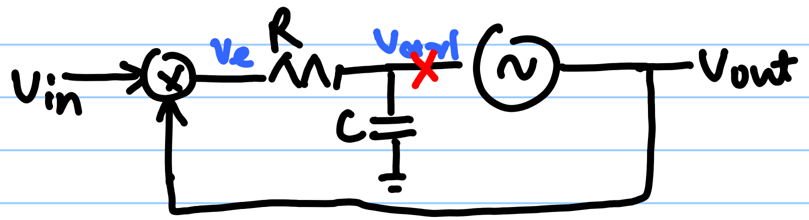
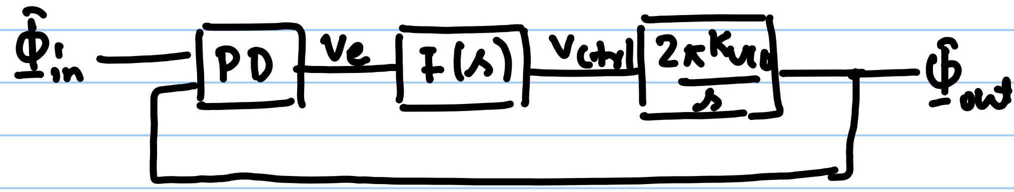
Note Title 08-08-2017

Lecture # 6





at t=0 $V_{in} = A_{in} \sin(\omega_{in} t)$

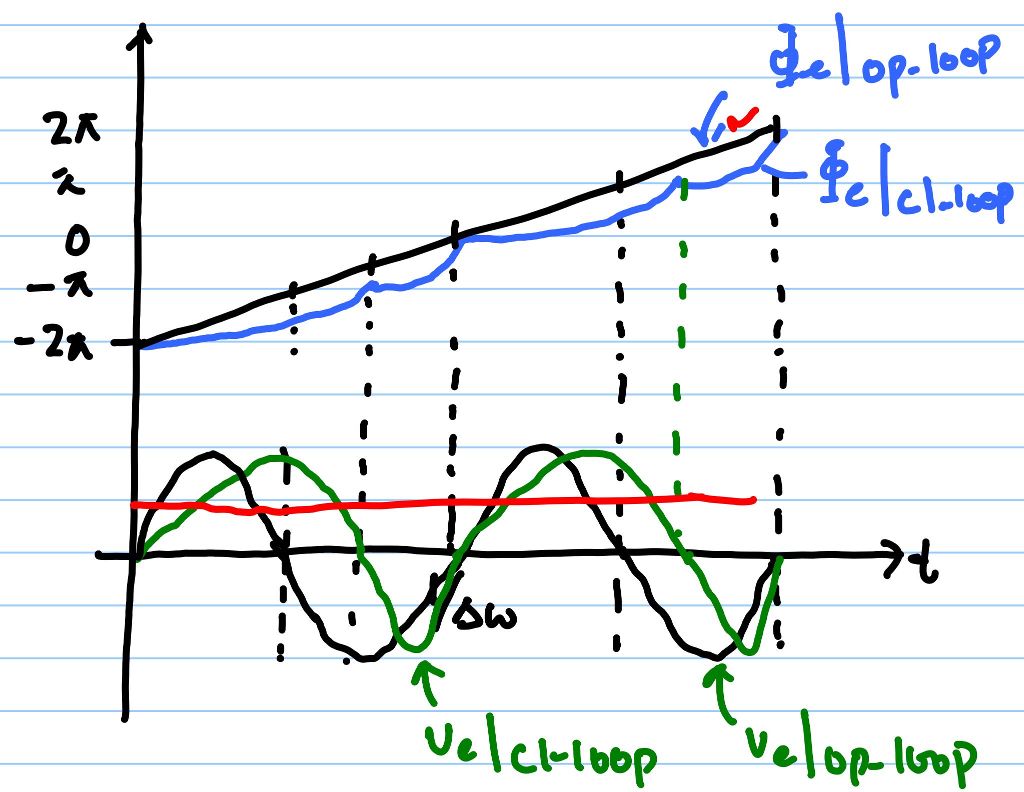
$V_{out} = A_{out} \cos\left(\int \omega_{free} + 2\pi K_{vco} V_{ctrl} \, dt\right)$

$V_e = 0$, $V_{ctrl} = 0$, $A_{in} = A_{out} = 1$

$V_e = V_{in} \times V_{out} = \frac{1}{2}\Big[\sin\left((\omega_{in} + \omega_{free} + \int 2\pi K_{vco} \cdot V_{ctrl}) \, dt\right)$
$+ \sin\left(\left[\omega_{in} - \omega_{free} - \int 2\pi K_{vco} V_{ctrl}\right] dt\right)\Big]$

$V_e = \frac{1}{2}\Big[\sin(\quad) + \sin\left(\Delta\omega \cdot t - 2\pi \int K_{vco} \cdot V_{ctrl} \, dt\right)$

$$\hat{\Phi}_e = \Delta\omega t - 2\pi \int K_{vco} \cdot V_{ctrl}\, dt$$



$$V_e = \frac{1}{2}\sin(\hat{\Phi}_e)$$

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$$\hat{\Phi}_{out} = \omega_{free} \cdot t + 2\pi K_{vco} \cdot K_{pd} \int \sin(\hat{\Phi}_e)\, dt$$

$$\hat{\Phi}_e(t) = \Delta\omega \cdot t - 2\pi K_{vco} \cdot K_{pd} \underbrace{\int \sin(\Delta\omega t)\, dt}_{\hat{\Phi}_e|_{open\ loop}}$$

$$\hat{\Phi}_e(t) = \Delta\omega \cdot t - \frac{2\pi K_{vco} \cdot K_{pd}}{\Delta\omega}\left(1 - \cos(\Delta\omega \cdot t)\right)$$

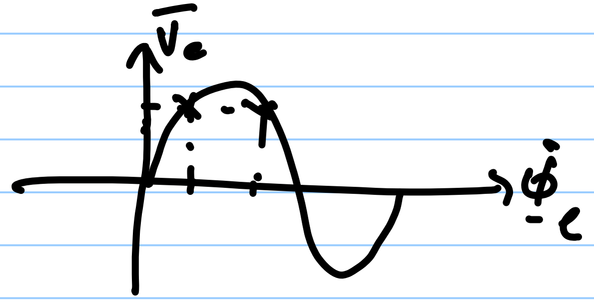
$$\hat{\Phi}_e(0) = \Delta\omega \cdot 0$$

$$\hat{\Phi}_e\left(\frac{1}{\Delta\omega}\right) = \Delta\omega \cdot \frac{1}{\Delta\omega} - 0$$

$$\hat{\Phi}_c\left(\frac{1}{2 \cdot \Delta\omega}\right) = \pi - \frac{x}{\Delta\omega}$$

In steady state, $\bar{V}_e = \frac{1}{2}\sin(\phi_e) = V_{ctrl} = \frac{\Delta\omega}{2\pi K_{VCO}}$

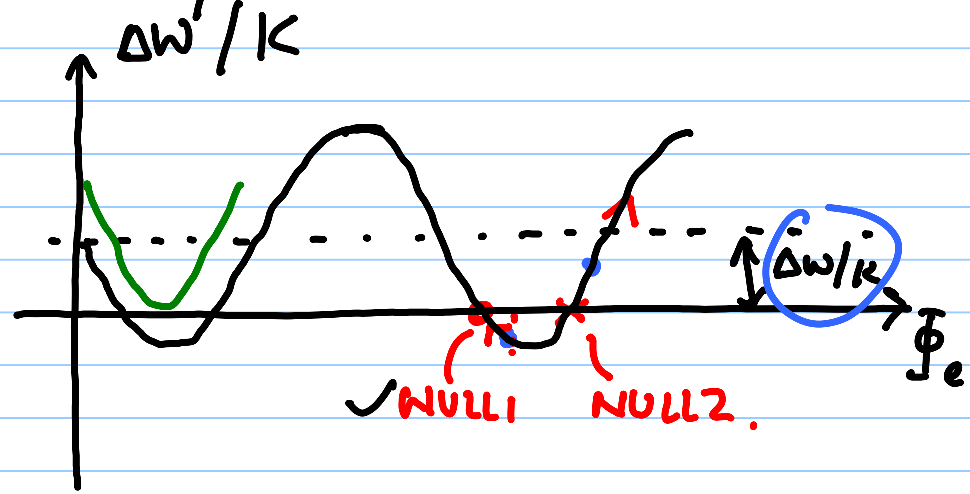
$K = 2\pi K_{VCO} \cdot K_{pd}$



$$\phi_e = \Delta\omega \cdot t - \underbrace{2\pi K_{VCO} \cdot K_{pd}}_{K} \int \sin(\phi_e)\, dt$$

$$\Delta\omega' = \frac{d\phi_e}{dt} = \Delta\omega - K\sin(\phi_e)$$

$$\frac{\Delta\omega'}{K} = \frac{\Delta\omega}{K} - \sin(\phi_e)$$



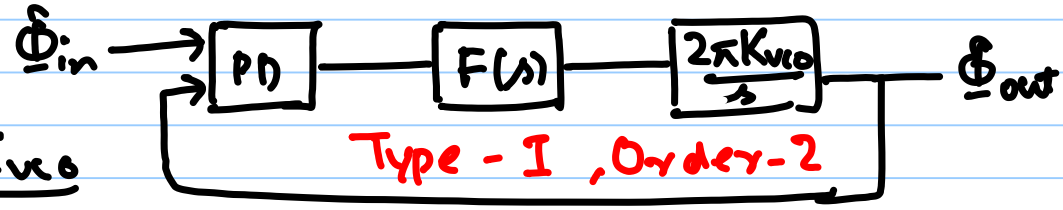
at NULL1: $\frac{\Delta\omega'}{K} < 0$

$$\Phi_e = \int \Delta\omega' \cdot dt$$

$$\frac{\Delta\omega}{K} = \sin(\Phi_e) \leq 1$$

To increase $\Delta\omega$ $\longrightarrow$ increase K.

PLL Type / Order



$$LG(s) = K_{pd} \cdot F(s) \cdot \frac{2\pi K_{vco}}{s}$$

if $F(s) = \frac{1}{1+s\tau}$, $K_{pd} = \frac{1}{2}$

Type : No. of integrators in PLL loop.

Order : No. of poles in PLL loop gain transfer function.

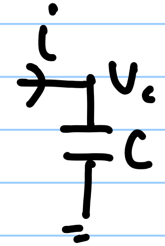
Type $\left\{ \begin{matrix} > \\ < \\ = \end{matrix} \right.$ Order

Type $\leq$ Order

$$\frac{\Delta\omega}{K} = \sin(\dot{\Phi}_e) \leq 1$$

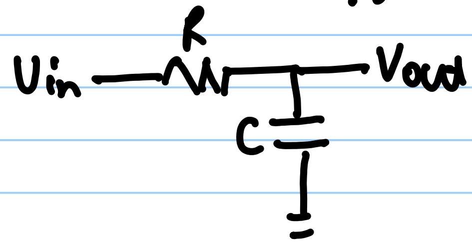
For large $\Delta\omega$ $\Rightarrow$ large K

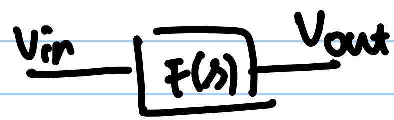
$$\frac{K}{s}$$

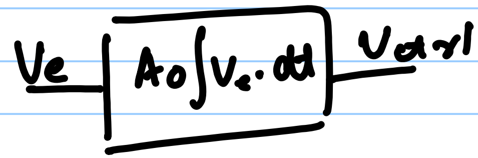


$$V_c = i \times \frac{1}{Cs} = \frac{i}{C} \frac{1}{s}$$

$$F(s) = \frac{A_0}{s}$$



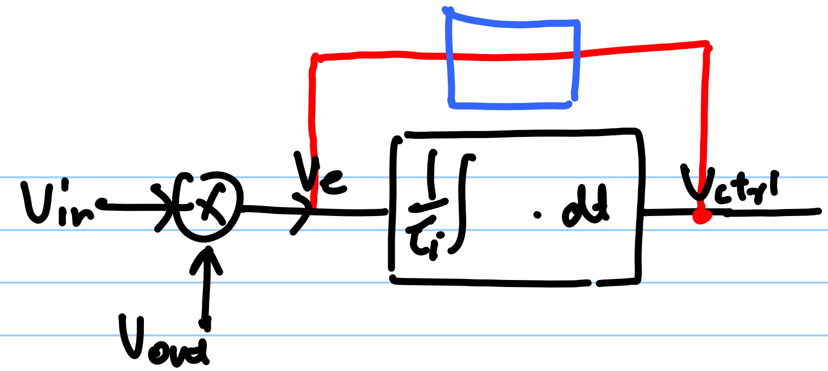




$$\frac{V_{out}}{V_{in}} = \frac{1}{1 + sRC}$$

$$\frac{V_{out}}{V_{in}} = \frac{A_0}{s}$$

$$LG(s) = K_{pd} \cdot \frac{A_0}{s} \frac{2\pi K_{vco}}{s}$$



$$V_e = \frac{1}{2}\sin(\Delta\omega . t)$$

$$V_{ctrl} = \int_0^{1/\Delta\omega} V_e \cdot dt$$

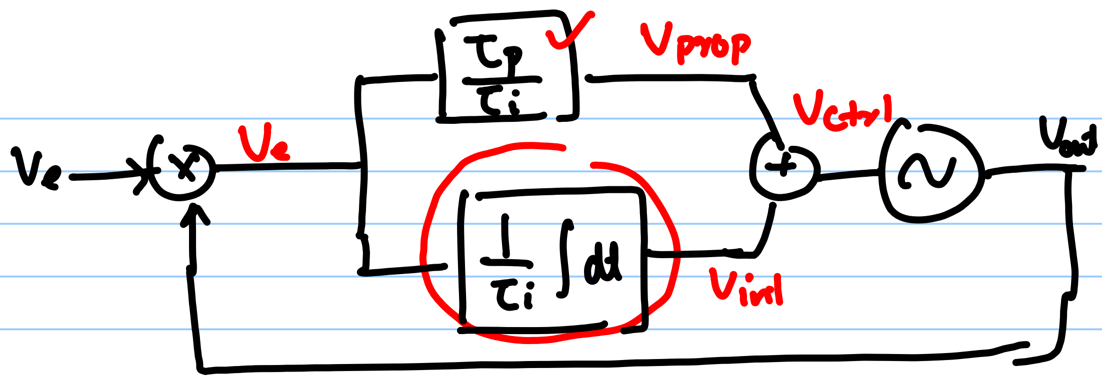
In locked state:

$\Delta\omega = 0$, $\Phi_e = 0$, $V_{ctrl} = \frac{\Delta\omega}{2\pi K_{vco}}$

Prop. + Int. ✓

Prop. ✗ ✓

Int. ✓ ✗



$\Delta\omega$

$\frac{I}{T}$

$$V_{ctrl} = V_{prop} + V_{int} = \frac{\Delta\omega}{2\pi K_{vco}}$$

$$= \frac{\tau_p}{\tau_i} V_e + \infty \times V_e =$$

$V_e = 0$