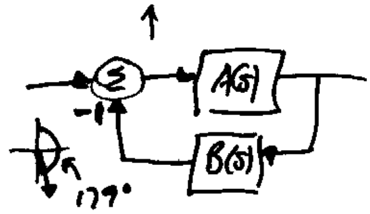
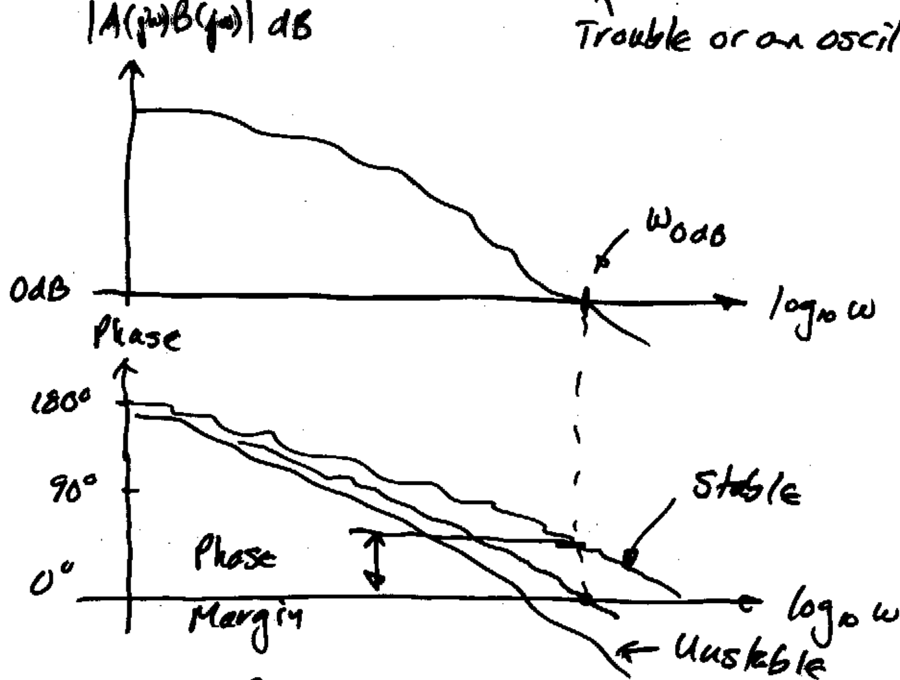
Feedback (Neg.) Stability

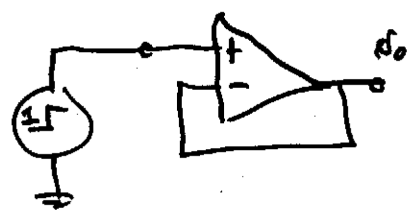


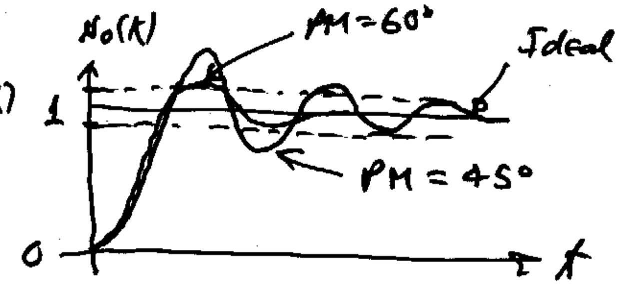
$$A_F(s) = \frac{A(s)}{1+A(s)B(s)} = \frac{A(s)}{1+(-1)}$$

↑ Trouble or an oscillator

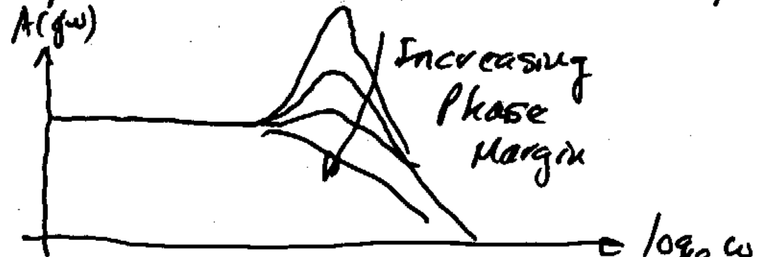


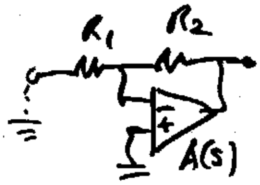
Op Amp Buffer -





Phase margin is crucial to achieving fast responses with sufficient accuracy.





$$LG = -A(s)\frac{R_1}{R_1+R_2}$$

- Slope of Phase → Time delay

OSCILLATORS

Intro –

Oscillators use some form of positive feedback to create a periodic waveform.

Classifications –

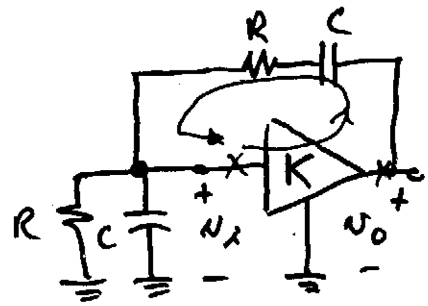
Tuned – Sinusoidal
Untuned – Square wave

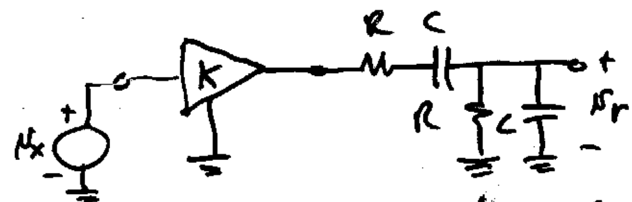
Criteria for Oscillation

1.) Loop gain = $1 + j0$ or $1\angle 0°$
2.) Determinant = 0

} Frequency of oscillation; Loop gain necessary for oscillation

Wien Bridge Oscillator





$$T(s) = A(s)\beta(s) = K \times \frac{R \| \frac{1}{sC}}{R + \frac{1}{sC} + R\|\frac{1}{sC}} \qquad R\|\frac{1}{sC} = \frac{R/sC}{R+\frac{1}{sC}} = \frac{R}{sRC+1}$$

$$T(s) = \frac{K\frac{R}{sRC+1}}{\left(\frac{sRC+1}{sC}\right) + \frac{R}{sRC+1}} = \frac{KR}{\frac{(sRC+1)^2}{sC} + R} = \frac{K\,sRC}{(sRC+1)^2 + sRC}$$

$$T(s) = \frac{sKRC}{s^2R^2C^2 + s2RC + 1 + sRC} = \frac{sKRC}{s^2R^2C^2 + s3RC + 1}$$

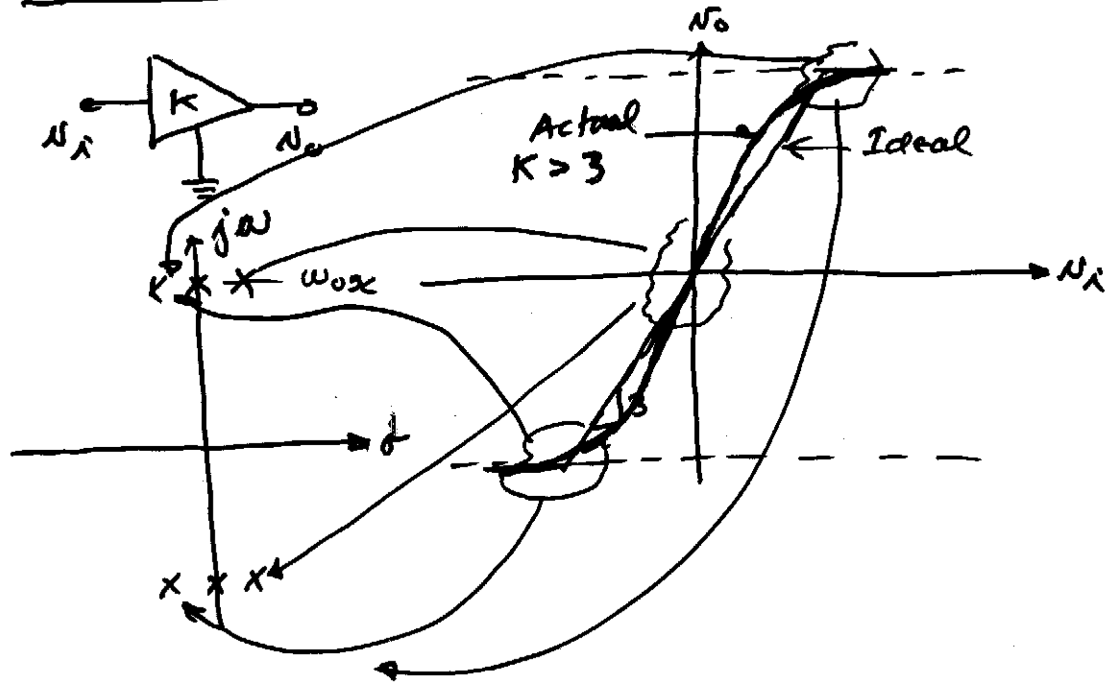
$$T(j\omega) = \frac{j\omega KRC}{1 - \omega^2R^2C^2 + j\omega 3RC} = 1 + j0 \rightarrow \omega^2R^2C^2 = 1$$

or $\boxed{\omega_{osc} = \frac{1}{RC}}$

$\boxed{K = 3}$

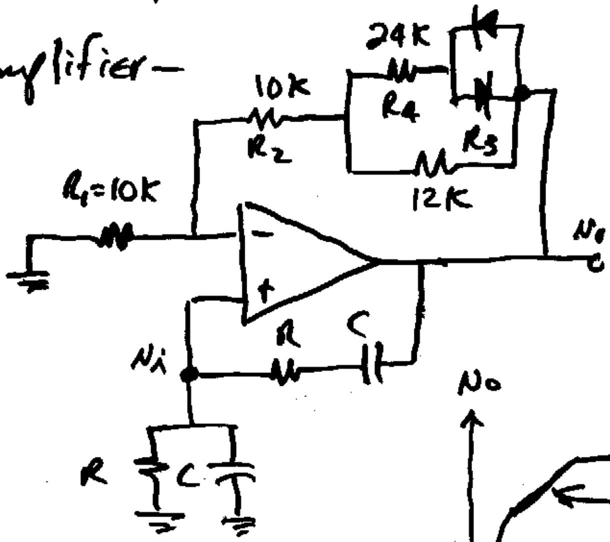
$R = 100k$ & $C = 1\mu F$ $\quad \frac{1}{RC} = \frac{1}{10^5 \cdot 10^{-6}} = 10$

Amplitude Stabilization of an Oscillator



The amplitude of the oscillator stabilizes at a value which cause the "effective" loop gain to be unity.

K amplifier –



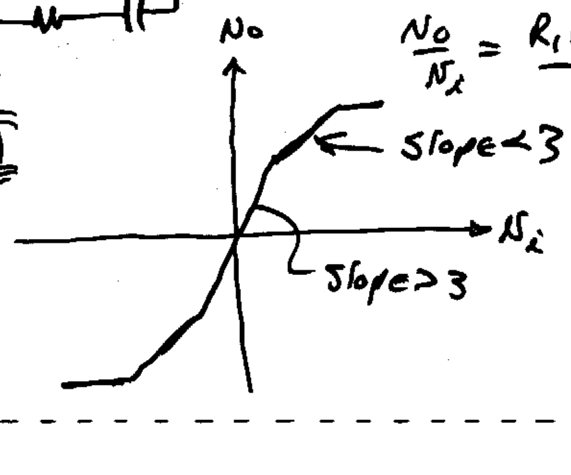
Gain = ?

Diodes off:

$$\frac{v_o}{v_i} = \frac{R_1+R_2+R_3}{R_1} = 3.2$$

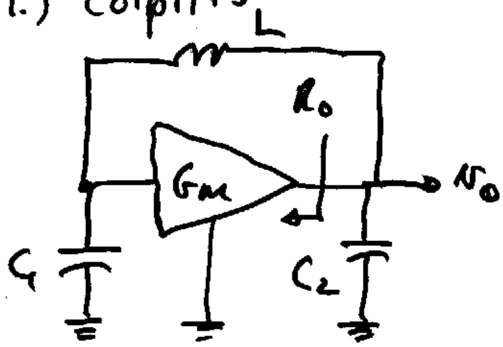
Diodes on:

$$\frac{v_o}{v_i} = \frac{R_1+R_2+R_3 \| R_4}{R_1} = 2.8$$



LC Oscillator

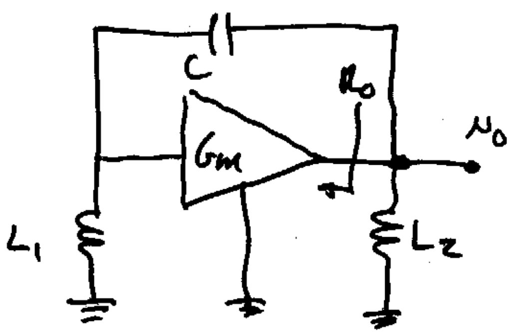
1.) Colpitts



$$\omega_{osc} = \frac{1}{\sqrt{L\left(\frac{C_1 C_2}{C_1 + C_2}\right)}}$$

$$G_m R_o = \frac{C_2}{C_1}$$

2.) Hartley



$$\omega_{osc} = \frac{1}{\sqrt{C(L_1 + L_2)}}$$

$$G_m R_o = \frac{L_1}{L_2}$$

Example