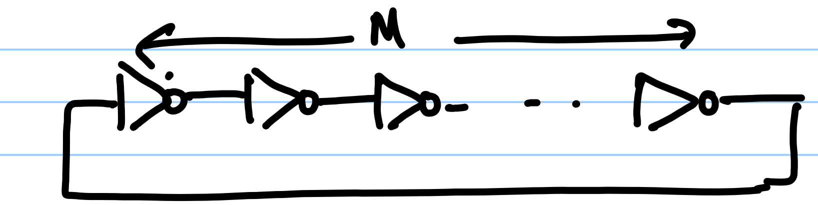
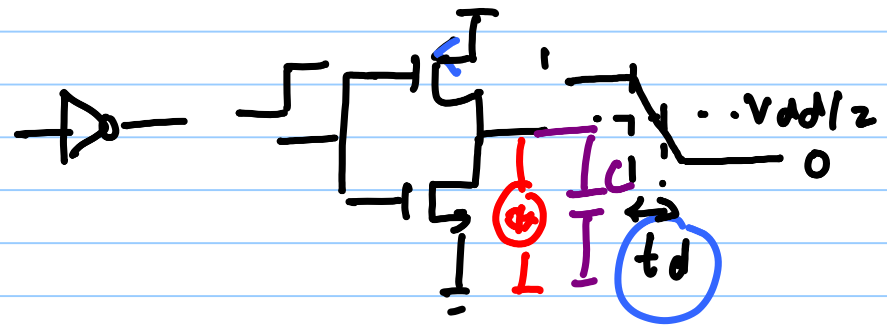
Note Title 16-10-2017

Lecture # 39



$$\sigma_{t_{dn}}^2 = \frac{4kT\gamma_N t_{dN}}{I_N(V_{DD}-V_{tn})} + \frac{kTC}{I_N^2}$$



T: Temperature

I_N: saturation current

$$f_0 = \frac{I/C}{MV_{DD}}$$

$I_N = I_P$

$\tau = M(t_{dp} + t_{dn})$

$$\sigma_\tau^2 = M(\sigma_{t_{dn}}^2 + \sigma_{t_{dp}}^2)$$

$$= M\left[\frac{4kT}{I\ (V_{DD}-V_t)}(\gamma_N+\gamma_P) + \frac{2kTC}{I^2}\right]$$

$$\sigma_\tau^2 = \frac{kT}{I f_0}\left(\frac{2}{V_{DD}-V_t}(\gamma_N+\gamma_p) + \frac{2}{V_{DD}}\right)$$

$$\mathcal{L}(f) = \sigma_\tau^2 \frac{f_0^3}{f^2} = \frac{2kT}{I}\left(\frac{1}{V_{DD}-V_t}(\gamma_N+\gamma_p) + \frac{1}{V_{DD}}\right)\left(\frac{f_0}{f}\right)^2$$

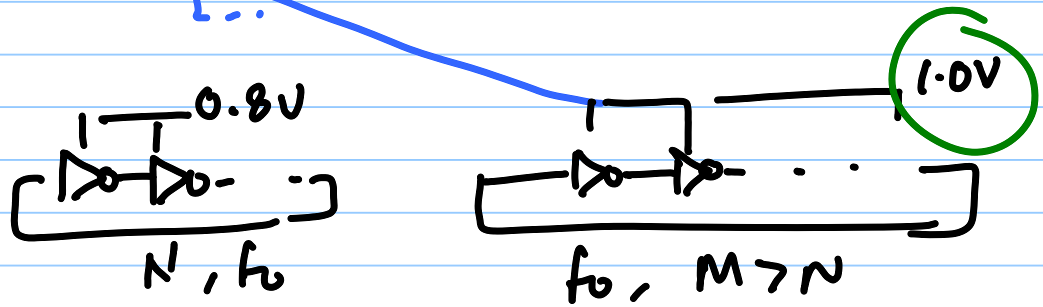
$\left(\frac{f_0}{f}\right)^2$

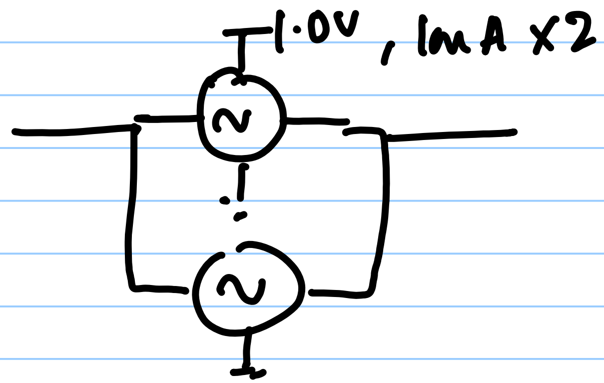
-90 dBc/Hz @ 1MHz.

-20 dB/dec.

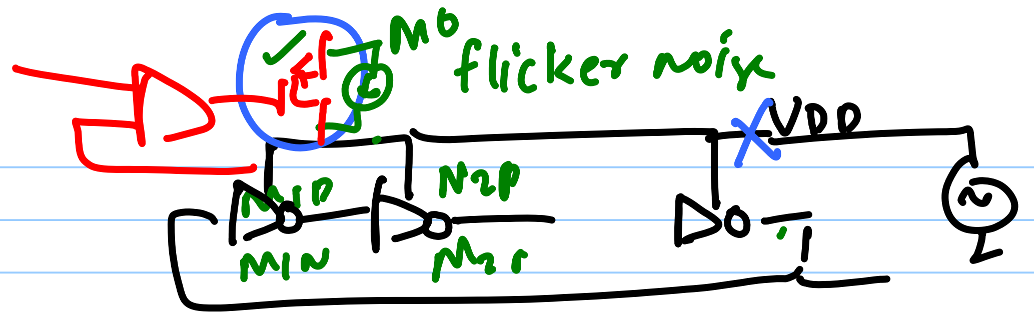
$\mathcal{L}(f) \propto \frac{1}{f^2}$

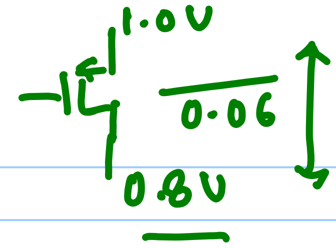
$\mathcal{L}(f) \propto \frac{1}{V_{DD}}$



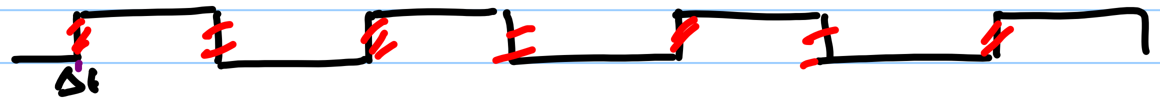


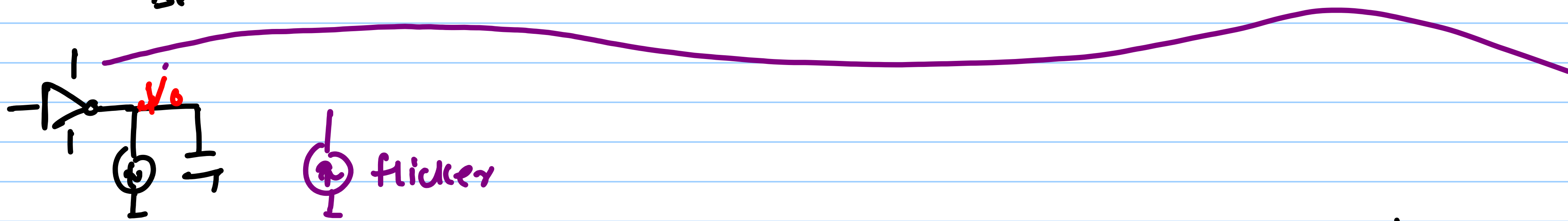
3 dB improvement.

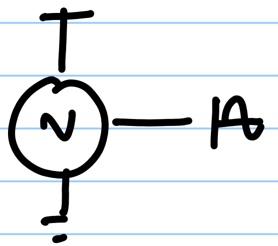




Ring Noise Summary







$$f_0 = \frac{I}{C V_{DD}} = \frac{2}{C V_{DD}} \left(\sum_{j=1}^{m} \frac{1}{I_{Nj}} + \frac{1}{I_{Pj}} \right)^{-1}$$

$$\frac{df_0}{dI_{Nj}} = \frac{C V_{DD} f_0^2}{2 I_{Nj}^2} = \frac{f_0}{2MI}$$

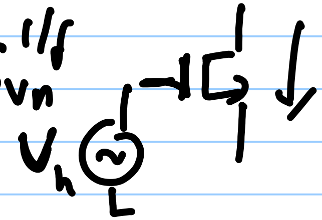
$$\mathcal{L}(f) = \frac{1}{4f^2}\left(\frac{f_0}{2MI}\right)^2 S_{i_{Nj}}^{1/f}(f)$$

$$\mathcal{L}(f) = \frac{(df/dI)^2}{4f^2} S_I(f)$$

$$\mathcal{L}(f) = \frac{(df/dv)}{4f^2} S_v(f)$$

$$\checkmark\; S_{v_n}^{1/f} = \frac{K_{fN}}{W L C_{ox}' f}$$

$S_{v_n}^{1/f}$



$$S_{i_n}^{1/f} = g_m^2 S_{v_n}^{1/f}$$

$$I = \frac{KW}{2L}(V_{GS} - V_t)^2$$

$$K = \mu C_{ox}$$

$$f_0 = \frac{2}{CV_{DD}}\left(\sum_{j=1}^{M} \frac{1}{I_{Nj}} + \frac{1}{I_{Pj}}\right)^{-1}$$

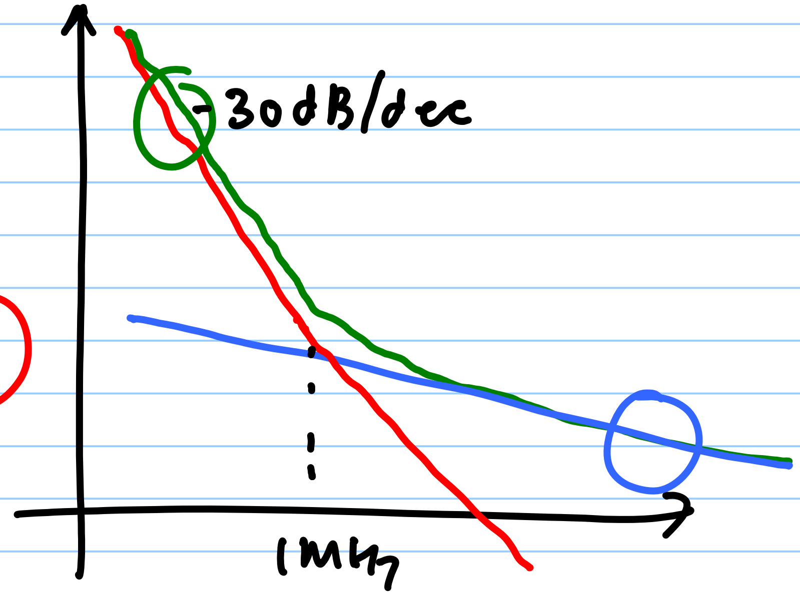
$$\left(\sum \frac{1}{I_{Nj}} + \frac{1}{I_{Pj}}\right)^{-1}$$

$$\frac{df_0}{dI_{Nk}} = \frac{2}{CV_{DD}} \frac{1}{\left(\sum \frac{1}{I_{Nj}} + \frac{1}{I_{Pj}}\right)^{-2}} \times \frac{-1}{I_{Nk}^2}$$

$$= \frac{f_0}{(\quad)^{-1}} \times \frac{1}{I_{Nk}^2} = \frac{f_0}{2MI}$$

$$\mathcal{L}(f) = \frac{1}{4f^2}\left(\frac{f_0}{2MI}\right)^2 \times M\left(S_{i,NK}^{1/f} + S_{i,PK}^{1/f}\right)$$

$$= \frac{C_{ox}'}{8MI}\left(\frac{\mu_N K_{fn}}{L_N^2} + \frac{\mu_P K_{fp}}{L_P^2}\right)\frac{f_0^2}{f^3}$$



White noise $(f_0/f)^2$

flicker noise f_0^2/f^3

−87 dBc/Hz @ 1MHz

$f_0 = 1$ GHz. −110 dBc/Hz 100 MHz

$f_0 = 2$ GHz −90 dBc/Hz 1 GHz