Fall 2021 (110-1)

控制系統
Control Systems

Unit 6D
Neutral Stability

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Sep 2021 – Jan 2022

Neutral Stability

- 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,

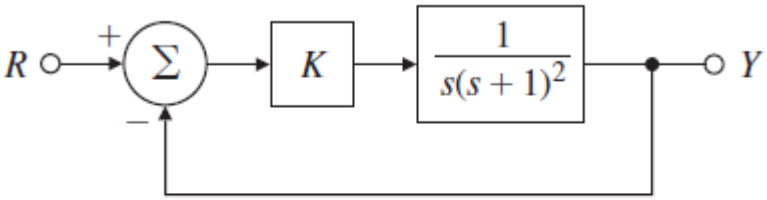
  we can determine stability by inspecting the denominator.

- However, the CL TF is usually unknown.

- Another way, to determine CL stability

  only by evaluating frequency response of OL TF.

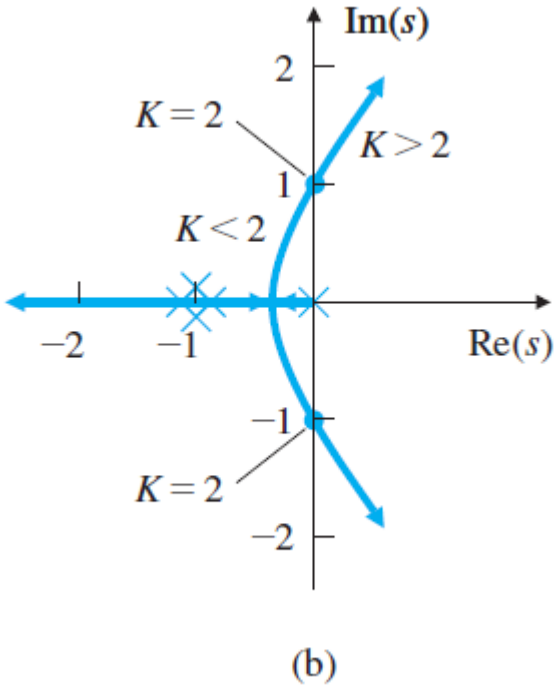
Neutral Stability



(a)

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

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



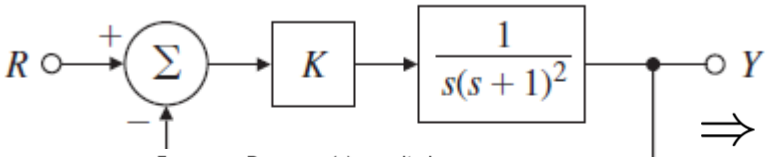
(b)

- 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

$$|\,K\,G(s)\,| = 1 \qquad |\,K\,G(jw)\,| = 1$$

$$\angle G(s) = 180^o \qquad \angle G(jw) = 180^o$$

Neutral Stability



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

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

$$|\,K\,G(jw)\,| = 1$$

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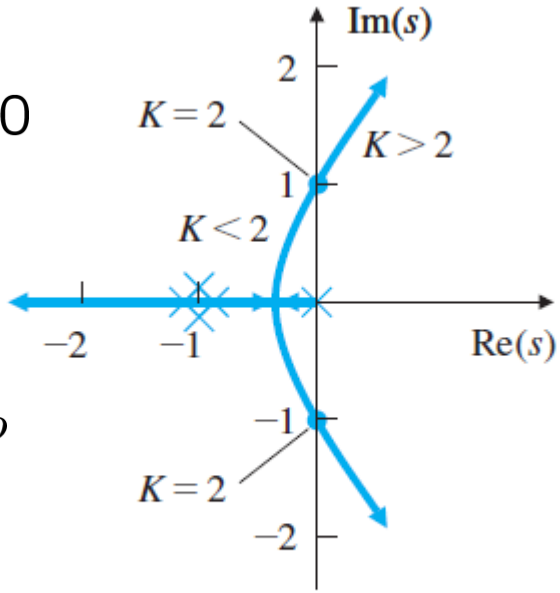
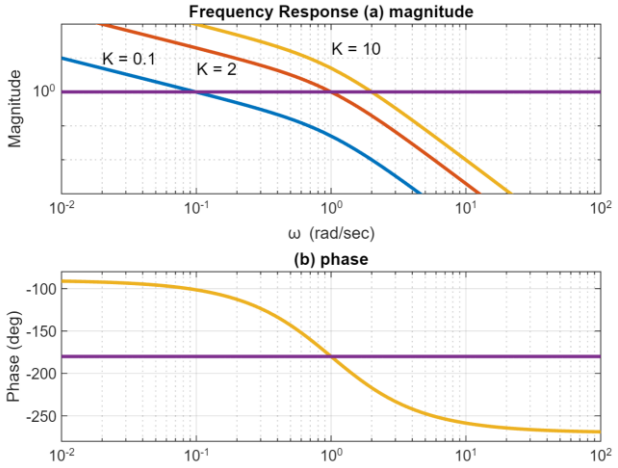
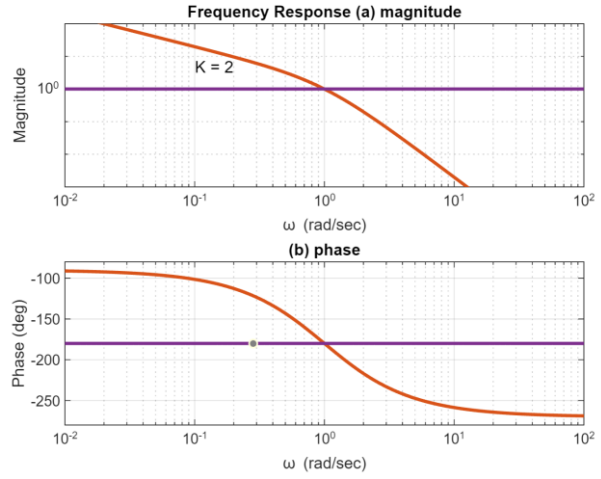
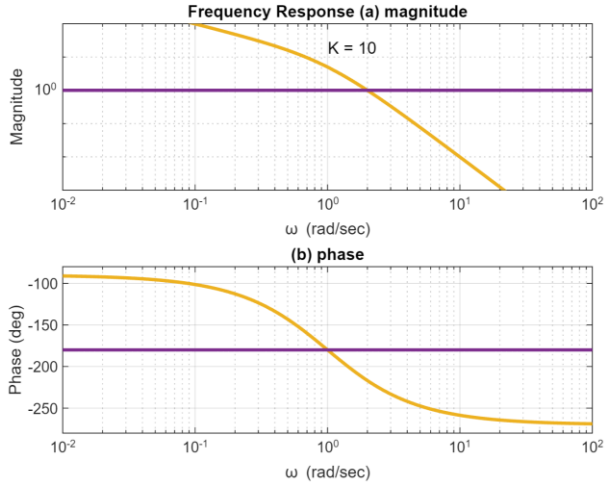
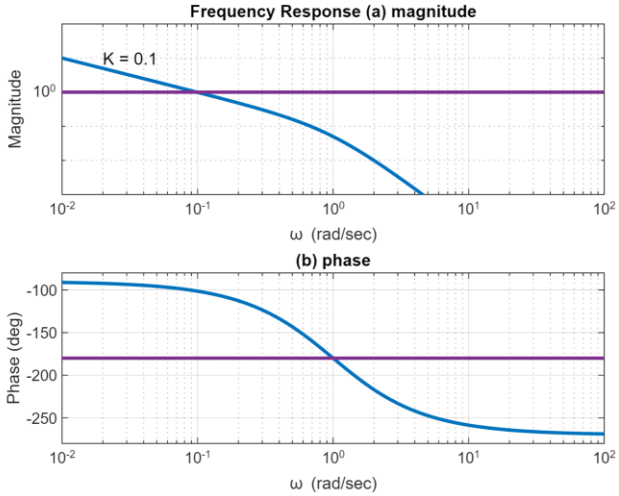




$$K = 2 \quad \frac{2}{s(s+1)^2} \qquad K = 10 \quad \frac{10}{s(s+1)^2} \qquad K = 0.1 \quad \frac{0.1}{s(s+1)^2}$$

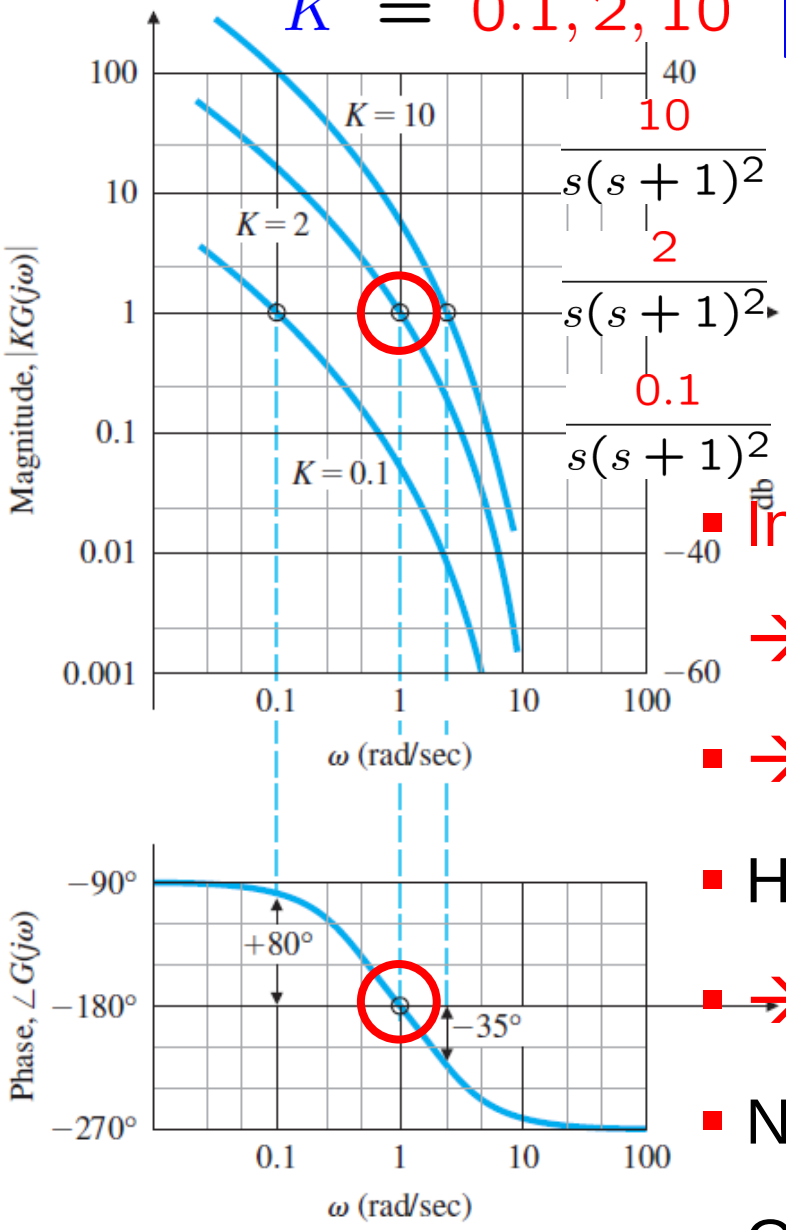


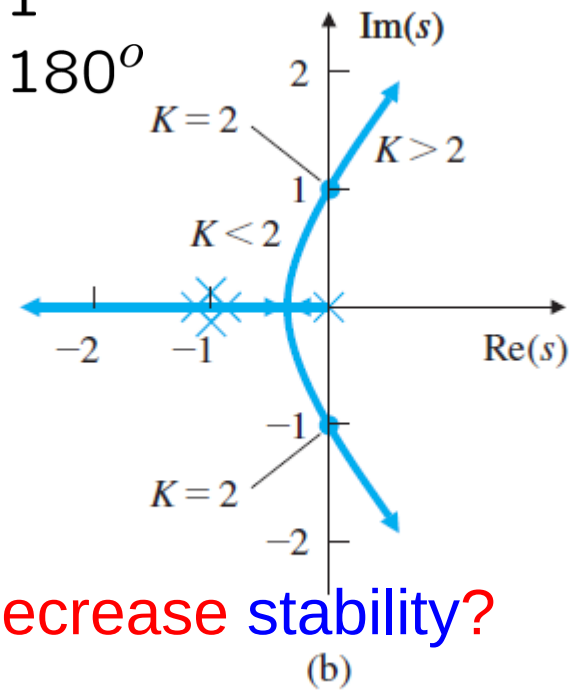




Neutral Stability

$K = 0.1, 2, 10$ $\quad |KG(jw)| = 1$, $\angle G(jw) = 180^o$





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