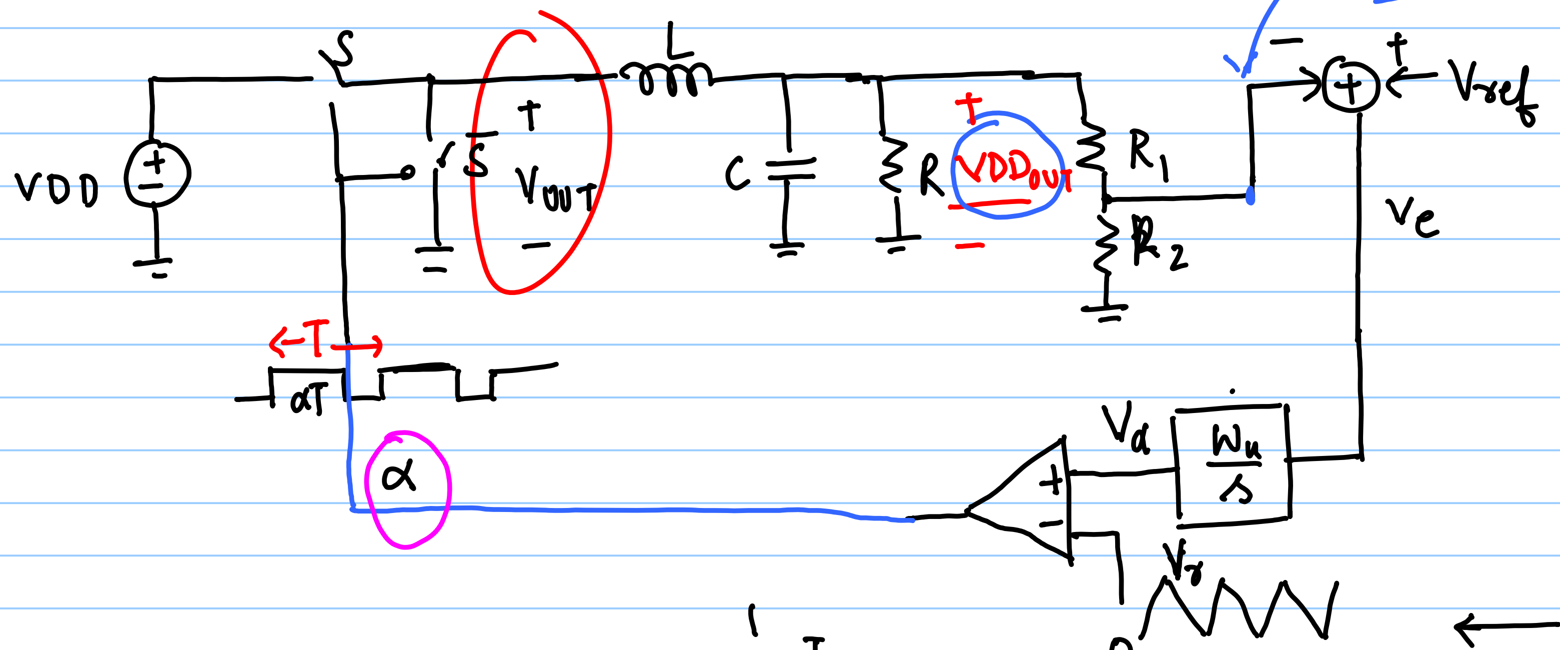
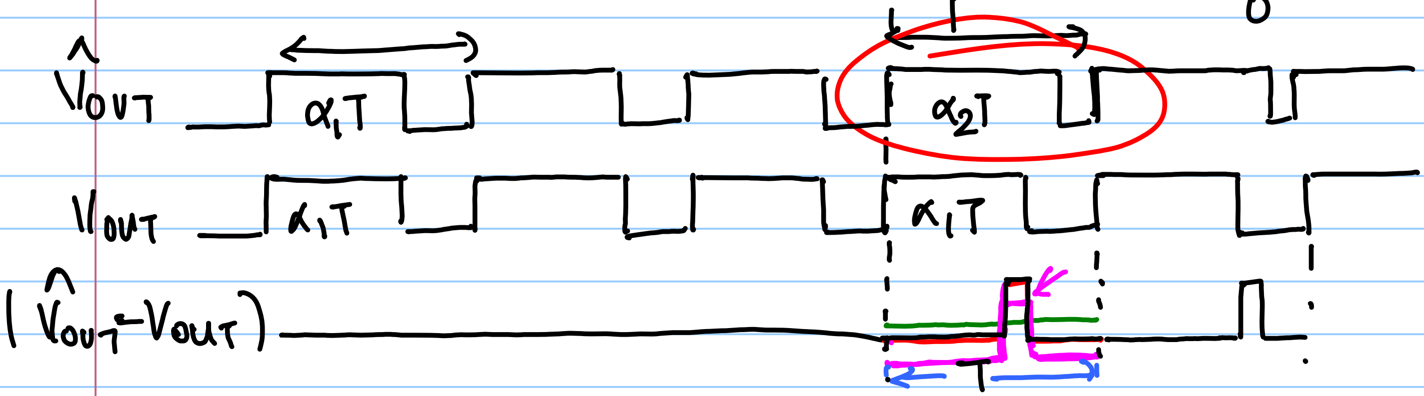
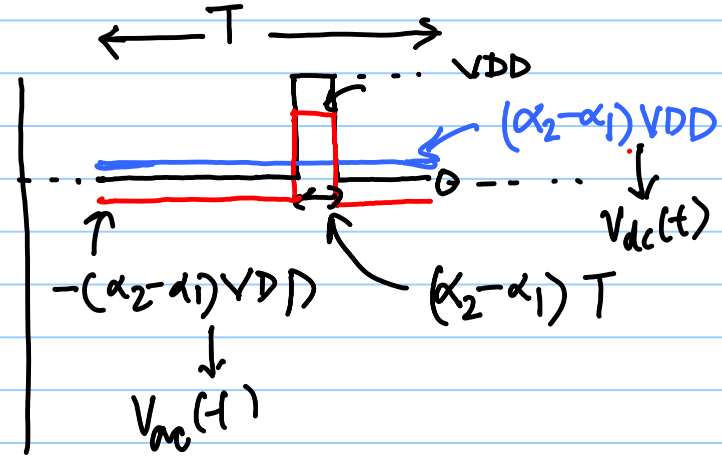
Note Title

Lecture # 31

$$\frac{R_2}{R_2+R_1} V_{DD_{out}} = \frac{1}{K} V_{DD_{out}}$$







$$\Delta VDD_{OUT} = f(t) * (\hat{V}_{OUT} - V_{OUT})$$

$$= \int_0^T (\hat{V}_{out}(\tau) - V_{out}(t))\, \underline{f(t-\tau)}\, d\tau$$

$$+ \int_T^{2T} \downarrow$$

$$+ \int_{2T}^{3T} \downarrow \quad + \cdots$$

$f(t-0) \to f(t-T)$

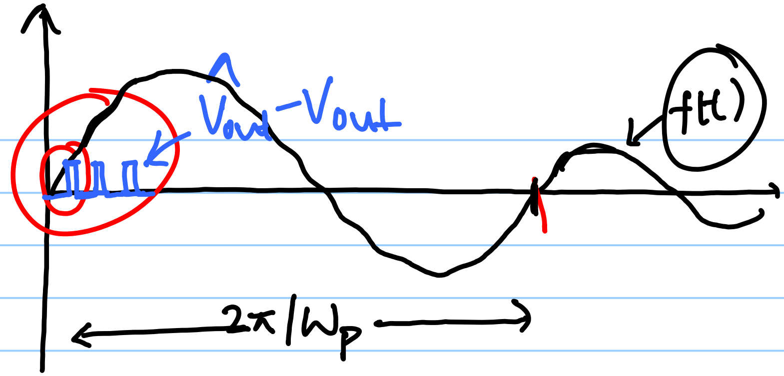
$\downarrow$

$f(t-T/2)$

$$= f(\downarrow) \int_0^T (\hat{V}_{out}(\tau) - V_{out}(\tau))\, d\tau.$$

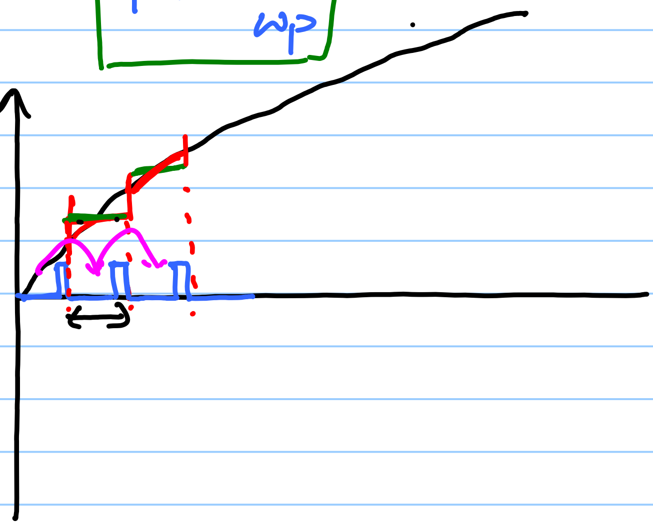
$f(t-3T/2)$

$$+ f(\ ) \int_T^{2T} \downarrow \quad d\tau$$



$$\omega_p = \frac{1}{\sqrt{LC}} \sqrt{1 - \left(\frac{1}{2Q_p}\right)^2}$$

$$\boxed{T \ll \frac{2\pi}{\omega_p}}$$



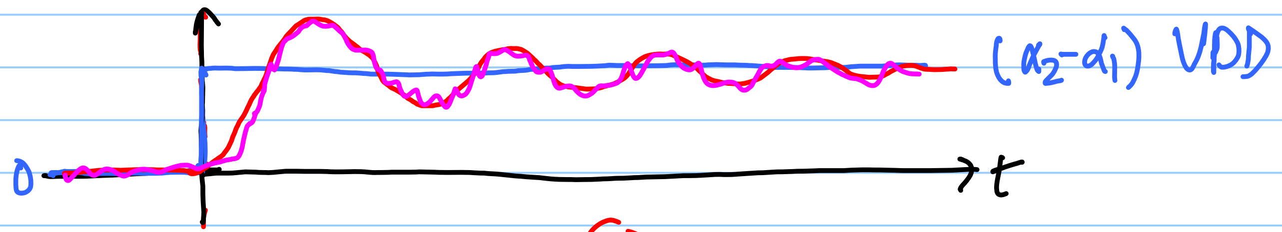
$$= f(\ ) \int_0^T \underbrace{\left(V_{dc}(\tau) + V_{ac}(\tau)\right)}\, d\tau \qquad \int_0^T V_{ac}(\tau)\, d\tau = 0$$

$$\neq$$

$$+ f(\ ) \int_T^{2T} \underbrace{\left(V_{dc}(\tau) + V_{ac}(\tau)\right)}\, d\tau + \cdots$$

$$= \int_0^t V_{dc}(\tau)\, f(t-\tau)\, d\tau + \underbrace{\int_0^t V_{ac}(\tau)\, f(t-\tau)\, d\tau}_{=0}$$

$$\Delta VDD_{OUT} = \int_0^t V_{dc}(\tau)\, \underline{f(t-\tau)}\, d\tau$$



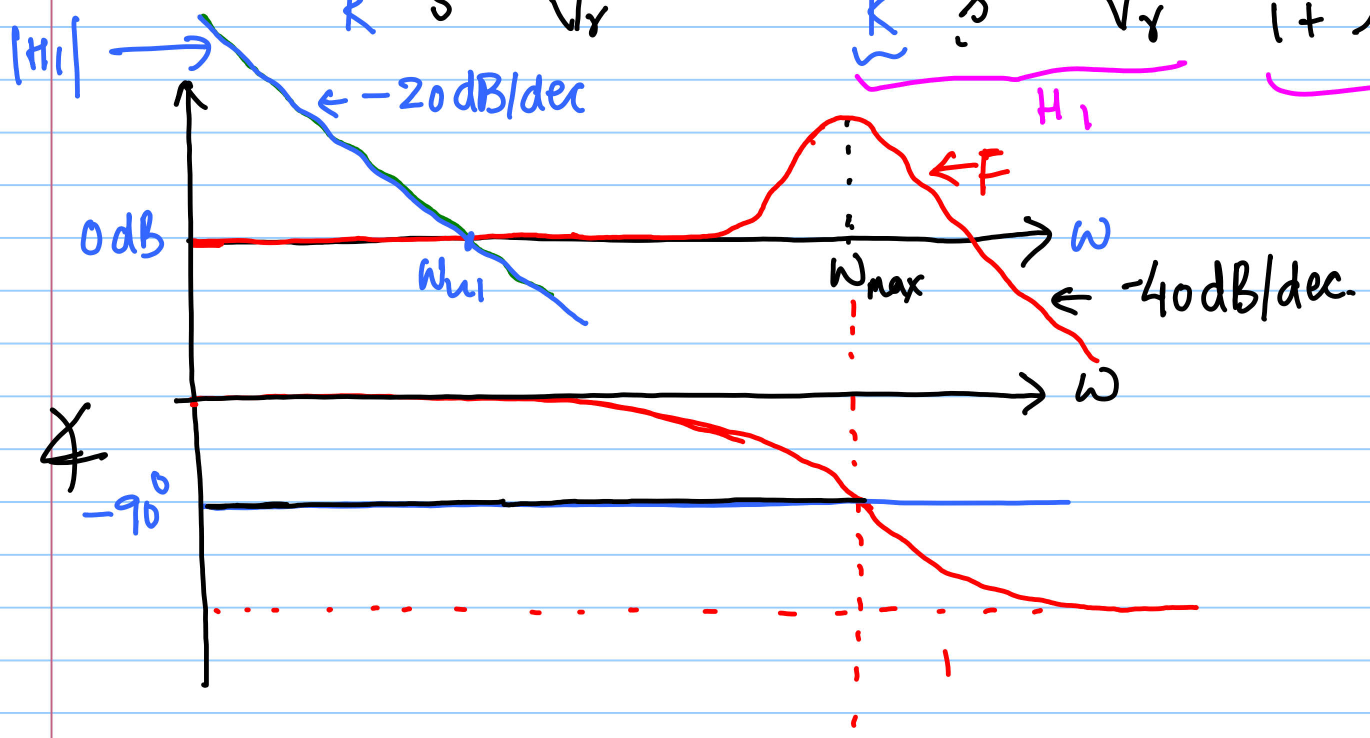
$$\Delta VDD_{OUT} = (\alpha_2-\alpha_1)VDD\left[1 - \underbrace{e^{-\sigma t}\left\{\cos(\omega_p t) + \frac{\sigma}{\omega_p}\sin(\omega_p t)\right\}}_{\to 0}\right] u(t)$$

Change in duty cycle = $(\Delta\alpha)u(t)$

$\Rightarrow \Delta VDD_{OUT}(t) = (\Delta\alpha) VDD \left[1 - e^{-\sigma t}(\quad) \right] u(t)$

$$\frac{\Delta VDD_{OUT}}{\Delta\alpha} = (VDD)\ F(s)$$

$$LG(s) = \frac{1}{K}\frac{W_u}{s}\frac{V_\alpha}{V_r}\ F(s) = \underbrace{\frac{1}{K}\frac{W_n}{s}\frac{V_\alpha}{V_r}}_{H_1}\ \underbrace{\frac{1}{1+\frac{sL}{R}+s^2LC}}_{F(s)}$$



$$W_{u1} = \frac{W_n}{K}\frac{V_\alpha}{V_r}$$

$$F(s) = \frac{1}{1 + \frac{s}{\omega_n Q_p} + \frac{s^2}{\omega_n^2}}$$

$$\omega_{max} = \omega_n \sqrt{1 - \frac{1}{2Q_p^2}}$$

$$|F(\omega)|_{max} = Q_p$$

$$F(s) = \frac{1}{\left(1 - \frac{\omega^2}{\omega_n^2}\right) + j\frac{\omega}{\omega_n Q_p}}$$

$$|F(s)| = \frac{1}{\sqrt{\left(1 - \frac{\omega^2}{\omega_n^2}\right)^2 + \frac{\omega^2}{\omega_n^2 Q_p^2}}}$$

$$\measuredangle F = -\tan^{-1}\left(\frac{\omega / \omega_n Q_p}{1 - \omega^2/\omega_n^2}\right)$$

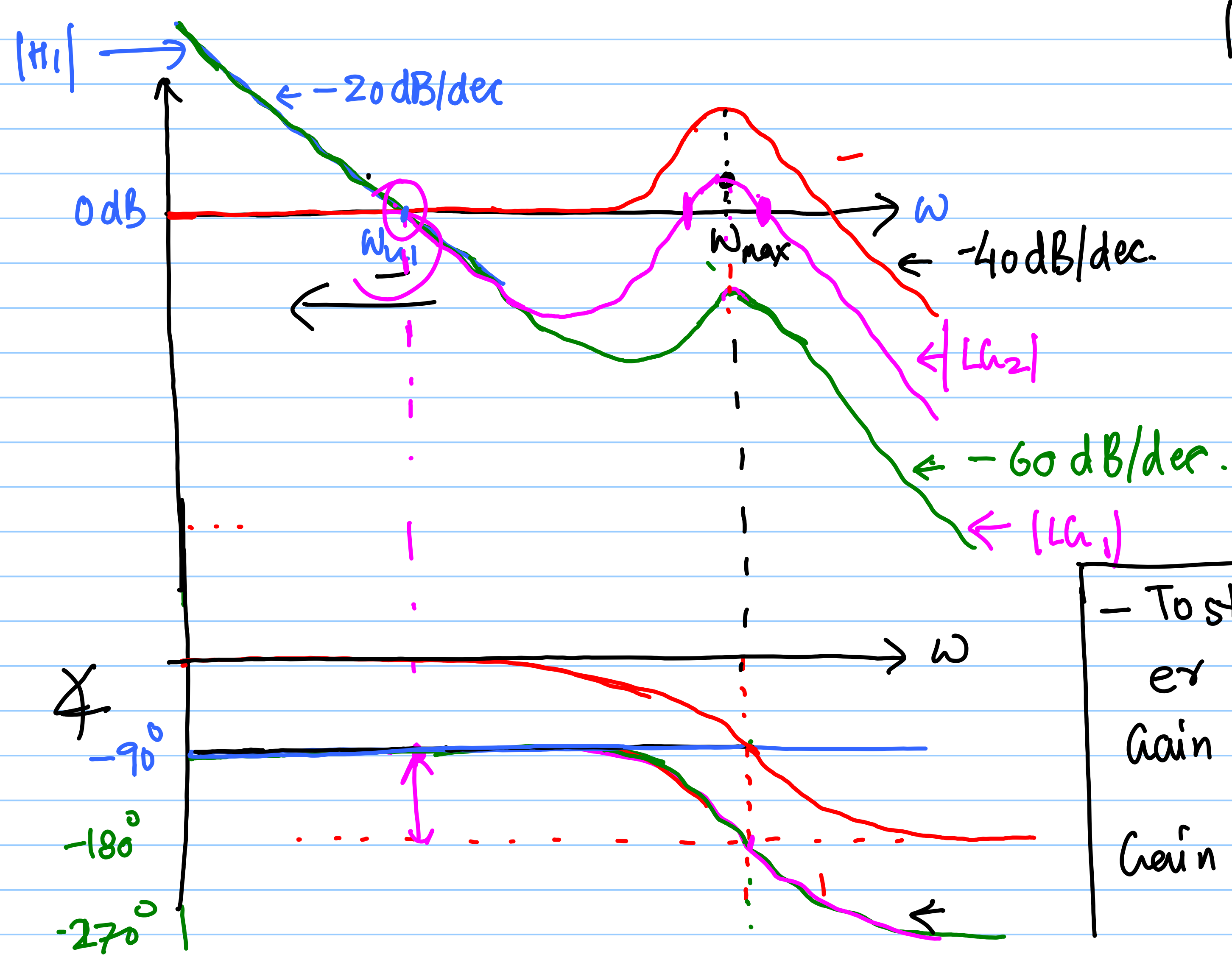
$$\measuredangle F(\omega_{max}) = -\tan^{-1}\left(\frac{\frac{1}{Q_p}\sqrt{1 - \frac{1}{2Q_p^2}}}{1 - \left(1 - \frac{1}{2Q_p^2}\right)}\right)$$

$$= -\tan^{-1}\left(\frac{1}{2Q_p}\sqrt{1 - \frac{1}{2Q_p^2}}\right)$$

$$F(s) = \frac{1}{(s+\sigma)^2 + \omega_p^2}$$

$$= \frac{1}{(s + \sigma + j\omega_p)(s + \sigma - j\omega_p)}$$

$$\measuredangle F = -\tan^{-1}\left(\frac{\omega + \omega_p}{\sigma}\right) - \tan^{-1}\left(\frac{\omega - \omega_p}{\sigma}\right)$$



$|LG_2|$: Gain $= 0\,dB$, $\measuredangle LG_2 = -180^\circ$ } Unstable

$|LG_1|$: Gain $< 0\,dB$ near ω_{max}

- To stablize switching converter

Gain of H_1 @ $\omega_{max} = \dfrac{\omega_{u1}}{\omega_{max}}$

Gain of F @ $\omega_{max} = Q_p$

$$|\text{Gain of } H_1 @ \omega_{max} \cdot \text{Gain of } f @ \omega_{max}| < 1$$

$$\frac{\omega_{u1}}{\omega_{max}} \cdot Q_p < 1$$

$$\omega_{u1} < \frac{\omega_{max}}{Q_p}$$

$$\boxed{\frac{1}{K} \frac{V_\alpha}{V_\gamma} \cdot \omega_u < \frac{\omega_{max}}{Q_p}}$$