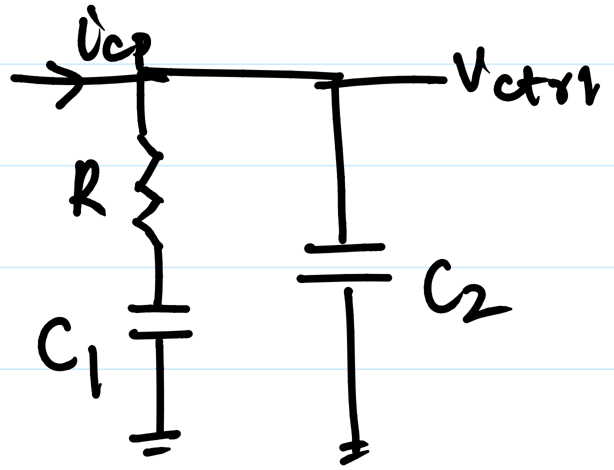
Lecture 33

Monday, April 3, 2017 10:58 AM

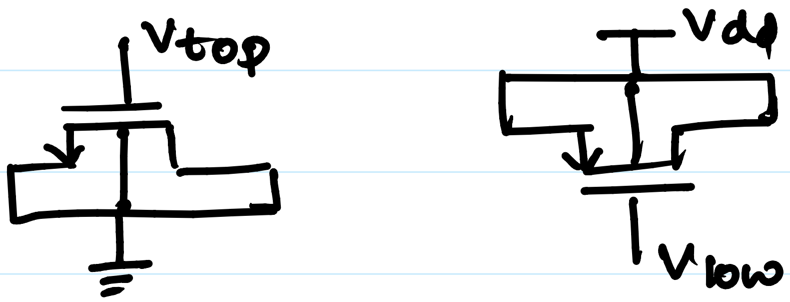
Loop Filter.



- Resistor
- Capacitor
  - Parallel plate Cap.
  - Fringe cap. using metal in same layer.

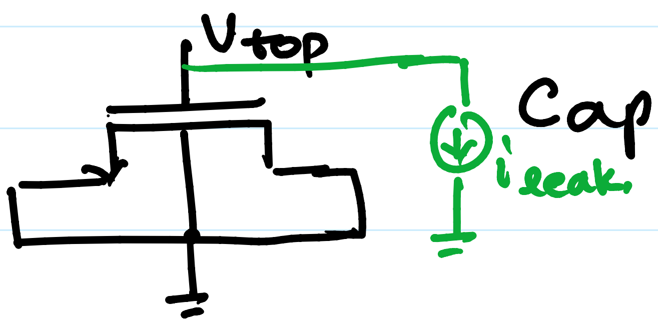
$0.5 - 2.0 \ fF/\mu m^2$

Ex. 100 pF $\rightarrow \dfrac{100 \times 10^{-12}}{2 \times 10^{-15}} = 50\,000 \ \mu m^2$.



Active Capacitor — NMOS cap. Vtop $0.1 \rightarrow 1.0$

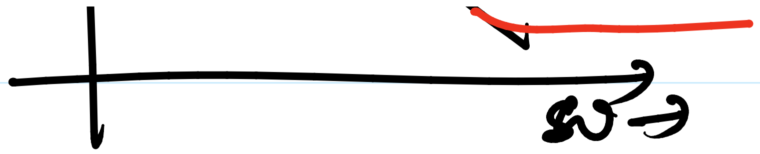
$1 fF/\mu m^2 \rightarrow 12 fF/\mu m^2$



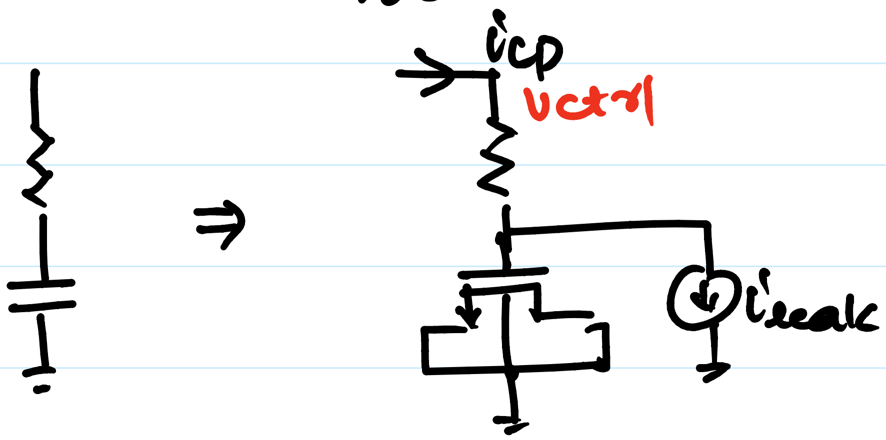
Cap. $10 fF/\mu m^2$

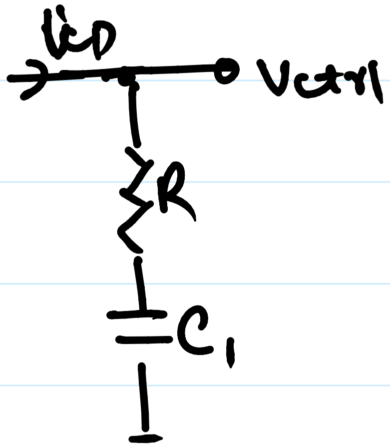
- leakage current
- Series resistor
- Voltage dependent

- Voltage dependent



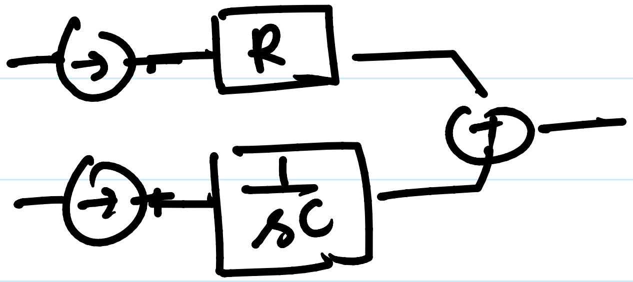
$Z_{in} = \frac{1}{sC}$

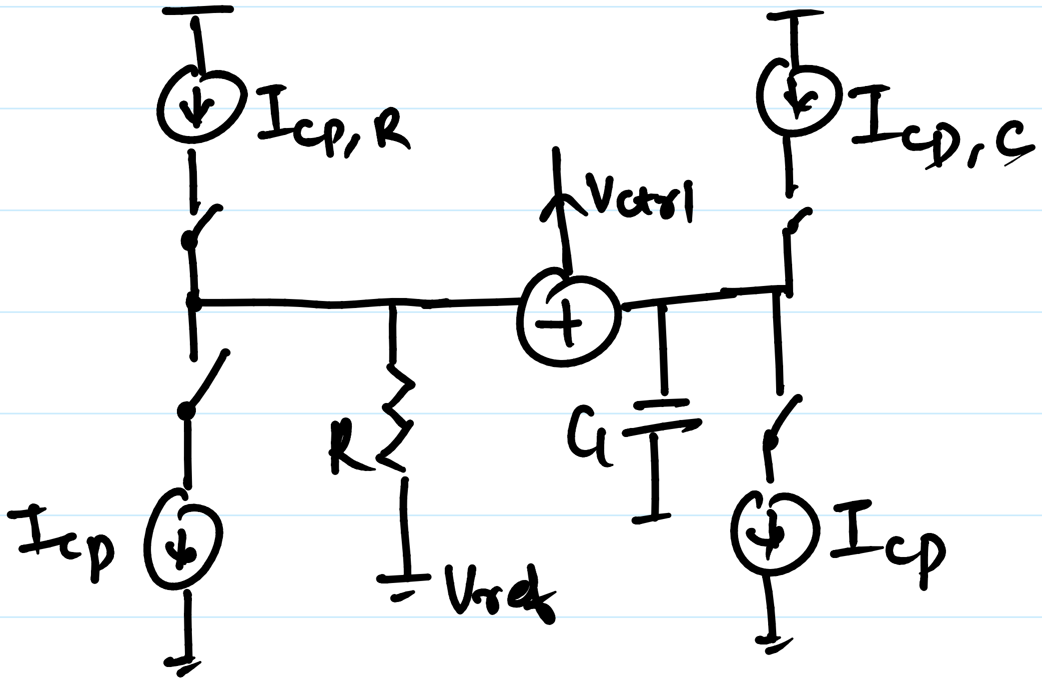




$Z_{in} = R + \frac{1}{sC}$

$V_{ctrl} = i_{cp}(R) + \frac{i_{cp}}{sC}$





- Mismatch in I_{cp} in R & C_1
- linearity of summer
- more hardware.

Dual-path loop filter

$$V_{ctrl} = I_{cp,R} \cdot R + I_{cp,c} \times \frac{1}{sC}$$

$$= \frac{I_{cp,c}}{sC}\left[1 + sC.R \, \frac{I_{cp,R}}{I_{cp,C}}\right]$$

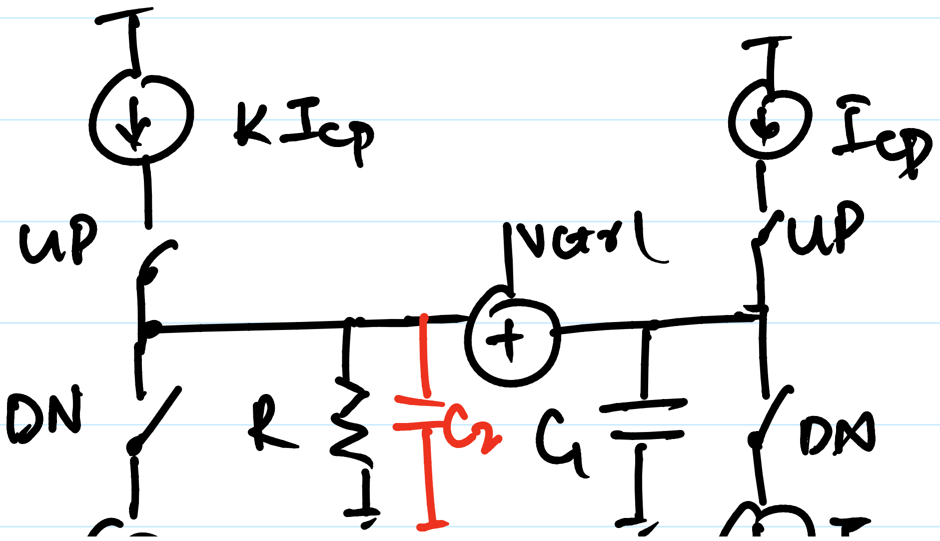
$$\frac{I_{cp}}{sC}\left[1 + sRC\right]$$

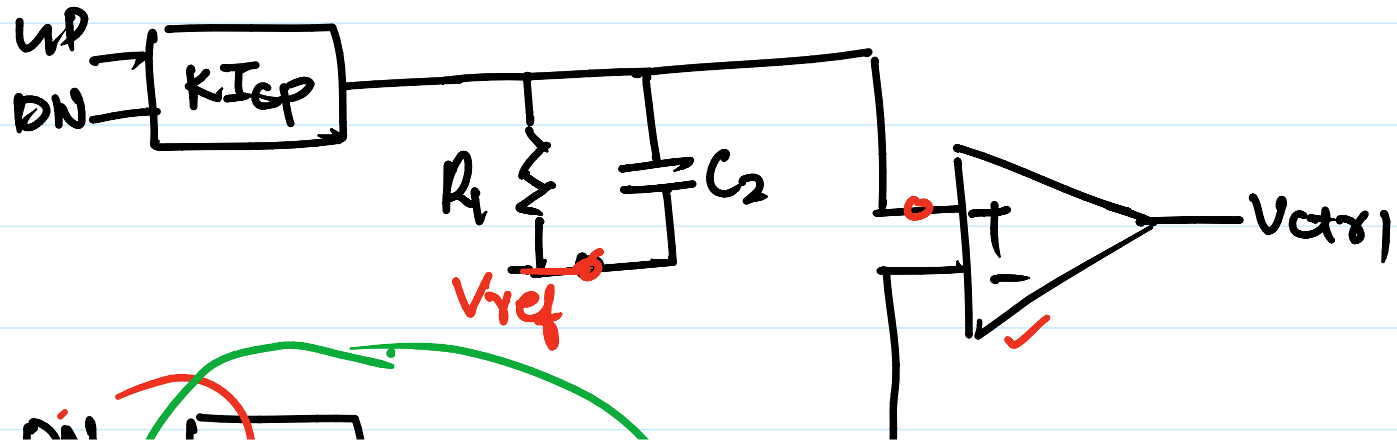
$$\omega_z = \frac{1}{RC}$$

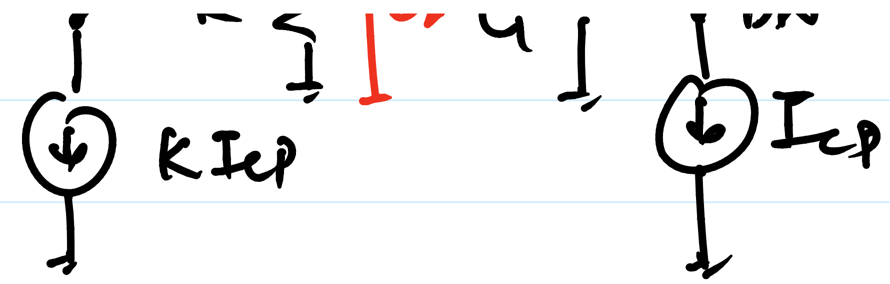
$$\omega_z = \frac{1}{RC \underbrace{\frac{I_{cp,R}}{I_{cp,c}}}_{C_{eff}}}$$

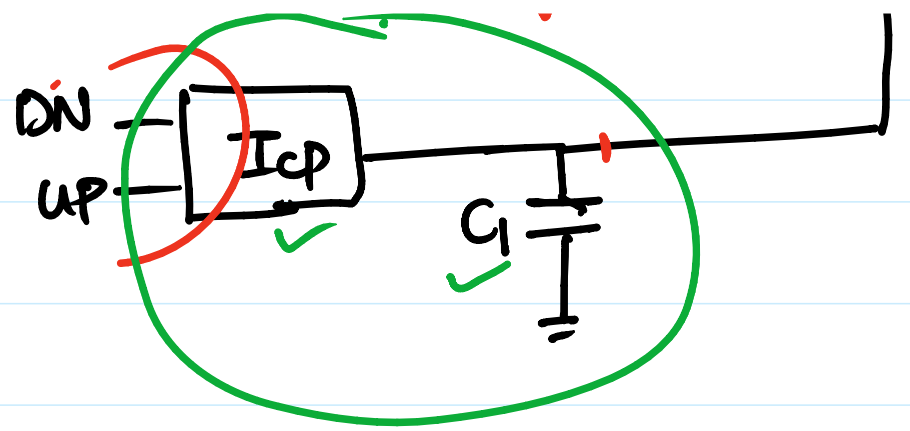
$$V_{ctrl}\Big|_{\frac{I_{cp,R}}{10} = I_{cp,c} = I_{cp}} = \frac{I_{cp}}{sC}\left[1 + sRC \cdot \underline{10}\right]$$

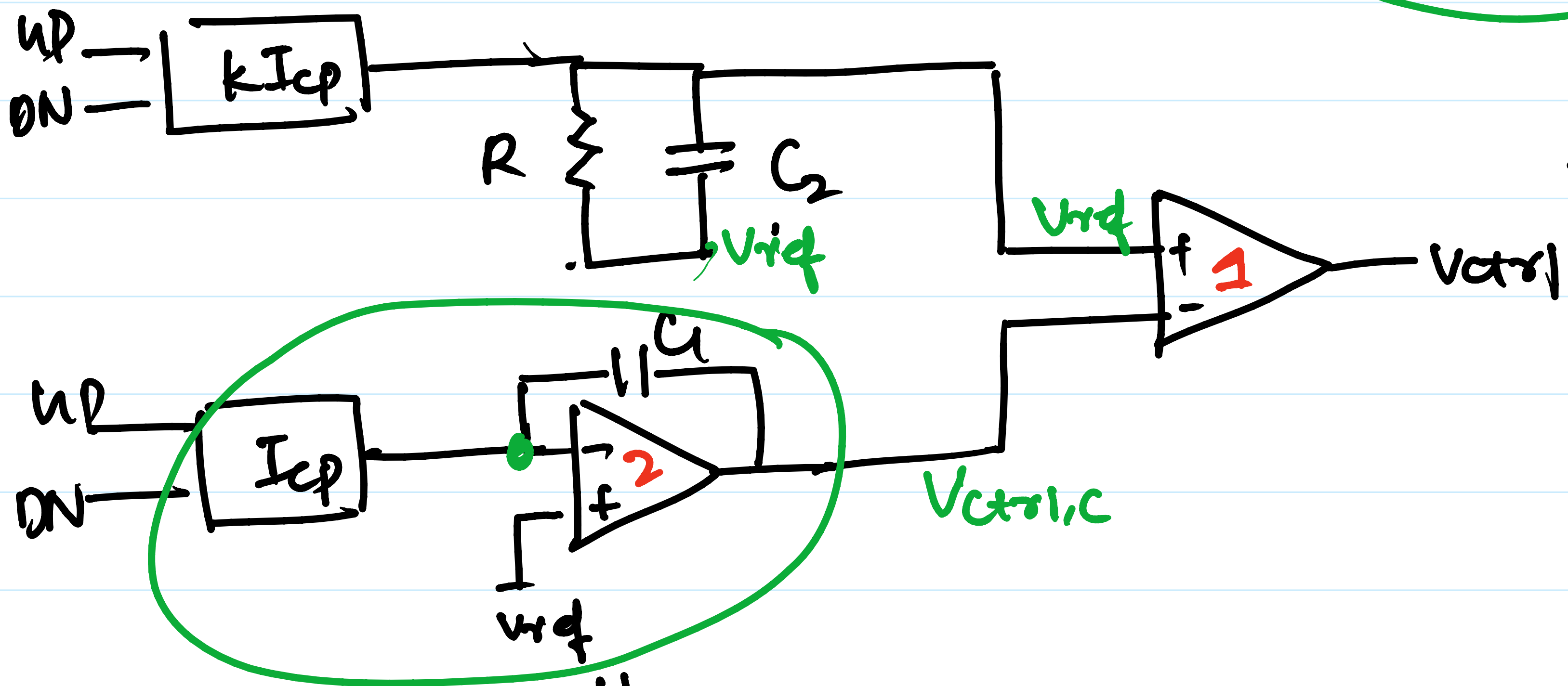
$$\omega_z = \frac{1}{10 \cdot R \cdot C}$$



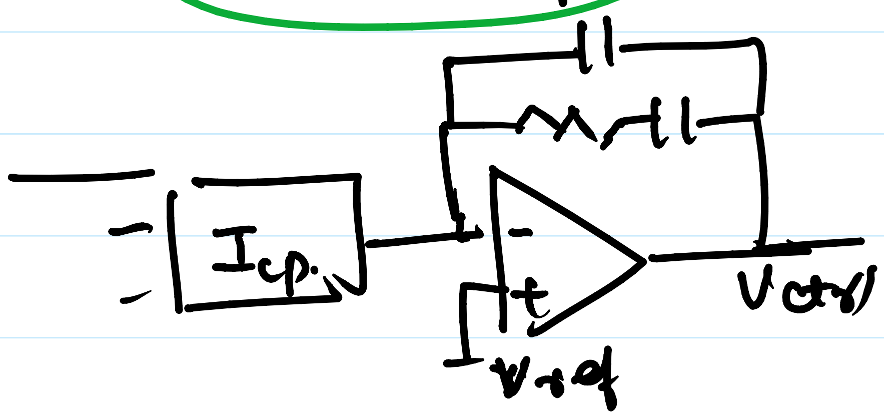


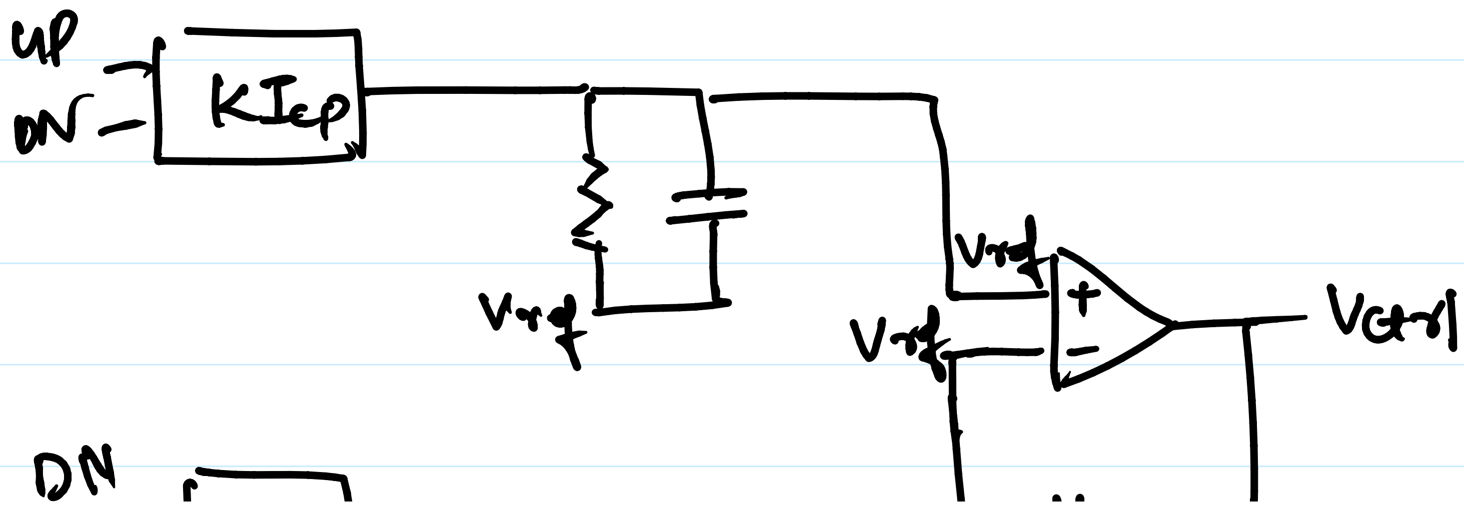


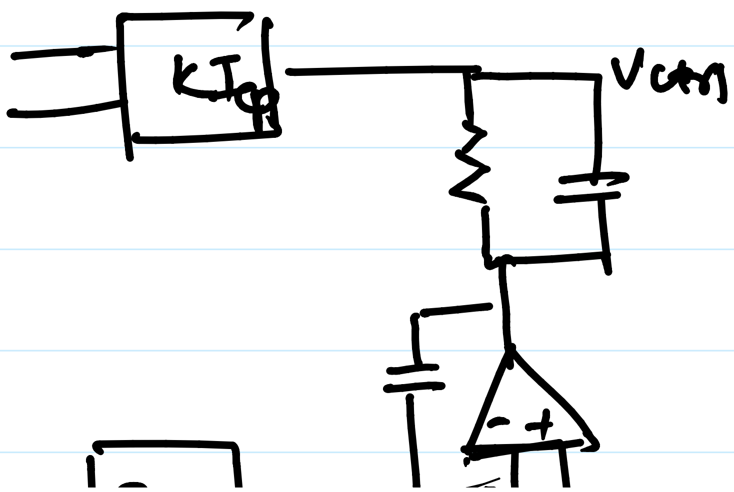


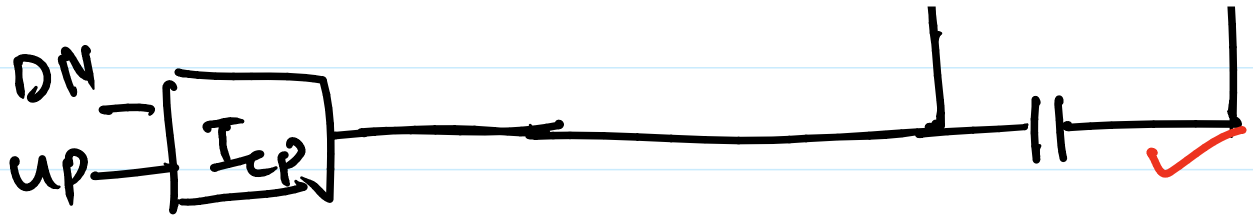


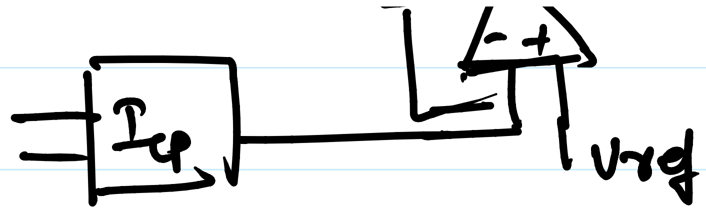
- Two Opamps
  Added noise & non-linearity of opamp.
- Channel length modulation in CP is negligible (0)









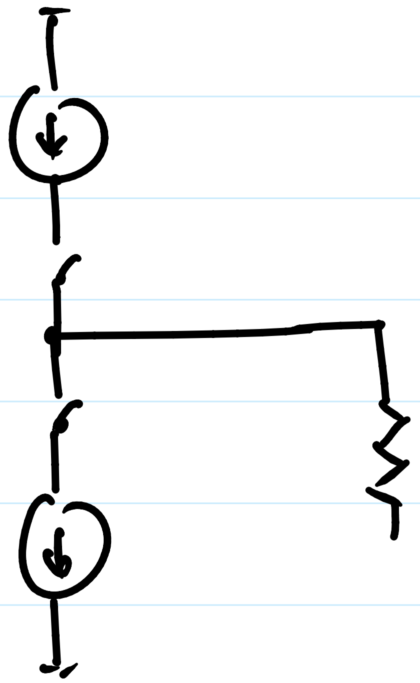


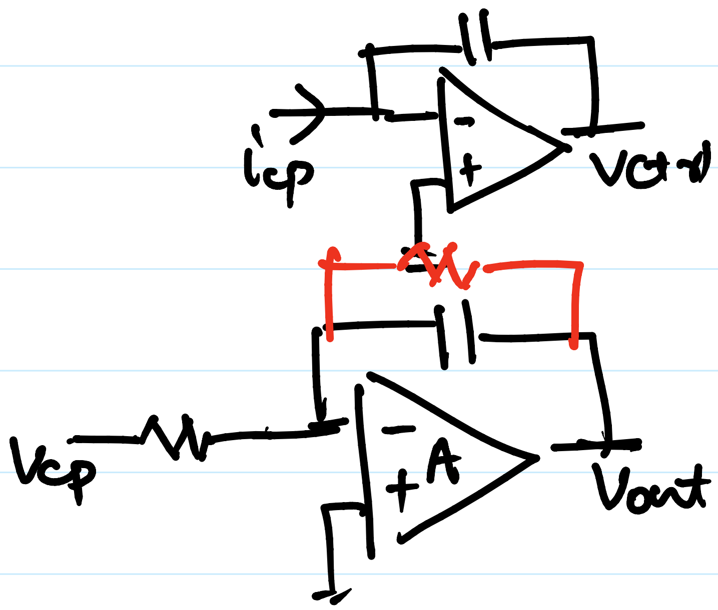
$$V_{ctrl} = K I_{cp} \times \frac{R}{1+sC_2R} + I_{cp} \cdot \frac{1}{sC_1}$$

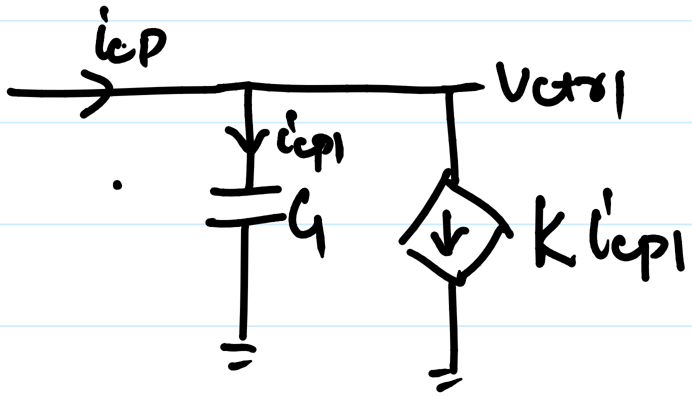
$$= \frac{I_{cp}}{(1+sC_2R)\,sC_1}\left[sRKC_1 + 1 + sC_2R\right]$$

$$= \frac{I_{cp}}{sC_1} \cdot \frac{1+sR(C_2+KC_1)}{1+sC_2R}$$

$$\frac{I_{cp}}{sC_1} \cdot \frac{(1+sRC_1)}{\left(1+s\frac{RC_1C_2}{C_1+C_2}\right)}$$



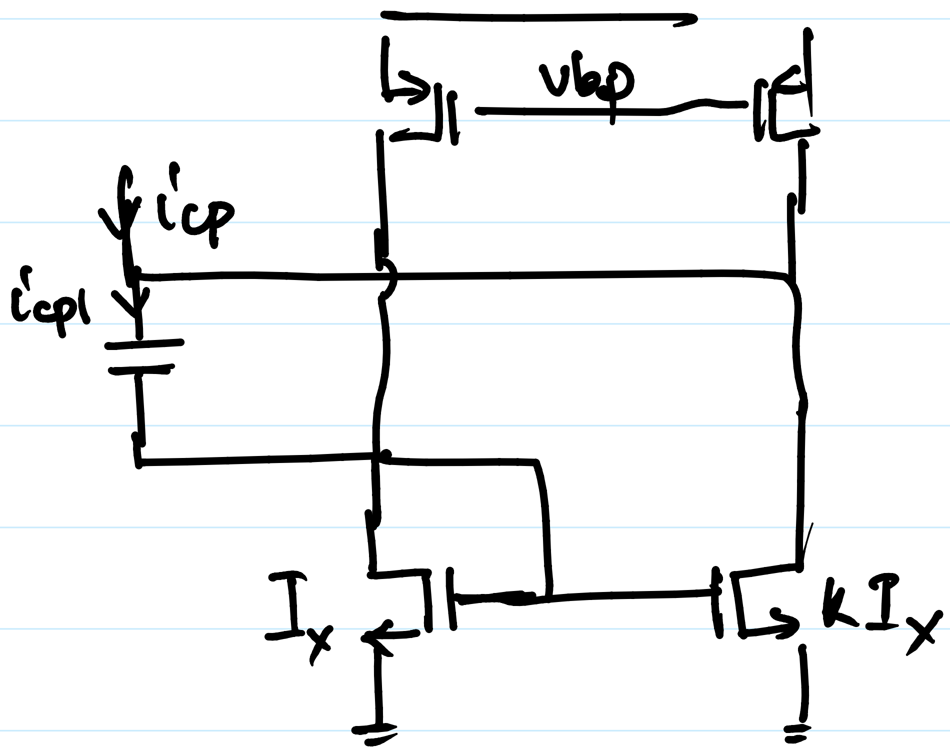


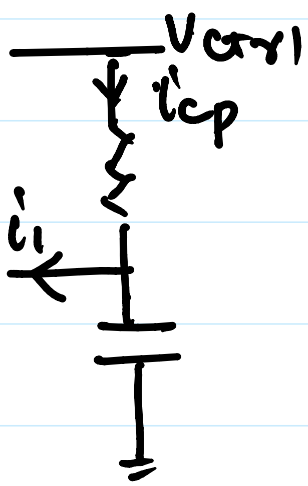


$$i_{cp} = i_{cp1} + K i_{cp1} = (1+K)\, i_{cp1}$$

$$V_{ctrl} = \frac{i_{cp1}}{sC} = \frac{i_{cp}}{s(1+K)C}$$

$$\frac{V_{ctrl}}{i_{cp}} = \frac{1}{s(1+K)C}$$



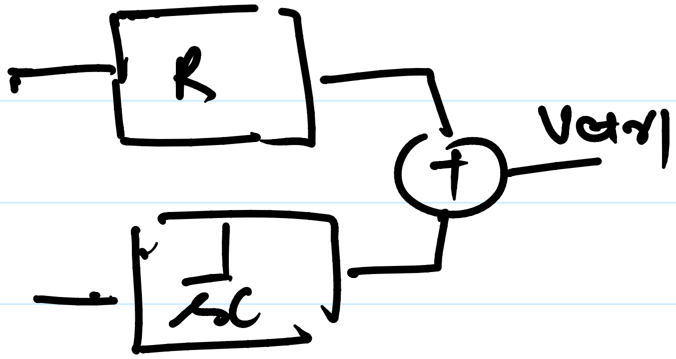


$$V_{ctrl} = i_{cp}R + (i_{cp} - i_1)\frac{1}{sC}$$

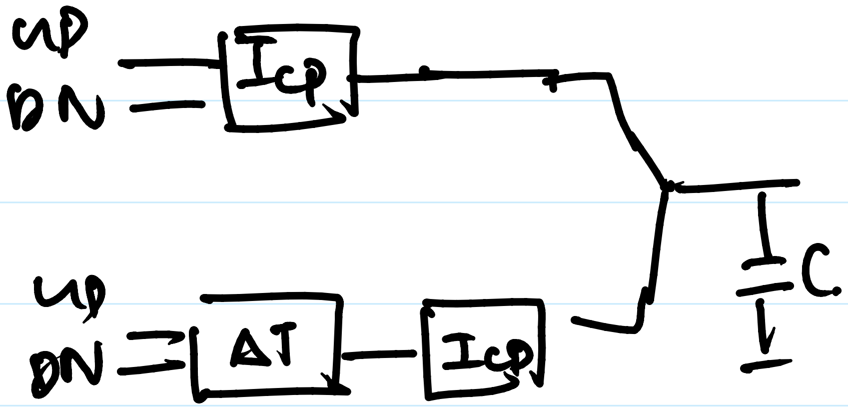
$$= \frac{i_{cp}}{sC}\left[sRC + \left(1 - \frac{i_1}{i_{cp}}\right)\right]$$

$$= \frac{i_{cp}\left(1 - \frac{i_1}{i_{cp}}\right)}{\;}\left[1 + \frac{sRC}{\;}\right]$$

$$\frac{\ldots\, i_{cp})}{sC}\left[1+\frac{sRC}{\left(1-\frac{i_1}{i_{cp}}\right)}\right]$$



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



$$V_{ctrl} = I_{cp}\left[1+e^{-s.\Delta T}\right]\frac{1}{sC}$$

$$= \frac{I_{cp}}{sC}\left[1+1-s.\Delta T\right]$$

$$= \frac{I_{cp}\cdot 2}{sC}\left[1-\frac{s.\Delta T}{2}\right]$$