Feedback

\[ x_0 = \quad A = \text{gain} \cdot \text{loop gain} \]
\[ x_f = \quad \beta = \text{feedback factor} \]
\[ x_i = \]
\[ A_f = \frac{x_0}{x_s} = \quad A_f = \text{closed-loop gain} \]

if loop gain \( A \beta \gg 1 \), \( A_f \approx \)

Gain Desensitivity

\[ \frac{dA_f}{dA} = \frac{1}{1 + A \beta} - \frac{A \beta}{(1 + A \beta)^2} = \frac{1}{(1 + A \beta)^2} \]

From this we can derive: 
\[ \frac{dA_f}{A_f} = \frac{1}{(1 + A \beta)} \frac{dA}{A} \]
Bandwidth Extension:

- Consider single pole at the high frequency:

\[ A(s) = \frac{A_m}{s/\omega_H + 1} \]

Now put into feedback loop:

Now what is the high frequency cutoff?

\[
A_f(s) = \frac{A(s)}{1 + \beta A(s)}
= \frac{\frac{A_m}{s/\omega_H + 1}}{1 + \frac{\beta A_m}{s/\omega_H + 1}}
= \frac{A_m}{s/\omega_H + 1 + A_m \beta}
\]

\[
A_c(s) = \frac{\frac{A_m}{1 + A_m \beta}}{s/\omega_H (1 + A_m \beta) + 1}
\]
There is a tradeoff between ____________________________

Same concept for the low frequency:

\[ \omega_L = \frac{\omega_L}{1 + A_m \beta} \]

Example: A 741 op amp has a dc gain of 108dB = 250,000 and \( f_H = 4.1 \text{Hz} \).
What if dc gain is off by 20%?
FEEDBACK

Basic Topologies:

- Consider $x_s$ and $x_o$ both voltages:
• Consider \( x_s \) and \( x_o \) both currents:

• Can also have series-series or shunt-shunt topologies (See Fig. 8.4 pg. 800)