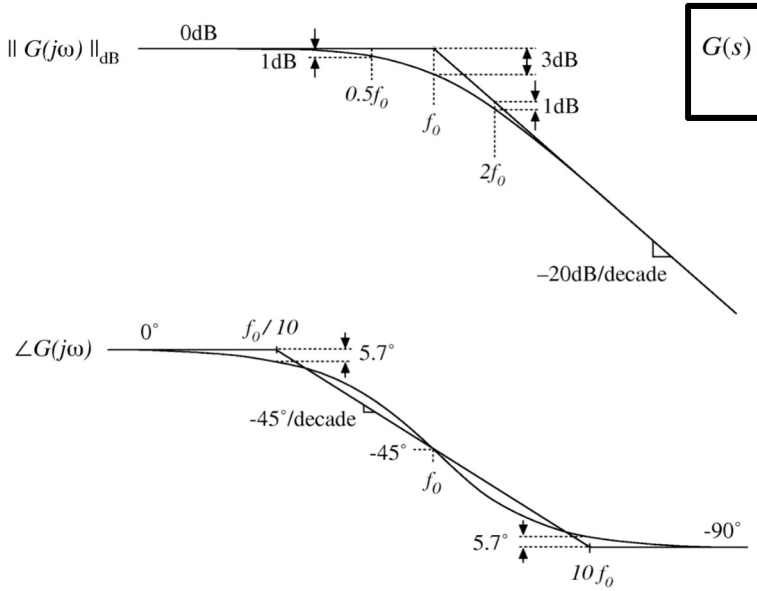
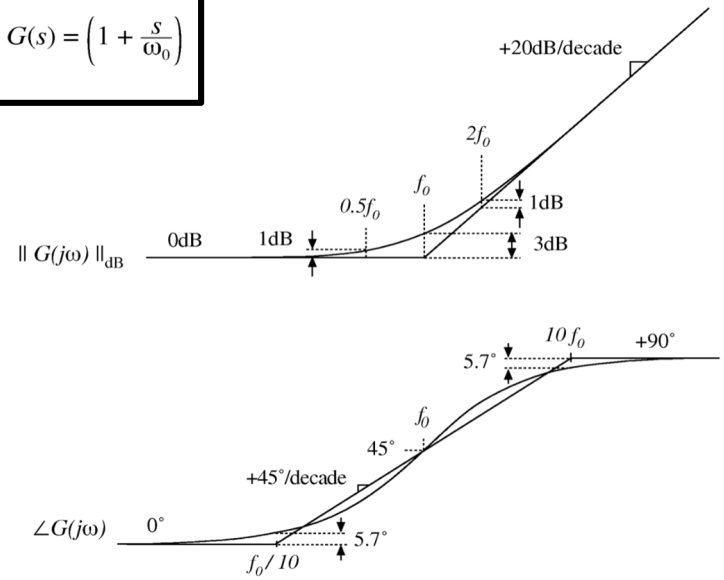
Real Pole

$$G(s) = \frac{1}{\left(1 + \frac{s}{\omega_0}\right)}$$



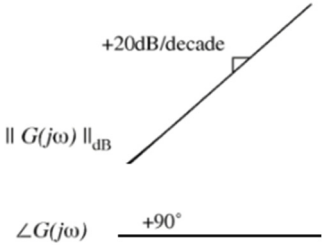
Real Zero

$$G(s) = \left(1 + \frac{s}{\omega_0}\right)$$



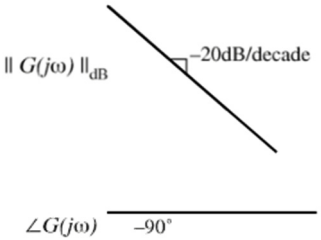
$$G(s) = s$$

LF Zero



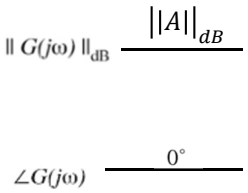
$$G(s) = \frac{1}{s}$$

LF Pole



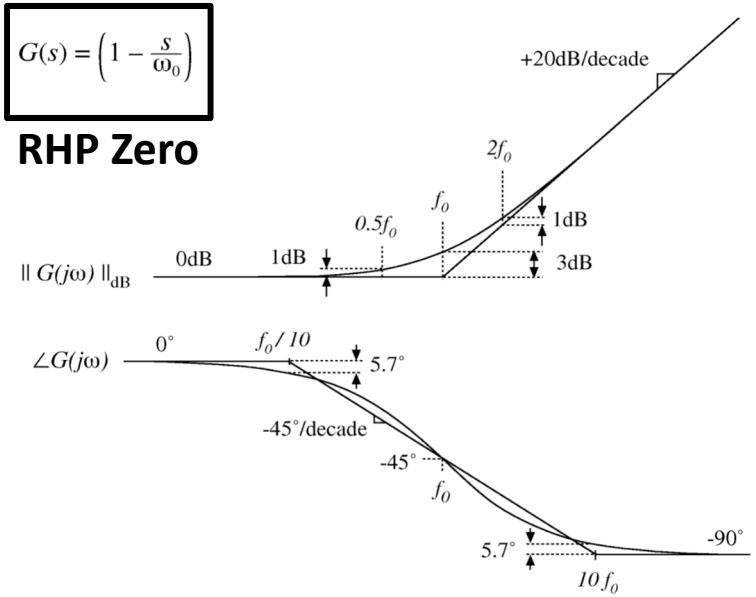
$$G(s) = A$$

Constant



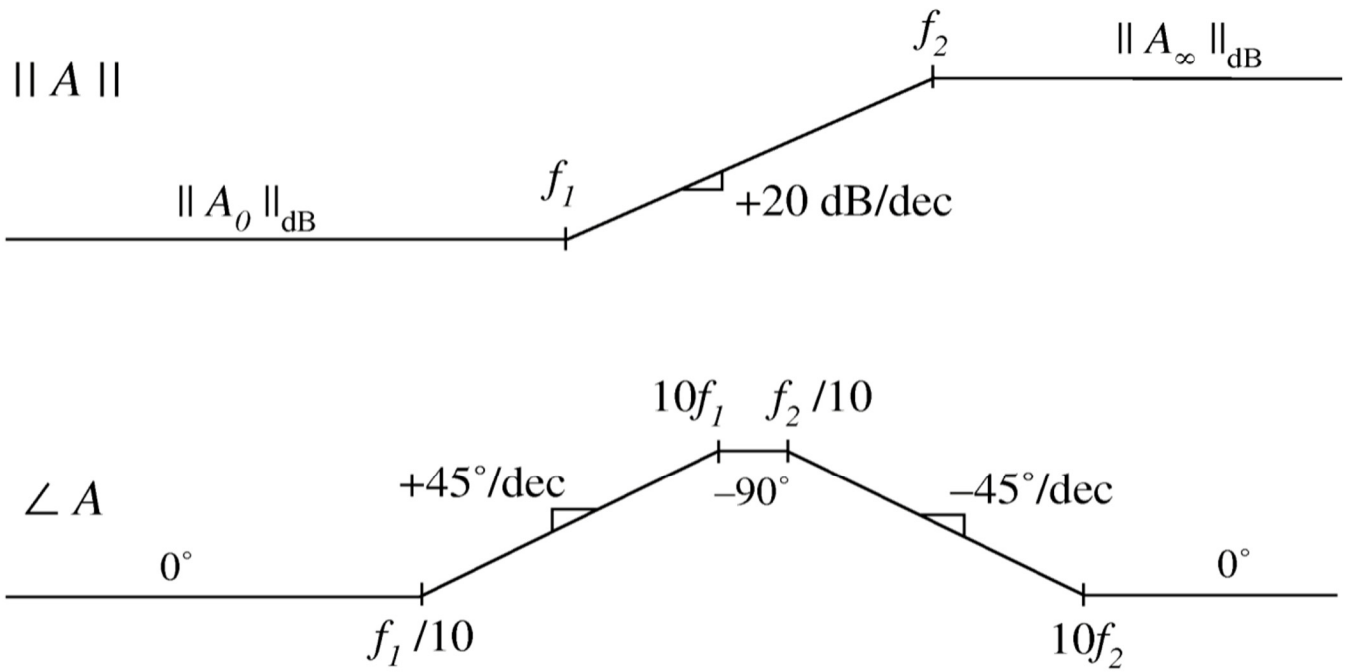
$$G(s) = \left(1 - \frac{s}{\omega_0}\right)$$

RHP Zero



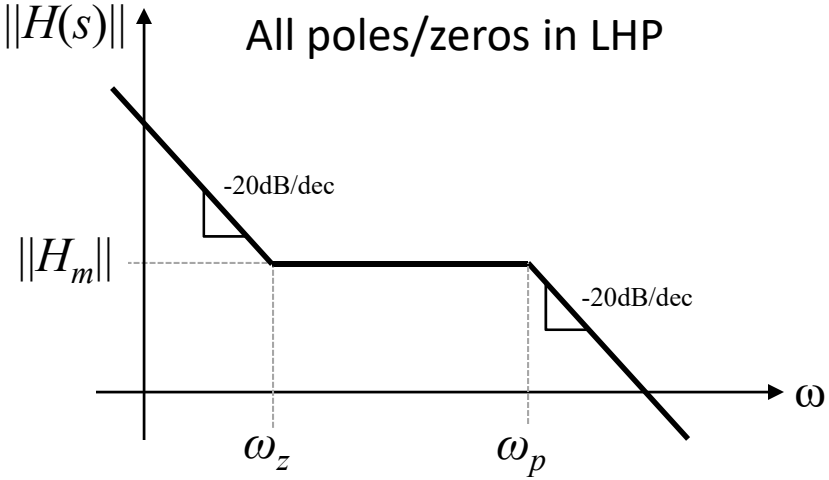
Example 2

Determine the transfer function $A(s)$ corresponding to the following asymptotes:

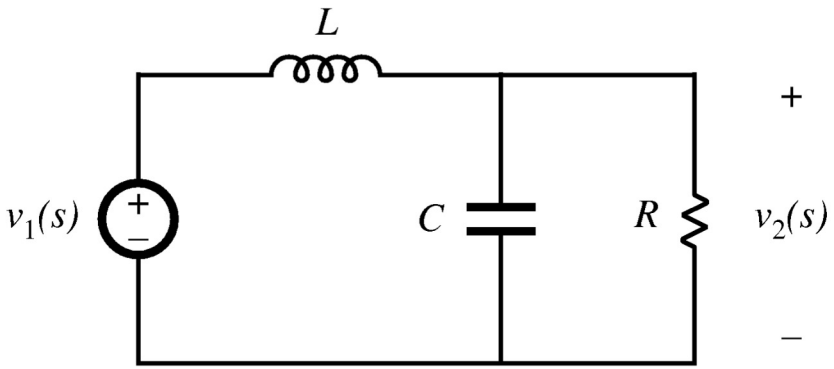


Example 3

All poles/zeros in LHP



Complex Poles



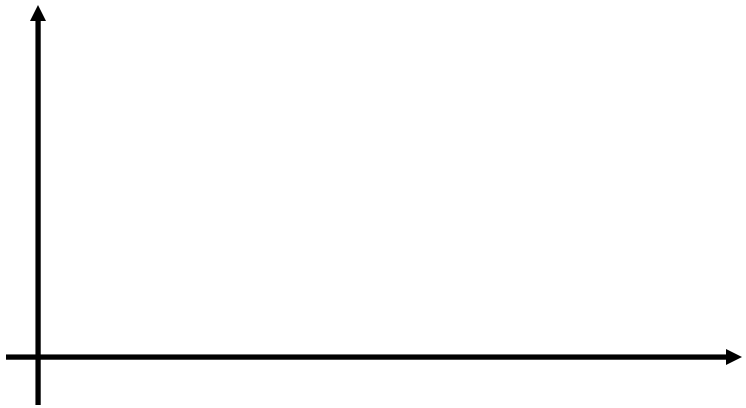
Two-pole low-pass filter example

Standard Form for Complex Poles

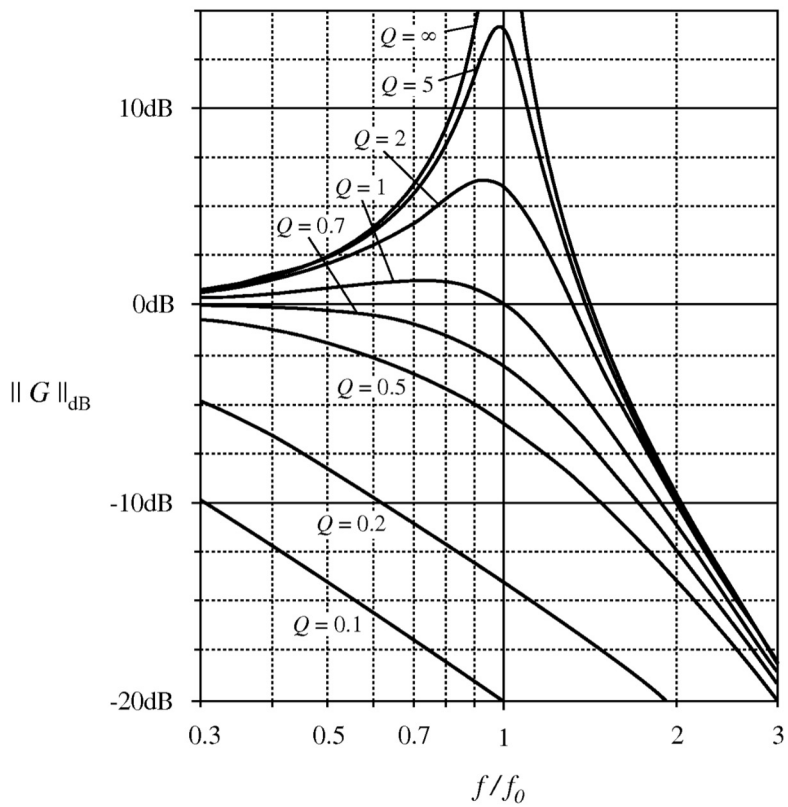
$$H(s) = \frac{1}{\left(\frac{s}{\omega_0}\right)^2 + \frac{s}{Q\omega_0} + 1}$$

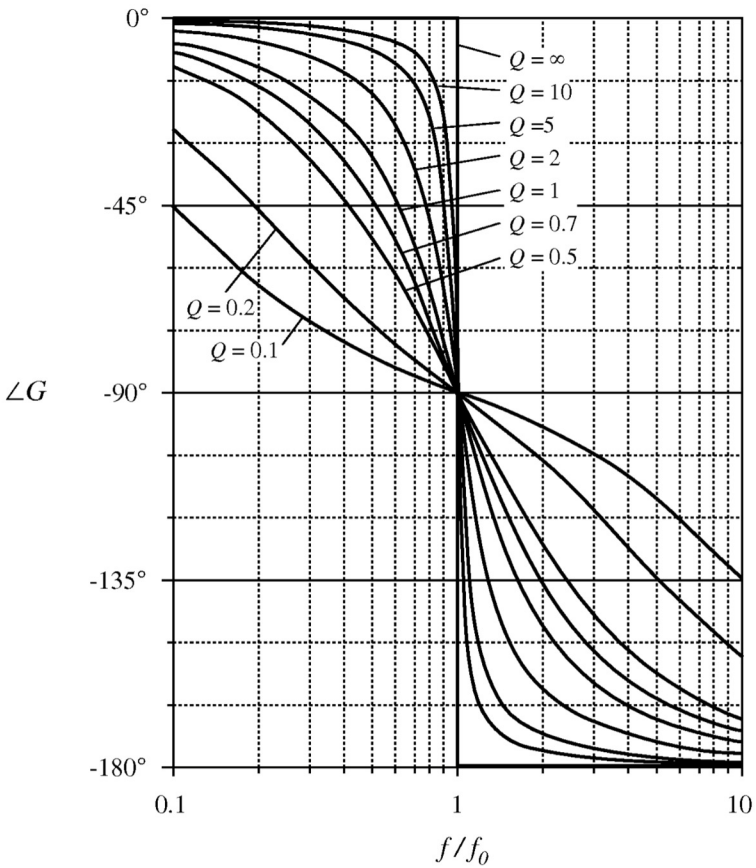
$$H(s) = \frac{1}{\left(\frac{s}{\omega_0}\right)^2 + 2\zeta\frac{s}{\omega_0} + 1}$$

Magnitude Asymptotes



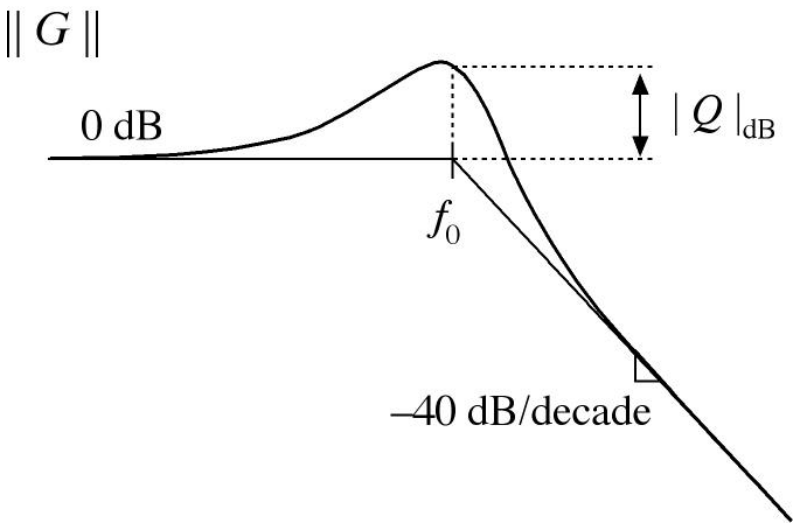
Curves for Varying Q



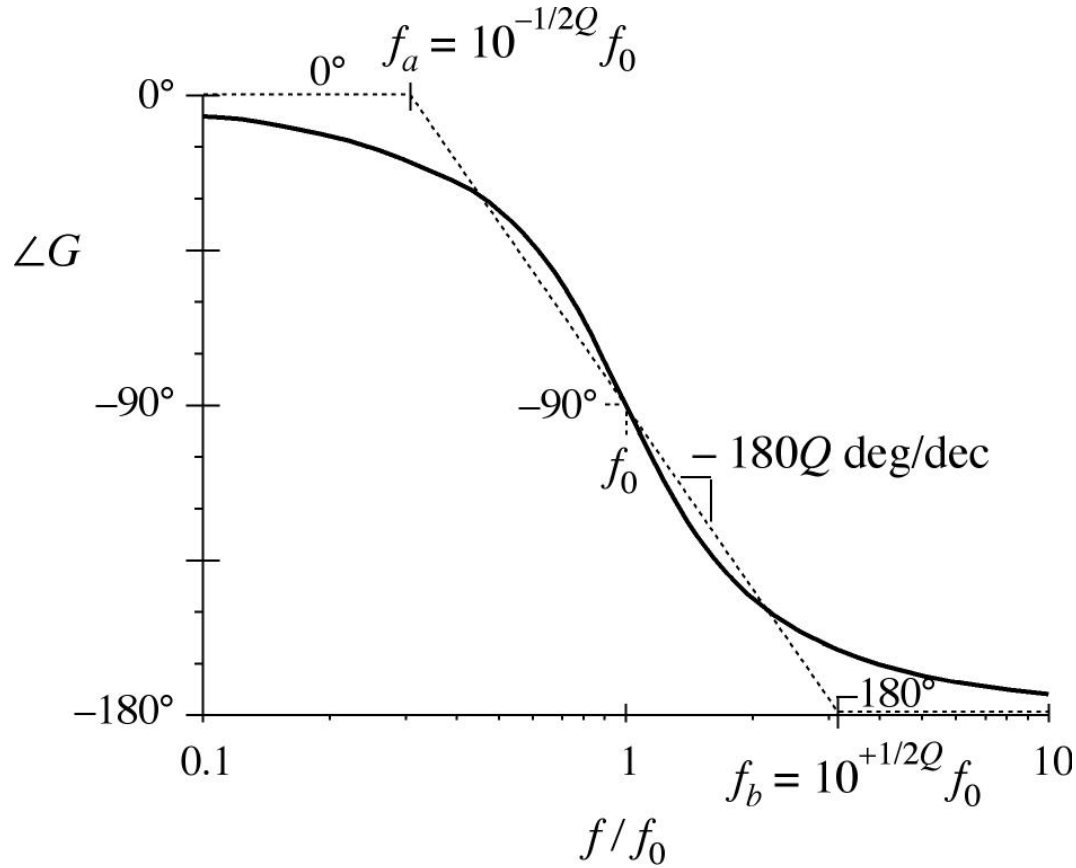


Asymptotes for Complex Poles, Q>0.5

Magnitude

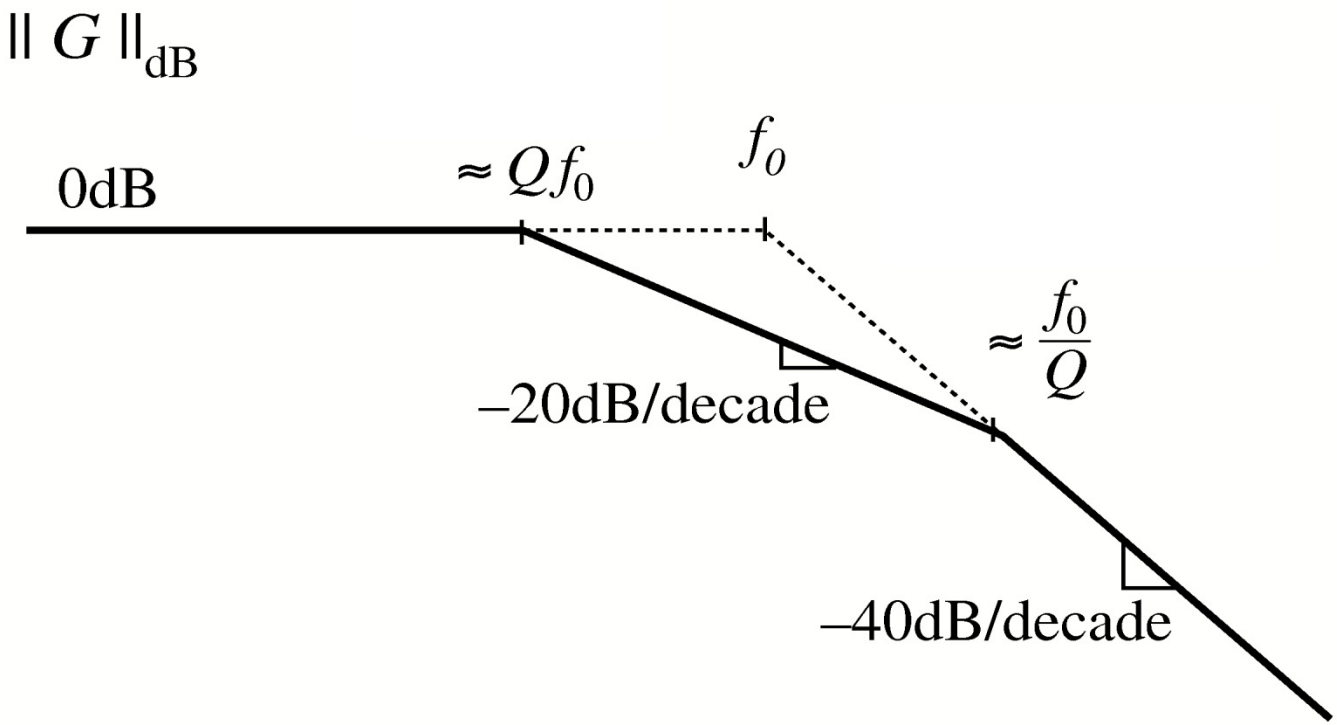


Phase



The Low-Q Approximation

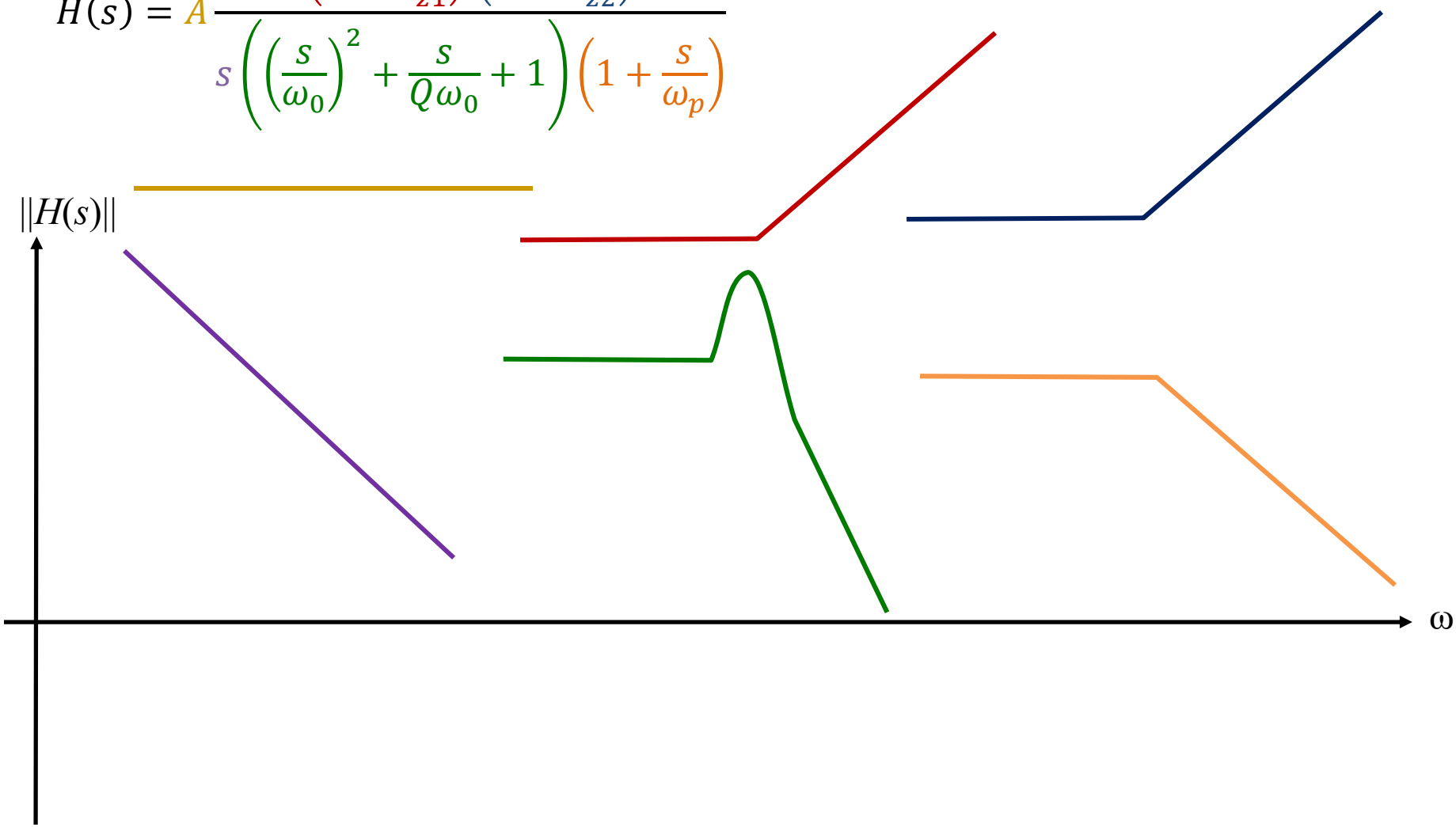
for $Q \ll 0.5$



Example

A	w_{z1}	w_{z2}	ω_0	Q	ω_p
1000	100	10k	1k	10	100k

$$H(s) = A\frac{\left(1+\frac{s}{w_{z1}}\right)\left(1+\frac{s}{w_{z2}}\right)}{s\left(\left(\frac{s}{\omega_0}\right)^2+\frac{s}{Q\omega_0}+1\right)\left(1+\frac{s}{\omega_p}\right)}$$



Example

A	w_{z1}	w_{z2}	ω_0	Q	ω_p
1000	100	10k	1k	10	100k

$$H(s) = A\frac{\left(1+\frac{s}{w_{z1}}\right)\left(1+\frac{s}{w_{z2}}\right)}{s\left(\left(\frac{s}{\omega_0}\right)^2+\frac{s}{Q\omega_0}+1\right)\left(1+\frac{s}{\omega_p}\right)}$$