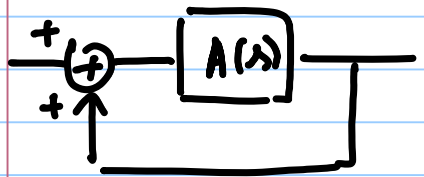
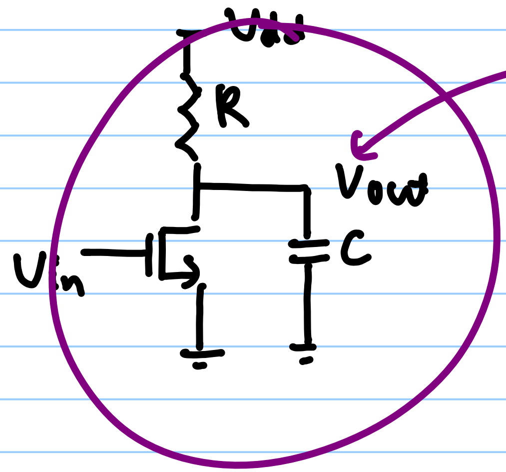
Note Title 03-10-2017

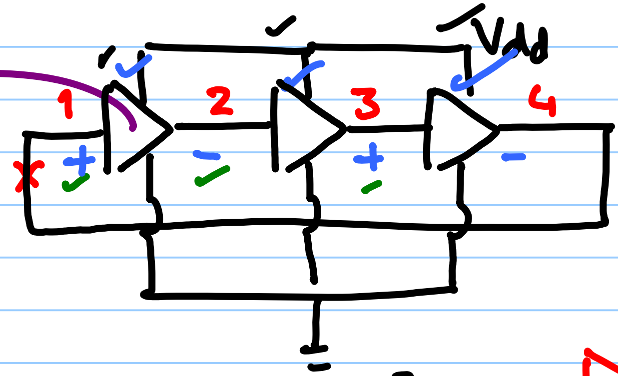
Lecture # 31

Oscillator



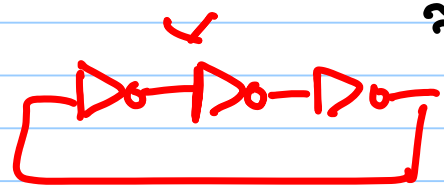
$|A(j\omega_{osc})| = 1, \quad \angle A(j\omega_{osc}) = 2k\pi$





$$\frac{V_{out}}{V_{in}} = -\frac{g_m(r_o \| R)}{1 + sC(r_o \| R)}$$

$$\approx -\frac{(g_m R) = A_0}{1 + sCR}$$



$$LG = \left(-\frac{A_0}{1 + s/\omega_p}\right)^3$$

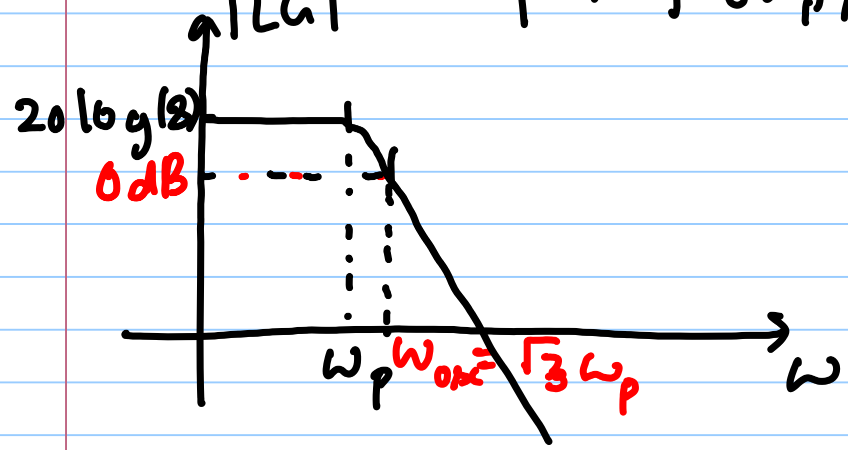
$$|LG(\omega_{osc})| = 1$$

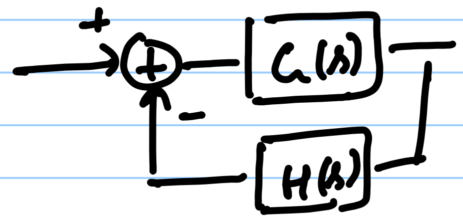
$$\angle LG(\omega_{osc}) = 2k\pi = -180^\circ - 3\tan^{-1}(\omega_{osc}/\omega_p) = -360^\circ$$

$$\tan^{-1}\left(\frac{\omega_{osc}}{\omega_p}\right) = 60^\circ \Rightarrow \frac{\omega_{osc}}{\omega_p} = \tan(60^\circ)$$

$$\Rightarrow \omega_{osc} = \sqrt{3}\,\omega_p = \frac{\sqrt{3}}{RC}$$

$$|LG| = \frac{A_0^3}{\left|1 + j\sqrt{3}\,\omega_p/\omega_p\right|^3} = \frac{A_0^3}{2^3} \Rightarrow A_0 = 2$$





$$\frac{G(s)}{1 + G(s)H(s)}$$

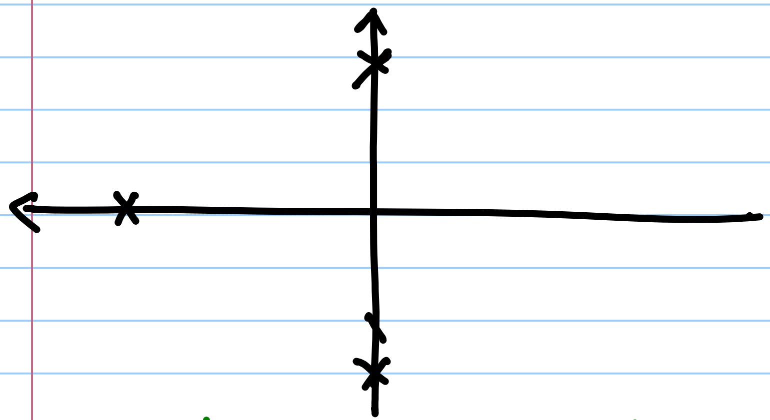
$$LG = \frac{-(2)^3}{(1 + s/\omega_p)^3}$$

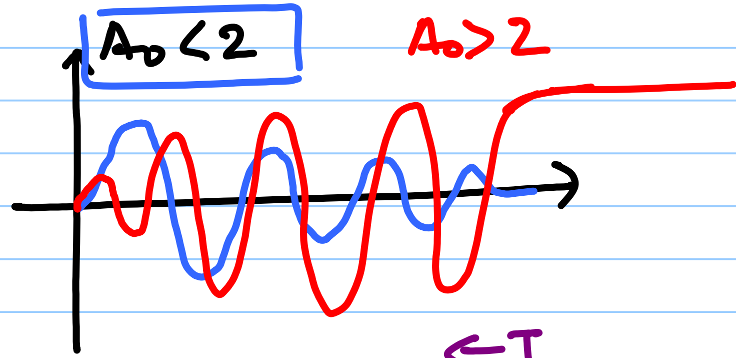
$$\frac{LG}{1 + LG} = \frac{-A_0^3}{-A_0^3 - (1 + s/\omega_p)^3}$$

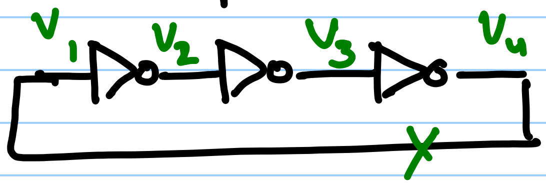
$$(1 + s/\omega_p)^3 + A_0^3 = 0$$

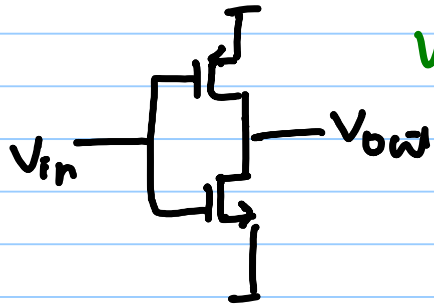
$$(1 + s/\omega_p)^3 = -A_0^3$$

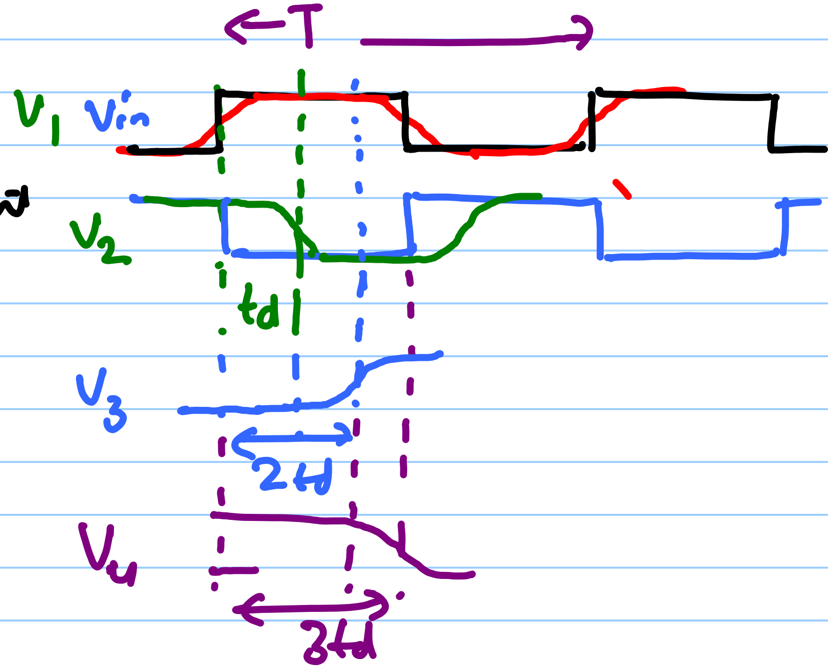
$$(-1)^{1/3} = e^{j\pi/3 + j\,2k\pi/3}, \quad k = 0, 1, 2$$







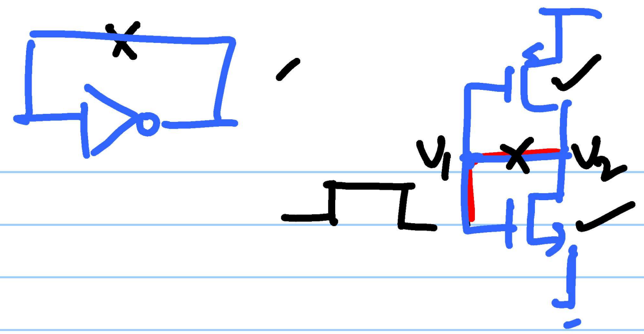


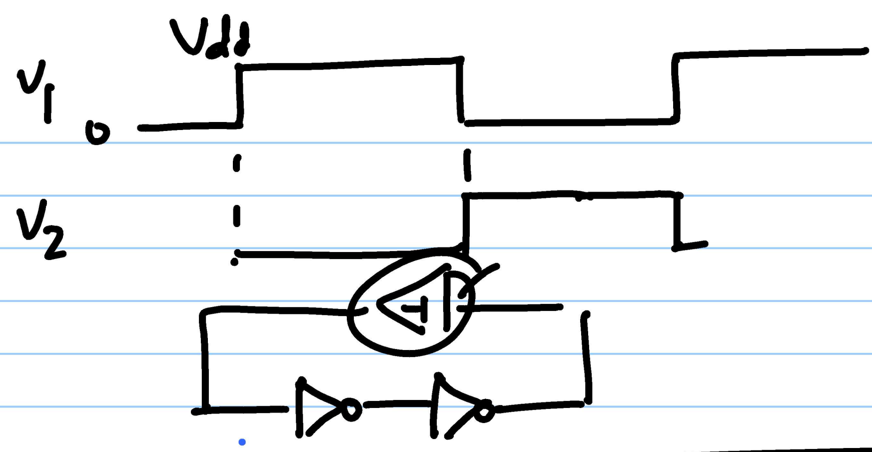


$$\frac{T}{2} = 3t_d$$

$$T = 6t_d$$

$$f_{osc} = \frac{1}{T} = \frac{1}{6t_d}$$





$V_{DS} > V_{GS} - V_{Th}$

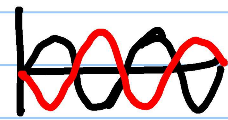
Oscillator Summary:

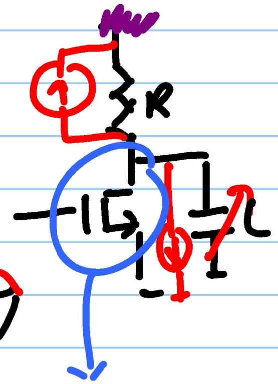
1.) Oscillation frequency, $\omega_{osc} = \frac{\sqrt{3}}{RC}$, $f_{osc} = \frac{\sqrt{3}}{2\pi RC}$

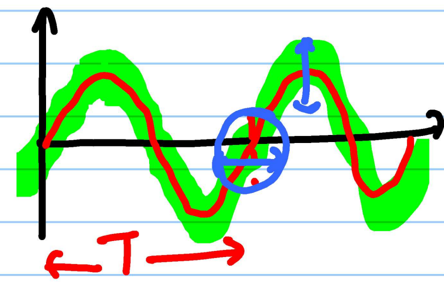
2) Amplitude : Limited output swing.

3) Power

4) Phase noise / Jitter



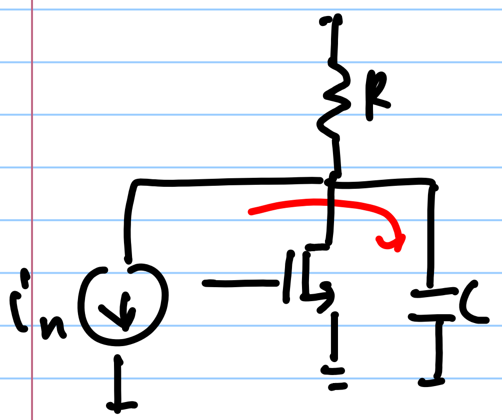


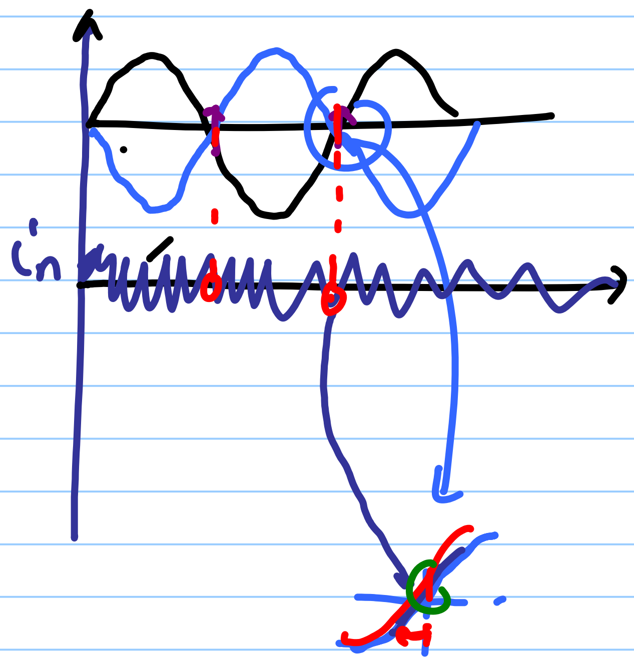


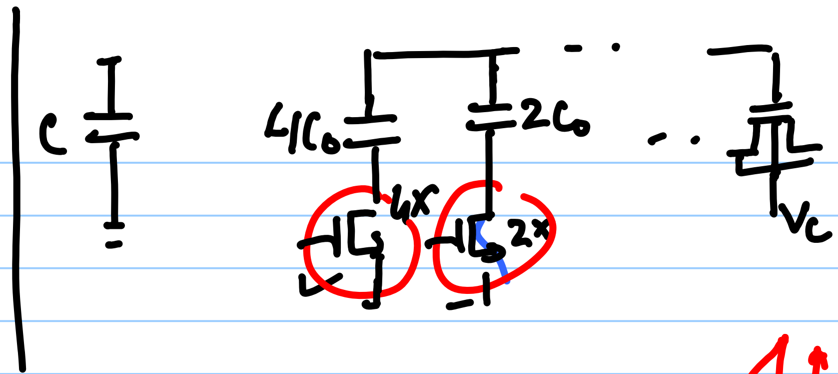
For R $\overline{i_n^2} = \frac{4KT}{R}$ A^2/Hz

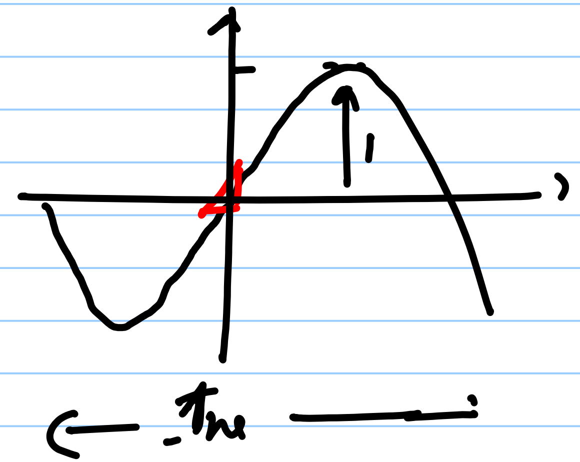
Mosfet $\overline{i_n^2} = 8KT/3 \; g_m$ A^2/Hz

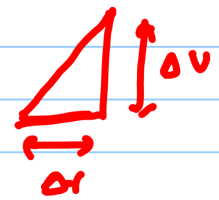
5)











$$\frac{dV_{out}}{dt} : A\omega = 1 \cdot 2\pi \times 10^9 = \frac{\Delta V}{\Delta t}$$

$$\Delta V = 2\pi \times 10^9 \times 1\,ps = 6.28 \times 10^{-3}$$

$$= \underline{6.28\ mV}$$