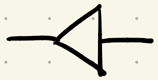
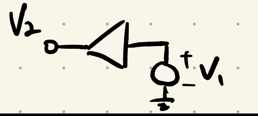
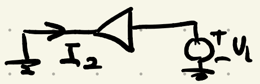
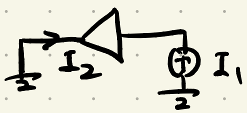
Lec 42

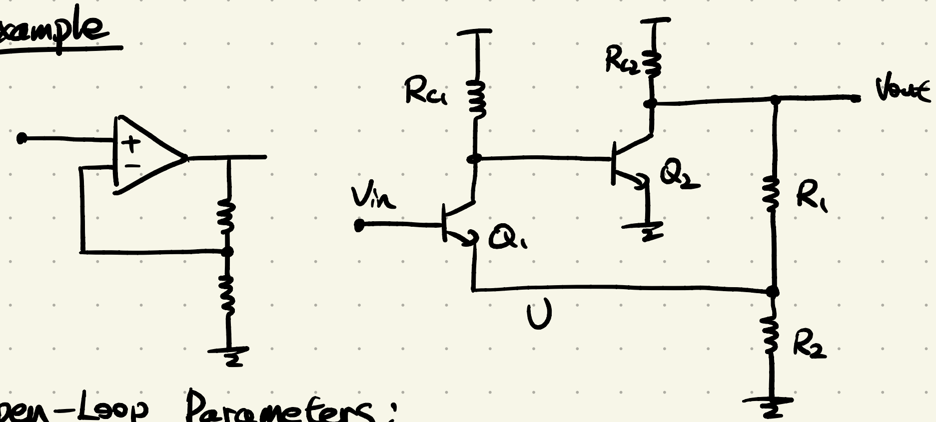
- Accurate Analysis of Feedback Circuits
  - Opening the Loop Properly
  - Calculation of the Feedback Factor

- Find the feedback factor, K

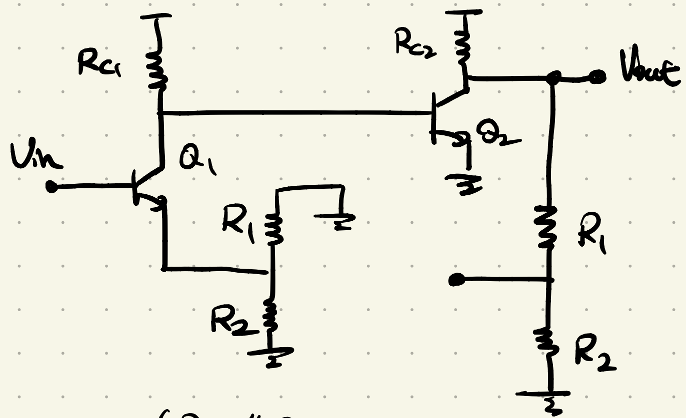


V V		$K = \frac{V_2}{V_1}$
V I		$K = \frac{I_2}{V_1}$
I V		$K = \frac{V_2}{I_1}$
I I		$K = \frac{I_2}{I_1}$

Example

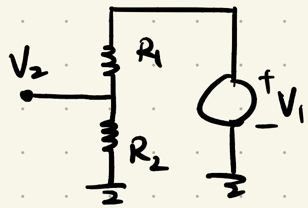


Open-Loop Parameters:



$$A_v = \frac{-(R_{C1} \parallel r_{\pi 2})}{\frac{1}{g_{m1}} + R_1 \parallel R_2} \cdot (-g_{m2})\left[R_{C2} \parallel (R_1+R_2)\right]$$

$R_{in} = r_{\pi 1} + (\beta+1)(R_1 \parallel R_2)$ $\quad R_{out} = R_{C2} \parallel (R_1+R_2)$



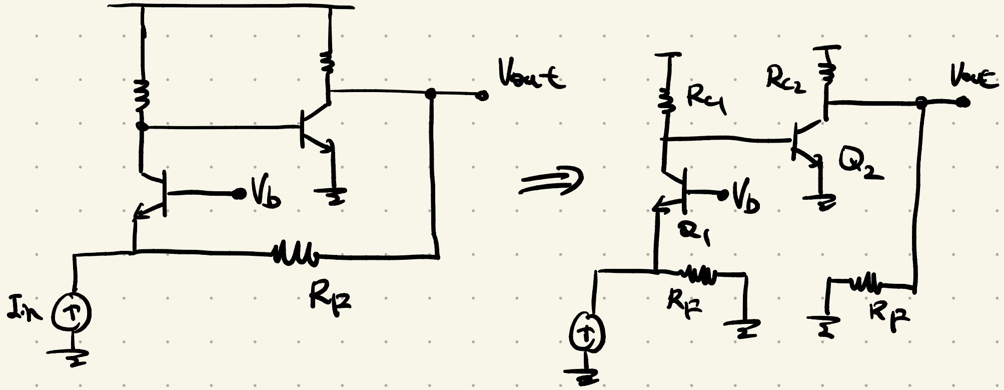
$K = \frac{R_2}{R_1+R_2}$

Closed-Loop Gain: $\frac{A_v}{1+KA_v}$

CL Input Imp.: $R_{in}(1+KA_v)$

CL Output Imp.: $\frac{R_{out}}{1+KA_v}$

Example



$$\text{Open-Loop Gain } R_o = \frac{R_F}{\frac{1}{g_{m1}} + R_F} \cdot (R_{C1} /\!/ r_{\pi 2}) \times -g_{m2} \times (R_{C2} /\!/ R_F)$$

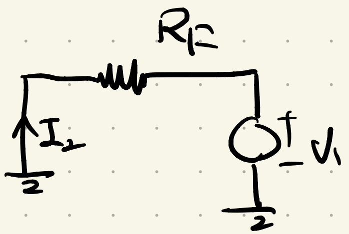
$$\text{Open-Loop Input Imp.} = \frac{1}{g_{m1}} /\!/ R_F = R_{in}$$

$$\text{Open-Loop Output Imp.} = R_{C2} /\!/ R_F = R_{out}$$

$$\text{Closed-Loop Gain} = \frac{R_o}{1 + KR_o}$$

$$\text{〃 Input Imp.} = \frac{R_{in}}{1 + KR_o}$$

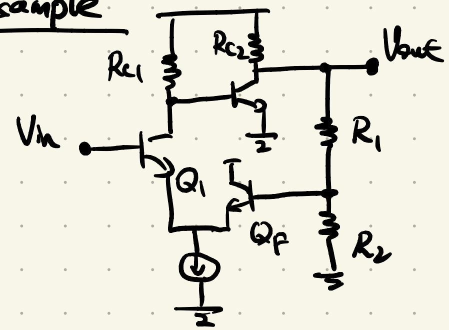
$$\text{〃 Output Imp.} = R_{out}(1 + KR_o)$$



$$K = \frac{I_2}{V_1} = -R_F$$

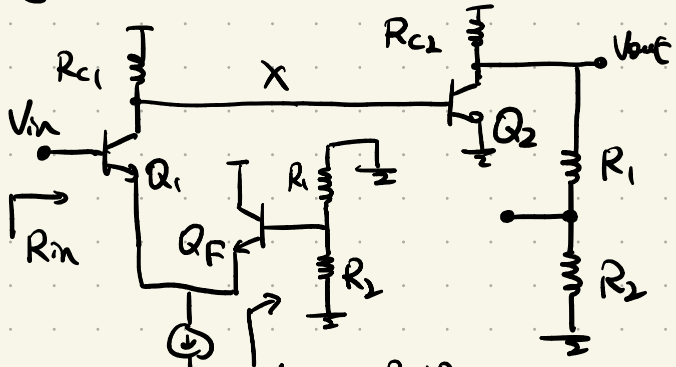
This is reasonable because KA_v should be positive

Example



Assume Q_F belongs to A_1

Opening the loop:



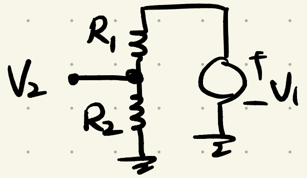
$$\frac{1}{g_{mF}} + \frac{R_1 /\!/ R_2}{1+\beta}$$

$$\frac{V_x}{V_{in}} = \frac{-R_{C1} /\!/ r_{\pi 2}}{\frac{1}{g_{m1}} + \frac{1}{g_{mF}} + \frac{R_1 /\!/ R_2}{\beta + 1}} \qquad \frac{V_{out}}{V_x} = -g_{m2}\left[R_{C2} /\!/ (R_1 + R_2)\right]$$

$$R_{in} = r_{\pi 1} + (\beta + 1)\left[\frac{1}{g_{mF}} + \frac{R_1 /\!/ R_2}{\beta + 1}\right]$$

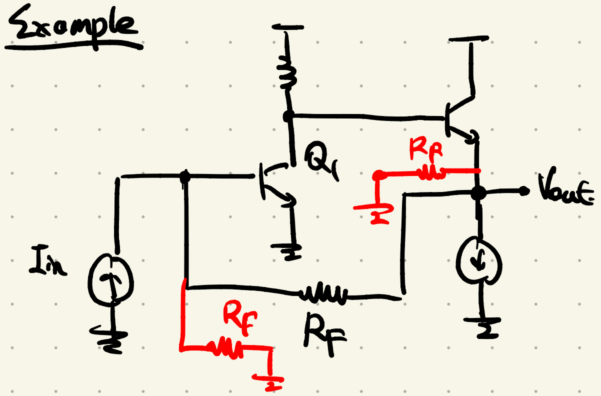
$$= r_{\pi 1} + r_{\pi F} + R_1 /\!/ R_2$$

$$R_{out} = R_{C2} /\!/ (R_1 + R_2)$$



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

Example



$$R_{in} = R_F /\!/ r_{\pi 1}$$

$$R_{out} = \left(\frac{R_C}{1+\beta} + \frac{1}{g_{m2}}\right) /\!/ R_F$$