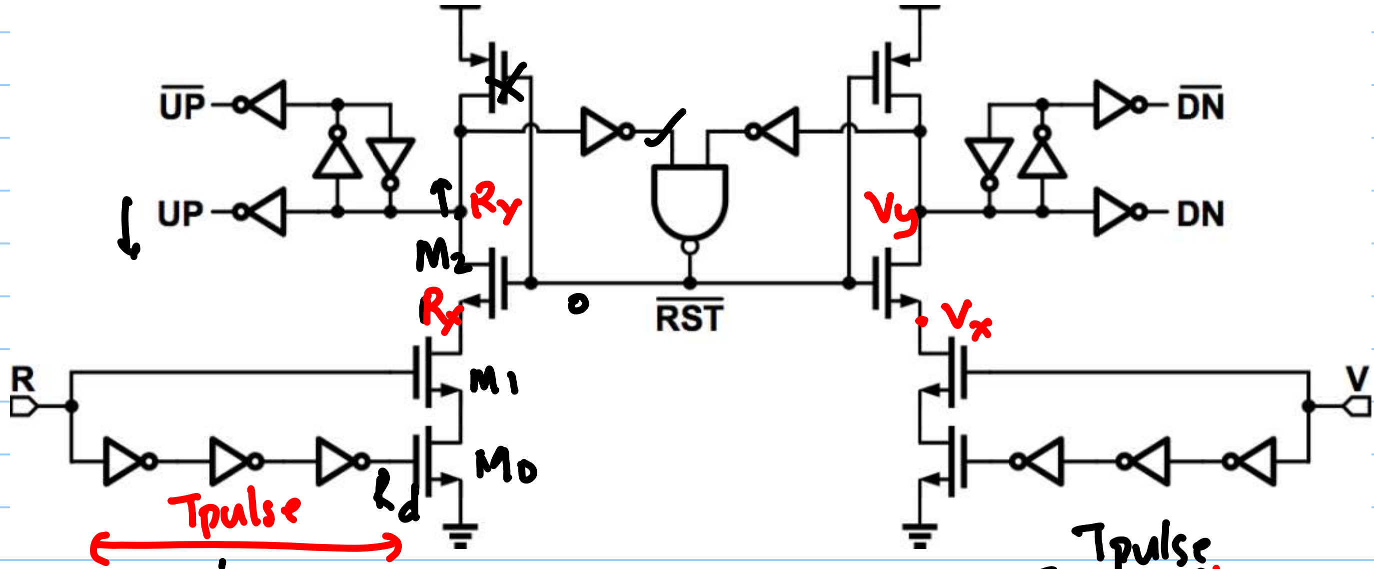
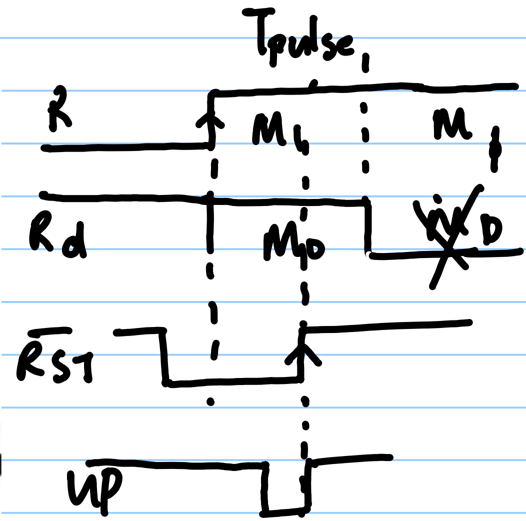
Lecture # 25

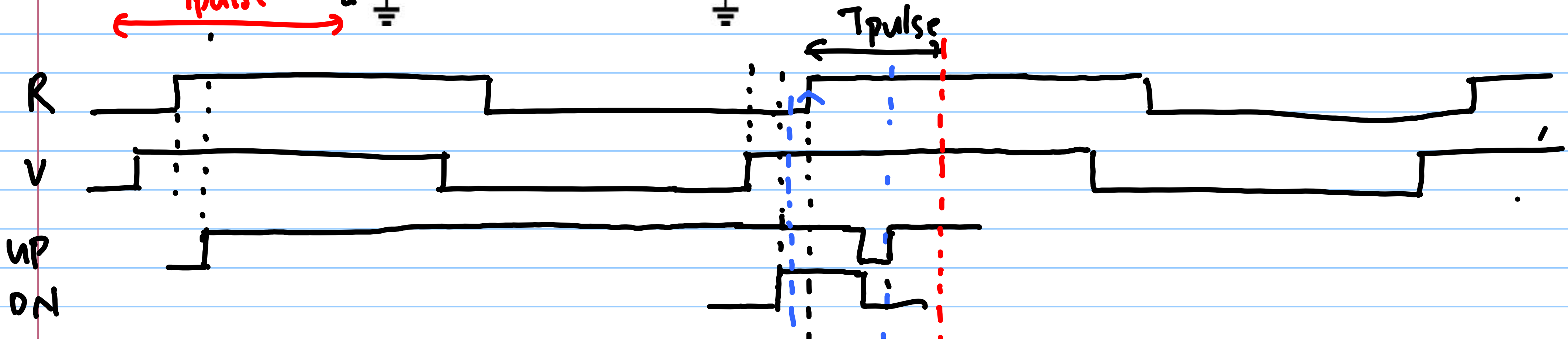
Note Title 20-09-2017

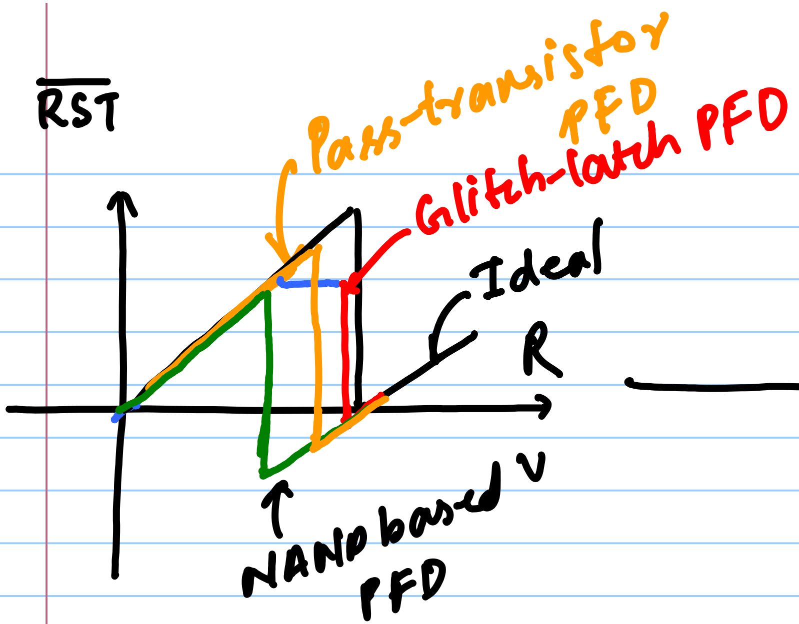
Phase frequency detectors (PFD)

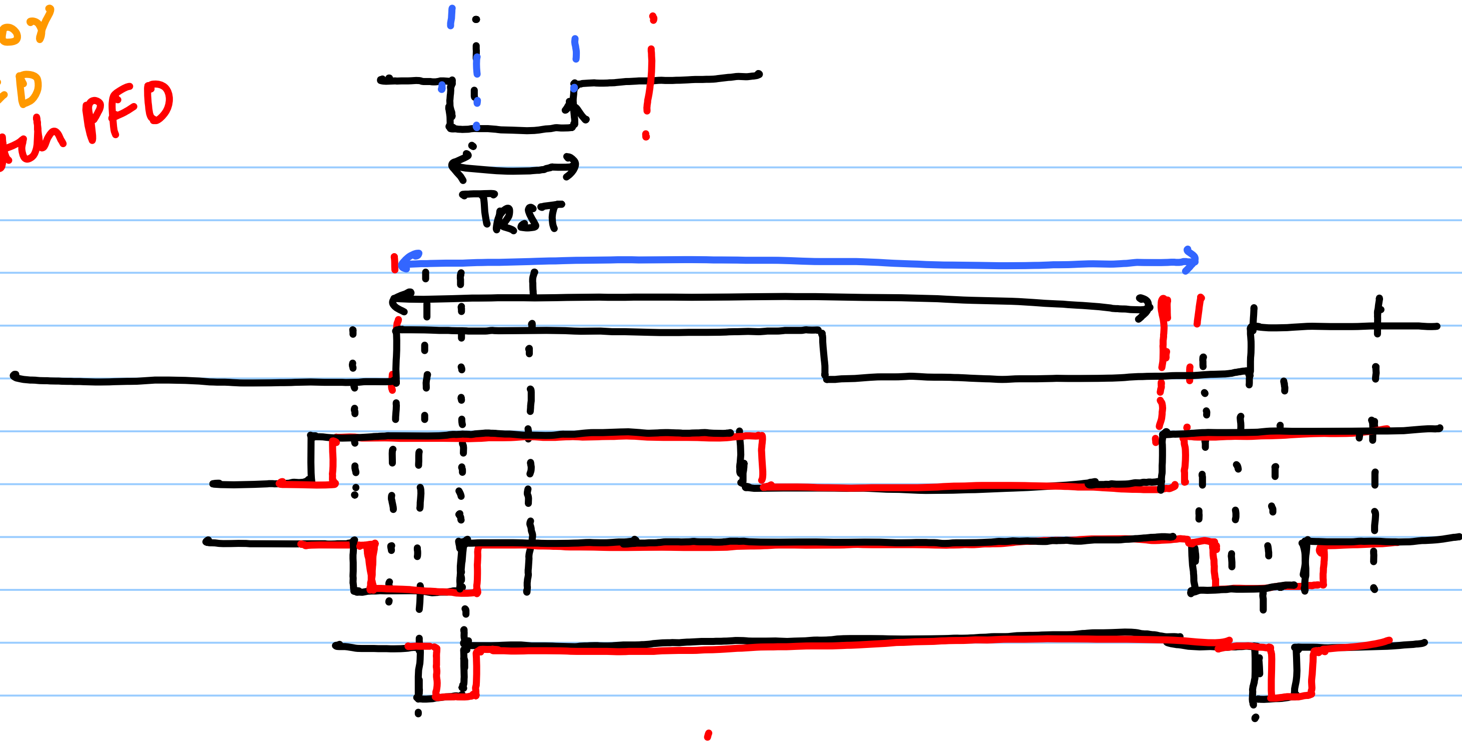
Glitch-latch based PFD





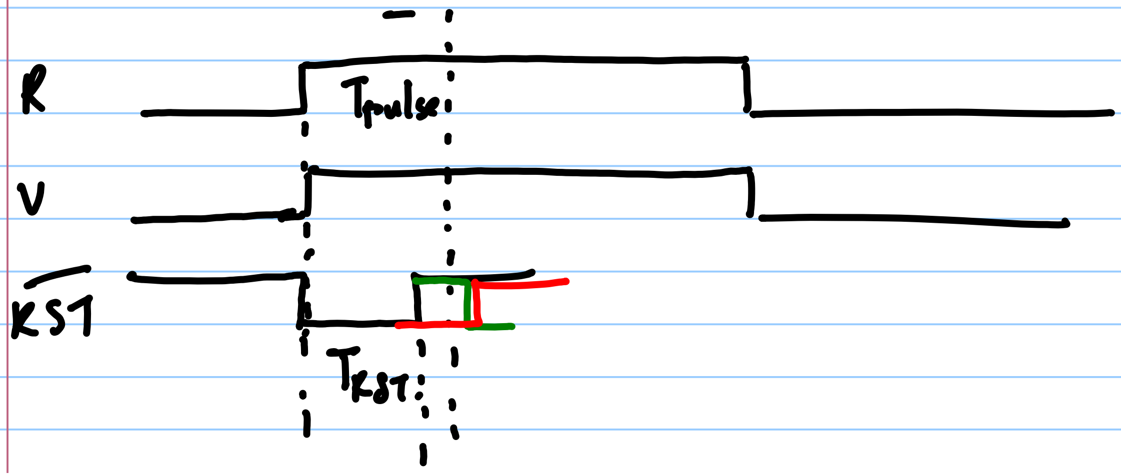


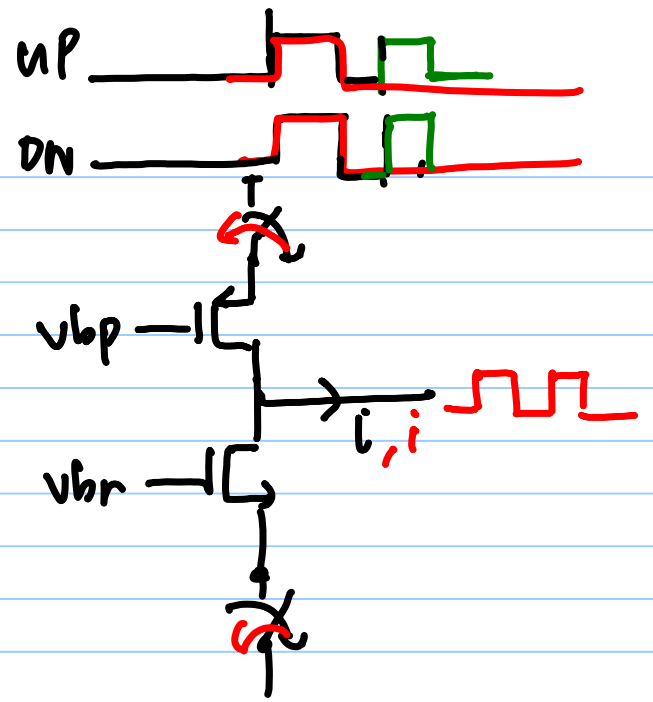




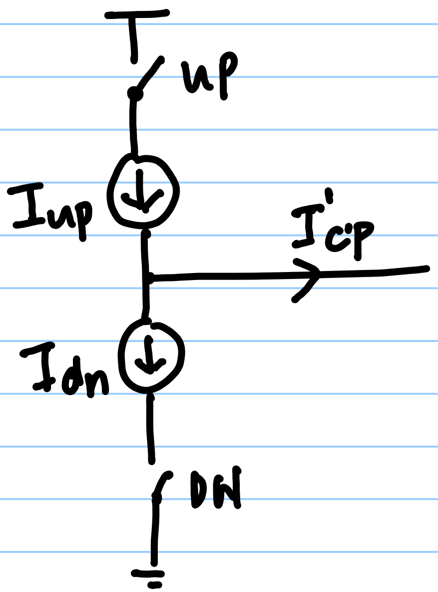
up

T_{pulse} $>$ $\leq$ T_{RST}

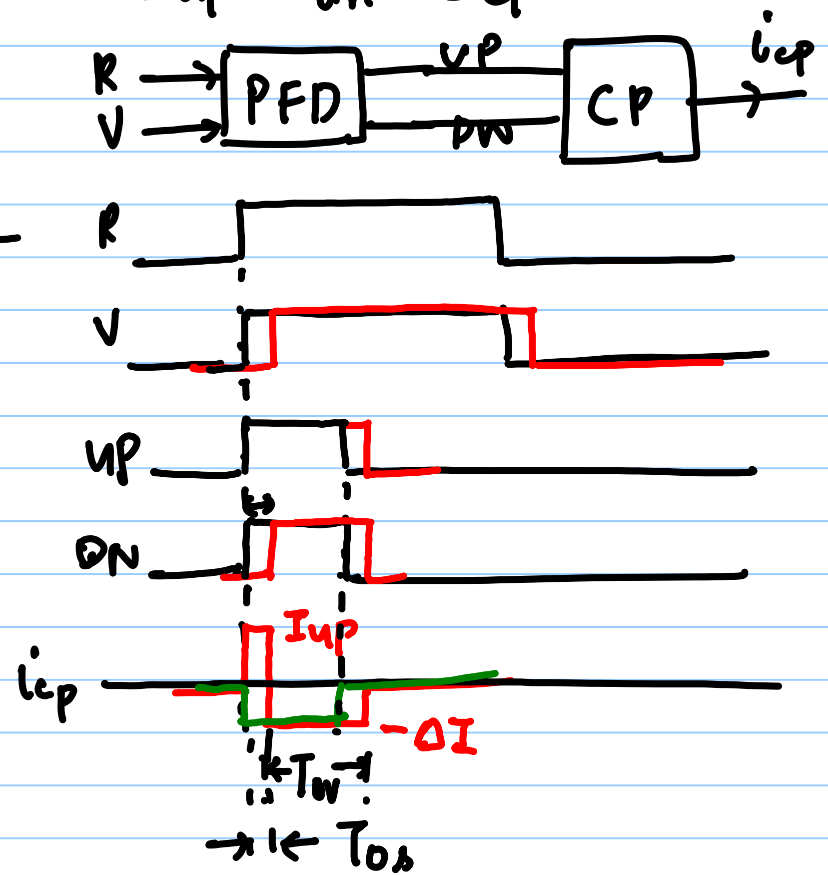



UP
DN
vbp
vbn
i

Charge-pump.



$I_{up} = I_{dn} = I_{cp}$



$I_{up} \cdot T_{os} = (I_{dn} - I_{up})\, T_{ov}$

$T_{os} = \frac{\Delta I}{I_{up}} \cdot T_{ov}$

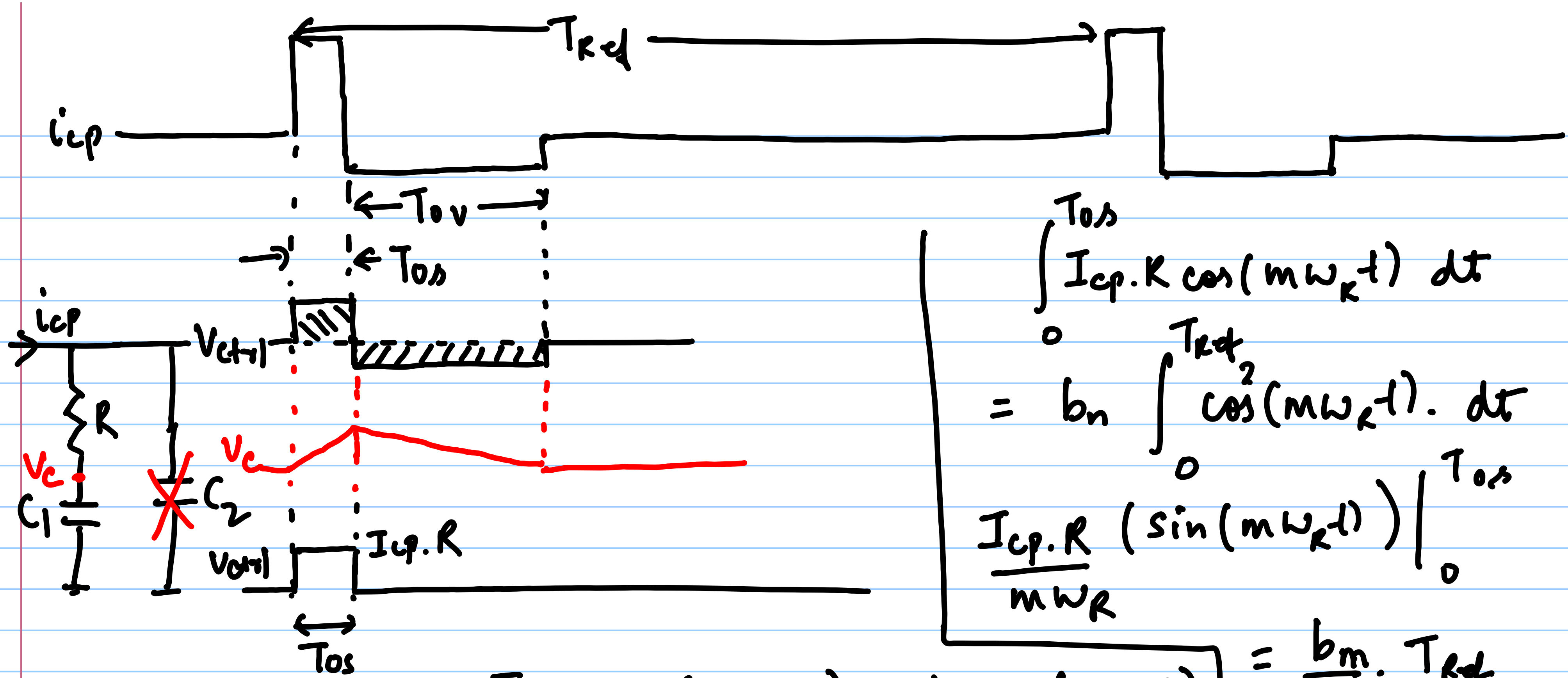
$\frac{T_{os}}{T_{ov}} = \frac{\Delta I}{I_{cp}}$

$I_{up} < I_{dn}$

$I_{dn} - I_{up} = \Delta I$

$I_{up} = I_{cp} \Rightarrow I_{dn} = I_{cp} + \Delta I$

$$\Phi_{os} = 2\pi \cdot \frac{T_{os}}{T_{ref}} = \frac{2\pi}{T_{ref}} \cdot \frac{\Delta I}{I_{cp}} \cdot T_{ov} = 2\pi \frac{T_{ov}}{T_{ref}} \cdot \frac{\Delta I}{I_{cp}}$$



$$\int_0^{T_{os}} I_{cp}.R\cos(m\omega_R t)\,dt$$

$$= b_n \int_0^{T_{Ref}} \cos^2(m\omega_R t).\,dt$$

$$\frac{I_{cp}.R}{m\omega_R}\left(\sin(m\omega_R t)\right)\Big|_0^{T_{os}} = \frac{b_m}{2}.T_{Ref}$$

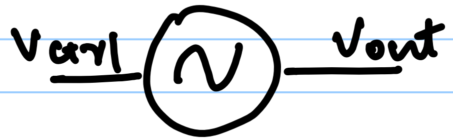
$$V_{ctrl}(t) = a_0 + \sum a_n \sin(n\omega_R t) + b_n \cos(n\omega_R t)$$

$$\omega_R = \frac{2\pi}{T_{Ref}}$$

$$b_n = \frac{2}{T_{Ref}} \frac{I_{cp}.R}{n\omega_R} \sin(\omega_R . T_{os})$$

$$b_n = \frac{2}{\cancel{T_{Ref}}} \cdot \frac{I_{cp} . R}{n . \frac{2\pi}{\cancel{T_{ref}}}} \sin\left(n . 2\pi . \underbrace{\frac{T_{os}}{T_{ref}}} \right)$$

$$= \underbrace{\frac{I_{cp} . R}{n\pi}} \sin(n . \phi_{os})$$



$$V_{out} = \sin\left(\omega_0 t + 2\pi K_{vco} \int V_{ctrl} . dt \right)$$

$$= \sin\left(\omega_0 t + 2\pi K_{vco} b_1' \int \sin(1 . \phi_{os}) . \cos(\omega_R t) . dt \right)$$

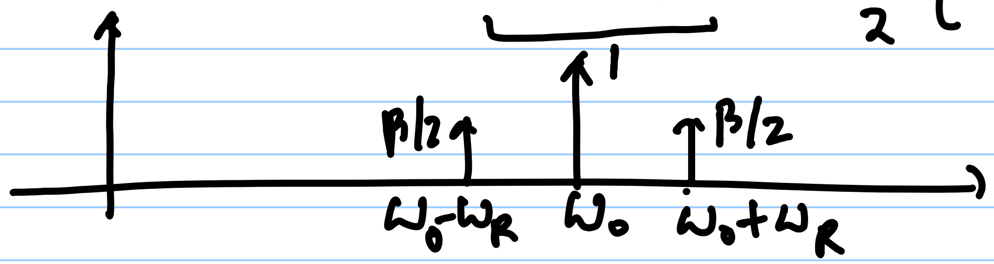
$$= \sin\left(\omega_0 t + \underbrace{\underset{\omega_R}{\underline{2\pi K_{vco} b_1' \sin(\phi_{os})}}}_{\beta} \sin(\omega_R t) \right)$$

$$= \sin\left(\omega_0 t + \beta . \sin(\omega_R t) \right)$$

$$= \sin(\omega_0 t) . \cos(\underbrace{\beta \sin(\omega_R t)}) + \cos(\omega_0 t) . \sin(\beta \sin(\omega_R t))$$

$$= \sin(\omega_0 t) . 1 + \cos(\omega_0 t) . \beta \sin(\omega_R t)$$

$$= \underbrace{\sin(\omega_0 t)}_{1} + \frac{\beta}{2}\left[\sin(\overline{\omega_0+\omega_R}\,t) - \sin(\overline{\omega_0-\omega_R}\,t)\right]$$



$$\beta = \frac{2\pi K_{vco}}{\omega_R}\,\frac{I_{cp}.R}{\pi}\sin(\Phi_{os}) = \frac{2\pi K_{vco}}{\omega_R}\,\frac{I_{cp}.R}{\cancel{\pi}}\,2\cancel{\pi}.\frac{T_{os}}{T_{ref}}.$$

$$= 2K_{vco}.\,I_{cp}.R\,\frac{\cancel{2\pi}}{\cancel{\frac{2\pi}{T_{ref}}}}\cdot\frac{T_{os}}{\cancel{T_{ref}}}$$

$$= 2\pi K_{vco}.\,I_{cp}.R.\,T_{os} = 2\pi.$$

$$LG = \frac{1}{\cancel{2\pi}}\,\frac{I_{cp}}{sC_1}(1+sRC_1)\,\frac{\cancel{2\pi}K_{vco}}{s}$$

$$|LG| = 1 \Rightarrow \frac{I_{cp}}{\cancel{C_1}}\cdot\frac{\cancel{s}RC_1}{\cancel{s}}\times\frac{K_{vco}}{s} = 1 \Rightarrow \omega_u = I_{cp}.R.K_{vco}$$

$$F_{BW} = I_{cp}.R\,K_{vco}/2\pi$$