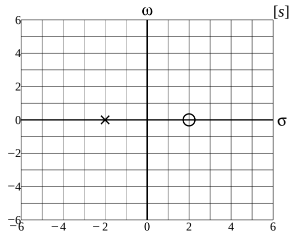
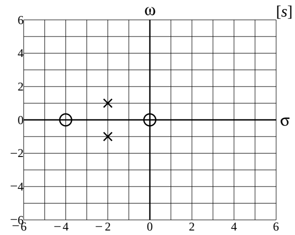
Solution to ECE Test #3 Su05

1. For each pole-zero plot, indicate which frequency response plot corresponds to it by writing in its letter designation.

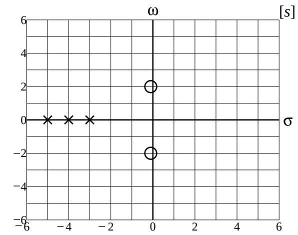
<u>F</u>



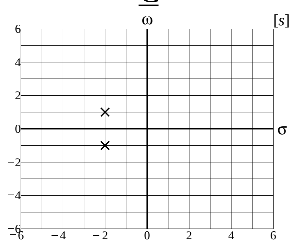
<u>B</u>



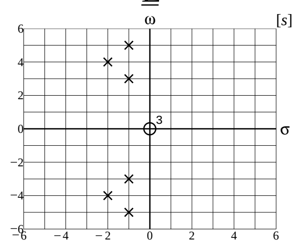
<u>D</u>



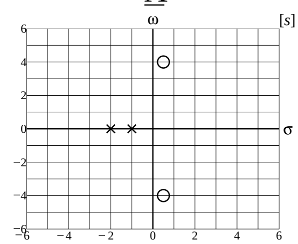
<u>C</u>



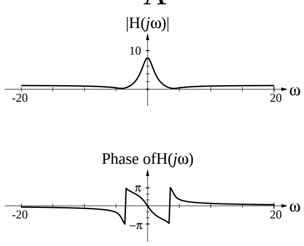
<u>E</u>



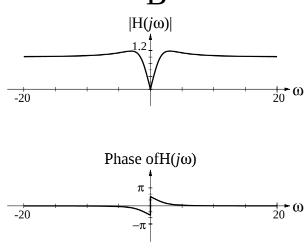
<u>A</u>



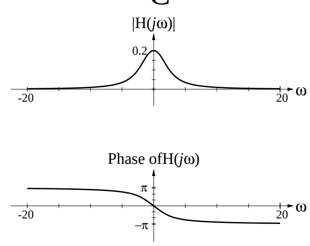
A



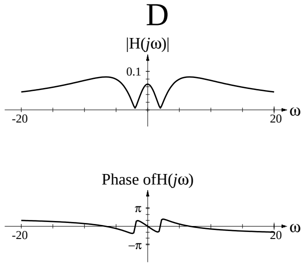
B



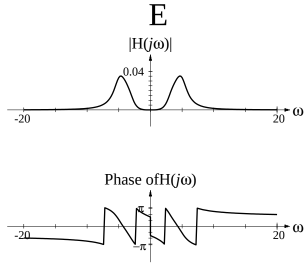
C



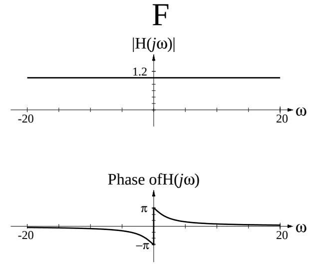
D



E

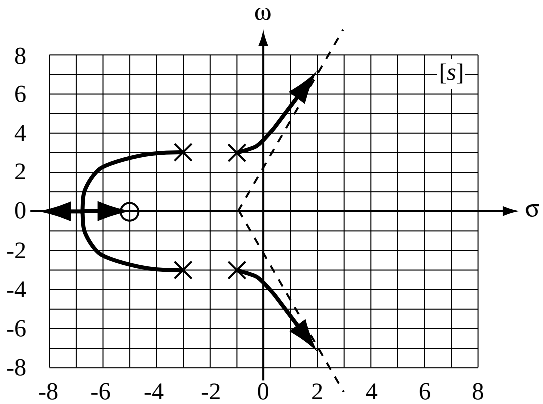


F

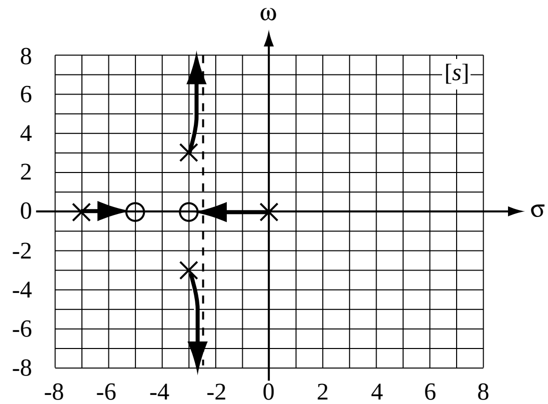


2. Sketch a root locus for each of these pole-zero plots assuming that these are the poles and zeros of the loop transfer function of a closed-loop system with an adjustable gain.

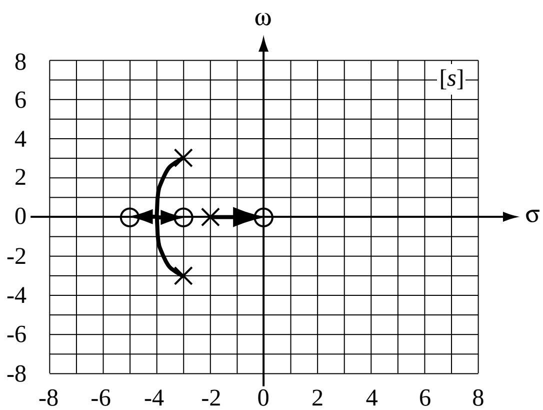
A



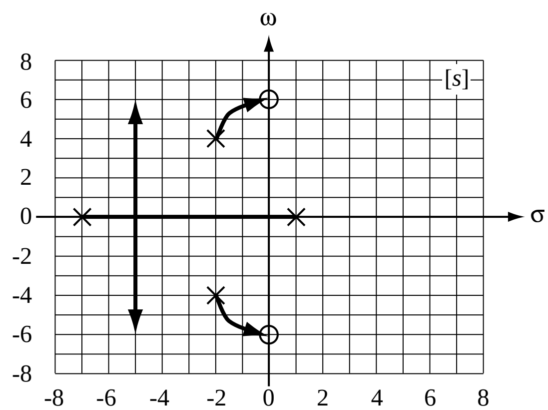
B



C



D



(continued on next page)

For each system indicate whether it will definitely be unstable at some finite positive value of K ($0 < K < \infty$) or definitely will be stable for all finite positive K or it is impossible to be sure. Explain your answer.

A Definitely unstable at some $K,\ 0 < K < \infty$ X

Definitely stable for all $K,\ 0 < K < \infty$

Impossible to be sure

Explanation Two branches of the root locus move into the right half-plane at a finite positive value of K.

B Definitely unstable at some $K,\ 0 < K < \infty$

Definitely stable for all $K,\ 0 < K < \infty$ X

Impossible to be sure

Explanation For any $K > 0$, the root locus is in the left half-plane and stays there because the two branches that go to infinity go vertically up and down.

C Definitely unstable at some $K,\ 0 < K < \infty$

Definitely stable for all $K,\ 0 < K < \infty$ X

Impossible to be sure

Explanation All root locus branches terminate on finite zeros, two of which are in the left half-plane and one of which is at the origin. Therefore for any K less than infinity, the root locus stays in the left half-plane.

D Definitely unstable at some $K,\ 0 < K < \infty$ X

Definitely stable for all $K,\ 0 < K < \infty$

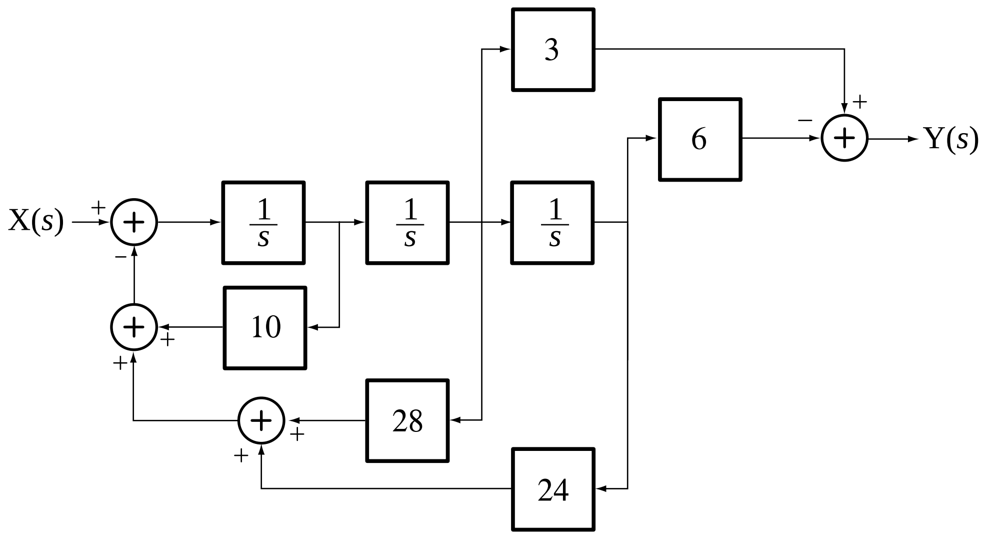
Impossible to be sure

Explanation One pole is in the RHP and the locus starts there so the system is unstable at low positive values of K.

3. Sketch a canonical realization of a system with the transfer function

$$\mathrm{H}(s) = 3\frac{s(s-2)}{(s+6)(s^2+4s+4)} .$$

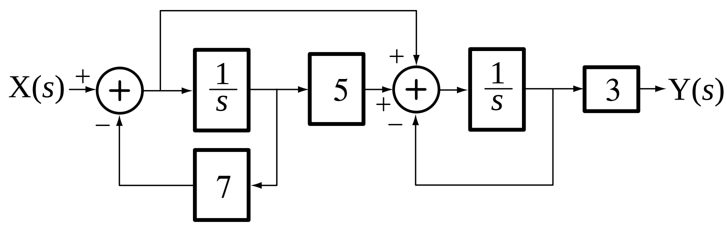
$$\mathrm{H}(s) = \frac{3s^2 - 6s}{s^3 + 10s^2 + 28s + 24}$$



4. Sketch a cascade realization of a system with the transfer function

$$H(s) = 3\frac{s+5}{s^2+8s+7} \; .$$

$$H(s) = 3\frac{s+5}{(s+7)(s+1)} = 3\times\frac{s+5}{s+7}\times\frac{1}{s+1}$$



5. A feedback system of the convential type has a forward-path transfer function

$$\mathrm{H}_1(s) = \frac{K}{s+8}$$

and a feedback-path transfer function

$$\mathrm{H}_2(s) = \frac{1}{s+12}.$$

K can be any real number. (Not just positive numbers.) For what range of *K*'s is this system stable?

$$\mathrm{H}(s) = \frac{\frac{K}{s+8}}{1+\frac{K}{s+8}\frac{1}{s+12}} = \frac{K(s+12)}{s^2+20s+96+K} = \frac{K(s+12)}{s^2+20s+96+K}$$

The roots of the denominator are at

$$p_{1,2} = \frac{-20 \pm \sqrt{400-384-4K}}{2} = -10 \pm \sqrt{4-K}$$

For any *K* greater than 4 the system is stable because the real part of the poles is fixed at -10 while the imaginary part varies. For any *K* less than 4 the roots are both real. When $\sqrt{4-K}$ equals or exceeds 10, one root has a non-negative real part. This occurs when $K \le -96$. Therefore for any $K \le -96$ the system is unstable. So the range of *K*'s for stability is $K > -96$.