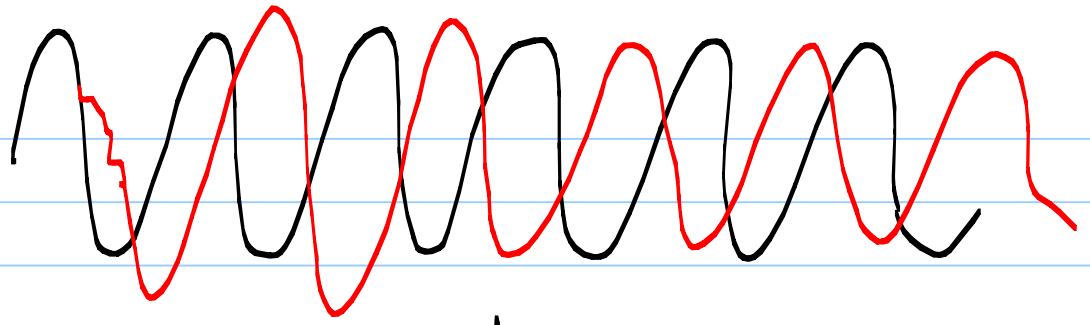
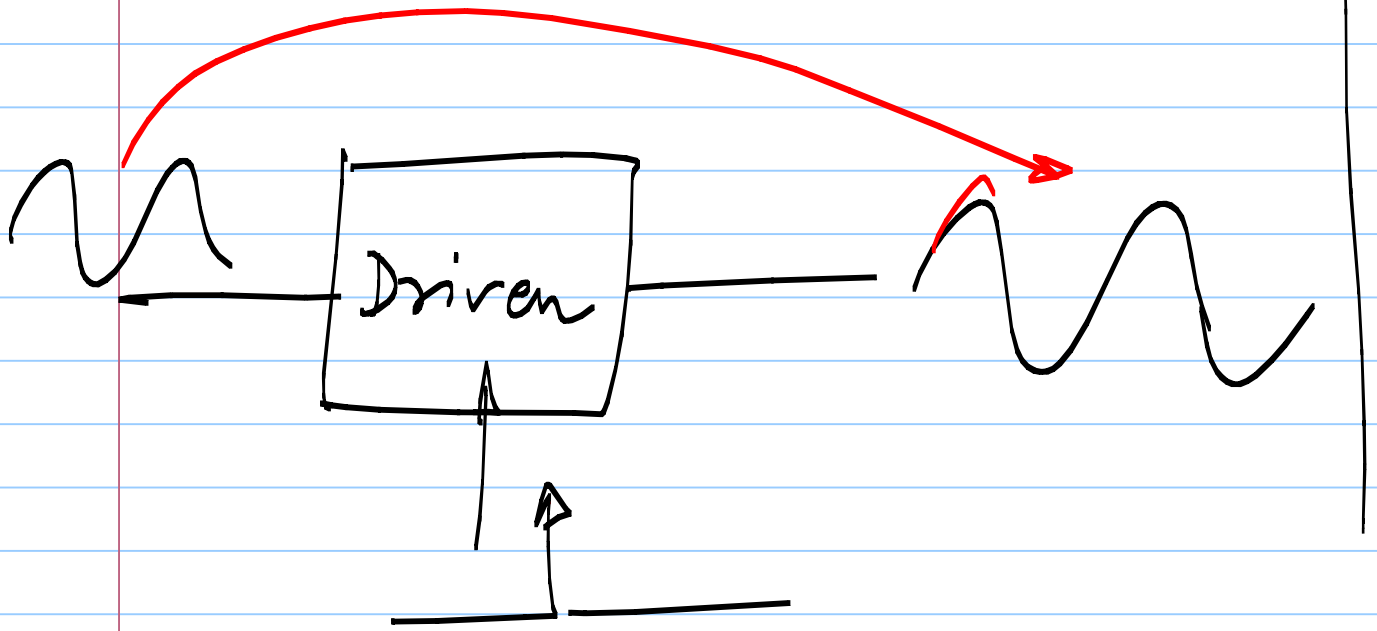
Lecture 20

Oscillator: autonomous





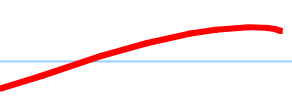
After a temporary disturbance, oscillator output amplitude is restored to the original

phase disturbances persist forever

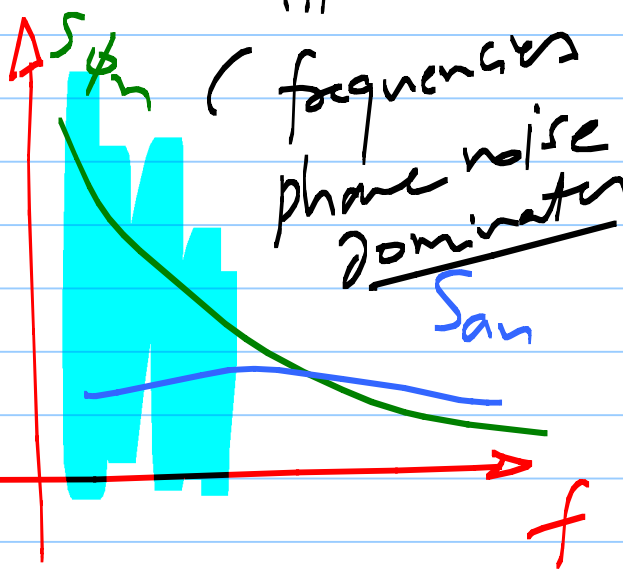
$(A_0 + a_n)\cos(2\pi f_0 t + \phi_n)$

amplitude noise

phase noise

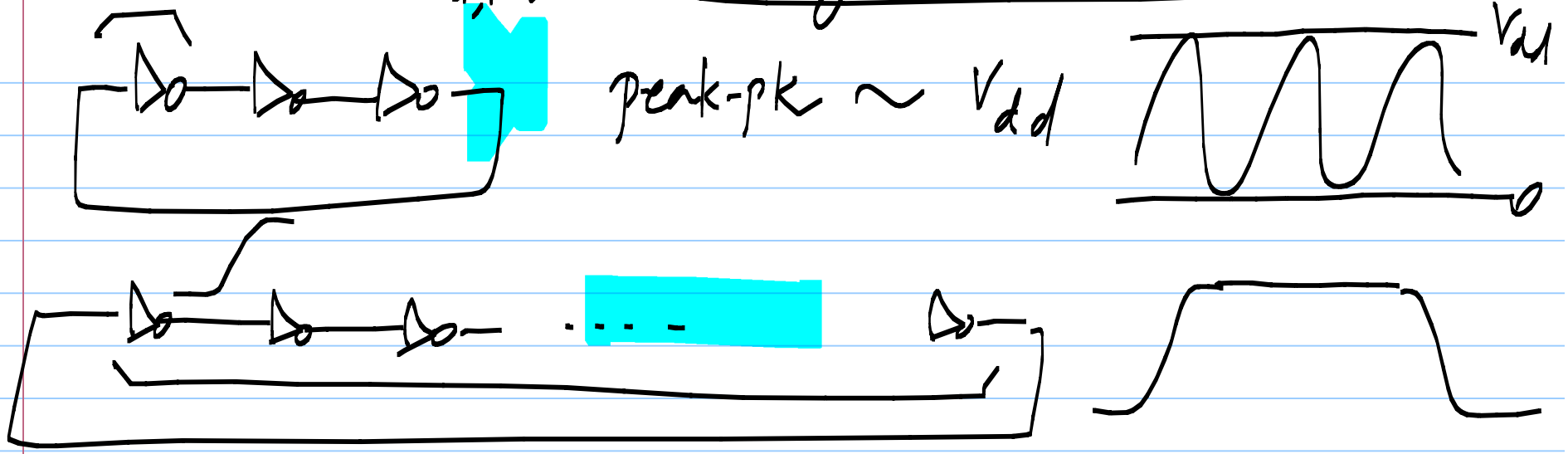


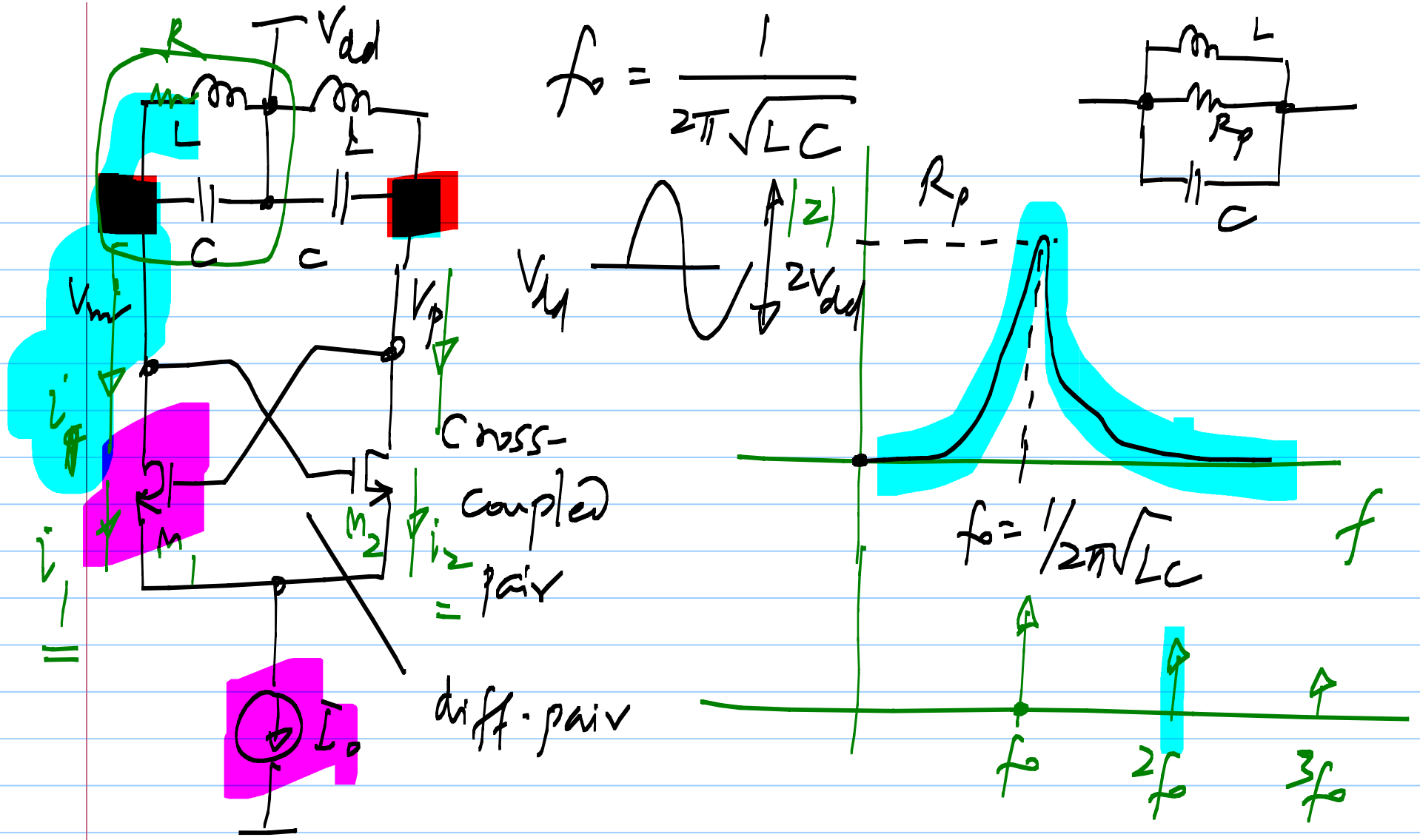
At low frequencies phase noise dominates



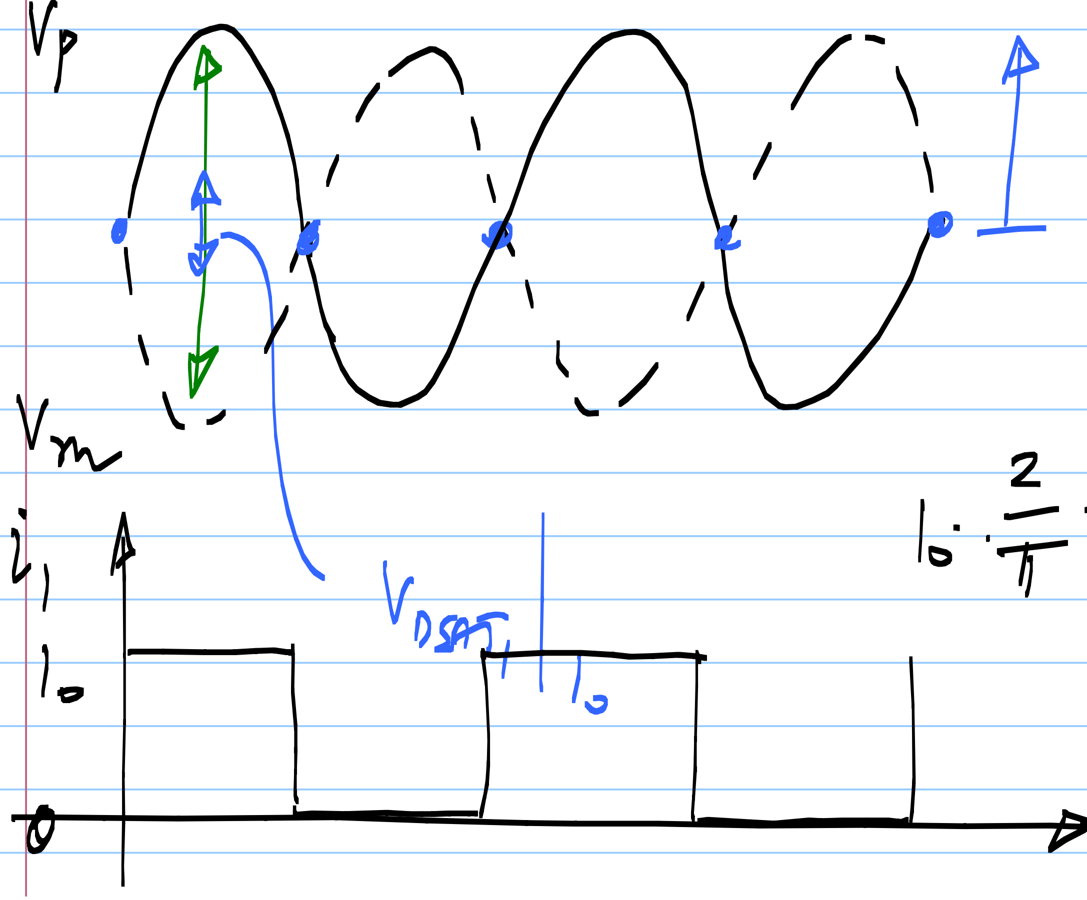
$f_{osc} = 1/2N \cdot t_{d,inv}$

Ring oscillator

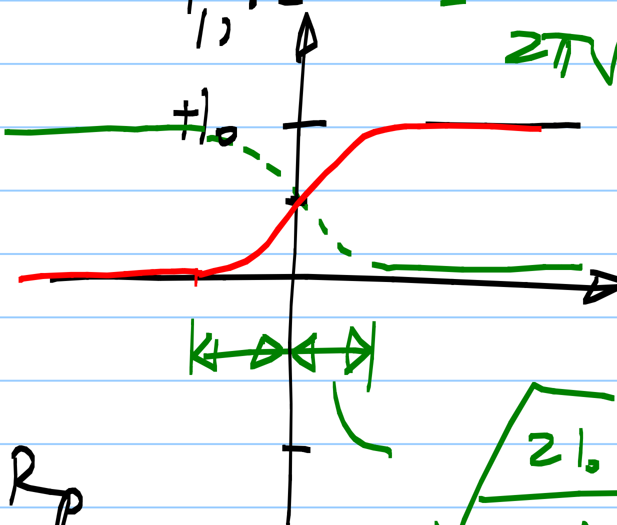



R
V_{dd}
L
L
C
C
V_m
V_p
i_1
i_2
M_1
M_2
Cross-coupled pair
diff. pair
I_0
$f_0 = \frac{1}{2\pi\sqrt{LC}}$
V_{in}
|Z|
$2V_{dd}$
R_p
L
R_p
C
$f_0 = 1/2\pi\sqrt{LC}$
f
f_0
$2f_0$
$3f_0$

output voltage waveform : sinusoidal @ $f_0 = \frac{1}{2\pi\sqrt{LC}}$

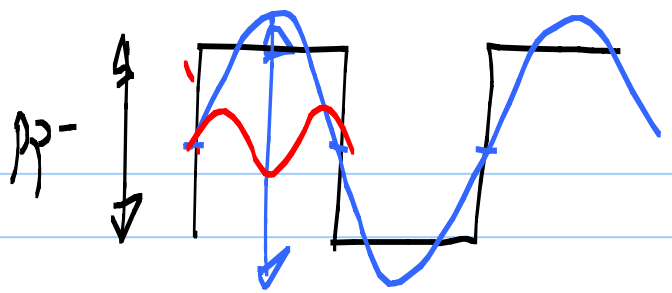


$I_0 \cdot \frac{2}{\pi} \cdot R_p$



$\sqrt{\frac{2I_0}{\mu_n C_{ox} W/L}}$

$V_{DSAT,1}\Big|_{I_0}$



Complete switching:

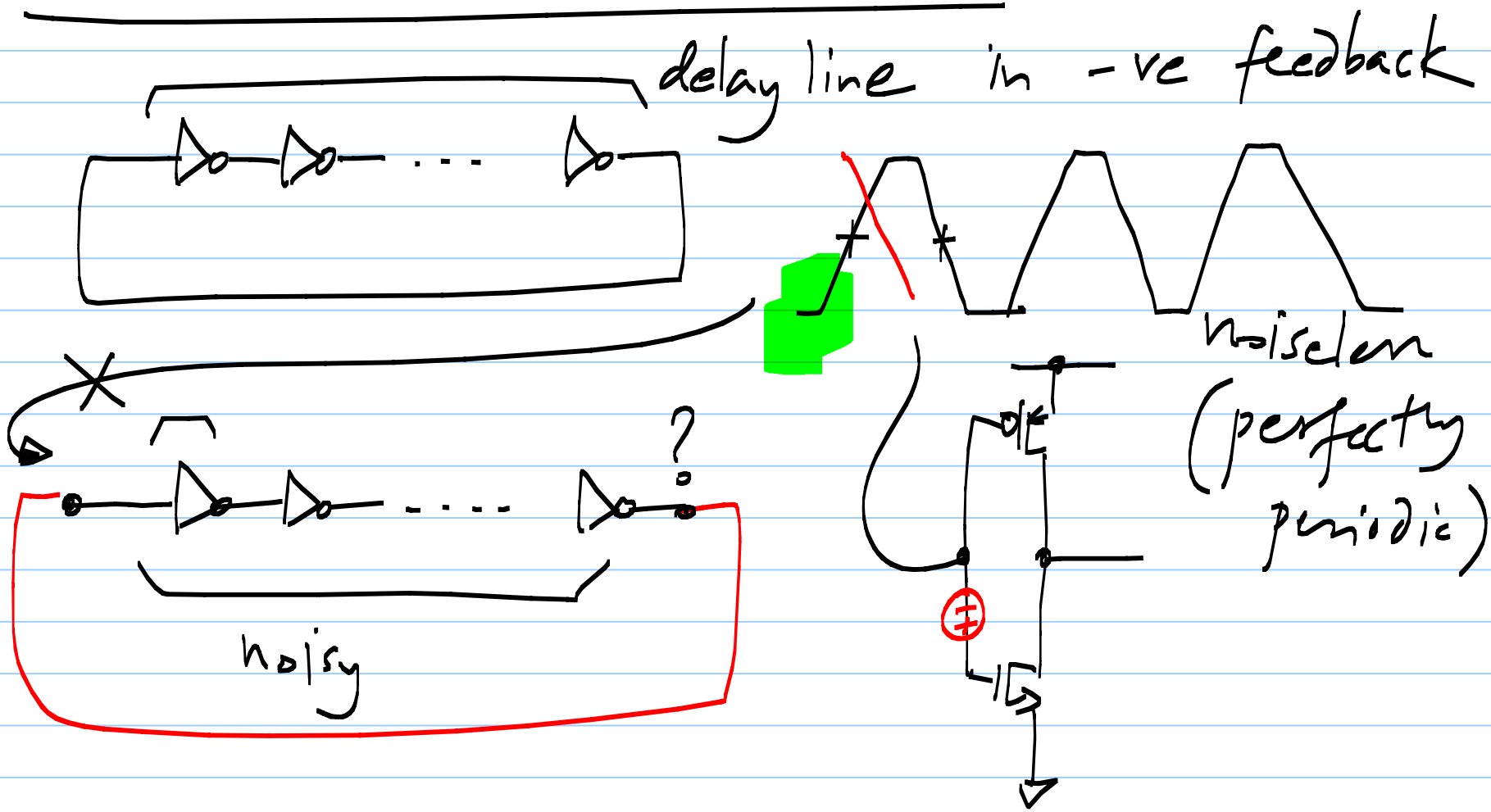
Oscillation amplitude:

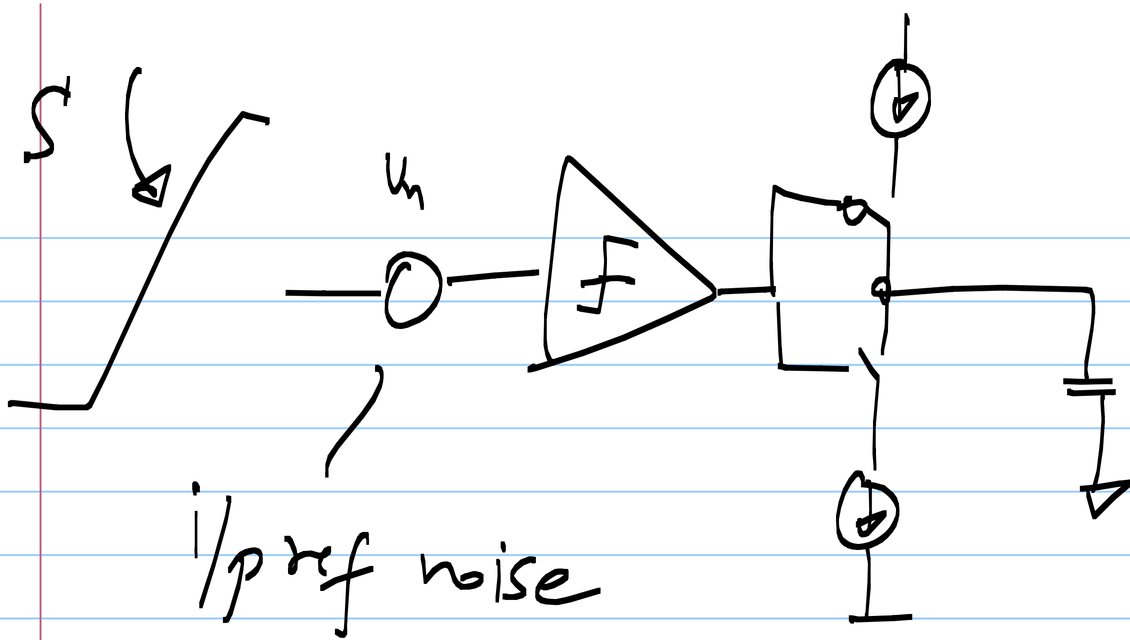
V_p, V_m : $\frac{2}{\pi} I_{pp}$ (peak)

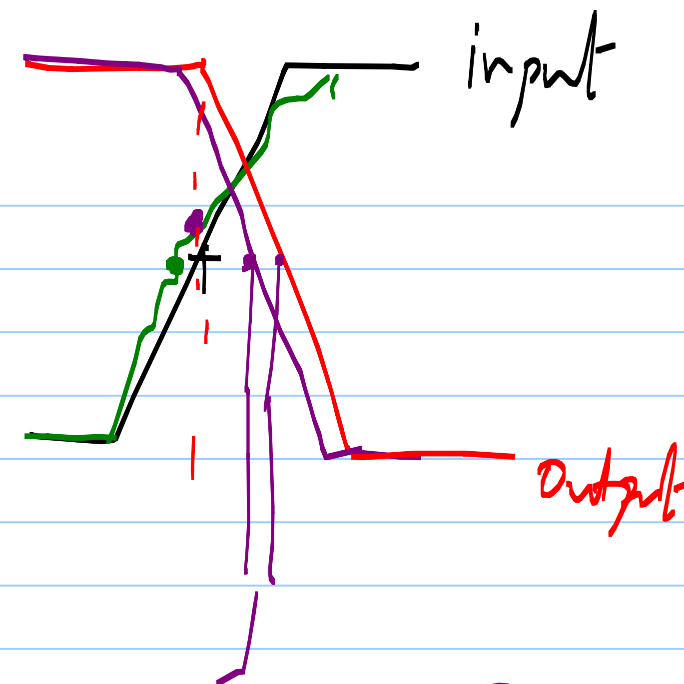
pk-pk of $(V_{p1} - V_{pm})$:

$$\frac{\delta}{\pi} I_{pp}$$

Phase noise in an oscillator:







$$\simeq \frac{\text{noise @ sw. instant}}{\text{slope}}$$

$$\text{Zero crossing shift} = \frac{v_n \big|_{\text{zero crossings}}}{\text{Slope}}$$

$$\text{phase shift} = \frac{2\pi}{T_0} \times \frac{v_n \big|_{\text{zero crossings}}}{\text{Slope}}$$

(T_0: osc. period)

Delay line

Osc.