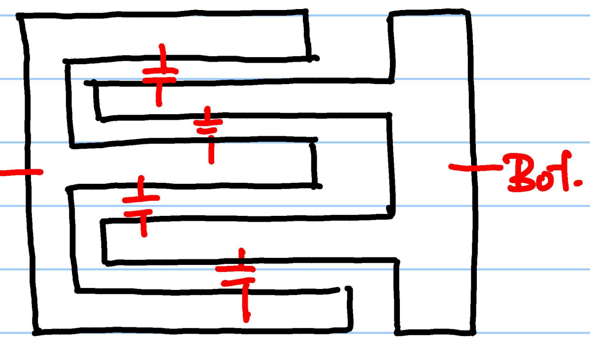
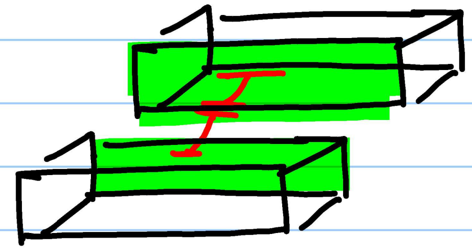
Note Title

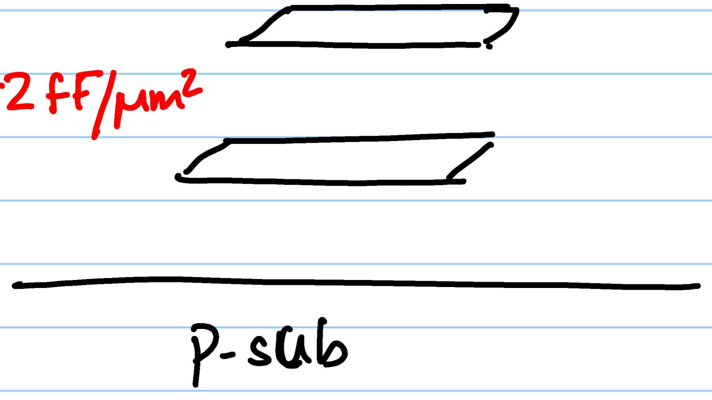
Lecture # 42

04-12-2020

Loop filter



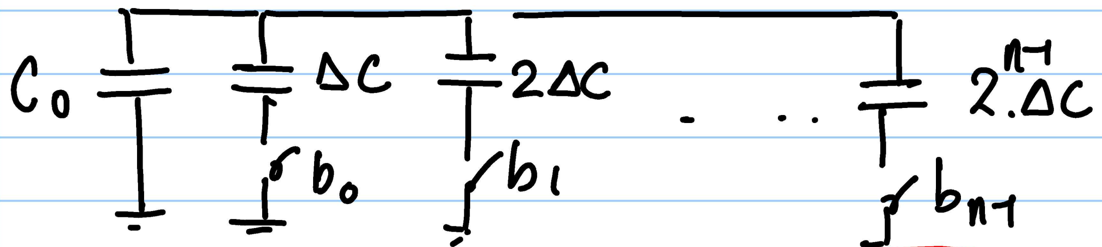




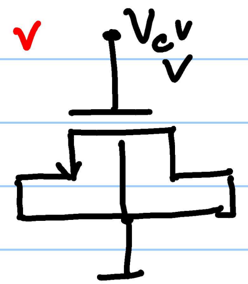
1-2 fF/µm²

$$\phi_m = f\left(\frac{C_1}{C_2}\right)$$

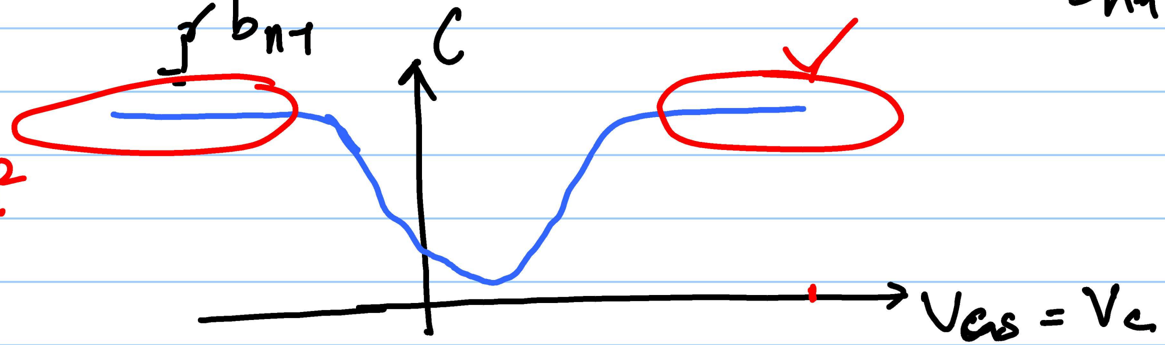
$$\omega_u = \frac{I_{cp} \cdot R\, K_{vco}}{N} \frac{C_1}{C_1 + C_2}$$

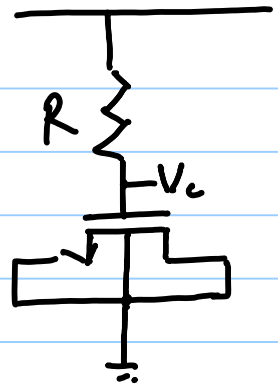


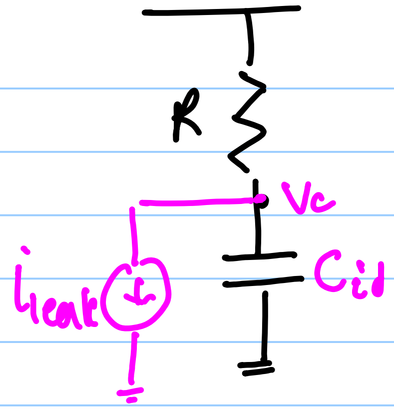
$$C_{tot} = C_0 + b_0 \cdot \Delta C + b_1 2^1 \cdot \Delta C + \cdots + b_{n-1} 2^{n-1} \cdot \Delta C$$

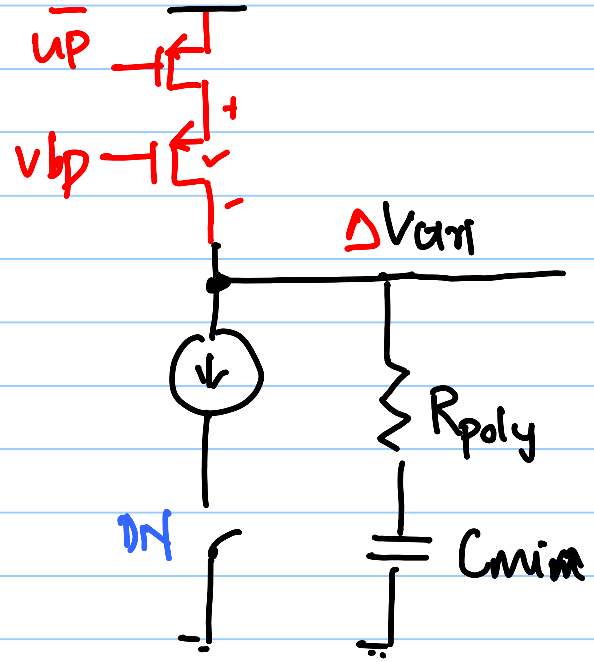


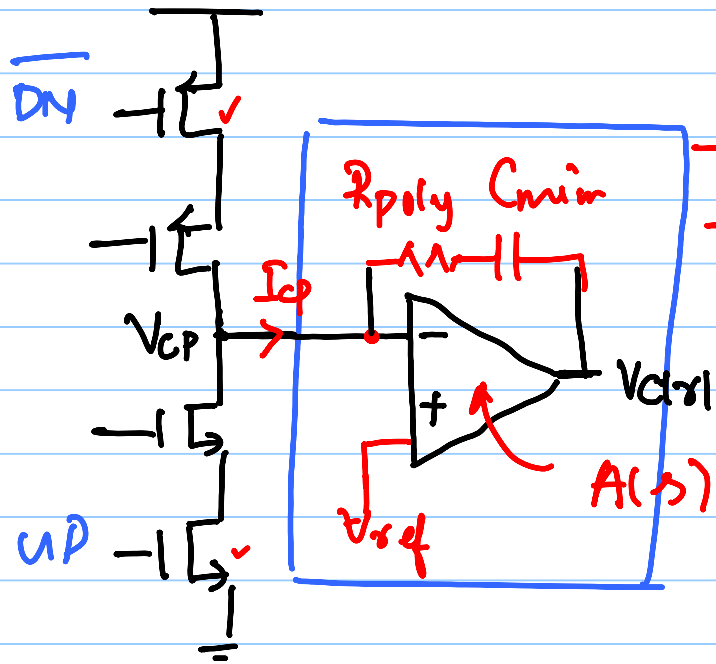
10-12 fF/µm²







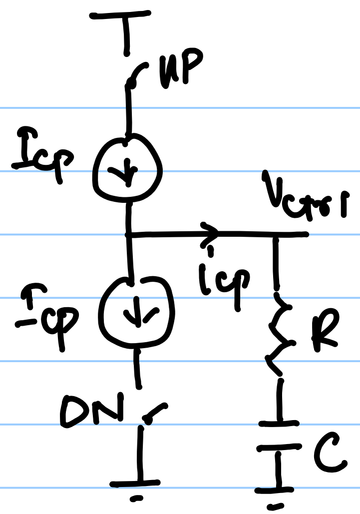




Opamp
- Gain
- Bandwidth
- Power
- Slew-rate

$$A(s) = \frac{A_0}{1+s/\omega_a}$$

$$\frac{V_{ctrl}}{I_{cp}} = - \left(R_{poly} + \frac{1}{sC_{min}}\right)$$



$$V_{ctrl}(s) = I_{cp}(s)\left(R + \frac{1}{sC}\right)$$

$$v_{ctrl}(t) = \underbrace{i_{cp}\cdot R}_{V_P} \pm \underbrace{\frac{1}{C}\int i_{cp}\cdot dt}_{V_I}$$

$$= i_{cp1}\cdot R + \frac{1}{C}\int i_{cp2}\, dt$$

$$V_{ctrl}(s) = I_{cp1}\cdot R + \frac{1}{sC} I_{cp2}$$

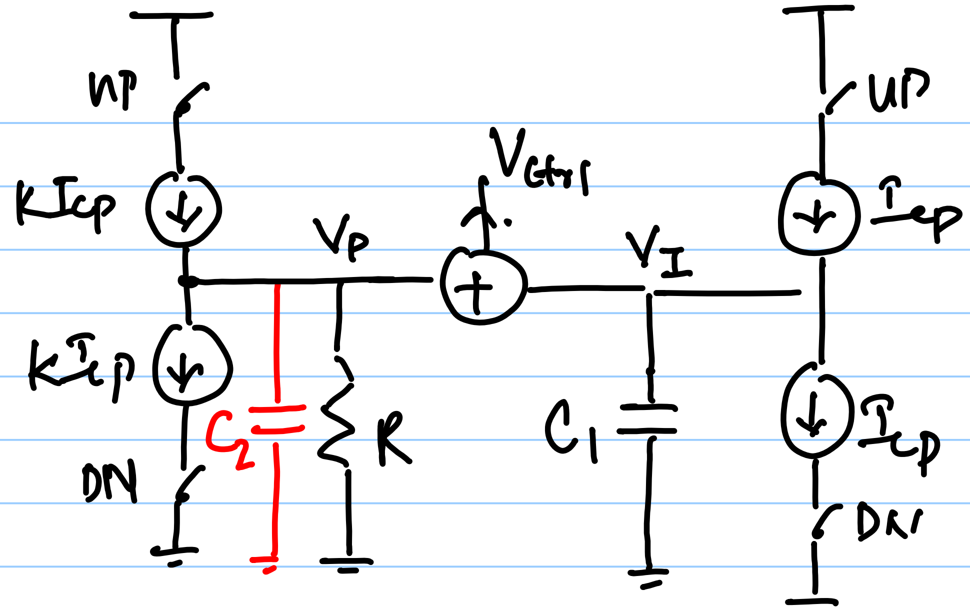
$$= \frac{I_{cp2}}{sC}\left(1 + \frac{I_{cp1}}{I_{cp2}} sRC\right)$$

$$\frac{V_{ctrl}}{I_{cp2}} = \frac{1}{sC}\left(1 + sR\left(\frac{I_{cp1}}{I_{cp2}}\right)C\right) = \frac{1}{sC}\left(1 + sR(KC_1)\right)$$

$$\omega_z = \frac{1}{R\left(\frac{I_{cp1}}{I_{cp2}}\right)C_1} = \frac{1}{RC_0} \Rightarrow \frac{I_{cp1}}{I_{cp2}} C_1 = C_0$$

$$\Rightarrow \frac{I_{cp1}}{I_{cp2}} > 1$$

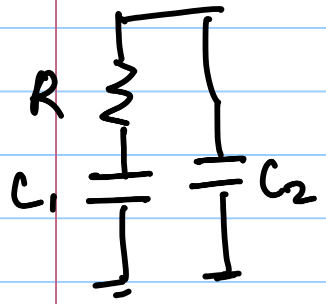
$$\omega_z = \frac{1}{RC_0}$$



$$V_{ctrl}(s) = \frac{KI_{cp}\,R}{1+sRC_2} + \frac{I_{cp}}{sC_1}$$

$$\frac{V_{ctrl}(s)}{I_{cp}} = \frac{K.R\,sC_1 + 1+sRC_2}{sC_1(1+sRC_2)}$$

$$= \frac{1+sR(KC_1+C_2)}{sC_1(1+sRC_2)}$$



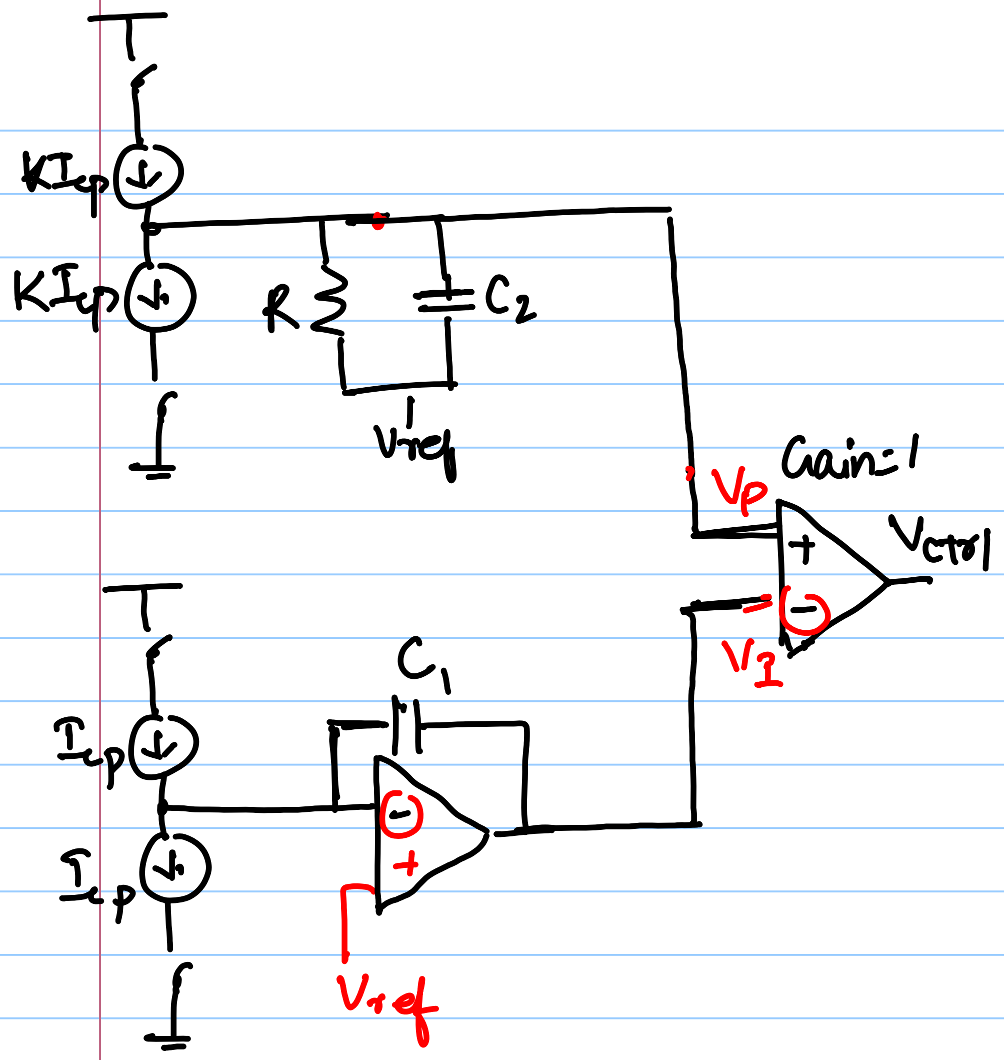
$$\frac{V_{ctrl}}{I_{cp}} = \frac{1+sRC_1}{\left(1+s\frac{RC_1C_2}{C_1+C_2}\right) \times s(C_1+C_2)}$$

$$W_Z = \frac{1}{RC_1}$$

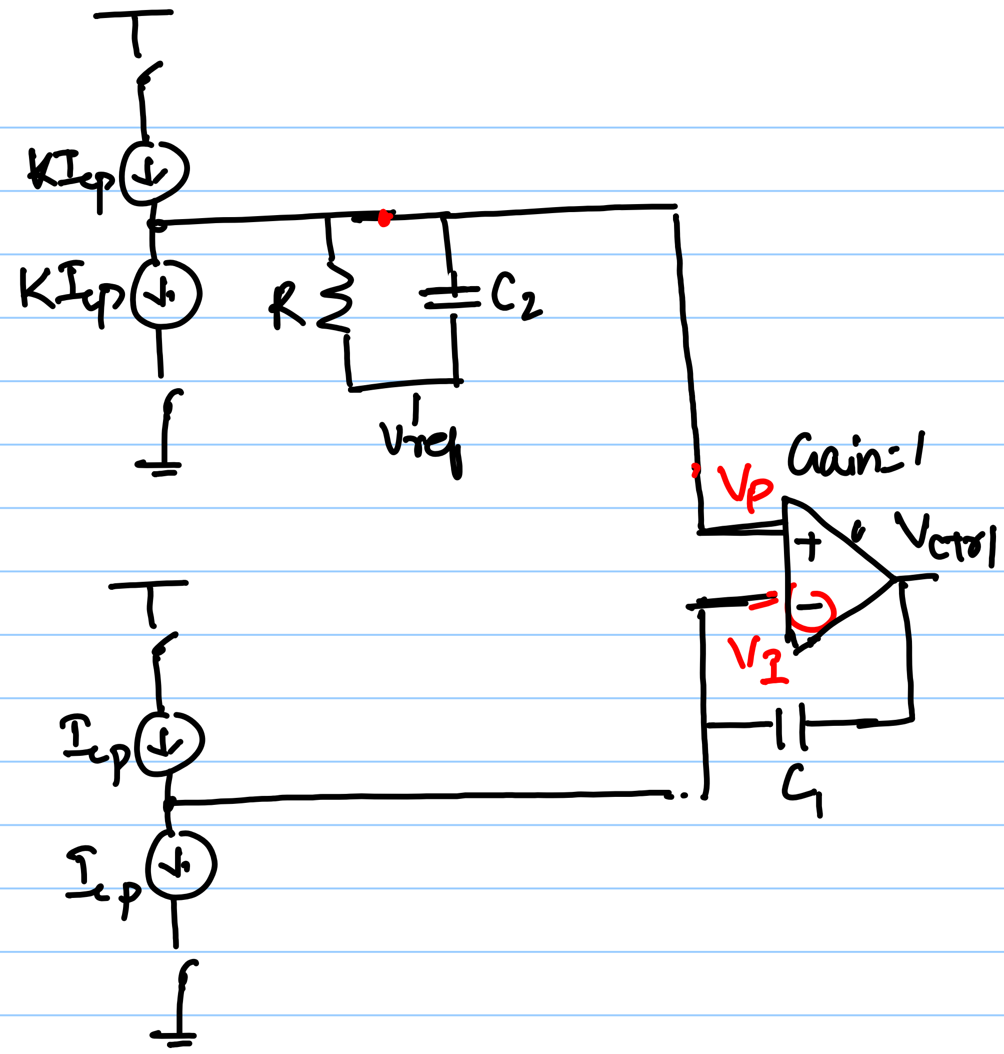
$$W_P = 0,\ \frac{1}{\frac{RC_1C_2}{C_1+C_2}}$$

$$W_Z = \frac{1}{R(KC_1+C_2)}$$

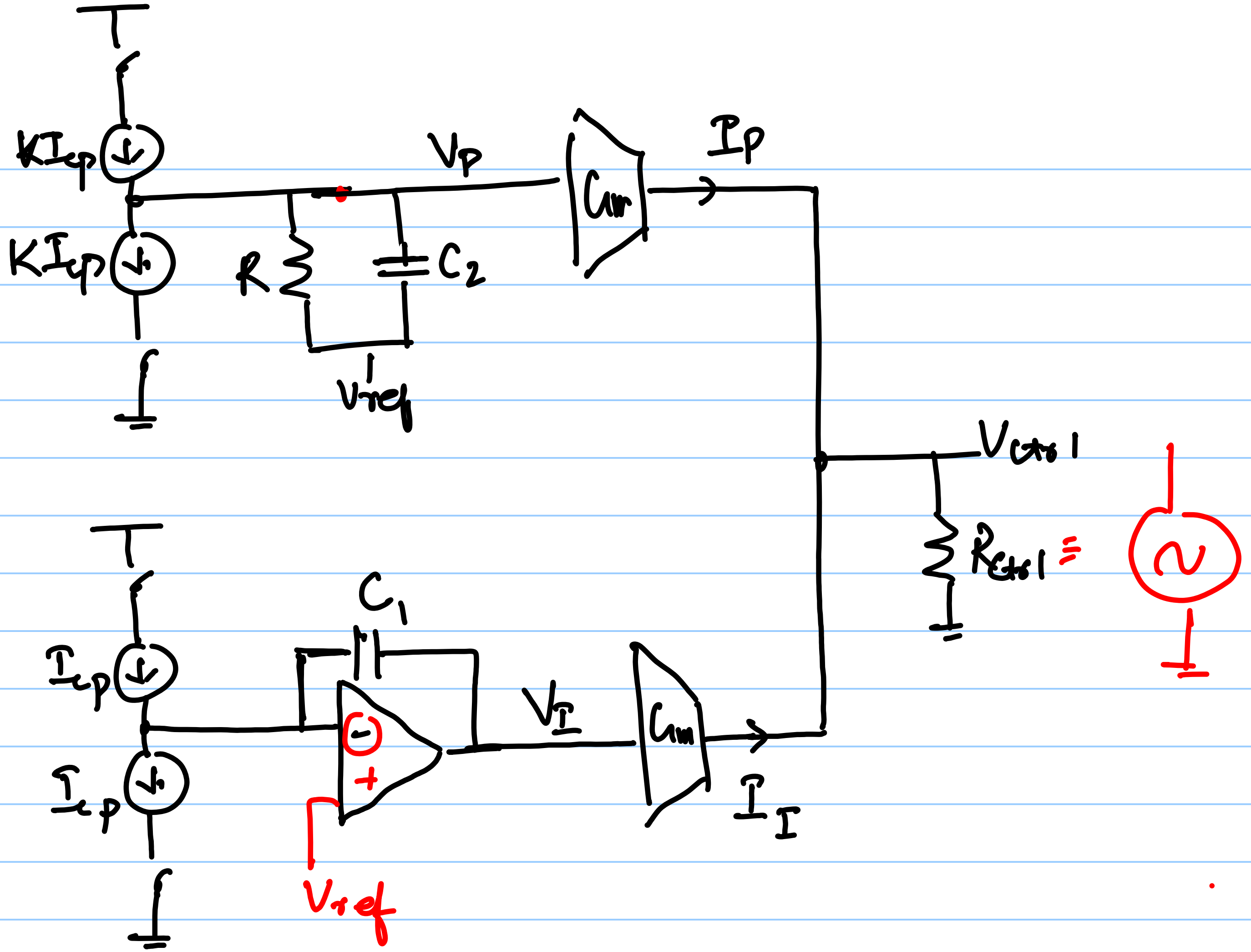
$$W_P = 0,\ \frac{1}{RC_2}$$



KI_{cp}
KI_{cp}
R
C_2
V_{ref}'
V_P
Gain: 1
V_{ctrl}
V_I
C_1
I_{cp}
I_{cp}
V_{ref}

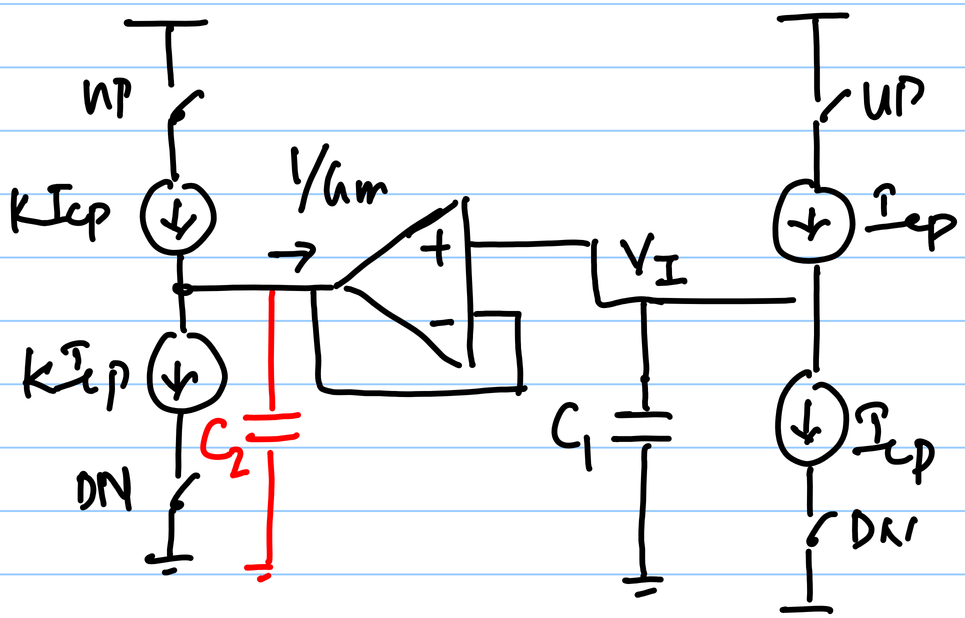


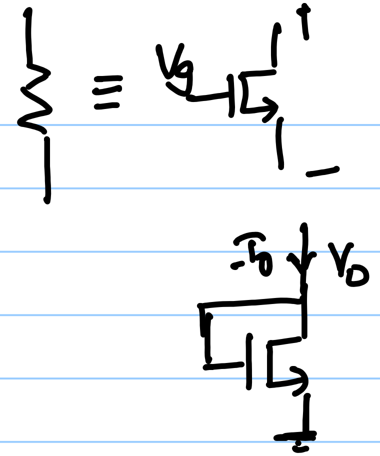
KI_{cp}
KI_{cp}
R
C_2
V_{ref}'
V_P
Gain: 1
V_{ctrl}
V_I
C_1
I_{cp}
I_{cp}



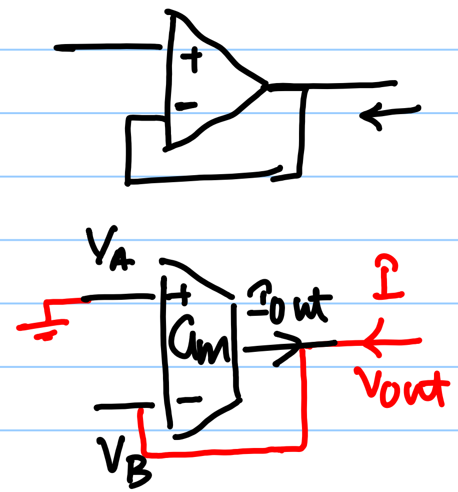
KIcp
KIcp
R
C2
Vref
Vp
Gm
Ip
Vctrl
Rctrl =
Icp
Icp
C1
Vref
VI
Gm
II

Dual Path Loop filter (DPLF)





$R = \frac{1}{g_m} = \frac{\Delta V_0}{\Delta I_0}$



$I_{out} = G_m (V_A - V_B)$

$I = - G_m (0 - V_{out})$

$\frac{V_{out}}{I} = \frac{1}{G_m}$