Note Title

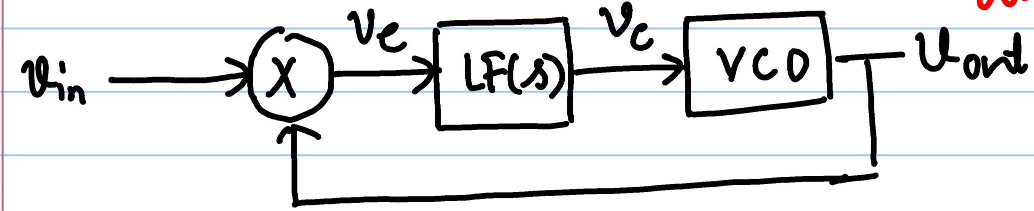
lecture 5

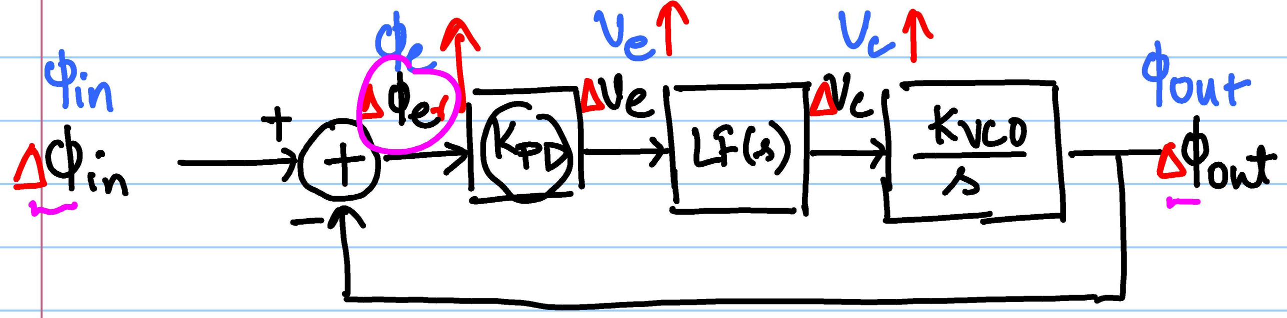
09-09-2020

$|v_e| \le \frac{1}{2}$

$\omega_{in} = \omega_0$

$\frac{d\phi_{er}}{dt} = 0$ ✓





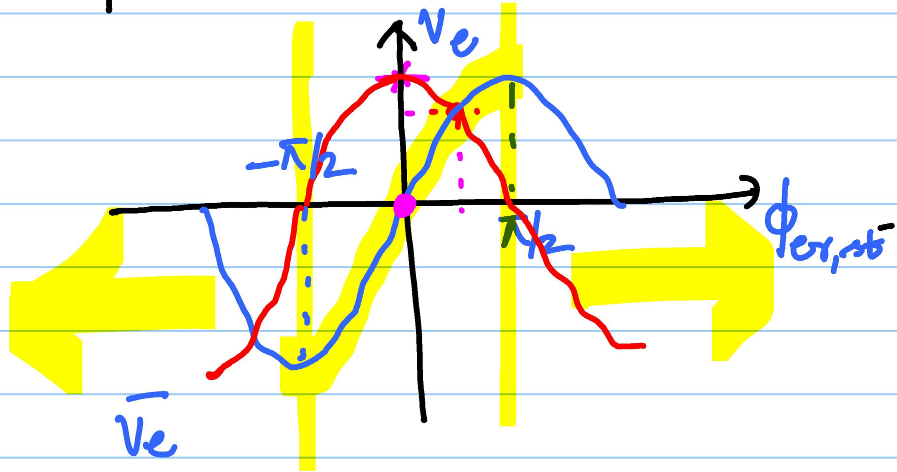
$$v_c = \frac{\omega_{in} - \omega_{free}}{K_{VCO}} = \frac{\Delta\omega}{K_{VCO}}$$

× ✓

$$v_e = \frac{a_{in} a_0}{2} \left[\sin(\omega_{in} t + \omega_0 t) + \sin\left(\int \omega_{in} - \omega_0 \cdot dt\right) \right]$$

$$v_e = \frac{a_{in} a_0}{2} \sin\left(\int \Delta\omega \cdot dt + \phi_{os}\right)$$

$$\underset{\sim}{V_e} = \frac{a_{in} a_0}{2} \sin(\phi_{er}) \checkmark$$



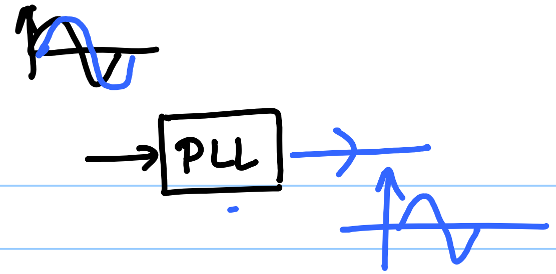
$$K_{PD} = \frac{\partial v_e}{d\phi_{er}} = \frac{a_{in} a_0}{2} \cos(\phi_{er})$$

$$\frac{\Delta\phi_{out}(s)}{\Delta\phi_{in}(s)} = \frac{K_{PD}\, LF(s)\, \frac{K_{VCO}}{s}}{1 + \frac{K_{PD}\, LF(s)\, K_{VCO}}{s}}$$

$$\frac{\Delta\omega_{out}(s)}{\Delta\omega_{in}(s)} = \frac{1}{1 + \frac{s}{K_{PD} K_{VCO} LF(s)}} \checkmark$$

at $t=0$

$$\Delta\phi_{in}(t) = \underbrace{\Delta\phi_{in}(0)}\, u(t) \quad \Rightarrow \quad \Delta\phi_{in}(s) = \frac{\Delta\phi_{in}(0)}{s}$$



$$\lim_{t\to\infty} \Delta\phi_{out}(t) = \lim_{s\to 0} s \, \Delta\phi_{out}(s)$$

$$= \lim_{s\to 0} s \cdot \Delta\phi_{in}(s) \cdot \frac{1}{1+\dfrac{s}{K_{PD}\,LF(s)\,K_{VCO}}}$$

$$= \lim_{s\to 0} \cancel{s} \cdot \frac{\Delta\phi_{in}(0)}{\cancel{s}} \, \frac{1}{1+\dfrac{s}{K_{PD}\,LF(s)\,K_{VCO}}}$$

$$= \underline{\Delta\phi_{in}(0)}$$

at $t=0$ $\quad \Delta\omega_{in} = \Delta\omega_{in}(0)\, u(t) \quad \Rightarrow \quad \Delta\phi_{in}(s) = \dfrac{\Delta\omega_{in}(s)}{s} = \dfrac{\Delta\omega_{in}(0)}{s^2}$

$$\lim_{t\to 0} \Delta\phi_{out}(t) = \lim_{s\to 0} \cancel{s} \cdot \frac{\Delta\omega_{in}(0)}{s^2} \, \frac{1}{1+\dfrac{s}{K_{PD}\,LF(s)\,K_{VCO}}}$$

$$= \lim_{s\to 0} \frac{\Delta\omega_{in}(0)}{s+\dfrac{s^2}{K_{PD}\,LF(s)\,K_{VCO}}} \to \underset{w}{\infty}$$

$$\lim_{t\to 0} \Delta\omega_{out}(t) = \lim_{s\to 0} \cancel{s}\cdot\frac{\Delta\omega_{in}(0)}{\cancel{s}} \frac{1}{1+\frac{s}{K_{PD}K_{VCO}LF(s)}}$$

$$= \Delta\omega_{in}(0)$$

$$\frac{\Delta\phi_{er}}{\Delta\phi_{in}} = \frac{\Delta\phi_{in}-}{\Delta\phi_{in}} \frac{\Delta\phi_{out}}{\Delta\phi_{in}} = 1 - \frac{\Delta\phi_{out}}{\Delta\phi_{in}} = \frac{1}{1+\frac{K_{VCO}K_{PD}LF(s)}{s}}$$

$$\Delta\phi_{in}(t) = \Delta\phi_{in}(0)\,u(t)$$

$$\lim_{t\to\infty} \Delta\phi_{er}(t) = \lim_{s\to 0} \cancel{s}\cdot\frac{\Delta\phi_{in}(0)}{\cancel{s}} \frac{1}{\underbrace{1+\frac{K_{VCO}K_{PD}LF(s)}{s}}_{\to\infty}}$$

$$= 0$$

$$\Delta\omega_{in}(t) = \Delta\omega_{in}(0)\,u(t)$$

$$\lim_{t\to\infty} \Delta\phi_{er}(t) = \lim_{s\to 0} \cancel{s}\cdot\frac{\Delta\omega_{in}(0)}{s^{\cancel{2}}} \frac{1}{\frac{\cancel{s}+K_{VCO}K_{PD}LF(s)}{\cancel{s}}} = \frac{\Delta\omega_{in}(0)}{K_{VCO}K_{PD}LF(0)}$$

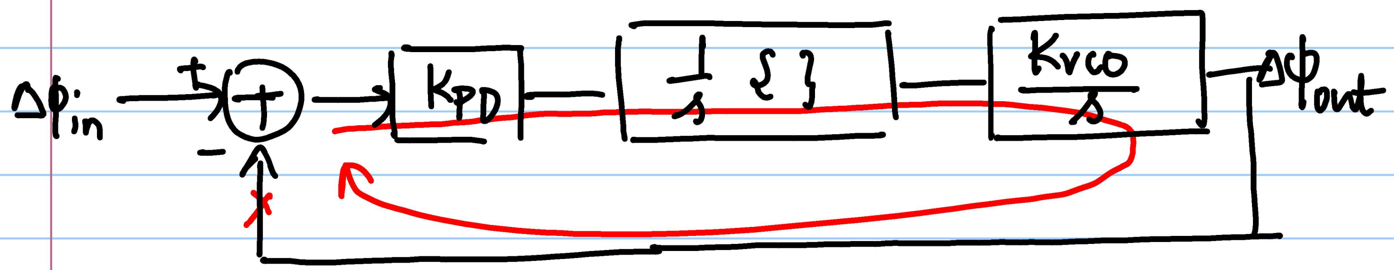
$$\lim_{t\to\infty} \Delta\phi_{er}(t) \uparrow = \frac{\Delta\omega_{in}(0)\uparrow}{\underset{1/2}{K_{PD}}\ \underset{\downarrow}{K_{VCO}}\ LF(0)} = \frac{\Delta\omega_{in}(0)}{K_{PD}K_{VCO}\underbrace{(1+0/\omega_z)}_{0}} \to 0$$

$\Delta\omega_{in}$

$$\lim_{s\to 0} LF(s) \to \infty$$

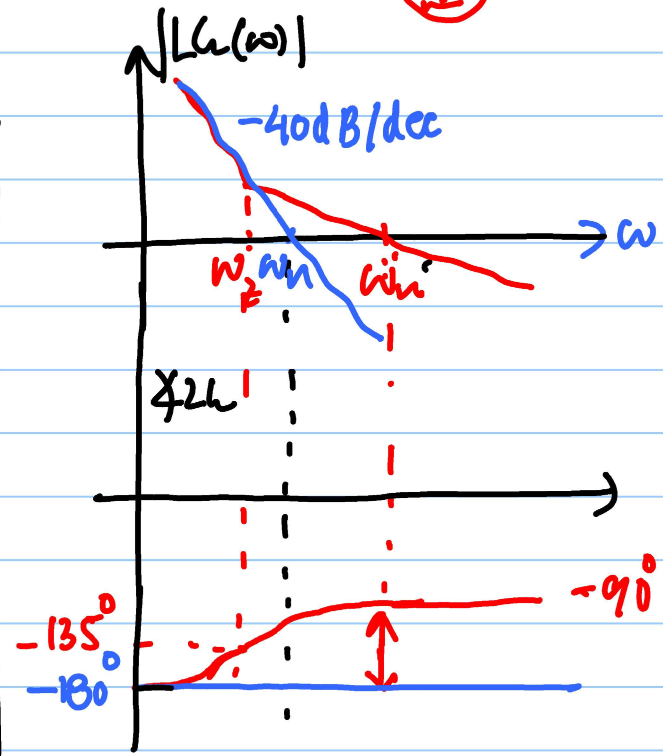
$$\underbrace{\lim_{t\to\infty} K_{PD}\,\phi_{er}(t)}= \frac{\Delta\omega_{in}(0)\uparrow}{\uparrow K_{VCO}\ LF(0)\uparrow}$$

$$\Rightarrow LF(s) = \frac{1}{s} \times \{\ \}$$



$$LG(s) = K_{PD}\ \frac{1}{s^2}\{\ \}\ \frac{K_{VCO}}{s}$$

$$= \frac{K_{PD}K_{VCO}}{s^2}\ \underbrace{(1+s/\omega_{z1})}_{\times(1+s/\omega_{z2})}$$ stable / not stable



$$\Delta\omega_{in}(t) = \Delta\omega_{in}(0)\, t\, u(t)$$

$$\Delta\omega_{in}(s) = \frac{\Delta\omega_{in}(0)}{s^2}$$

$$\Delta\phi_{in}(s) = \frac{\Delta\omega_{in}(0)}{s^3}$$

$$\lim_{t\to\infty} \Delta\phi_{er}(t)\uparrow = \lim_{s\to 0} \cancel{s}\cdot \frac{\Delta\omega_{in}(0)}{\cancel{s^3}\, s^2} \cdot \frac{1}{s^2 + \frac{K_{PD}K_{VCO}(1+s/\omega_z)}{\cancel{s^2}}}$$

$$= \lim_{s\to 0} \frac{\Delta\omega_{in}(0)\uparrow}{\frac{K_{PD}\,K_{VCO}\,(1+0/\omega_z)}{s}} \to 0$$

- Type of PLL : # of integrators in PLL
- Order of PLL : # of poles in PLL