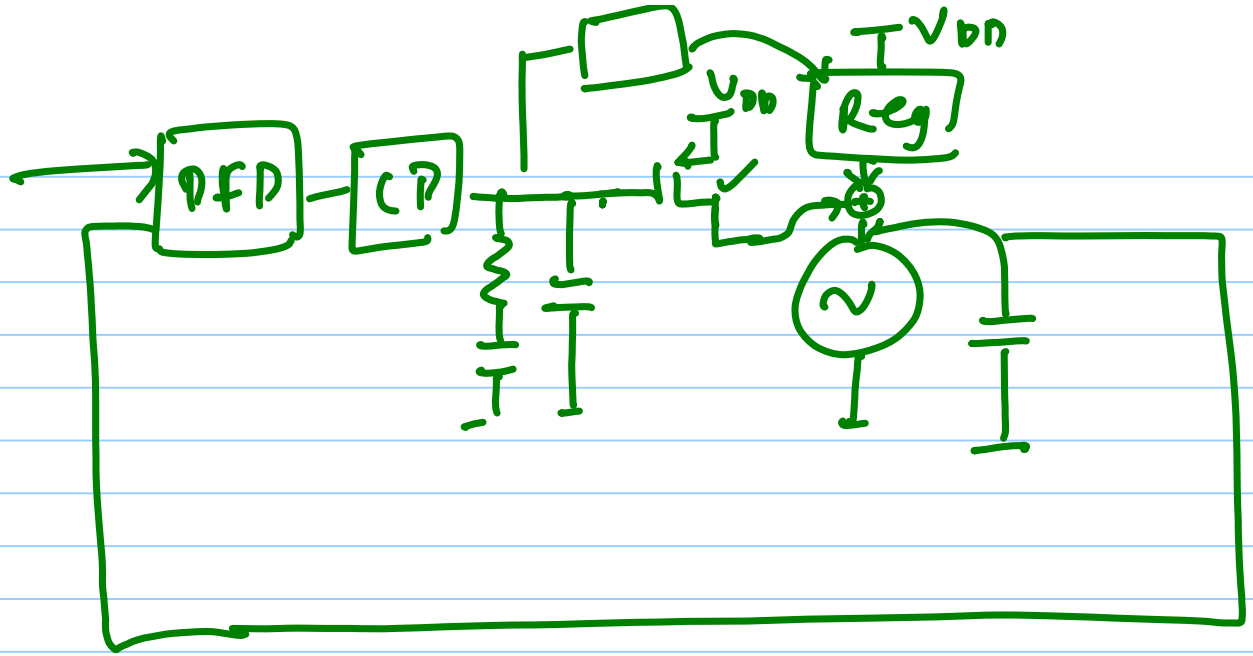


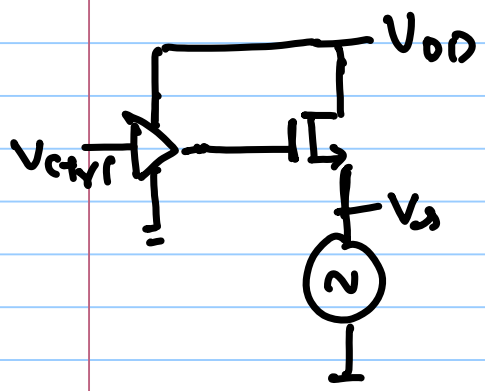


$$-g_m v_x + \frac{(V_{DD} - v_s)}{r_{ds}} = \frac{v_s (1 + s C_o r_{VCO})}{r_{VCO}}$$

$$v_s \left(\frac{1}{r_{ds}} + \frac{1}{r_{VCO}} + s C_o \right) = \frac{V_{dd}}{r_{ds}} - g_m v_x$$

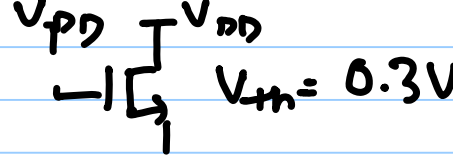
$$\frac{v_s}{V_{dd}} = \frac{r_{VCO}}{r_{ds} + r_{VCO}} \times \frac{1}{\left[1 + s C_o (r_{VCO} \| r_{ds}) \right]} - \frac{g_m}{1 + s C_o (r_o \| r_{VCO})} \frac{v_x}{V_{dd}}$$

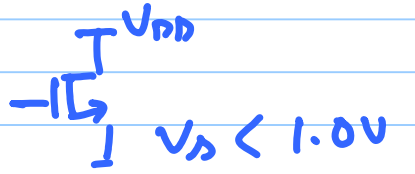




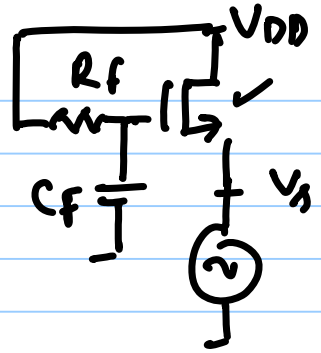
NMOS o/p stage

- Max. freq is limited.
- $\frac{V_o}{V_{dd}} \approx \frac{1}{g_m r_{ds}}$

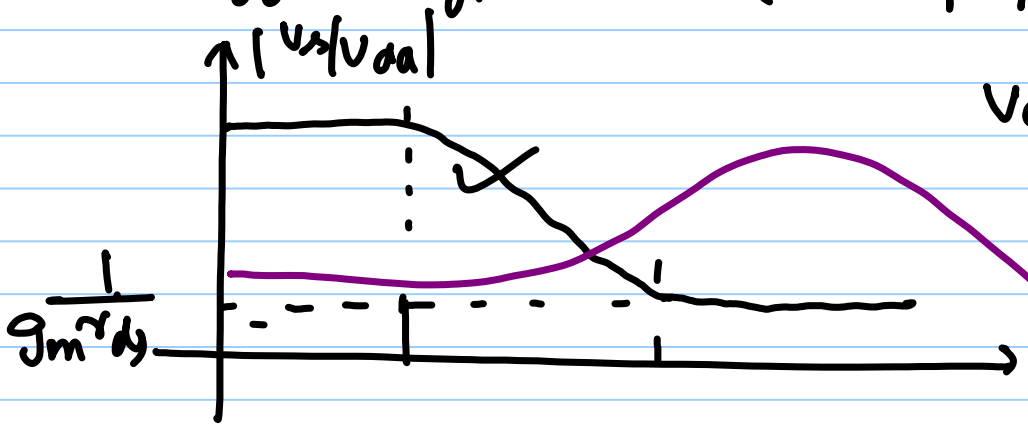


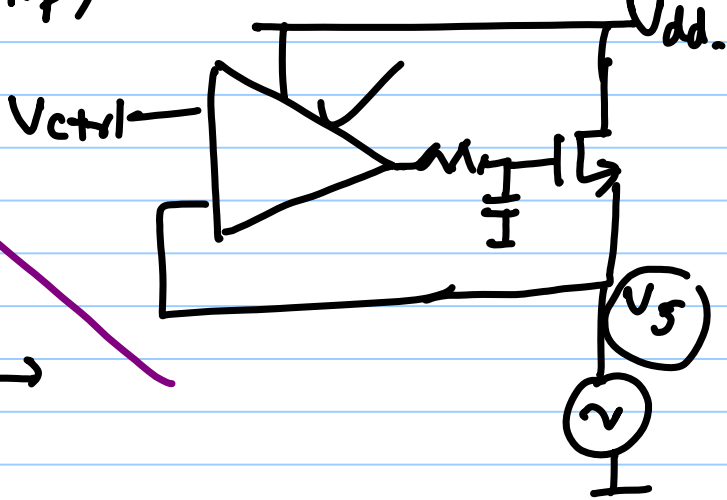


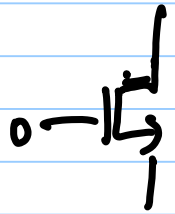
Native device, $V_{th} = 0$



$$\frac{V_s}{V_{dd}} \simeq \frac{1}{g_m r_{ds}} + \frac{1}{(1+sC_f R_f)}$$







Cascaded regulator