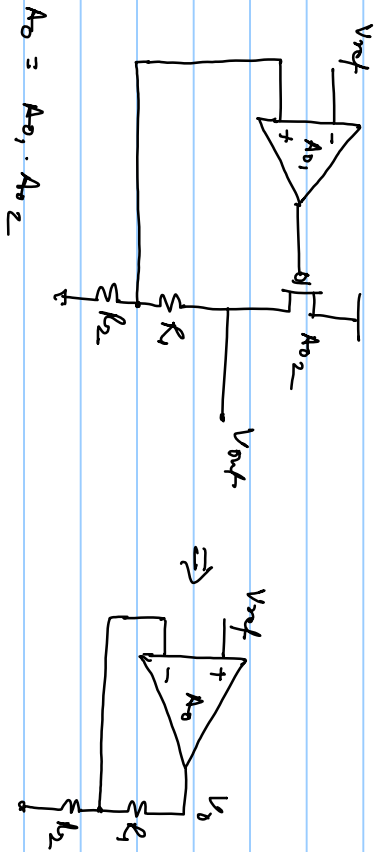


## Sources of Error in Regulators

1. Loop gain
2.  $V_{ref}$
3. Mismatch in feedback resistor (error in  $\beta$ )
4. Offset



Closed loop gain

$$= \frac{A_0}{1 + \beta A_0} = \frac{1}{\beta} \quad \text{if } \beta A_0 \gg 1$$

①

Example :

$$\text{if } \beta = \frac{1}{2}$$

$$V_{ref} = 0.6 \text{ V}$$

$$V_0 = 1.2 \text{ V}$$

$$V_0 = \frac{A_0}{1 + \beta A_0} V_{ref}$$

assume  $A_0 = 10^5$

$$V_0 = \frac{10^5 \times 0.6}{1 + 50} = \frac{100000 \times 0.6}{51} = 1.176$$

$$\text{Error} = -0.023 \text{ V} \approx 2\%$$

In order to reduce error, we should have large  $\beta A_0$  or for smaller  $\beta$ ,  $A_0$  must be increased ( $\rightarrow$  to  $10^5$ )

②

$V_{ref}$ .

$$V_0 \approx \frac{V_{ref}}{\beta}$$

any error in  $V_{ref}$  will directly affect your  $V_{out}$ .  
Error is more for smaller  $\beta$ .

③ Mismatch in feedback resistors.

$$\beta = \frac{R_2}{R_1 + R_2}$$

$$V_{out} = \frac{V_{ref}}{\beta}$$

Assume,  $R_2$  &  $R_1$  have  $\pm \Delta R$  error.

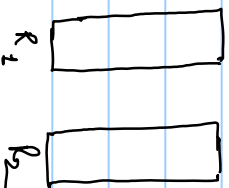
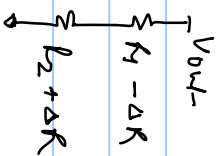
$$R_2 \rightarrow R_2 + \Delta R$$

$$R_1 \rightarrow R_1 - \Delta R$$

$$\beta' = \frac{R_2 + \Delta R}{R_1 - \Delta R} = \frac{R_2}{R_1 + R_2} \left( 1 + \frac{\Delta R}{R_2} \right)$$

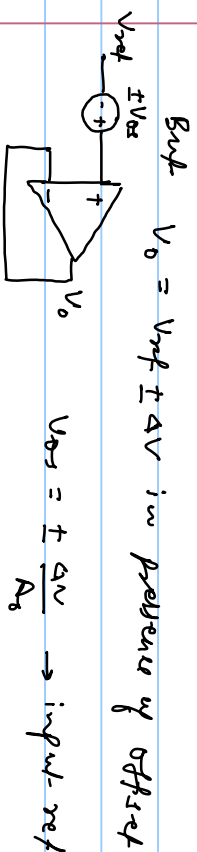
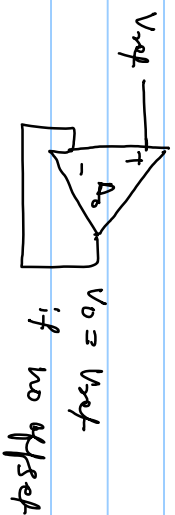
$$= \beta (1 + \Delta \beta)$$

$$V_o = \frac{V_{ref}}{\beta'}$$

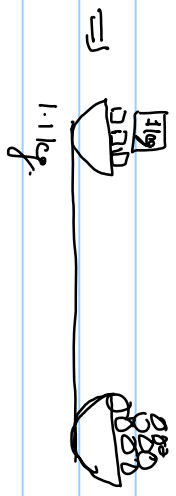
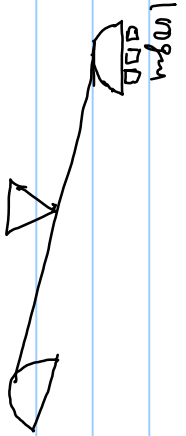
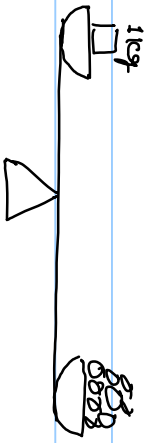


(7)

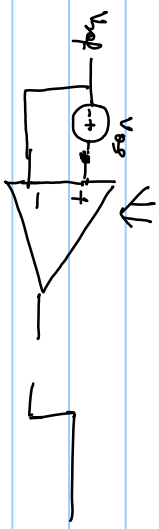
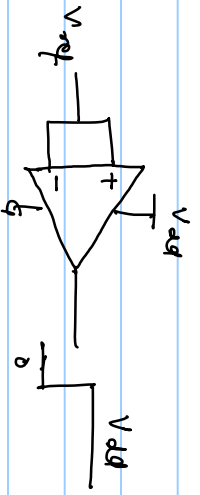
offset



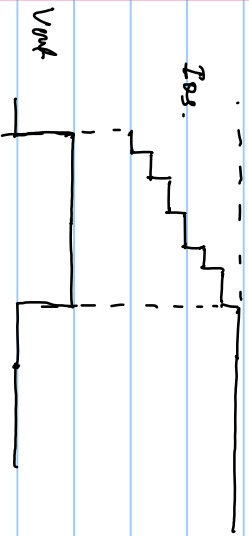
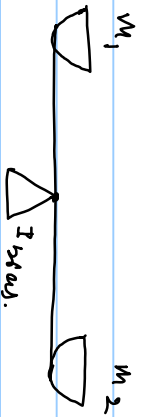
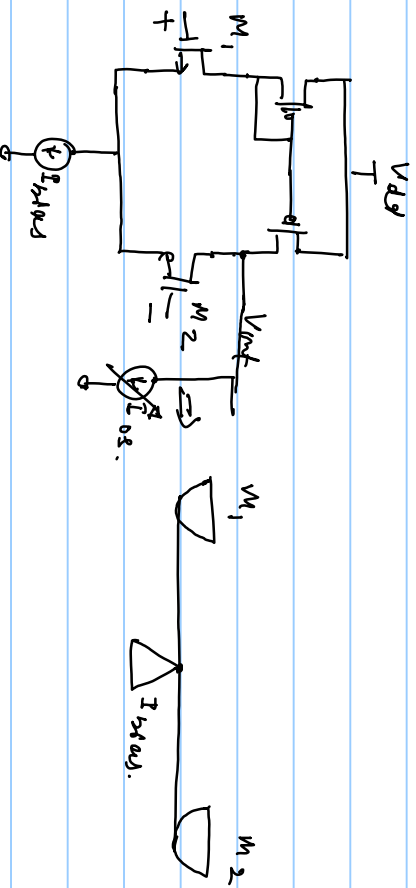
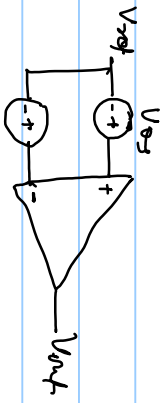
$$V_{ref} = \pm \frac{\Delta V}{A_o} \rightarrow \text{input-referred offset.}$$



error  
or  
offset  
(100µm)



offset correction. (static offset cancellation)



2nd method.

