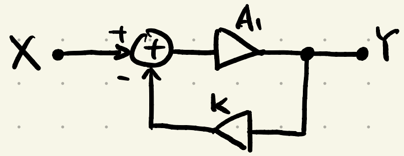
Lec 30 Properties of Negative Feedback

Review of Lec 29

Properties of feedback:



① Gain Desensitization

② Bandwidth Extension

③ Modification of Input and Output Impedances

④ Higher Linearity

$$\frac{Y}{X} = \frac{A_1}{1+KA_1} \approx \frac{1}{K} \quad (\text{if } KA_1 \gg 1)$$

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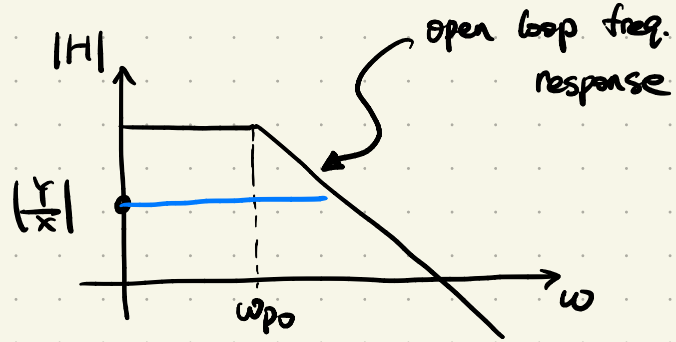
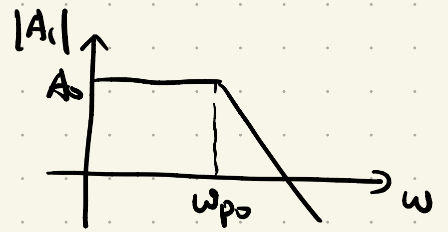
① Gain Desensitization

If A_1 changes due to various factors (temp, supply, freq., load impedance, the closed loop gain does not change as much.

② Bandwidth Extension



As an example, $A_1(s) = \dfrac{A_0}{1+\frac{s}{\omega_{po}}}$



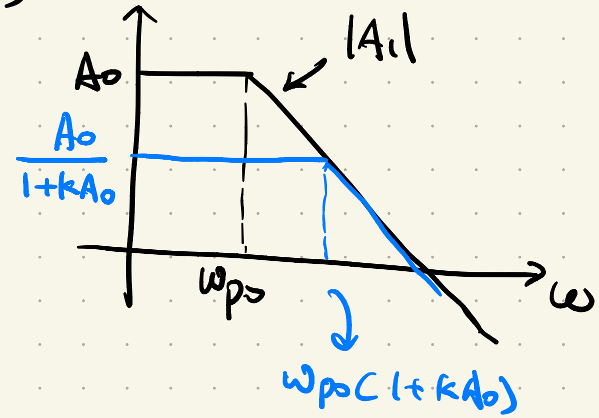
$$\frac{Y}{X}(s) = \frac{\frac{A_0}{1+\frac{s}{\omega_{po}}}}{1+K\frac{A_0}{1+\frac{s}{\omega_{po}}}}$$

$$= \frac{A_0}{1+KA_0+\frac{s}{\omega_{po}}} = \frac{\frac{A_0}{1+KA_0}}{1+\frac{s}{(1+KA_0)\omega_{po}}}$$

If $s=0 \Rightarrow \frac{Y}{X} = \frac{A_0}{1+KA_0}$

closed-loop pole:

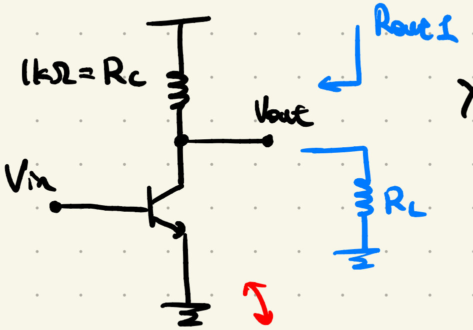
$\omega_{po}(1+KA_0)$

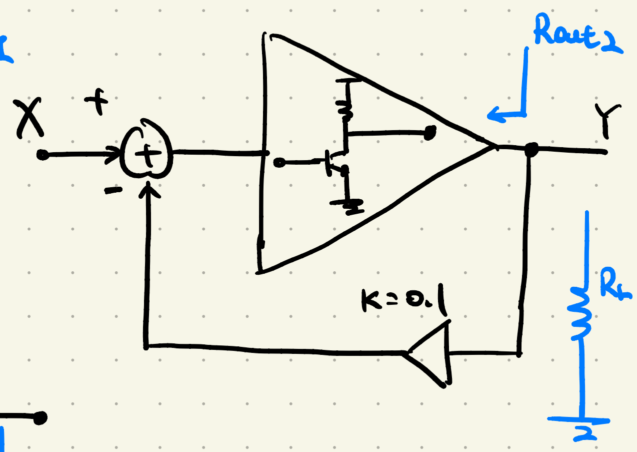


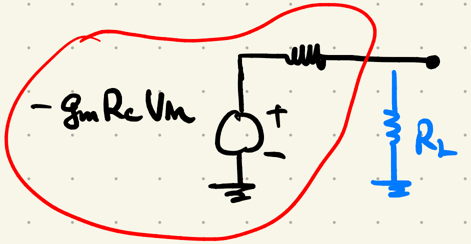
③ Modification of Input and Output Impedances

Without Feedback

With Feedback







If $R_L = 1\,k\Omega \Rightarrow$ the gain drops by a factor of 2 $\Rightarrow$ the output voltage swing drops by a factor of 2

without R_L

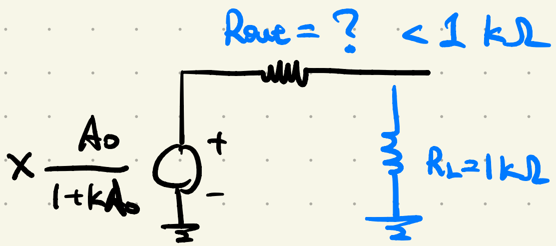
$$A_v = \frac{50}{1+5} = 8.33$$

with $R_L = 1\,k\Omega$

$$A_v = \frac{25}{1+2.5} \simeq 7.2$$

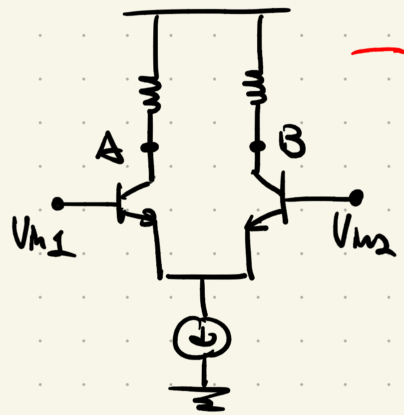
$A_v = -50$ (without load)

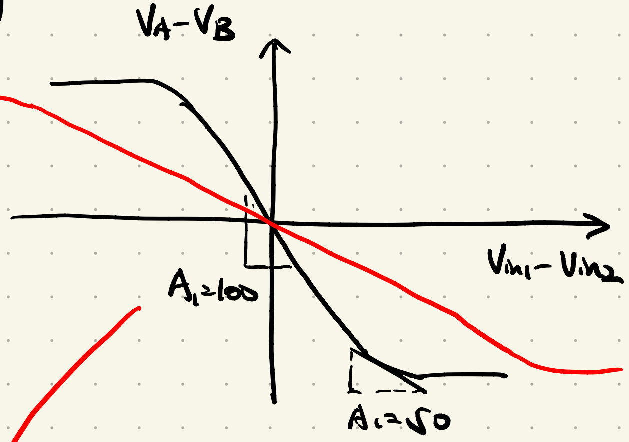
$= -25$ with $R_L = 1\,k\Omega$



$R_{out_2} < R_{out\,1}$

④ Higher Linearity





closed-loop gain

$$= \frac{A_1}{1+kA_1} = 9.1$$

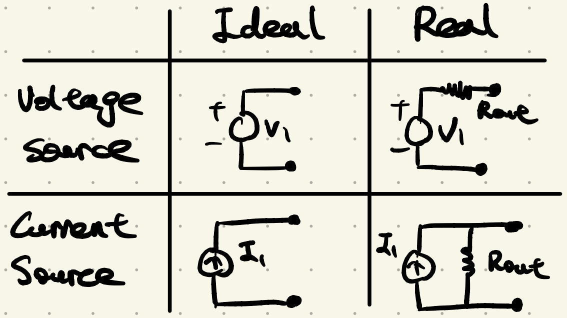
closed-loop gain

$$= \frac{A_1}{1+kA_1} = 8.33$$

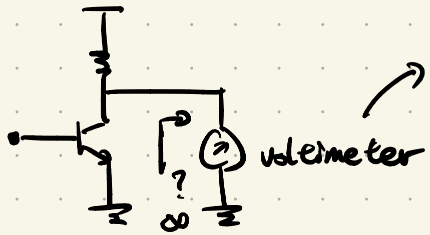
Prerequisites for Analysis of Feedback Circuits.

- A few Quick Notes

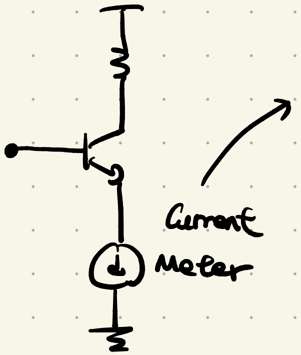
(a) Ideal vs. Real Sources



(b) How do we measure a voltage or a current?



any device or circuit that measures voltage must have a high Impedance



Impedance should be low