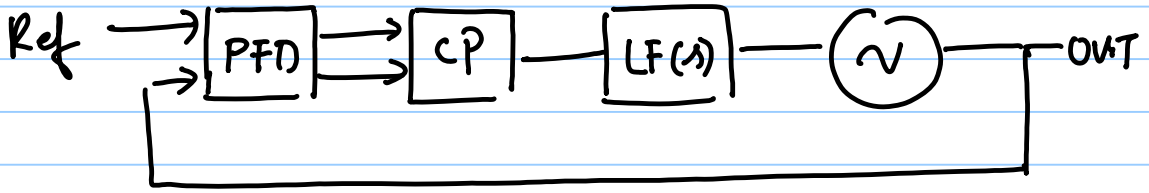
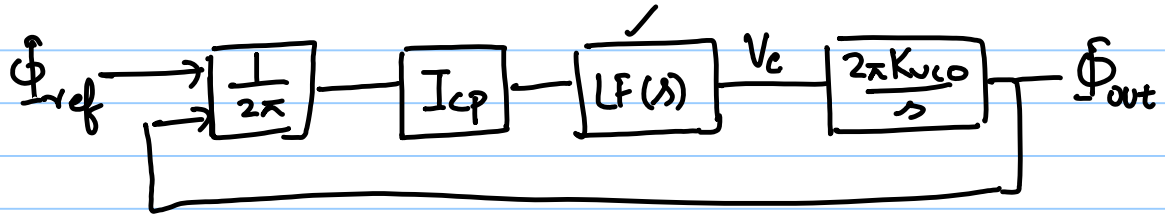
Lecture # 14

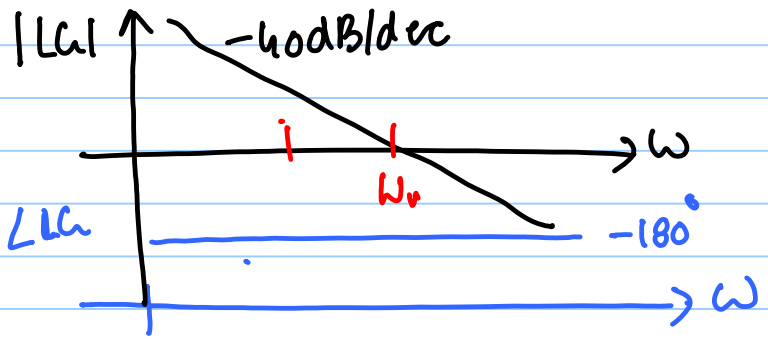
Note Title 30-08-2018

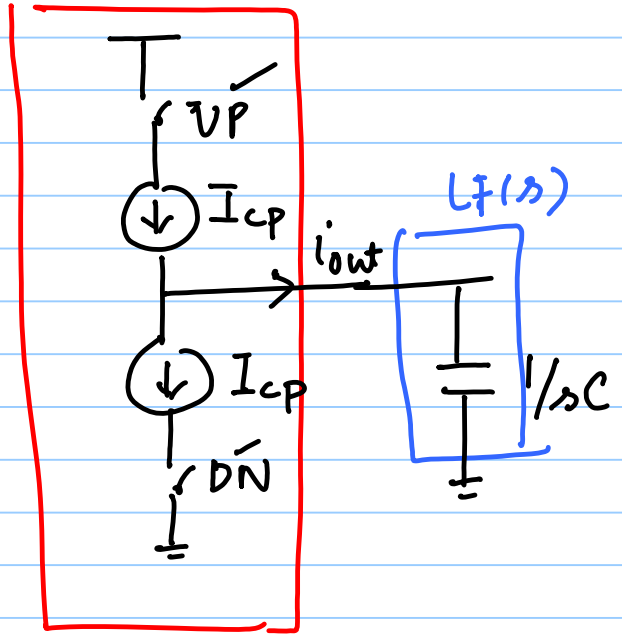




$LF(s) = 1/sC$

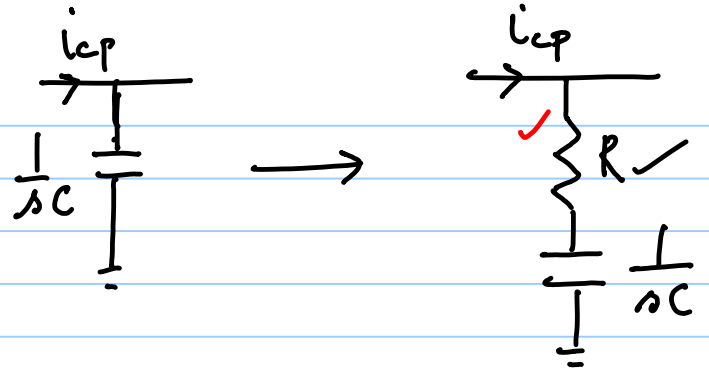
$$LG(s) = \frac{1}{2\pi} I_{CP} \frac{1}{sC} \frac{2\pi K_{VCO}}{s} = \frac{I_{CP}}{s^2 C} \times K_{VCO}$$



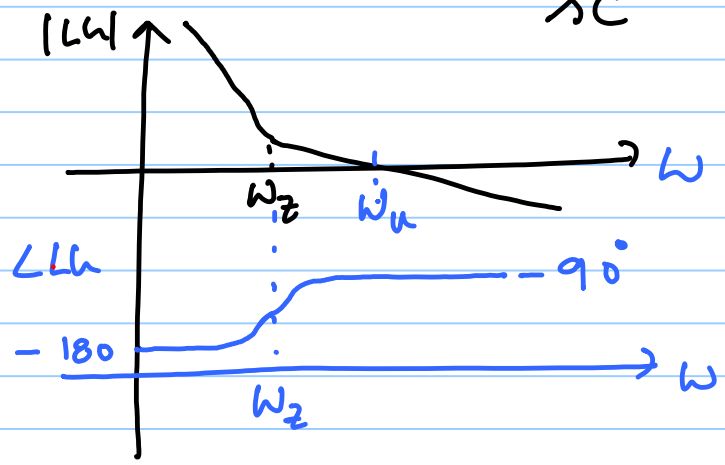


Charge-pump

$$\frac{i_{out}(s)}{\Phi_e(s)}$$



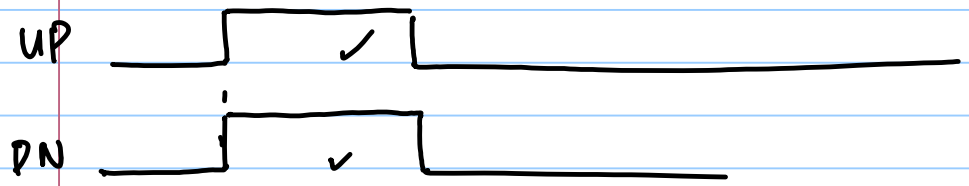
$$LF(s) = R + \frac{1}{sC} = \frac{1+sRC}{sC}$$



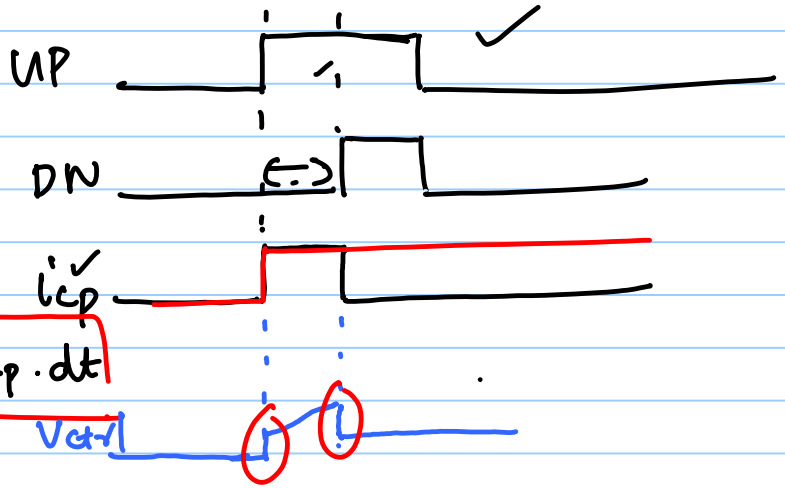
$$LH(s) = \frac{I_{cp}\,(1+sRC)\,K_{vco}}{s^2C}$$

$$\omega_z = \frac{1}{RC}, \quad \omega_{p1} = \omega_{p2} = 0$$

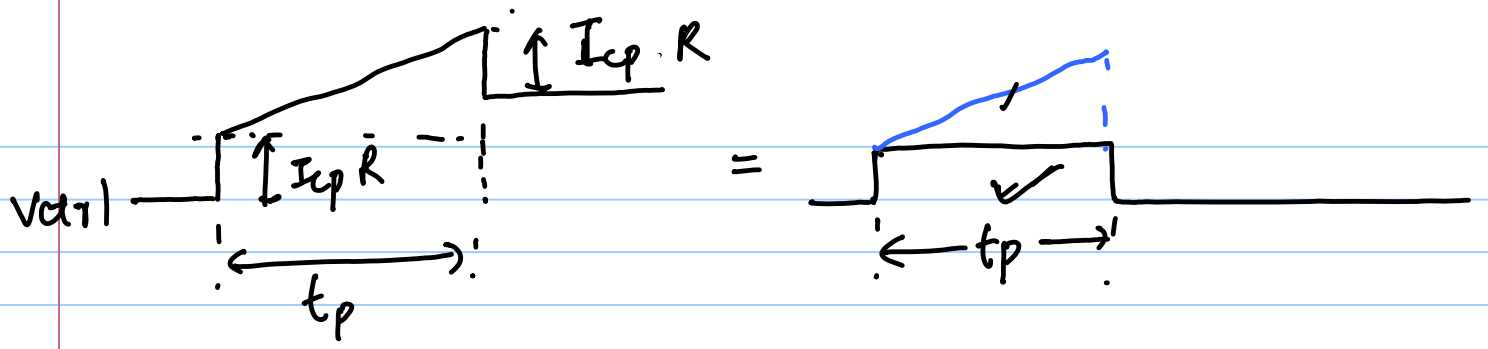
$$i = C\frac{dV}{dt}$$

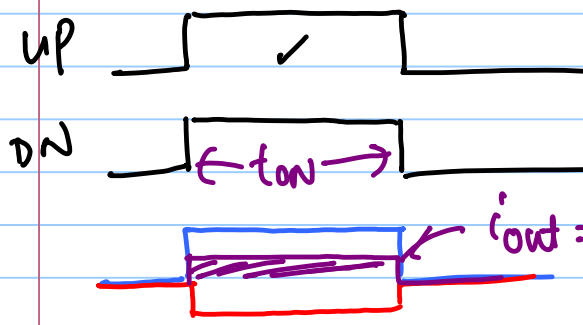


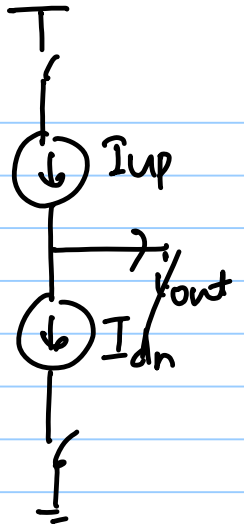
t=0



$$V_{ctrl}(t) = V_{ctrl}(0) + i_{cp}.R + \frac{1}{C}\int i_{cp}.dt$$





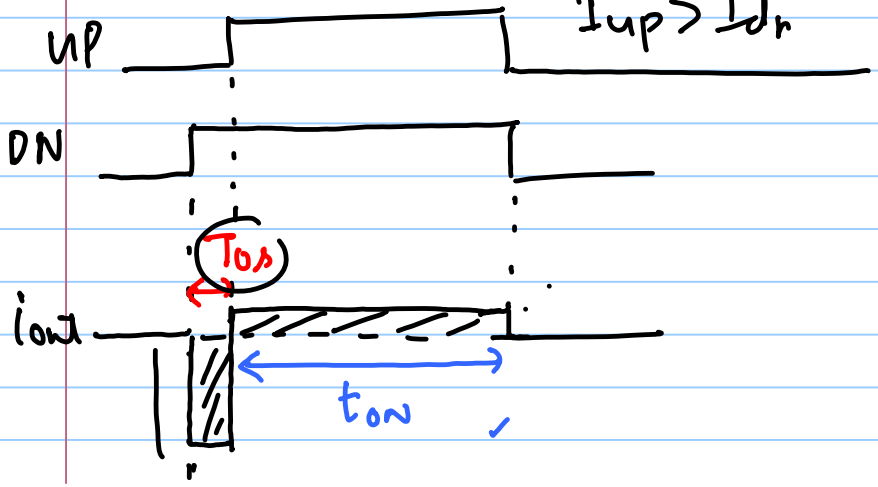


$i_{out} = I_{up} - I_{dn}$ if $I_{up} > I_{dn}$

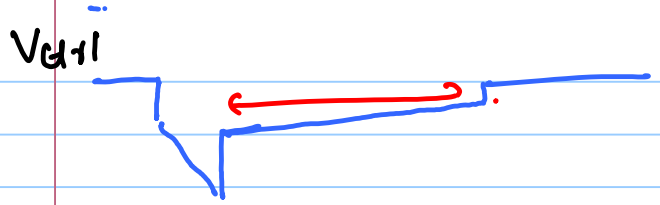
$I_{up} = I_{dn} = I_{cp}$

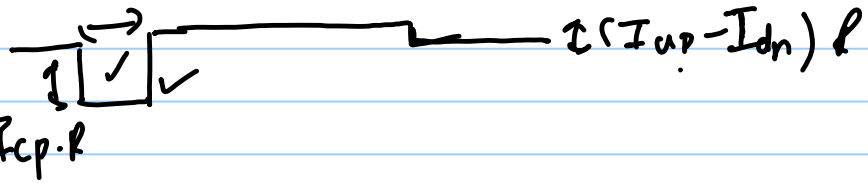
$I_{up} \neq I_{dn}$

Min. time for switching $\longrightarrow t_{ON}$ $\xrightarrow{I_{up} \neq I_{dn}}$ i_{out}



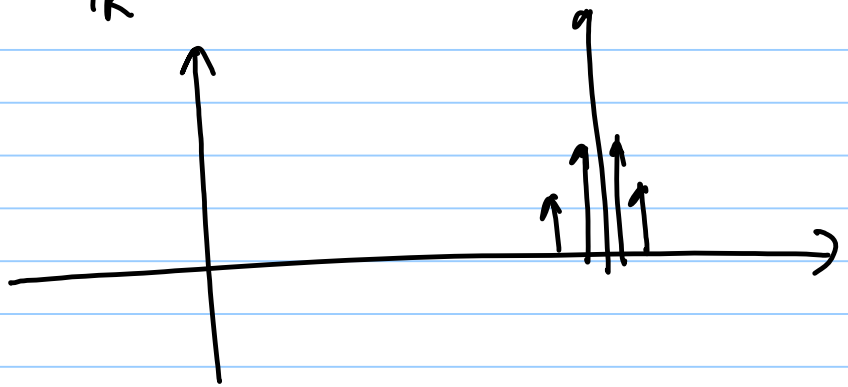
$I_{dn} \times T_{OS} = (I_{up} - I_{dn})\, t_{ON}$





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

$$\omega_R = \frac{2\pi}{T_R} \quad \text{reference freq.}$$



$$V_{out} = \sin\left(\omega_{out} t + 2\pi K_{VCO} \int V_{ctrl}\, dt\right)$$

$$= \sin\left(\omega_{out} t + \underbrace{2\pi K_{VCO} \frac{a_1}{\omega_R}}_{A_{1R}} (-\cos(\omega_R t))\right)$$

$$= \sin(\omega_{out} t) \cos\left(A_{1R} \cos(\omega_R t)\right) + \sin\left(A_{1R} \cos(\omega_R t)\right) \cdot \cos(\omega_{out} t)$$

$$A_{1R} \cos(\omega_R t) \cdot \cos(\omega_{out} t)$$

$$\frac{A_{1R}}{2}\left[\cos(\omega_{out} + \omega_R t) + \cos(\omega_{out} - \omega_R t)\right]$$