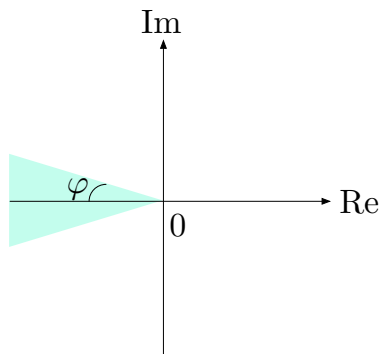


## Overshoot in Frequency Domain

Suppose we want  $M_p \leq c$

$$M_p = \underbrace{\exp\left(-\frac{\pi\zeta}{\sqrt{1-\zeta^2}}\right)}_{\text{decreasing function}} \leq c \quad \text{— need large damping ratio}$$

Geometrically, we want poles to lie in the shaded region:



$$\begin{aligned}\frac{\zeta}{\sqrt{1-\zeta^2}} &= \frac{\omega_n \zeta}{\omega_n \sqrt{1-\zeta^2}} \\ &= \frac{\sigma}{\omega_d} = \cot \varphi\end{aligned}$$

— need  $\varphi$  to be small

**Intuition:** good damping  $\rightarrow$   
good decay in 1/2 period