

Lec 44.

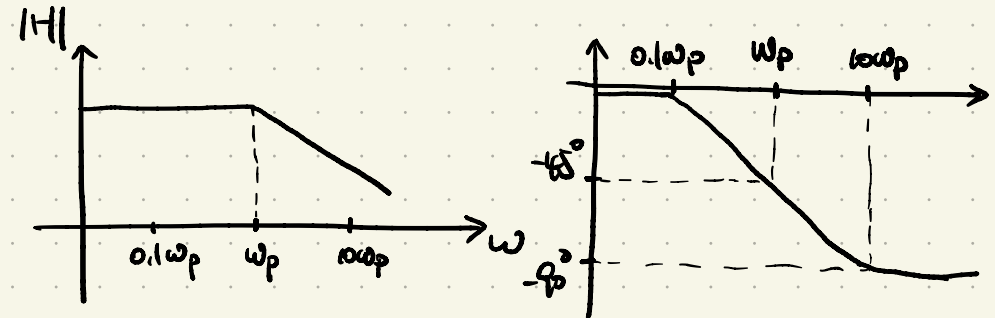
- Bode's Rules
- Stability Conditions
- Circuit Examples

Important Points

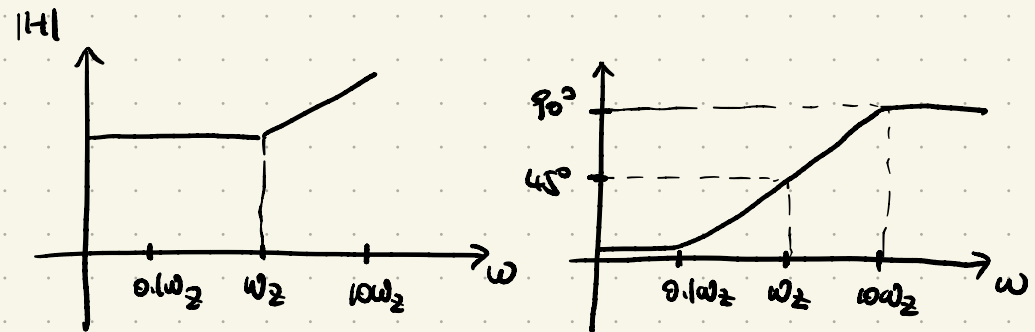
- ① If the open-loop system satisfies $KH(j\omega_0) = -1$ the closed-loop system is unstable
- ② Even if $X=0$, the system will oscillate if $KH(j\omega_0) = -1$
- ③ What happens if $|KH(j\omega_0)| > 1$ and $\angle KH(j\omega_0) = 180^\circ$
 \Rightarrow still unstable.
- ④ K usually has no phase shift:
 $\angle KH(j\omega_0) \approx \angle H(j\omega_0)$

Bode's Rules

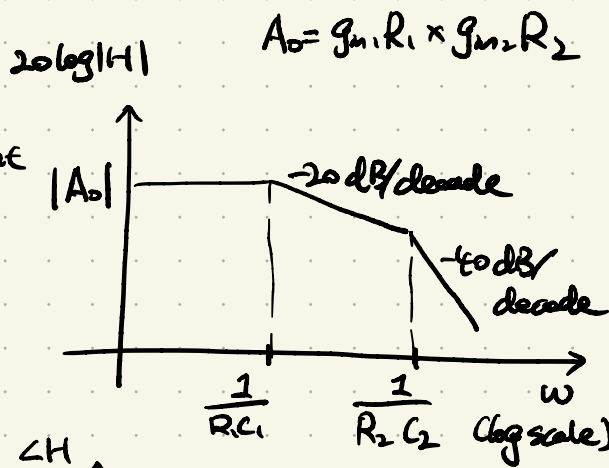
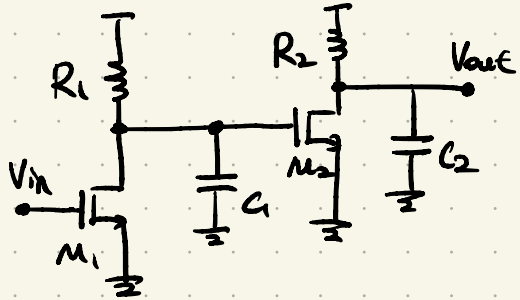
- If we have a pole at ω_p , then $\angle H$ experiences a change of -45° at ω_p and -90° at $10\omega_p$



- If we have a zero at ω_z the $\angle H$ experiences a change of $+45^\circ$ at ω_z and $+90^\circ$ at $10\omega_z$



Example



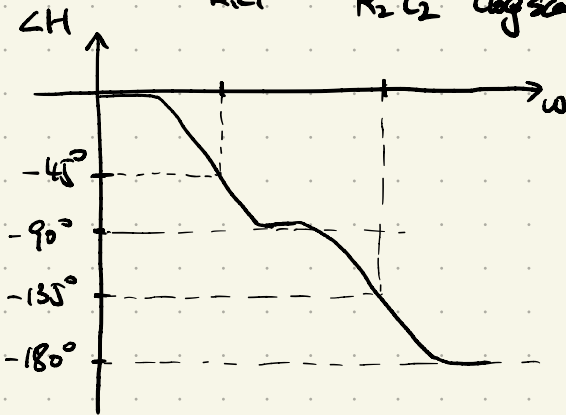
$$KH(j\omega_0) = -1$$

$$\begin{cases} |KH(j\omega_0)| = 1 \\ \angle KH(j\omega_0) = 180^\circ \end{cases}$$

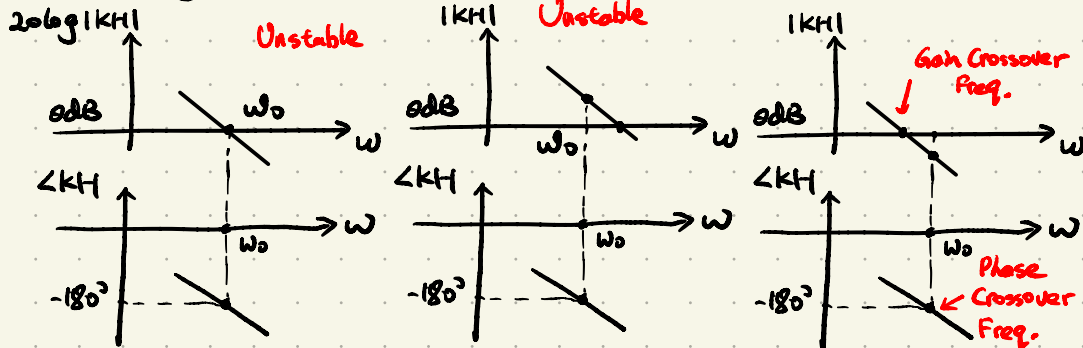
$$G(s) = \frac{1}{1 + \frac{s}{\omega_p}}$$

$$\Rightarrow \angle G = \arctan \frac{\omega}{\omega_p} = -90^\circ \text{ only for } \omega \rightarrow \infty$$

then the system will reach 180° only if $\omega \rightarrow \infty$



Stability Condition



For stability: Gain Crossover Freq.
< Phase Crossover Freq.

Example

