Solution to ECE Test #7 S08 #1

Refer to the typical feedback system below.

1. Let $\mathrm{H}_1(s) = K/s$ and let $\mathrm{H}_2(s) = s+4$. For what range of real values of K is this system stable?

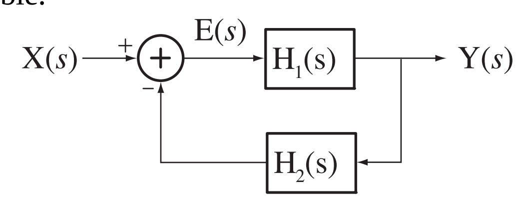
$\mathrm{H}(s) = \dfrac{K/s}{1+K\dfrac{s+4}{s}} = \dfrac{K}{(K+1)s+4K}$ Poles are at $s = \dfrac{-4K}{K+1}$. For stability the poles must have a negative real part. Since they are guaranteed real in this case they must simply be negative. If K is postive, $-4K$ is negative and $K+1$ is positive, making $\dfrac{-4K}{K+1}$ negative. If K is negative, $-4K$ is positive and $K+1$ is positive if K is also greater than -1. $K+1$ is negative if K is less than -1. Therefore, overall, for stability K must be less than -1 or greater than 0. The range is $K < -1$ or $K > 0$.

2. Let $\mathrm{H}_1(s) = \dfrac{s}{s^2+9}$ and let $\mathrm{H}_2(s) = 1/s$. Where are the poles of $\mathrm{H}(s) = \mathrm{Y}(s)/\mathrm{X}(s)$?

$\mathrm{H}(s) = \dfrac{s/(s^2+9)}{1+1/(s^2+9)} = \dfrac{s}{s^2+10}$, Poles at $s = \pm j\sqrt{10}$.

Is this feedback system stable or unstable? Stable Unstable
If it is unstable is it also marginally stable? Yes No Does Not Apply

System is marginally stable, therefore unstable.



Solution to ECE Test #7 S08 #1

Refer to the typical feedback system below.

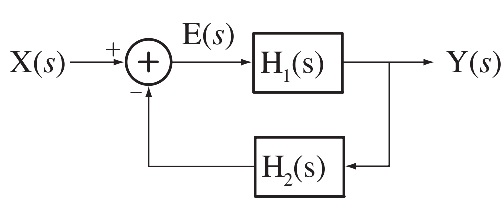
1. Let $\mathrm{H}_1(s) = K/2s$ and let $\mathrm{H}_2(s) = s+4$. For what range of real values of K is this system stable?

$\mathrm{H}(s) = \dfrac{K/2s}{1+K\dfrac{s+4}{2s}} = \dfrac{K}{(K+2)s+4K}$ Poles are at $s = \dfrac{-4K}{K+2}$. For stability the poles must have a negative real part. Since they are guaranteed real in this case they must simply be negative. If K is postive, $-4K$ is negative and $K+2$ is positive, making $\dfrac{-4K}{K+2}$ negative. If K is negative, $-4K$ is positive and $K+2$ is positive if K is also greater than -2. $K+2$ is negative if K is less than -2. Therefore, overall, for stability K must be less than -2 or greater than 0. The range is $K < -2$ or $K > 0$.

2. Let $\mathrm{H}_1(s) = \dfrac{s}{s^2-9}$ and let $\mathrm{H}_2(s) = 1/s$. Where are the poles of $\mathrm{H}(s) = \mathrm{Y}(s)/\mathrm{X}(s)$?

$\mathrm{H}(s) = \dfrac{s/(s^2-9)}{1+1/(s^2-9)} = \dfrac{s}{s^2-8}$, Poles at $s = \pm\sqrt{8}$.

Is this feedback system stable or unstable? Stable Unstable
If it is unstable is it also marginally stable? Yes No Does Not Apply
System is unstable and not marginally stable.



Solution to ECE Test #7 S08 #1

Refer to the typical feedback system below.

1. Let $\mathrm{H}_1(s) = K/(s+1)$ and let $\mathrm{H}_2(s) = s+4$. For what range of real values of K is this system stable?

$$\mathrm{H}(s) = \frac{K/(s+1)}{1+K\dfrac{s+4}{s+1}} = \frac{K}{(K+1)s+4K+1}$$

Poles are at $s = \dfrac{-(4K+1)}{K+1}$. For stability the poles must have a negative real part. Since they are guaranteed real in this case they must simply be negative. If K is postive, $-(4K+1)$ is negative and $K+1$ is positive, making $\dfrac{-(4K+1)}{K+1}$ negative. If K is less than -1/4, $-(4K+1)$ is positive and $K+1$ is positive if K is also greater than -1. $K+1$ is negative if K is less than -1 making $\dfrac{-(4K+1)}{K+1}$ negative. Therefore, overall, for stability K must be less than -1 or greater than -1/4. The range is $K < -1$ or $K > -1/4$.

2. Let $\mathrm{H}_1(s) = \dfrac{s}{s^2+4}$ and let $\mathrm{H}_2(s) = 1/s$. Where are the poles of $\mathrm{H}(s) = \mathrm{Y}(s)/\mathrm{X}(s)$?

$$\mathrm{H}(s) = \frac{s/(s^2+4)}{1+1/(s^2+4)} = \frac{s}{s^2+5}$$, Poles at $s = \pm j\sqrt{5}$.

Is this feedback system stable or unstable? Stable Unstable
If it is unstable is it also marginally stable? Yes No Does Not Apply

System is marginally stable, therefore unstable.