

Solution to ECE Test #11 S08 #1

1. For a feedback system with closed-loop transfer function $H(s)$ and loop transfer function $T(s)$ which includes an adjustable gain K , if the number of finite poles exceeds the number of finite zeros by 3 or more the system is guaranteed to be unstable at some finite positive value of K .
2. For a feedback system with closed-loop transfer function $H(z)$ and loop transfer function $T(z)$ which includes an adjustable gain K , what is the most general relationship between the number of finite poles and the number of finite zeros that guarantees that the system will be unstable at some finite positive value of K ?

The number of finite poles exceeds the number of finite zeros.

3. For the root locus of a feedback system with loop transfer function $T(s) = \frac{Ks(s+2)}{(s+5)(s^2+5s+4)(s^2+9s+14)}$ what is the angle in radians between the asymptotes of the branches that go to the zeros at infinity?

$$m = 3 \Rightarrow \text{Angle between asymptotes} = 2\pi/3$$

Where is the center of gravity (intersection point) of the asymptotes?

$$T(s) = \frac{Ks(s+2)}{(s+5)(s+4)(s+1)(s+2)(s+7)}$$

$$\Rightarrow \text{C.G. at } \frac{-5-4-1-2-7+0+2}{3} = -17/3 \cong -5.667$$

4. A stable unity-gain-feedback system has a forward-path transfer function $H(s)$. For each $H(s)$ and each type of excitation fill in the steady state error with either zero, finite or infinite.

$$H(s) = \frac{A}{s(s+4)}, \text{ Unit Step Excitation} \quad \text{Zero}$$

$$H(s) = \frac{A}{s(s+4)}, \text{ Unit Ramp Excitation} \quad \text{Finite}$$

$$H(s) = \frac{A}{(s+2)(s+4)}, \text{ Unit Step Excitation} \quad \text{Finite}$$

$$H(s) = \frac{A}{(s+2)(s+4)}, \text{ Unit Ramp Excitation} \quad \text{Infinite}$$

Solution to ECE Test #11 S08 #2

1. For a feedback system with closed-loop transfer function $H(s)$ and loop transfer function $T(s)$ which includes an adjustable gain K , if the number of finite poles exceeds the number of finite zeros by 3 or more the system is guaranteed to be unstable at some finite positive value of K .
2. For a feedback system with closed-loop transfer function $H(z)$ and loop transfer function $T(z)$ which includes an adjustable gain K , what is the most general relationship between the number of finite poles and the number of finite zeros that guarantees that the system will be unstable at some finite positive value of K ?

The number of finite poles exceeds the number of finite zeros.

3. For the root locus of a feedback system with loop transfer function $T(s) = \frac{K(s+8)}{(s+12)(s^2+5s+4)(s^2+9s+14)}$ what is the angle in radians between the asymptotes of the branches that go to the zeros at infinity?

$$m = 4 \Rightarrow \text{Angle between asymptotes} = \pi/2$$

Where is the center of gravity (intersection point) of the asymptotes?

$$T(s) = \frac{K(s+8)}{(s+12)(s+4)(s+1)(s+2)(s+7)}$$

$$\Rightarrow \text{C.G. at } \frac{-12-4-1-2-7+8}{4} = -4.5$$

4. A stable unity-gain-feedback system has a forward-path transfer function $H(s)$. For each $H(s)$ and each type of excitation fill in the steady state error with either zero, finite or infinite.

$$H(s) = \frac{A}{(s+2)(s+4)}, \text{ Unit Step Excitation} \quad \text{Finite}$$

$$H(s) = \frac{A}{(s+2)(s+4)}, \text{ Unit Ramp Excitation} \quad \text{Infinite}$$

$$H(s) = \frac{A}{s(s+4)}, \text{ Unit Step Excitation} \quad \text{Zero}$$

$$H(s) = \frac{A}{s(s+4)}, \text{ Unit Ramp Excitation} \quad \text{Finite}$$

Solution to ECE Test #11 S08 #3

1. For a feedback system with closed-loop transfer function $H(s)$ and loop transfer function $T(s)$ which includes an adjustable gain K , if the number of finite poles exceeds the number of finite zeros by 3 or more the system is guaranteed to be unstable at some finite positive value of K .
2. For a feedback system with closed-loop transfer function $H(z)$ and loop transfer function $T(z)$ which includes an adjustable gain K , what is the most general relationship between the number of finite poles and the number of finite zeros that guarantees that the system will be unstable at some finite positive value of K ?

The number of finite poles exceeds the number of finite zeros.

3. For the root locus of a feedback system with loop transfer function $T(s) = \frac{Ks^2(s+13)}{(s+7)(s^2+5s+4)(s^2+9s+14)}$ what is the angle in radians between the asymptotes of the branches that go to the zeros at infinity?

$$m = 2 \Rightarrow \text{Angle between asymptotes} = \pi$$

Where is the center of gravity (intersection point) of the asymptotes?

$$T(s) = \frac{Ks^2(s+13)}{(s+7)(s+4)(s+1)(s+2)(s+7)}$$

$$\Rightarrow \text{C.G. at } \frac{-7-4-1-2-7+0+13}{2} = -4$$

4. A stable unity-gain-feedback system has a forward-path transfer function $H(s)$. For each $H(s)$ and each type of excitation fill in the steady state error with either zero, finite or infinite.

$$H(s) = \frac{A}{s(s+4)}, \text{ Unit Ramp Excitation} \quad \text{Finite}$$

$$H(s) = \frac{A}{s(s+4)}, \text{ Unit Step Excitation} \quad \text{Zero}$$

$$H(s) = \frac{A}{(s+2)(s+4)}, \text{ Unit Ramp Excitation} \quad \text{Infinite}$$

$$H(s) = \frac{A}{(s+2)(s+4)}, \text{ Unit Step Excitation} \quad \text{Finite}$$