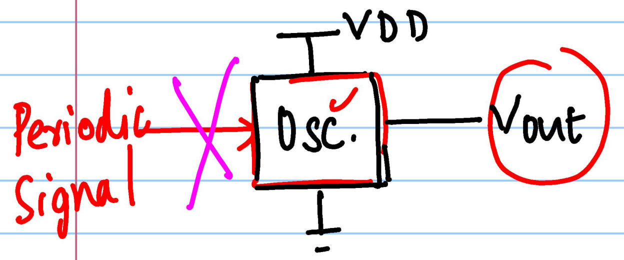
Note Title

Lecture # 41

Oscillator : Produces periodic signals

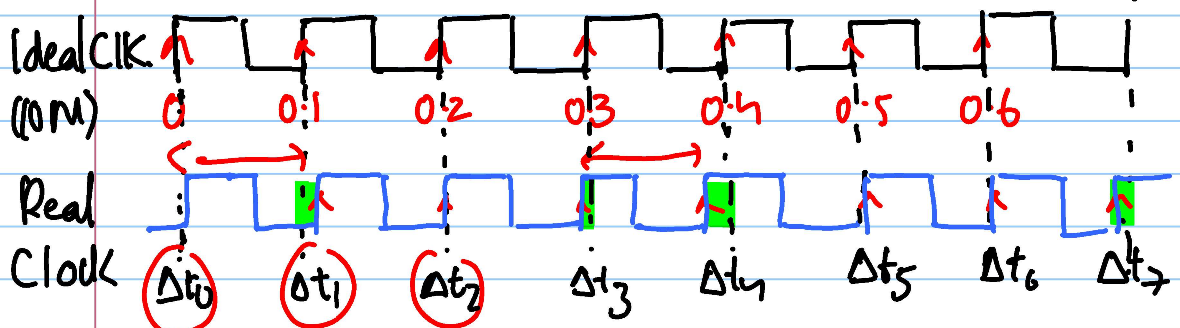


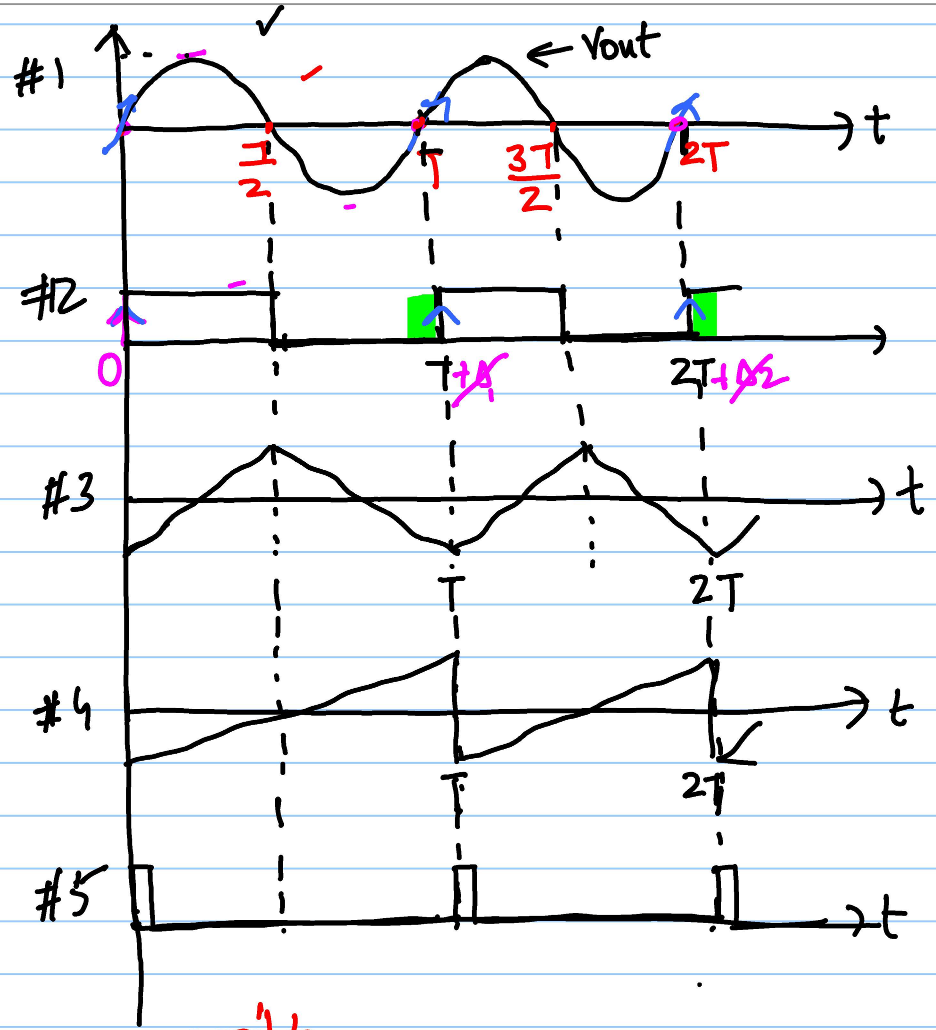
Periodic Output. (Clock)

10 Mb/s → 10 MHz

frequency, $f = \frac{1}{T}$

$\omega = \frac{2\pi}{T}$





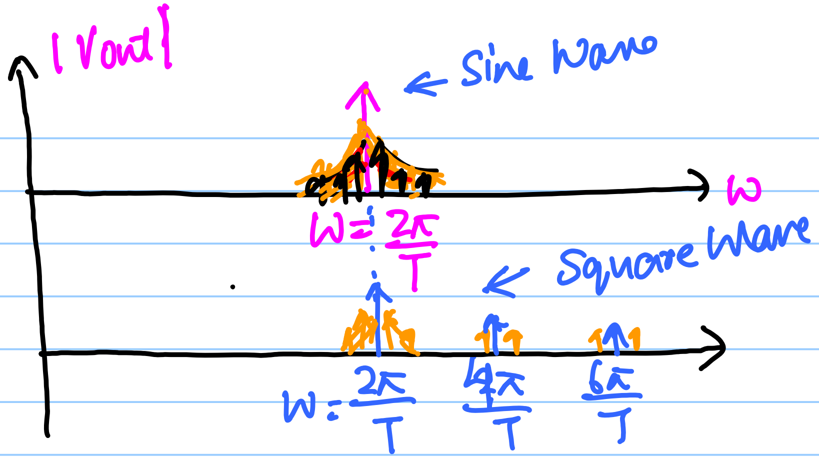
Δt_i : Gaussian Distribution

Standard deviation of Δt as minimum as possible.

1. Crystal Oscillator (Piezoelectric)

- ΔF is very low. (10 ppm) Stability of the oscillator
- Very low noise
- Tunability is very low.

@ 10 MHz → 11 MHz



Clock Source, $f_0 + \Delta F$

$$\frac{\pm \Delta F}{f_0} \times 10^6 = \text{frequency error in ppm}$$

$$\frac{\Delta F}{1\,GHz} \times 10^6 = 10 \text{ ppm}$$

$$= \pm 10$$

$$\Delta F = \frac{10}{10^6} \times 10^9 = 10^4 \text{ Hz}$$

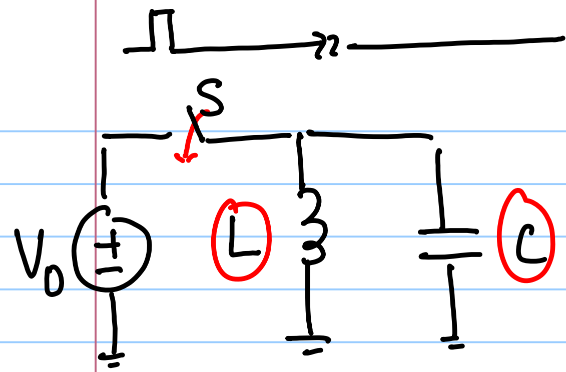
$\Delta f = 10$ KHz.

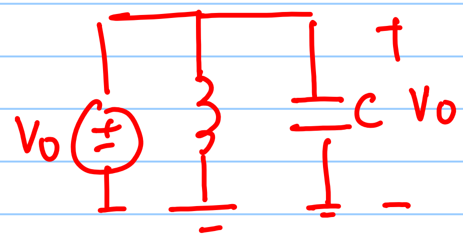
2. Tuned LC oscillator

- ΔF is low
- Low Noise
- Tunablity is low

$$\frac{1\,MHz}{1\,GHz} \times 10^6$$

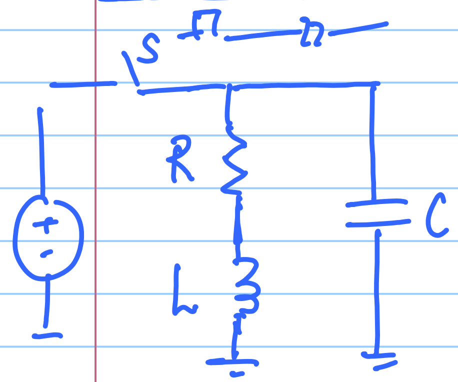
$$= \frac{1}{10^3} \times 10^6 = 10^3$$

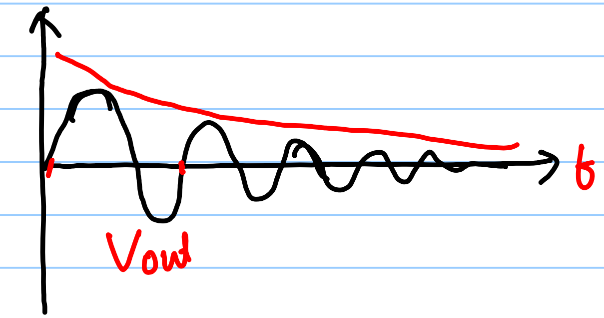




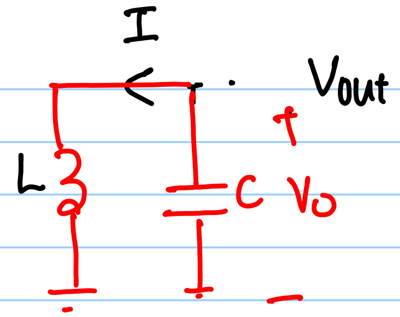
Closed Switch.

$$\omega_0 = \frac{1}{\sqrt{LC}}, \quad f_0 = \frac{1}{T} = \frac{1}{2\pi\sqrt{LC}}$$





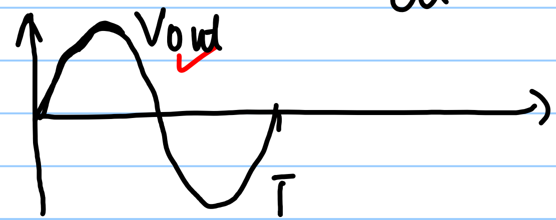
Switch is open.



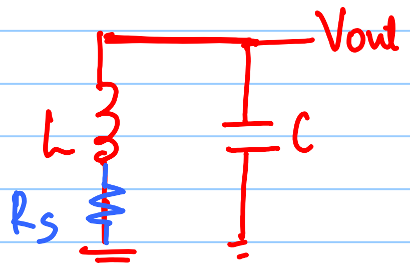
$$C\frac{dV_{out}}{dt} = -I$$

$$V_{out} = L\frac{dI}{dt}$$

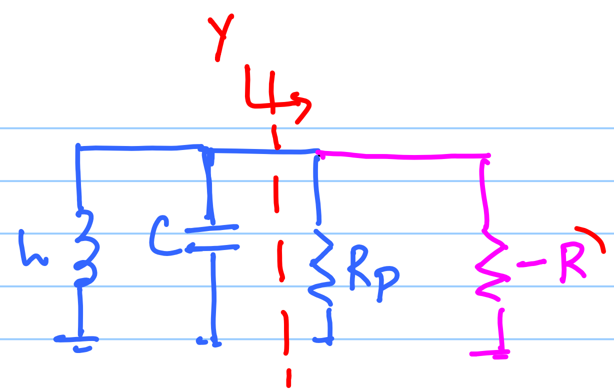
$$V_{out} = -LC\frac{d^2V_{out}}{dt^2} \Rightarrow V_{out} = A\sin(\omega t)$$



$$\omega_0 = \frac{2\pi}{T} = \frac{1}{\sqrt{LC}}$$



$\equiv$ @ $\omega_0 = \frac{1}{\sqrt{LC}}$

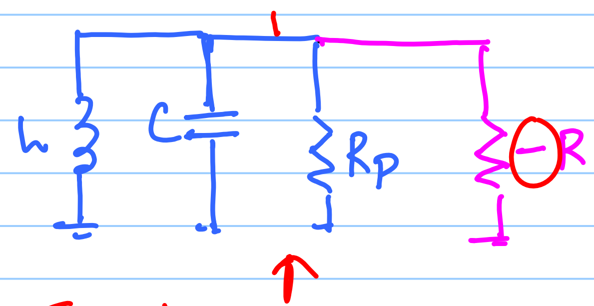


$$Y = \frac{1}{R_p} - \frac{1}{R}$$

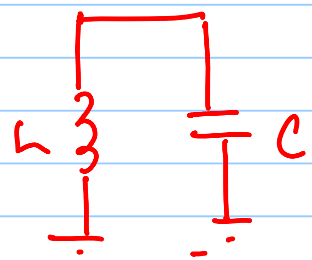
$$Z = \frac{R_p(-R)}{R_p - R}$$

$$(R_s + j\omega_0 L) \| \frac{1}{j\omega_0 C} = \left(j\omega_0 L \| \frac{1}{j\omega_0 C} \| R_p \right)$$

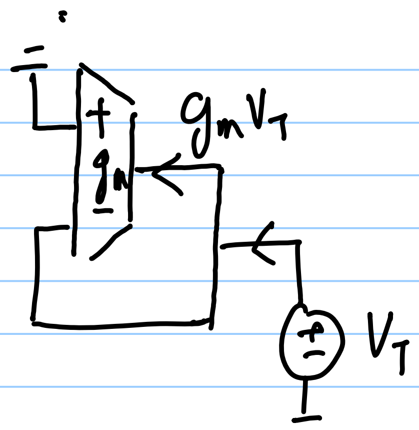
if $R = R_p$: $Z \to \infty$, $Y \to 0$



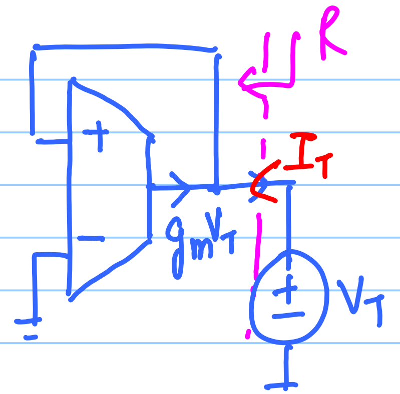
$R = R_p$ →



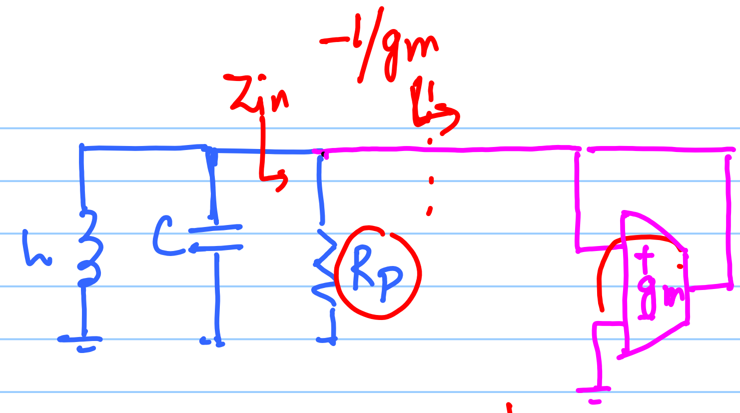
$\omega_0 = \frac{1}{\sqrt{LC}}$ ✓



$R = \frac{1}{g_m}$

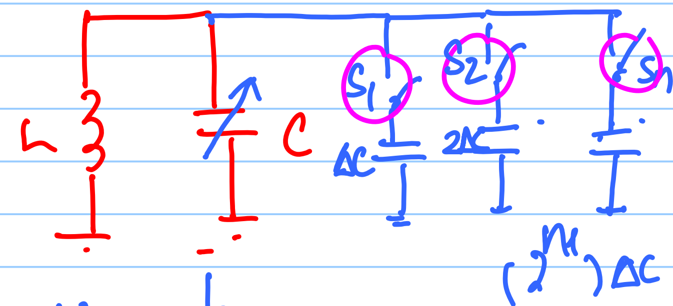


$R = \frac{V_T}{I_T} = -\frac{1}{g_m}$



$Z_{in} = \frac{-1}{g_m} \parallel R_P \xrightarrow{@ g_m = \frac{1}{R_P}} \infty$

$\Downarrow$

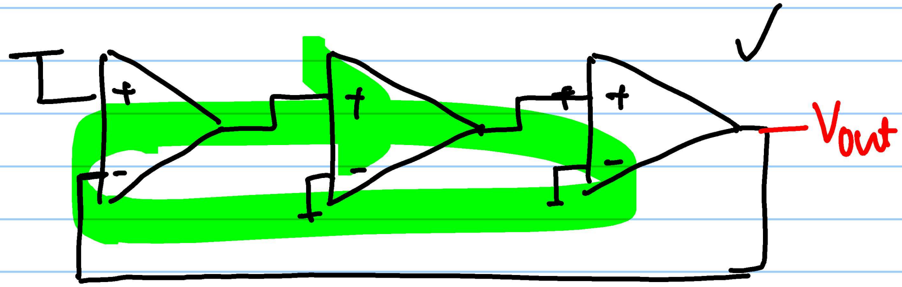


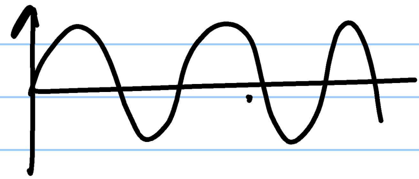
$\omega_0 = \frac{1}{\sqrt{LC}}$

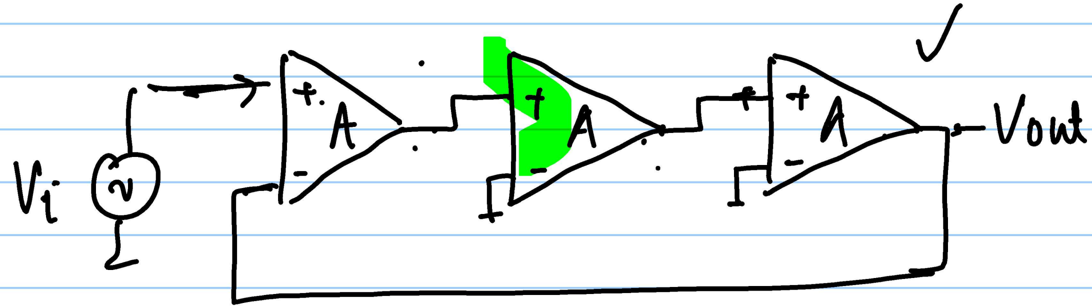
$C_{Total} = C + S_1 \cdot \Delta C + S_2 \cdot (2\Delta C) \ldots$

3. Ring Oscillator.

- Amplifiers
- Inverters (Delay elements)







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

$$\frac{V_{out}}{V_i} = 1$$