Feedback Applications

18.8-Using feedback (negative) to control the frequency response.

Summary-

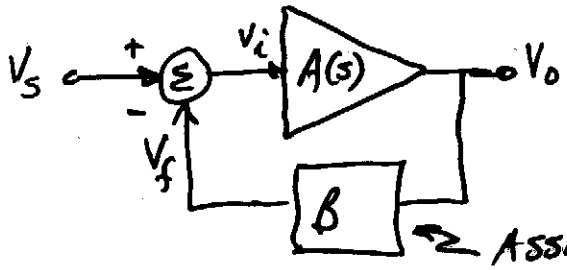
1.) Influence on resistance - shunt ↓, series ↑

2.) $A_F \to \frac{1}{B}$ as loop gain $AB >> 1$

3.) Method of identifying and analyzing fb. ckts.

Influence of -fb on frequency response -

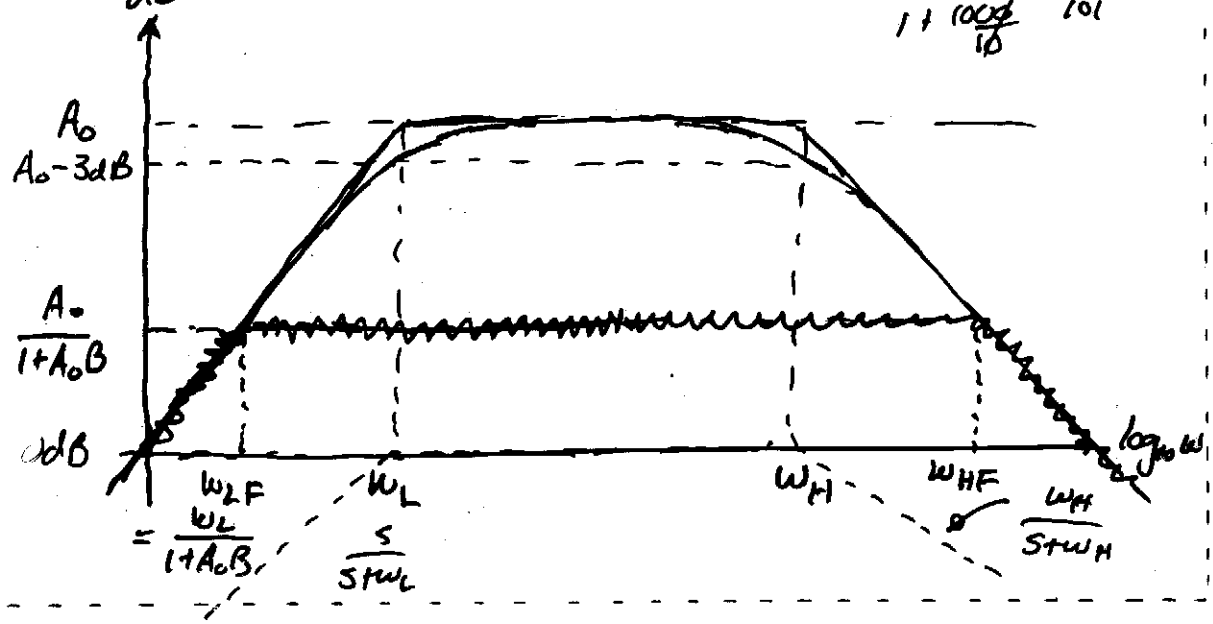
Neg. fb ckt:



Assume B is not a function of frequency

$$A(s) = \frac{A_o \omega_H s}{(s+\omega_L)(s+\omega_H)}$$

$\frac{1000}{1+\frac{1000}{10}} = \frac{1000}{101} \approx 10$



Approximate $A(s)$ as

1.) Low frequency response ($\omega < \omega_H$)

$$A(s) = \frac{A_0 \omega_H s}{(s+\omega_L)(s+\omega_H)} \longrightarrow \frac{A_0 s}{s+\omega_L}$$

$$A_F(s) = \frac{A(s)}{1+\beta A(s)} = \frac{1}{\frac{1}{A(s)}+\beta} = \frac{1}{\frac{s+\omega_L}{A_0 s}+\beta} = \frac{A_0 s}{s+\omega_L+sA_0\beta}$$

$$A_F(s) = \frac{A_0 s}{s(1+A_0\beta)+\omega_L} = \left(\frac{A_0}{1+A_0\beta}\right)\left(\frac{s}{s+\frac{\omega_L}{1+A_0\beta}}\right)$$

$$= A_{0F}\,\frac{s}{s+\omega_{LF}} \qquad \boxed{\omega_{LF} = \frac{\omega_L}{1+A_0\beta} \;\&\; A_{0F} = \frac{A_0}{1+A_0\beta}}$$

2.) High frequency response ($\omega > \omega_L$)

$$A(s) = \frac{A_0 \omega_H s}{(s+\omega_L)(s+\omega_H)} \longrightarrow \frac{A_0 \omega_H}{s+\omega_H}$$

$$A_F(s) = \frac{1}{\frac{1}{A(s)}+\beta} = \frac{1}{\frac{s+\omega_H}{A_0\omega_H}+\beta} = \frac{A_0\omega_H}{s+\omega_H+\omega_H A_0\beta} = \frac{A_0\omega_H}{s+\omega_H(1+A_0\beta)}$$

$$A_F(s) = \frac{A_0}{1+A_0\beta}\,\frac{\omega_H(1+A_0\beta)}{s+\omega_H(1+A_0\beta)} = A_F(0)\,\frac{\omega_{HF}}{s+\omega_{HF}}$$

$$\boxed{A_F(0) = A_{0F} = \frac{A_0}{1+A_0\beta} \;\&\; \omega_{HF} = \omega_H(1+A_0\beta)}$$

18.9 Calculation of the Loop Gain of a Feedback Circuit

Why do we want to find the loop gain?

1.) Estimate the influence of feedback on impedance

Shunt: $R_{inF} = \frac{R_{in}}{1+\text{Loop Gain}}$ & $R_{outF} = \frac{R_{out}}{1+\text{Loop Gain}}$

Series: $R_{inF} = R_{in}(1+\text{Loop Gain})$ & $R_{outF} = R_{out}^{*}(1+\text{Loop Gain})$

* R_{out} & R_{outF} is the resistance in series with the loop.

2.) To find the stability of the loop. I.e. will neg. fb. become pos. fb. and oscillate?