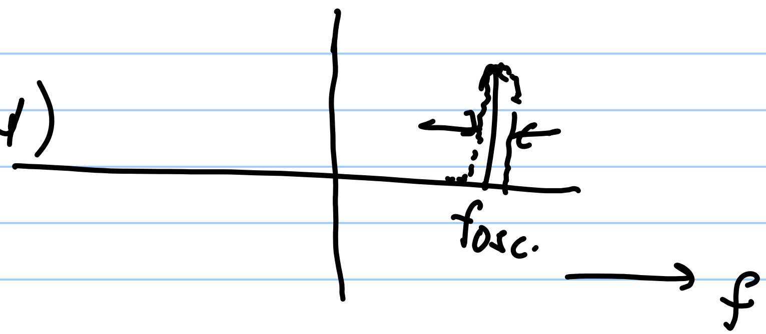
EE2019

Note Title 4/5/2019

Oscillators

Unstable system mainly used as clock generator.

1. Tuned Oscillator
   - → based on LC
   - → High-Q (Band Pass, narrow band)
   - → Produces Sinusoidal o/p.



2. RC phase shift based oscillators
   - → Ring oscillator
   - → Low Pass oscillators. (wide band)
   - → not very high-Q.

→ quasi sine

3. Relaxation Oscillator

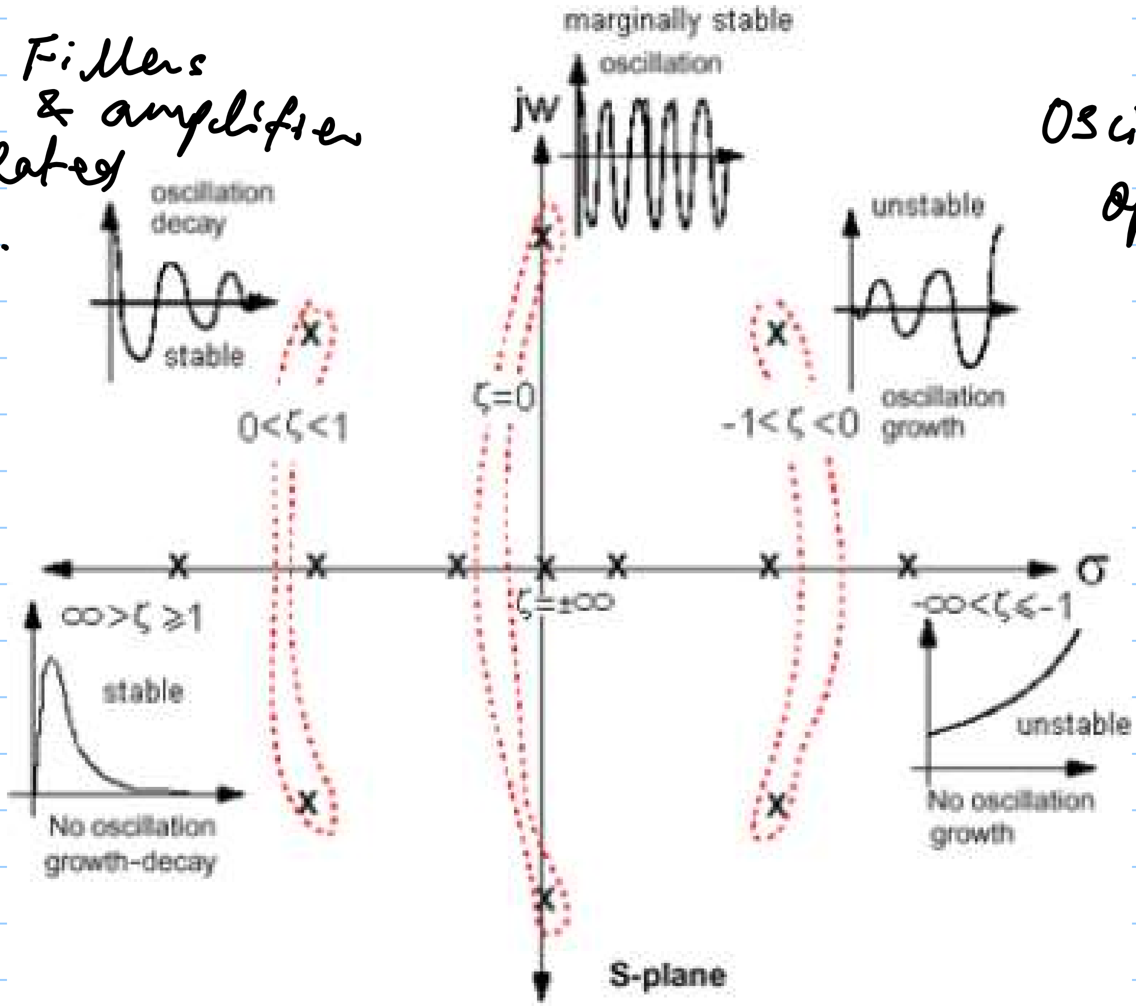
→ Mostly based on non-linear element (comparators or schmitt trigger)

→ Based on charging & discharging of capacitor.

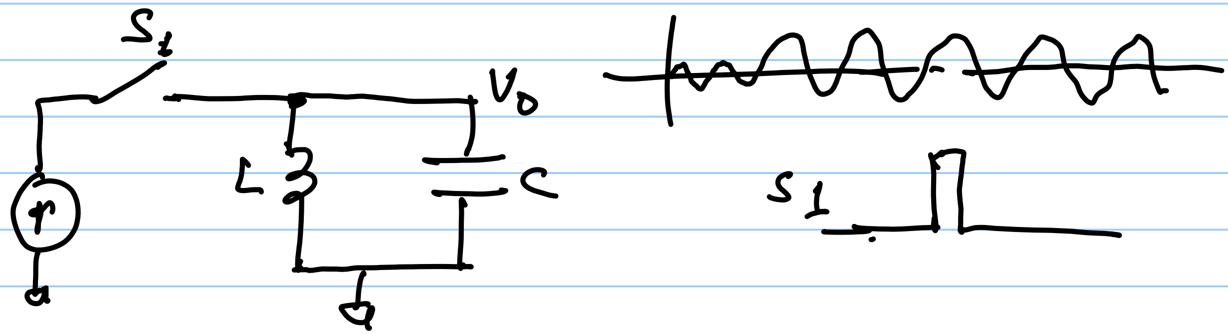
→ Mostly gives non-sinusoidal clock (triangular or square)

Filters & amplifier are operated in L.H.P.

$$Q = \frac{1}{2\xi}$$

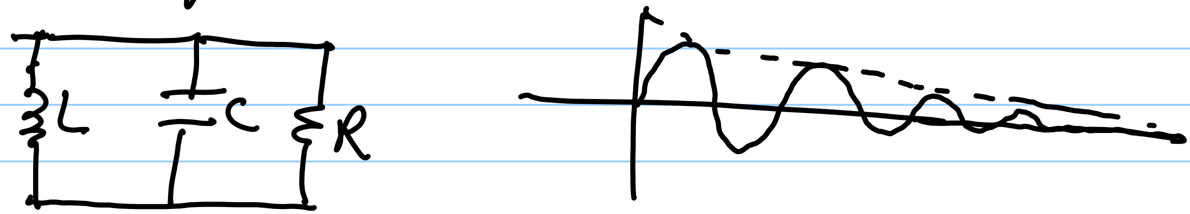


Oscillators are operated in R.H.P or jw axis



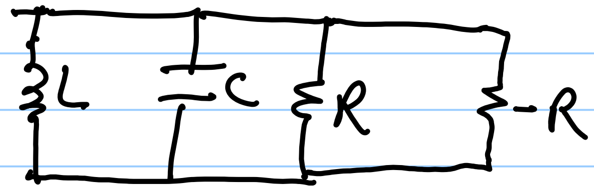
In practical L is not loss-less so oscillations will die out.

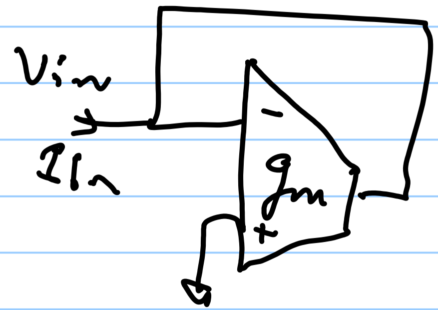
Lossy LCR

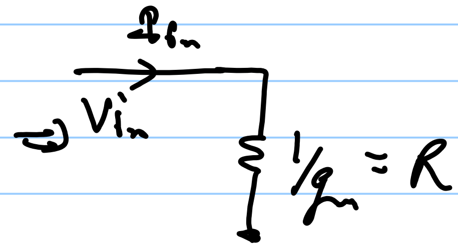


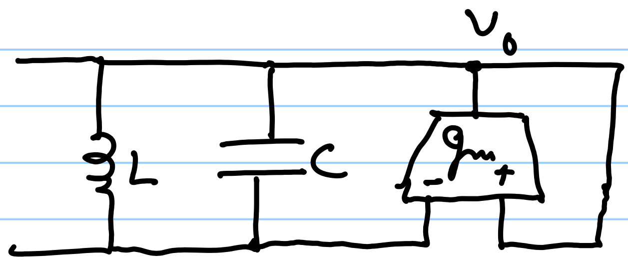
We need to cancel R by adding -R (negative Resistance)

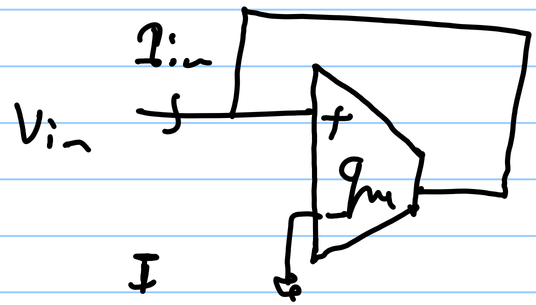
Loop LCR

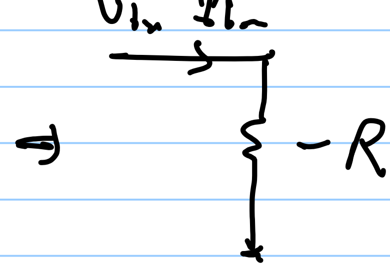


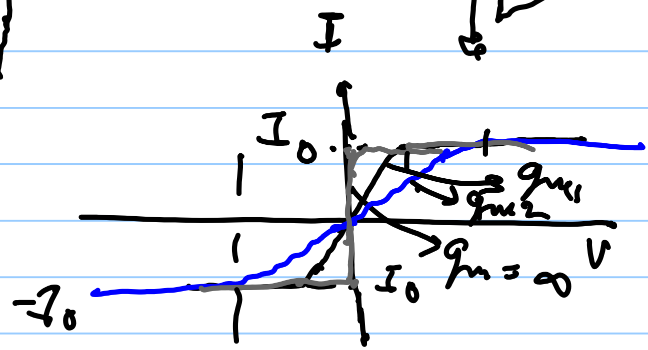








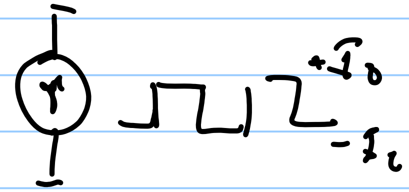




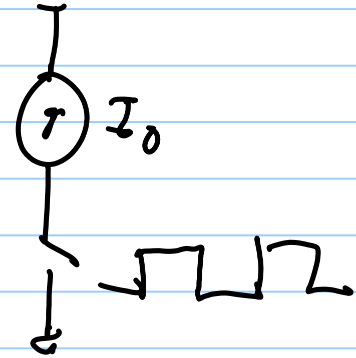
$$g_m = \frac{\partial I}{\partial V}$$

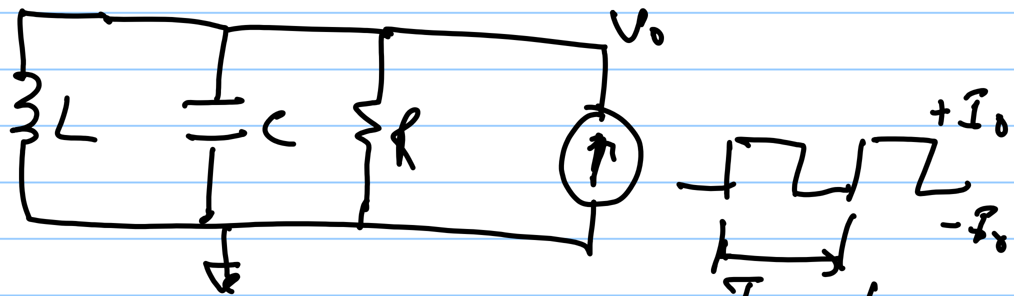
$$g_{m1} > g_{m2}$$

$g_m = \infty$



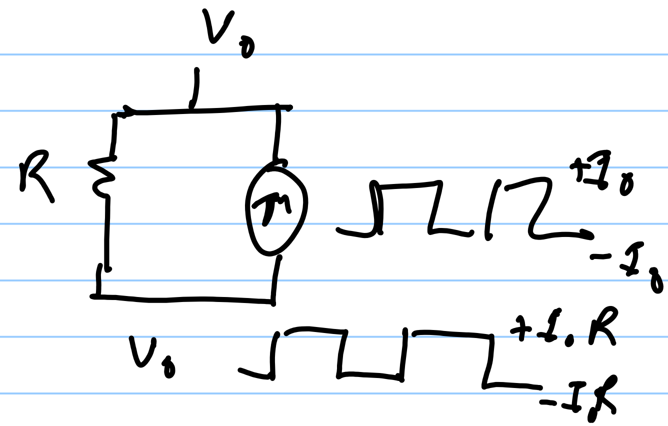
$\Rightarrow$

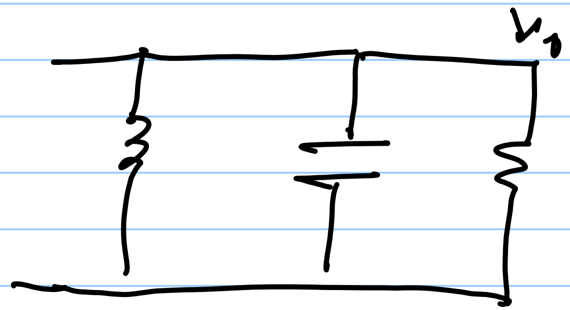


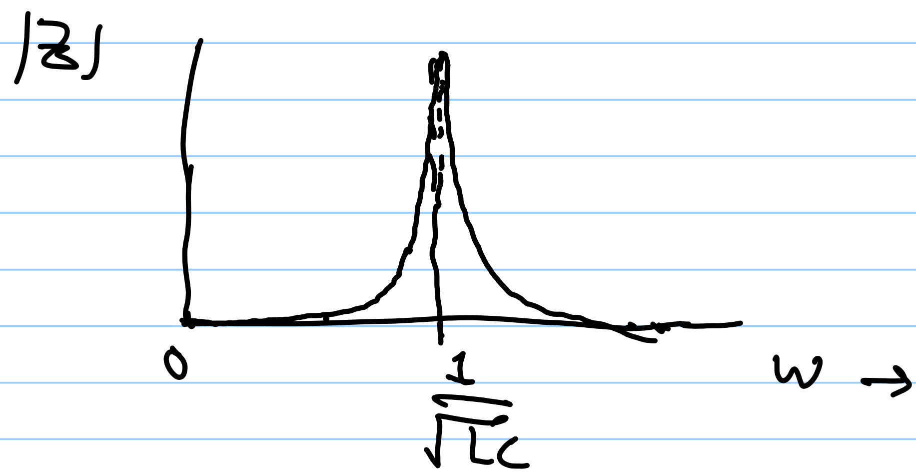


$T_0 = \frac{1}{f_0}$

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

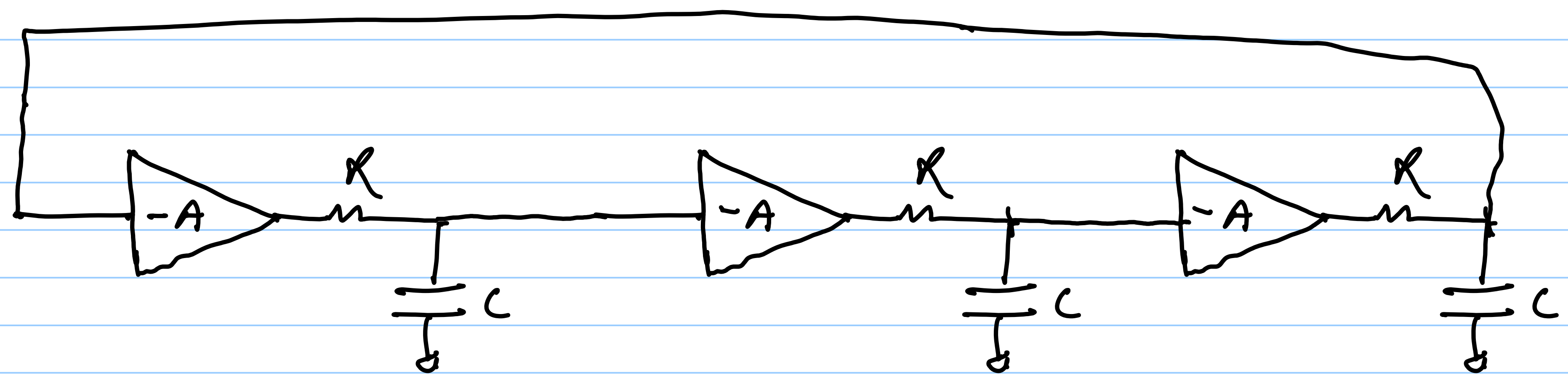






Only component appears of v_0 is the fundamental harmonic ($\omega_0 = \frac{1}{\sqrt{LC}}$) so we always get sinusoidal oscillations irrespective of value of g_m

Ring Oscillator

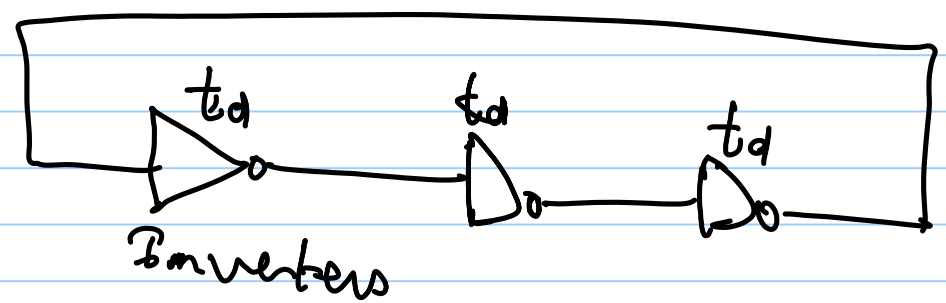


$A \geq 1$

each stage phase required = 60°.

total phase shift = 180° + 180° = 360°

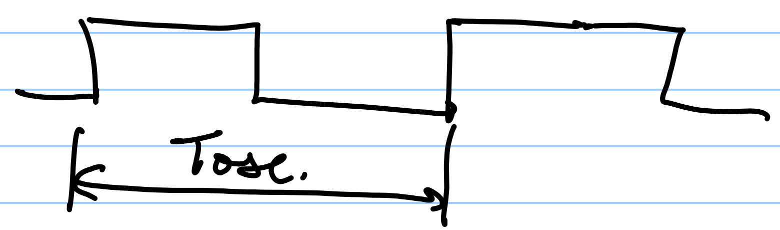
→ the feedback.



f_{osc} is frequency of oscillation.

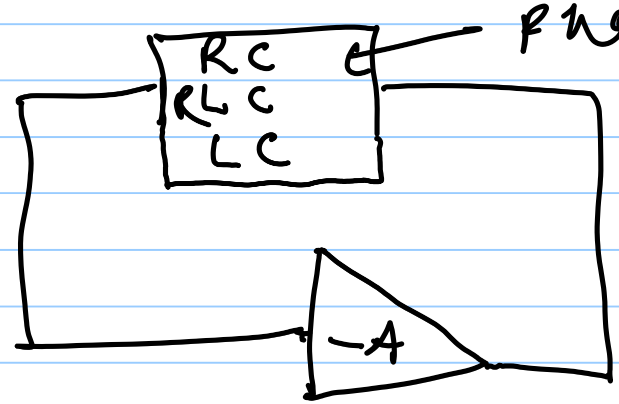
$t_d \rightarrow$ inverter delay

$T_{osc} = \frac{1}{f_{osc}}$



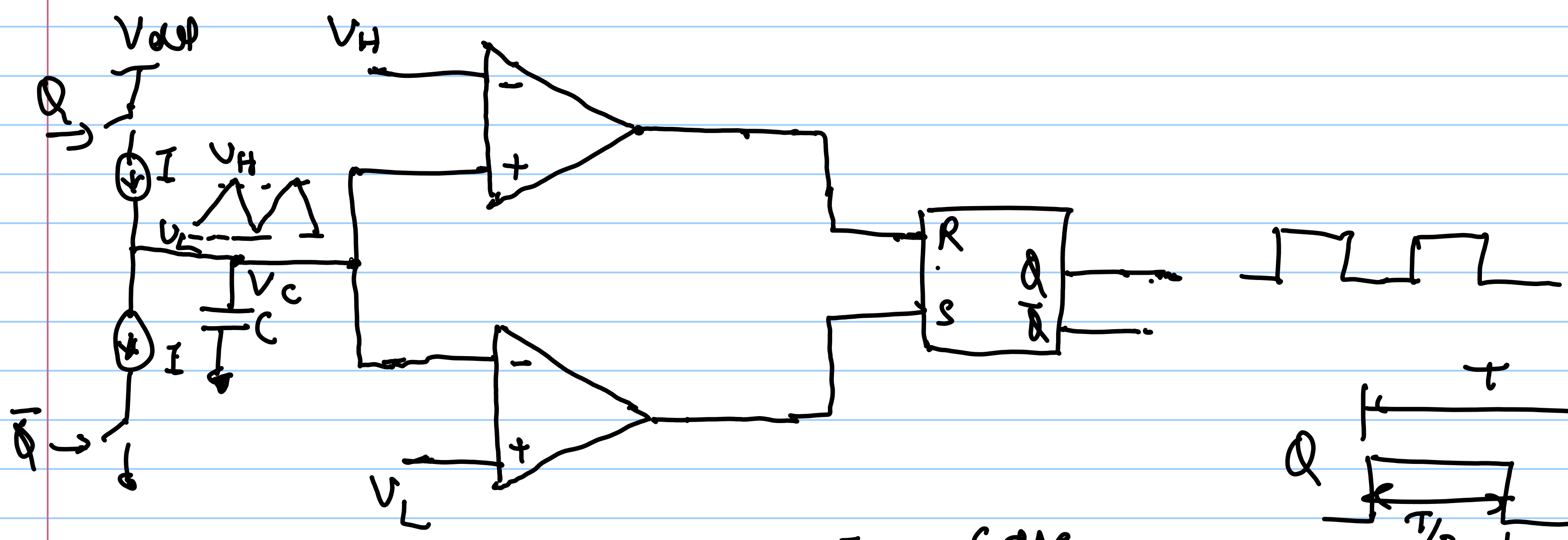
total phase shift introduced by inverters = 180°

$\Rightarrow$ delay $= \frac{T_{osc}}{2} = 3t_d \Rightarrow T_{osc} = 6t_d$.



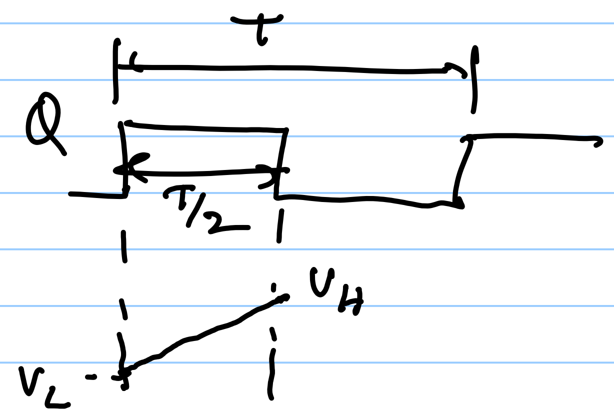
phase shift = 180°

Relaxation oscillator



$$I = \frac{C\,dV}{dt}$$

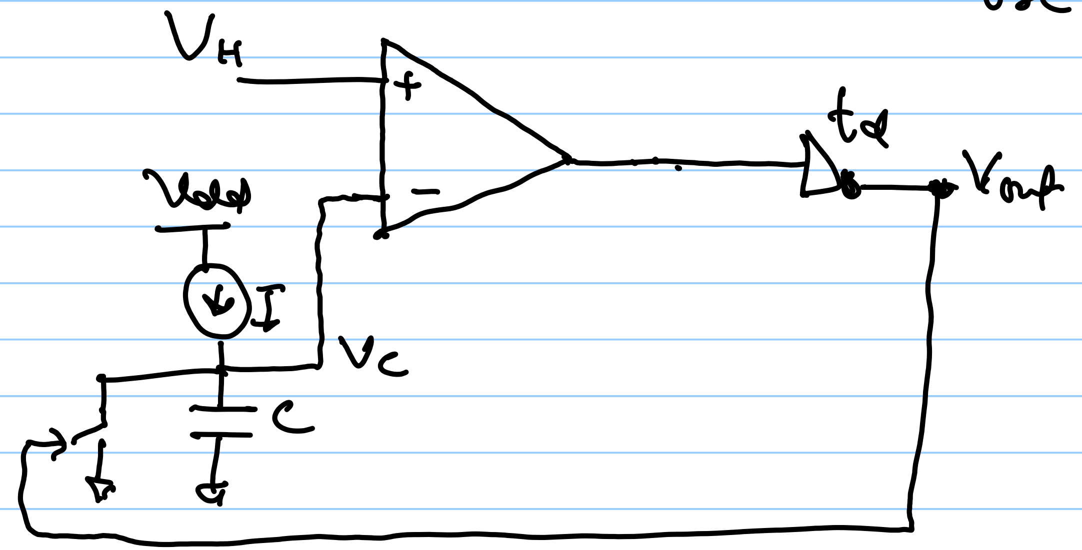
$$dt = T/2$$
$$dV = V_H - V_L$$

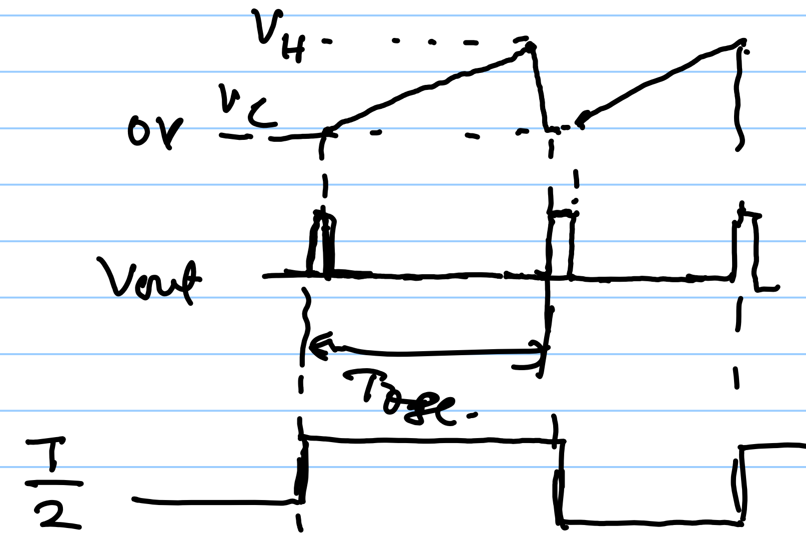


$$I = C\,\frac{(V_H - V_L)}{T/2} \Rightarrow \frac{I}{C} = \frac{2(V_H - V_L)}{T}$$

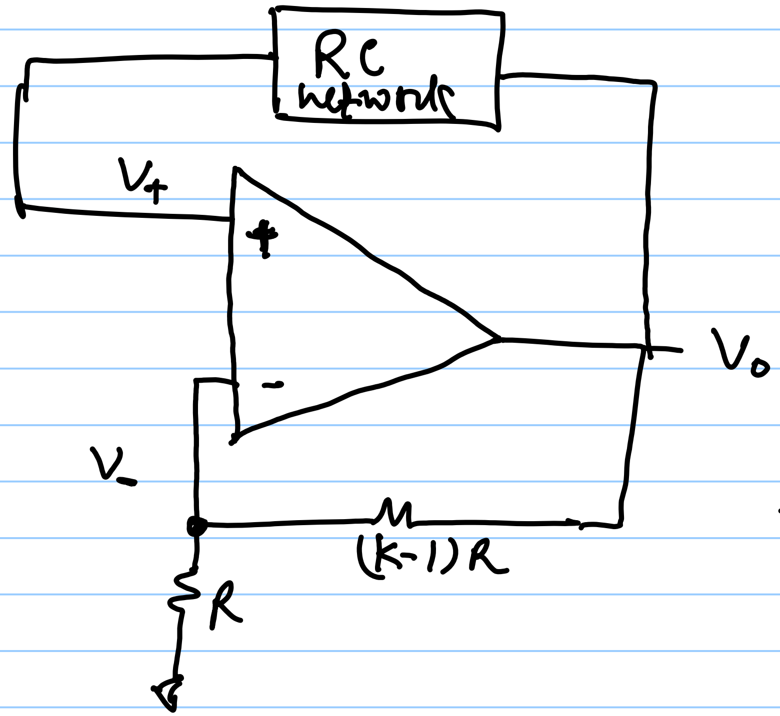
$$\frac{1}{T} = \frac{I}{2C(V_H - V_L)} = f_{osc}.$$

$$t_d \ll T_{osc}$$



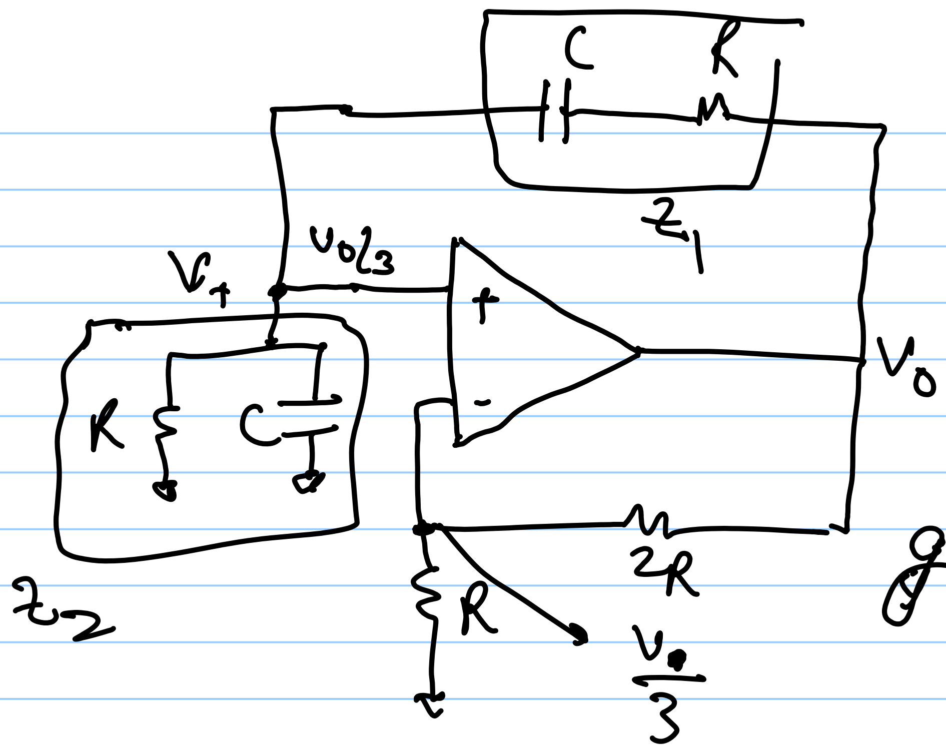


Wien Bridge oscillator.



frequency at which

$V_+ > V_-$



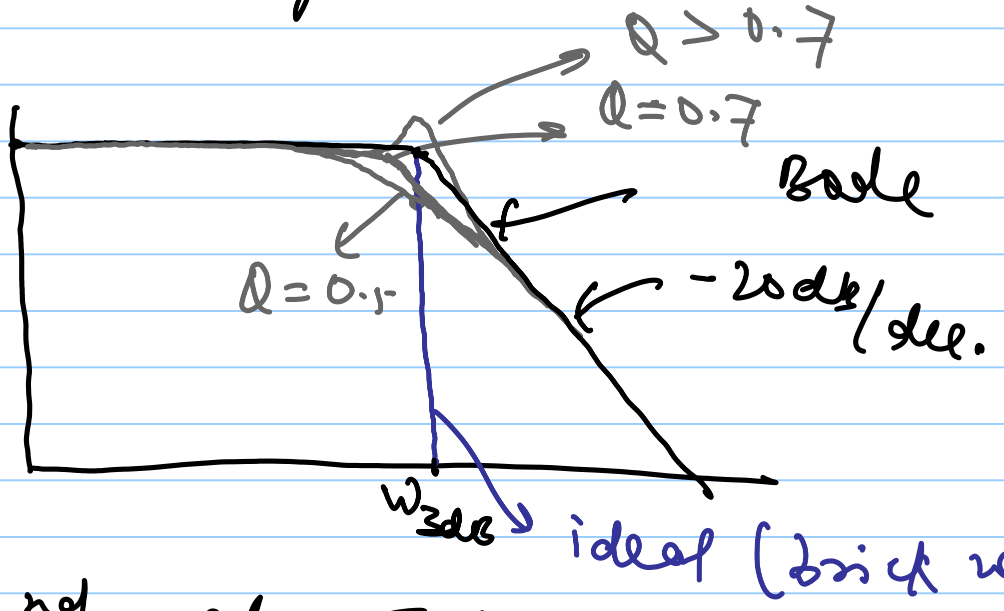
$\omega_0 = \frac{1}{RC}$

gain, $k = 3$

$$V_+ = \frac{Z_2}{Z_1 + Z_2}$$

Butterworth Filter

Maximally Flat magnitude Response



$Q = 0.7$ in 2^{nd} order Filter ensures flattest magnitude response.

$$H(s) = \frac{w_0^2}{s^2 + \frac{w_0}{Q_0} s + w_0^2}$$

$$Q_0 = 0.7 = \frac{1}{\sqrt{2}}$$

$$H(s) * H(-s) = |H(s)|^2$$

$$H(s) * H(-s) = \frac{w_0^2 \times w_0^2}{\left(s^2 + \frac{w_0}{Q_0} s + w_0^2\right)\left(s^2 - \frac{w_0}{Q_0 s} + w_0^2\right)}$$

$$= \frac{w_0^4}{(s^2 + w_0^2)^2 - \left(\frac{w_0}{Q_0} s\right)^2}$$

$$= \frac{\omega_0^4}{s^4 + \omega_0^4 + 2s^2\omega_0^2 - \frac{\omega_0^2}{Q_0^2} s^2}$$

$$Q_0 = \frac{1}{\sqrt{2}}$$

$$= \frac{\omega_0^4}{s^4 + \omega_0^4 + \cancel{2s^2\omega_0^2} - \cancel{2s^2\omega_0^2}} = \frac{\omega_0^4}{s^4 + \omega_0^4}$$

$$|H(s)|^2 = \frac{\omega_0^{2N}}{a_2 s^2 + a_4 s^4 + \cdots a_{2N} s^{2N} + \omega_0^{2N}}$$