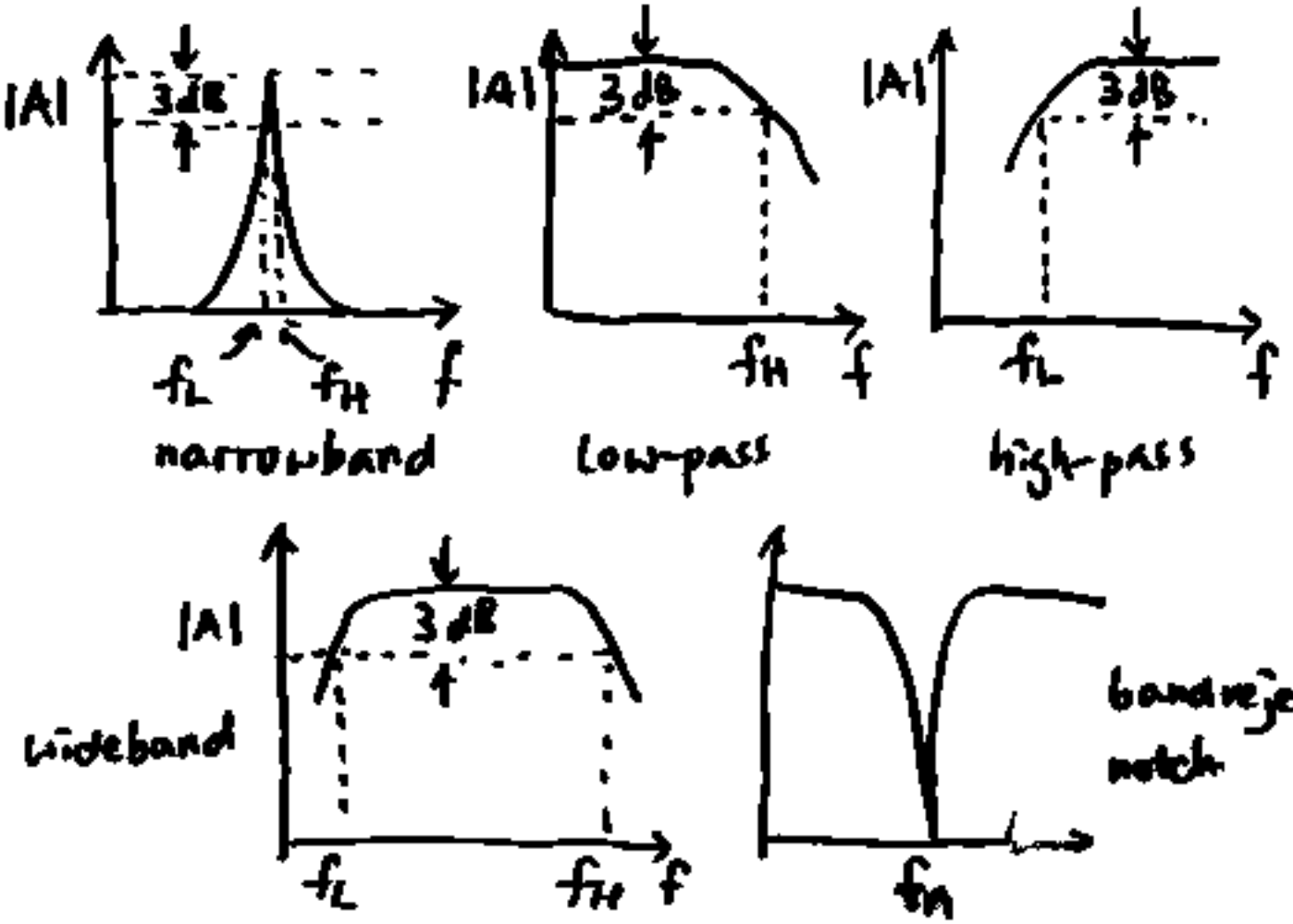
Frequency Response

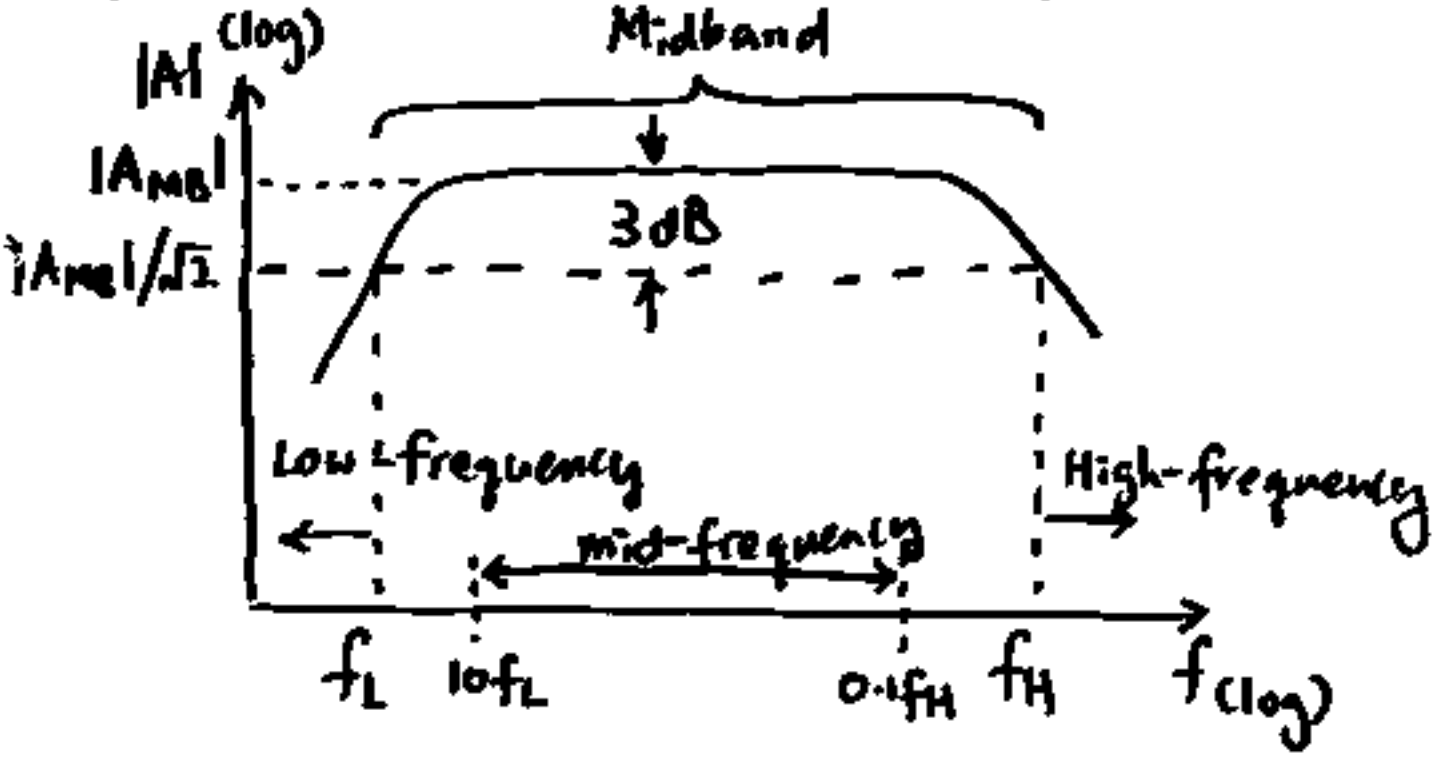
Performance may change as a function of frequency

(a) Stereo amp should work well from 20Hz to 20kHz

(b) Filters should pass the freq. contained in a desired signal and reject all others



Upper and Lower Corner Frequencies



f_L : lower corner frequency

(ω_L) lower half-power frequency

$$|A(jf_L)| = |A_{MB}|/\sqrt{2}$$

sinusoidal voltage source $V_i(jf)$

$$P_{MAX} = \frac{1}{2}\frac{(|A_{MB}||V_i|)^2}{R_L}$$

$$@ f_L, \quad P = \frac{P_{MAX}}{2}$$

(ω_H) f_H : upper corner (half-power) frequency

Bandwidth: $\omega_H - \omega_L$ or $f_H - f_L$

dB: decibels

$$A_{dB} = 20 \log_{10} |A_0| \qquad A_0 = \frac{V_{out}}{V_{in}}$$

A_0	A_{dB}
1	0
0.707	-3
1.414	3
2	6
10	20
100	40
1000	60

dB allows products or quotients of factors to be handled as sums or diff

$$A(f) = \frac{-25\left(j\frac{f}{10}\right)}{\left(1+j\frac{f}{10}\right)\left(1+j\frac{f}{10^4}\right)}$$

$$A_{dB} = 20\log|-25| + 20\log\left|j\tfrac{f}{10}\right| - 20\log\left|1+j\tfrac{f}{10}\right| - 20\log\left|1+j\tfrac{f}{10^4}\right|$$

Bode plots (Magnitude)

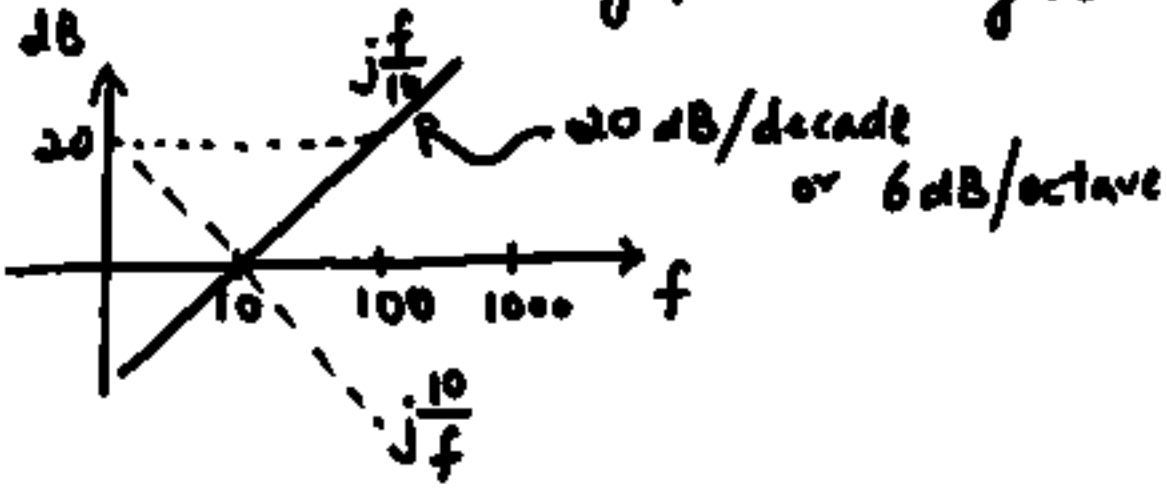
Constant factor

$$A_{dB}(-25) = 20 \log |-25| = 28\,dB$$

Direct variation with frequency

$$A_{dB}(jf/f_a) = 20 \log \frac{f}{f_a}$$

$$= 20 \log f - 20 \log f_a$$

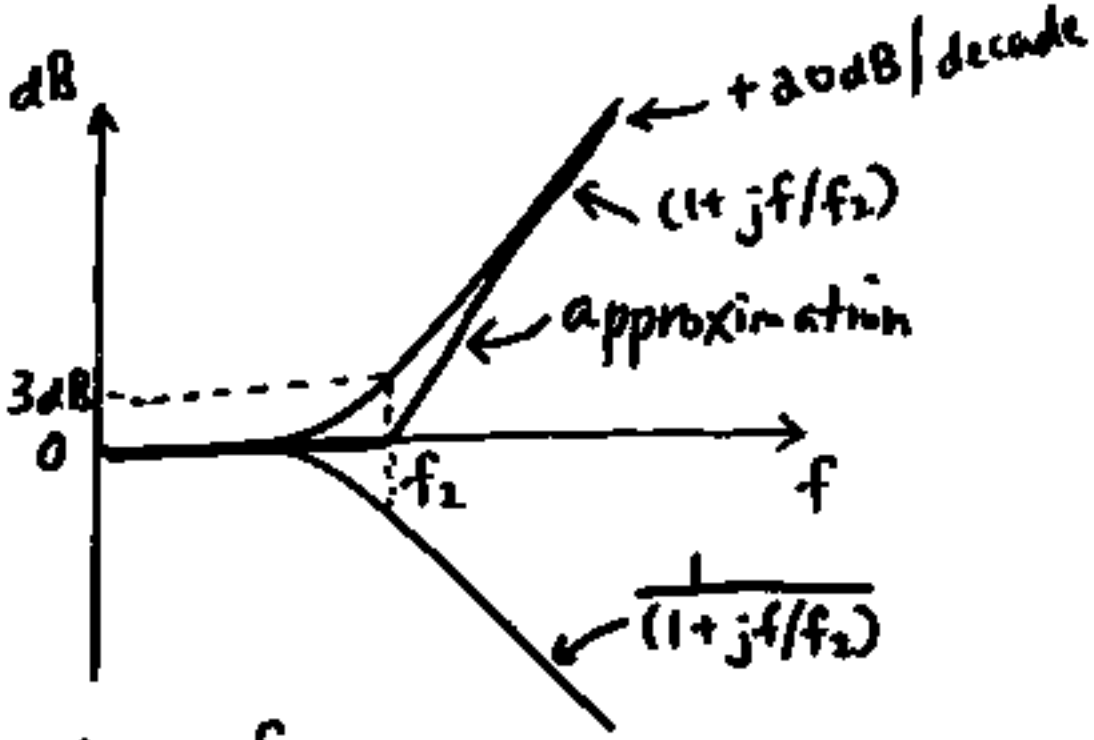


The $(1+j\frac{f}{f_2})$ factor

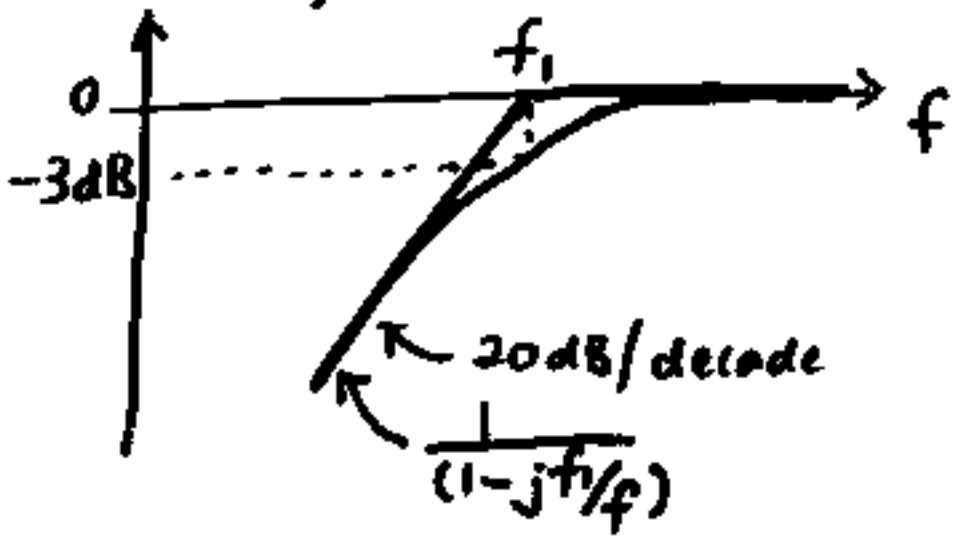
$$A_{dB}(1+jf/f_2) = 20\log(1+(f/f_2)^2)^{1/2}$$

When $f = f_2$

$$|1+j1| = \sqrt{2} \Rightarrow A_{dB} = 3\,dB$$

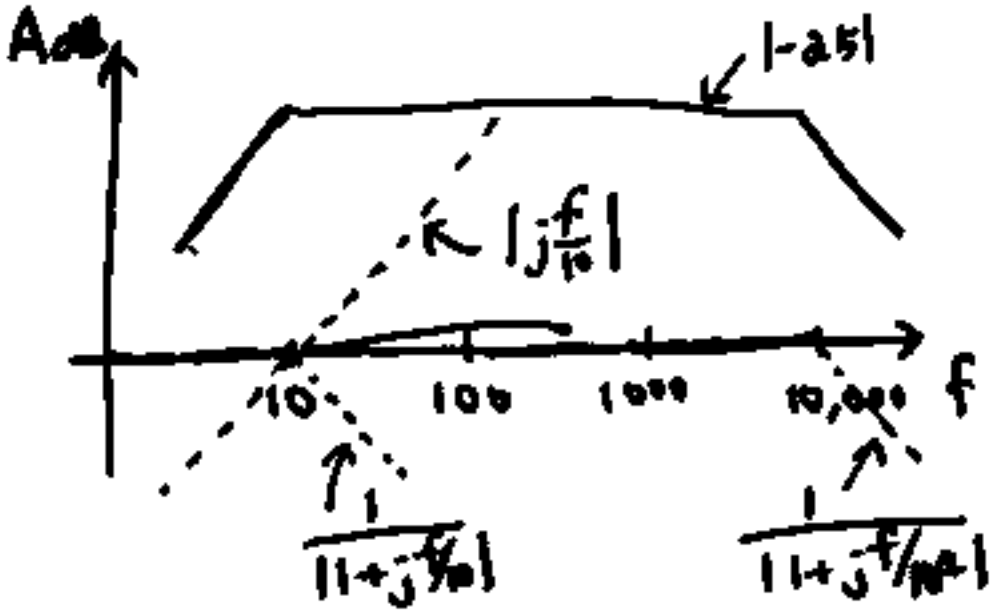


The $(1-j\frac{f_1}{f})$ factor

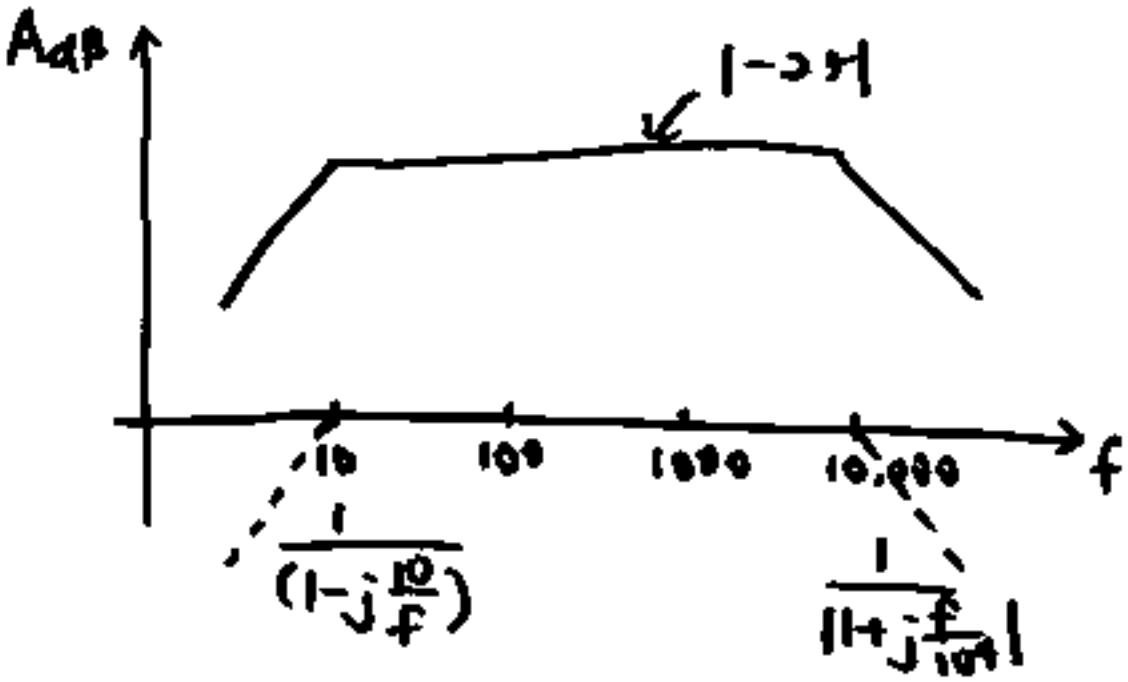


The Composite Curve

$$A(f) = \frac{-25\left(j\frac{f}{10}\right)}{\left(1+j\frac{f}{10}\right)\left(1+j\frac{f}{10^4}\right)}$$



$$A(f) = \frac{-25}{\left(1-j\frac{10}{f}\right)\left(1+j\frac{f}{10^4}\right)}$$



Bode plot (phase)

$$A + jB = Ke^{j\theta}$$

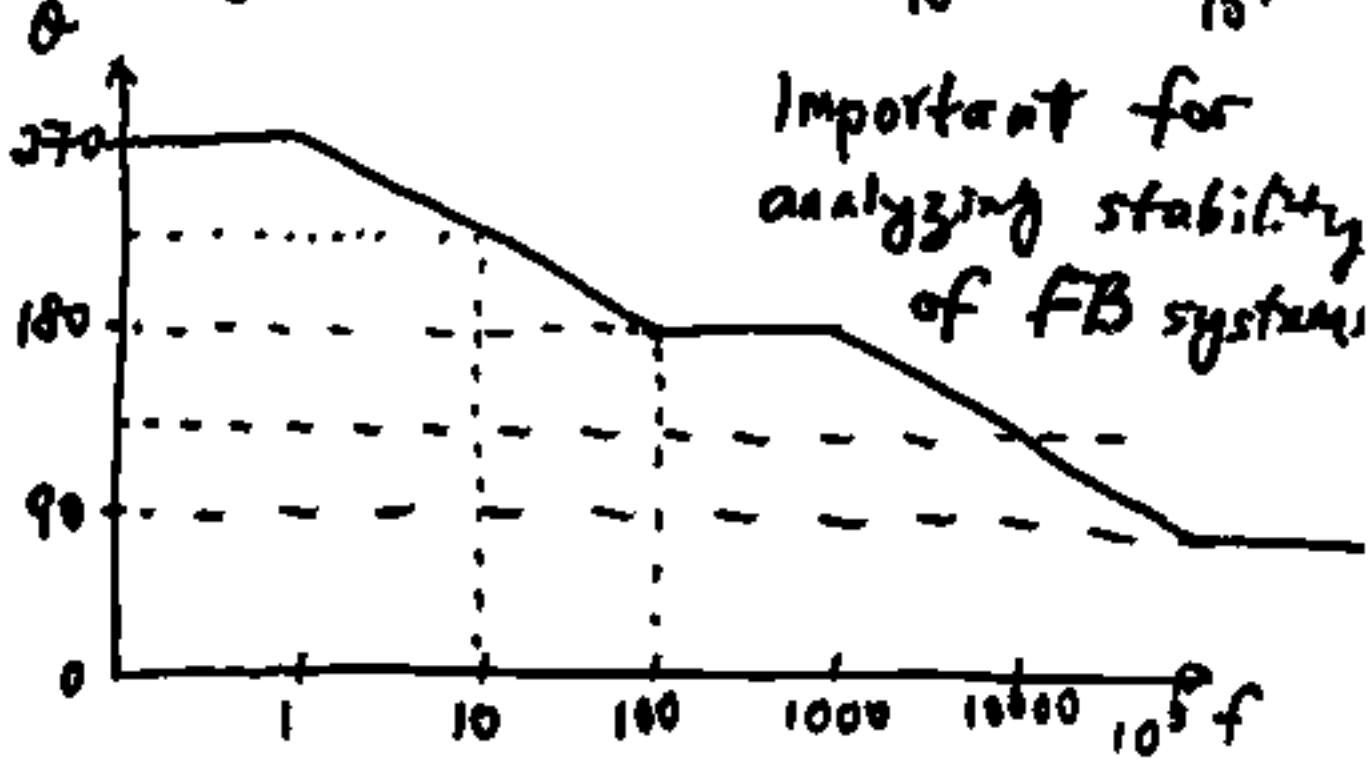
$$K = |A + jB|, \quad \theta = \tan^{-1} B/A$$

$$A(f) = \frac{-25\left(j\frac{f}{10}\right)}{\left(1+j\frac{f}{10}\right)\left(1+j\frac{f}{10^4}\right)}$$

$$= \frac{K_1 e^{j\theta_1} K_2 e^{j\theta_2}}{K_3 e^{j\theta_3} K_4 e^{j\theta_4}}$$

$$= \frac{K_1 K_2}{K_3 K_4} e^{j(\theta_1+\theta_2-\theta_3-\theta_4)} \equiv e^{j\theta}$$

$$\theta = +180 + 90 - \tan^{-1}\frac{f}{10} - \tan^{-1}\frac{f}{10^4}$$



Important for analyzing stability of FB systems