

Fall 2022 (111-1)

控制系統
Control Systems

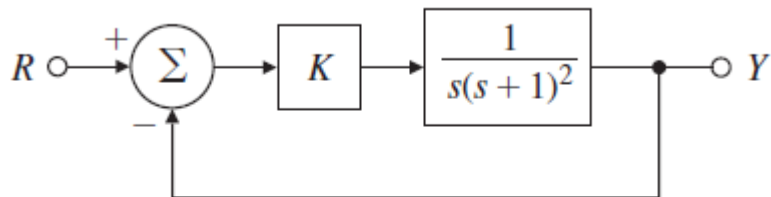
Unit 6D
Neutral Stability

Feng-Li Lian

NTU-EE

Sep 2022 – Dec 2022

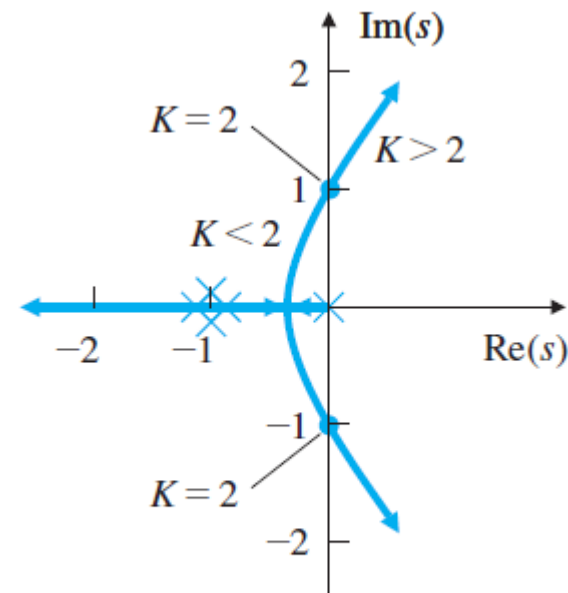
- In early days of electric communications, most instruments were judged in terms of their frequency response.
- That is, when feedback amplifier was introduced, techniques to determine stability in presence of feedback were based on this response.
- Suppose the CL TF is known, we can determine stability by inspecting the denominator.
- However, the CL TF is usually unknown.
- Another way, to determine CL stability only by evaluating frequency response of OL TF.



$$\Rightarrow 1 + K L(s) = 0$$

$$\Rightarrow L(s) = -\frac{1}{K}$$

(a)



(b)

- **Neutrally stable points:** roots lie on the IM axis, $s = j(1)$ or $j(-1)$
- In Section 5.1, all points on the locus have the property that

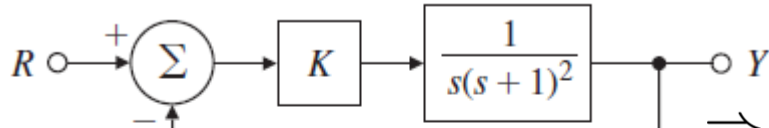
$$|K G(s)| = 1$$

$$\angle G(s) = 180^\circ$$

$$|K G(j\omega)| = 1$$

$$\angle G(j\omega) = 180^\circ$$

Neutral Stability

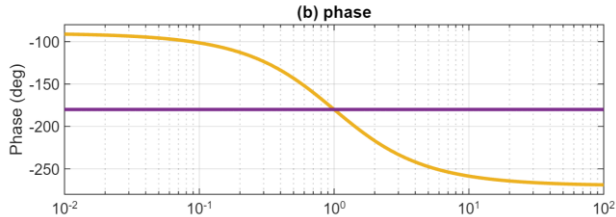
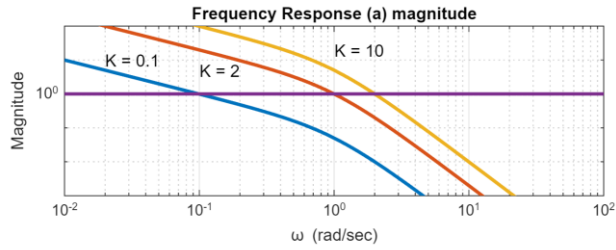
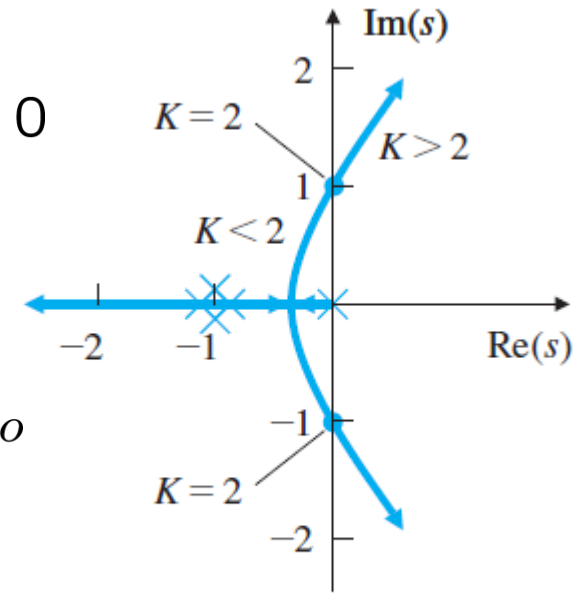


$$\Rightarrow 1 + K L(s) = 0$$

$$\Rightarrow L(s) = -\frac{1}{K}$$

$$|K G(j\omega)| = 1$$

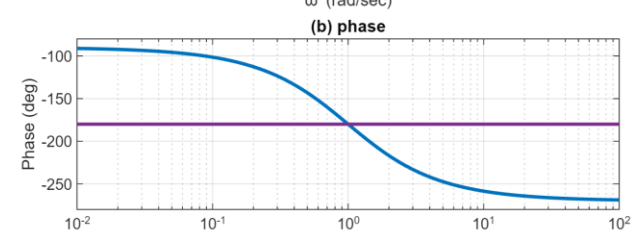
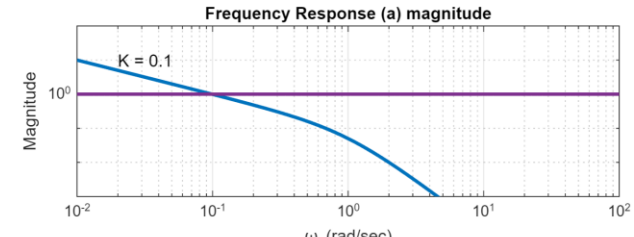
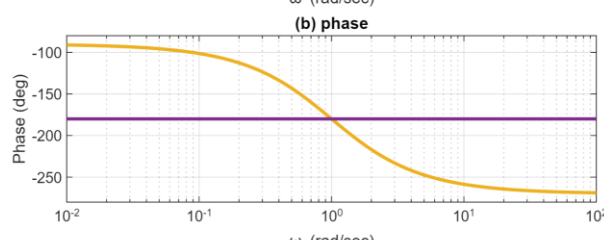
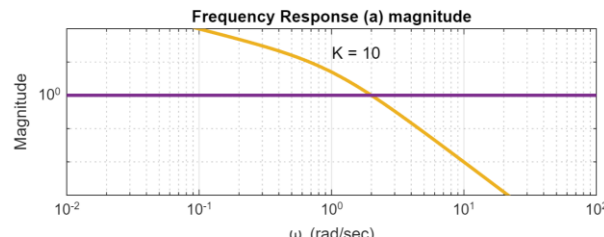
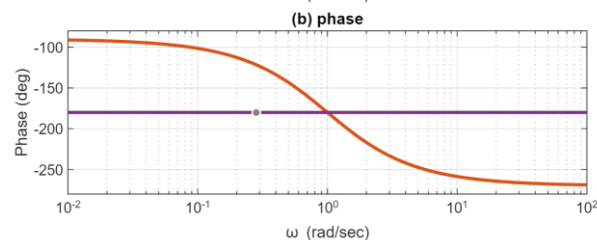
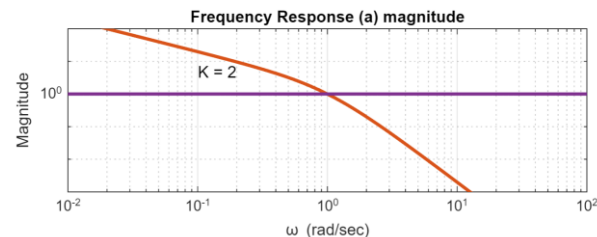
$$\angle G(j\omega) = 180^\circ$$

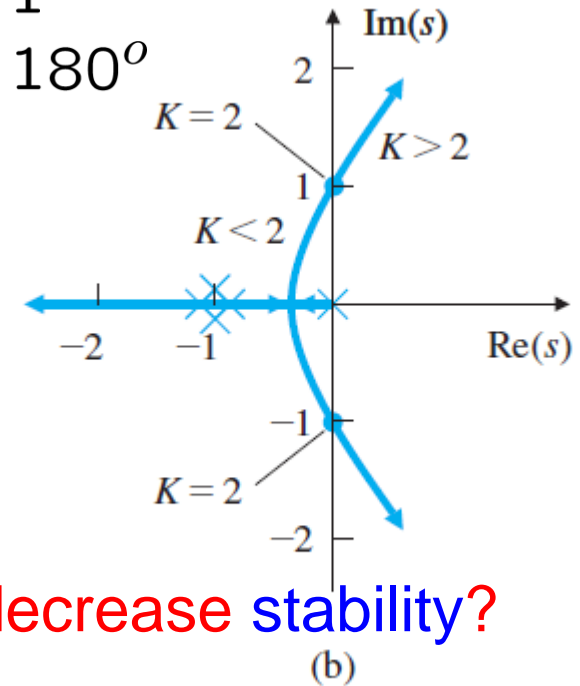
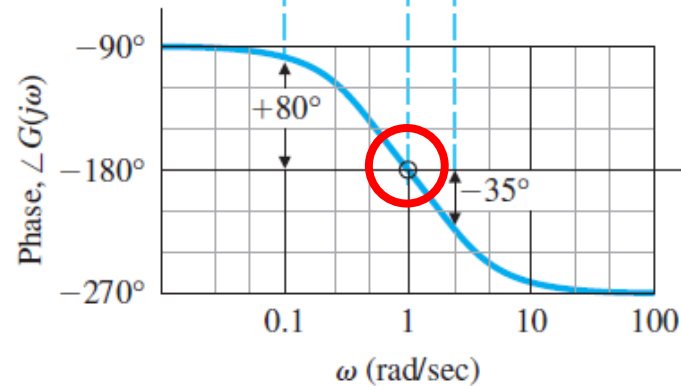
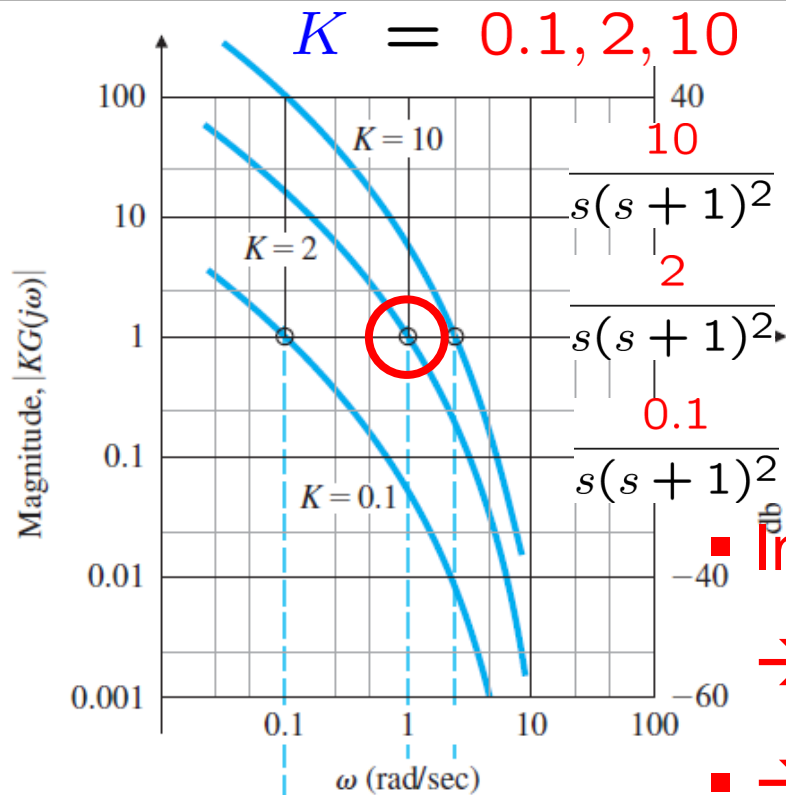


$$K = 2 \frac{2}{s(s+1)^2}$$

$$K = 10 \frac{10}{s(s+1)^2}$$

$$K = 0.1 \frac{0.1}{s(s+1)^2}$$





- Increasing gain
→ increase OR decrease stability?
- → $|KG(j\omega)| < 1$!!!
- However, for some systems,
- → $|KG(j\omega)| > 1$!!!
- Need to check their root locus
- OR, by Nyquist Stability Criterion