Control Systems

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Third Year ECE

Unit-III

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Lecture 6

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Steady state error for Ramp input for Type 2 system

For type two system, n=2

$$G(s).H(s) = \frac{K(1+T_1 s)(1+T_2 s)................(1+T_m s)}{s^2(1+T_a s)(1+T_b s)................(1+T_n s)}$$

The velocity error constant is given by,

$$K_v = \lim_{s\to 0} sG(s).H(s)$$

$$K_v = \lim_{s\to 0} s\left\{\frac{K(1+T_1 s)(1+T_2 s)................(1+T_m s)}{s^2(1+T_a s)(1+T_b s)................(1+T_n s)}\right\}$$

$$K_v = \frac{K(1+T_1 s)(1+T_2 s)................(1+T_m s)}{s(1+T_a s)(1+T_b s)................(1+T_n s)}$$

Steady state error for Ramp input for Type 2 system

$$K_v = \infty$$

The steady state error is given by,

$$e_{ss}(t) = \frac{A}{K_v}$$

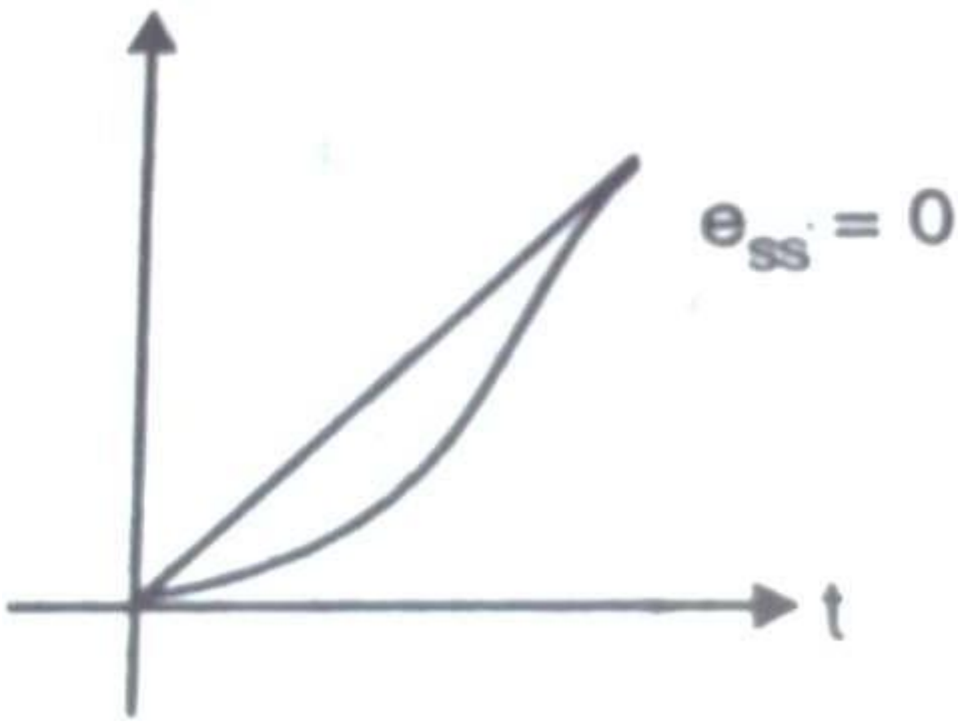
$$e_{ss}(t) = \frac{A}{\infty}$$

$$e_{ss}(t) = 0$$

Steady state error for Ramp input for Type 2 system

$$e_{ss}(t) = 0$$

There is no steady state error for a ramp input for type two system



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Steady state error for Parabolic input for Type 0 system

For type zero system, n=0

$$G(s).H(s) = \frac{K(1+T_1 s)(1+T_2 s)................(1+T_m s)}{(1+T_a s)(1+T_b s)................(1+T_n s)}$$

The acceleration error constant is given by,

$$K_a = \lim_{s \to 0} s^2 G(s).H(s)$$

$$K_a = \lim_{s \to 0} s^2 \left\{ \frac{K(1+T_1 s)(1+T_2 s)................(1+T_m s)}{(1+T_a s)(1+T_b s)................(1+T_n s)} \right\}$$

$$K_a = 0 \times \left\{ \frac{K(1+T_1 s)(1+T_2 s)................(1+T_m s)}{(1+T_a s)(1+T_b s)................(1+T_n s)} \right\}$$

Steady state error for Parabolic input for Type 0 system

$$K_a = 0$$

The steady state error is given by,

$$e_{ss}(t) = \frac{A}{K_a}$$

$$e_{ss}(t) = \frac{A}{0}$$

$$e_{ss}(t) = \infty$$

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Steady state error for <u>Parabolic input</u> for <u>Type 0</u> system

$$e_{ss}(t) = \infty$$

There is infinite steady state error indicating failure to track a parabolic input in type zero system

Steady state error for Parabolic input for Type 1 system

For type one system, n=1

$$G(s).H(s) = \frac{K(1+T_1 s)(1+T_2 s)................(1+T_m s)}{s(1+T_a s)(1+T_b s)................(1+T_n s)}$$

The acceleration error constant is given by,

$$K_a = \lim_{s\to 0} s^2 G(s).H(s)$$

$$K_a = \lim_{s\to 0} s^2 \{\frac{K(1+T_1 s)(1+T_2 s)................(1+T_m s)}{s(1+T_a s)(1+T_b s)................(1+T_n s)}\}$$

$$K_a = 0 \times \{\frac{K(1+T_1 s)(1+T_2 s)................(1+T_m s)}{(1+T_a s)(1+T_b s)................(1+T_n s)}\}$$

Steady state error for Parabolic input for Type 1 system

$$K_a = 0$$

The steady state error is given by,

$$e_{ss}(t) = \frac{A}{K_a}$$

$$e_{ss}(t) = \frac{A}{0}$$

$$e_{ss}(t) = \infty$$

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Steady state error for Parabolic input for Type 1 system

$$e_{ss}(t) = \infty$$

There is infinite steady state error indicating failure to track a parabolic input in type one system

Steady state error for Parabolic input for Type 2 system

For type two system, n=2

$$G(s).H(s) = \frac{K(1+T_1 s)(1+T_2 s)...............(1+T_m s)}{s^2(1+T_a s)(1+T_b s)...............(1+T_n s)}$$

The acceleration error constant is given by,

$$K_a = \lim_{s \to 0} s^2 G(s).H(s)$$

$$K_a = \lim_{s \to 0} s^2 \left\{ \frac{K(1+T_1 s)(1+T_2 s)...............(1+T_m s)}{s^2(1+T_a s)(1+T_b s)...............(1+T_n s)} \right\}$$

$$K_a = \left\{ \frac{K(1+T_1 s)(1+T_2 s)...............(1+T_m s)}{(1+T_a s)(1+T_b s)...............(1+T_n s)} \right\}$$

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Steady state error for Parabolic input for Type 2 system

$$K_a = K$$

The steady state error is given by,

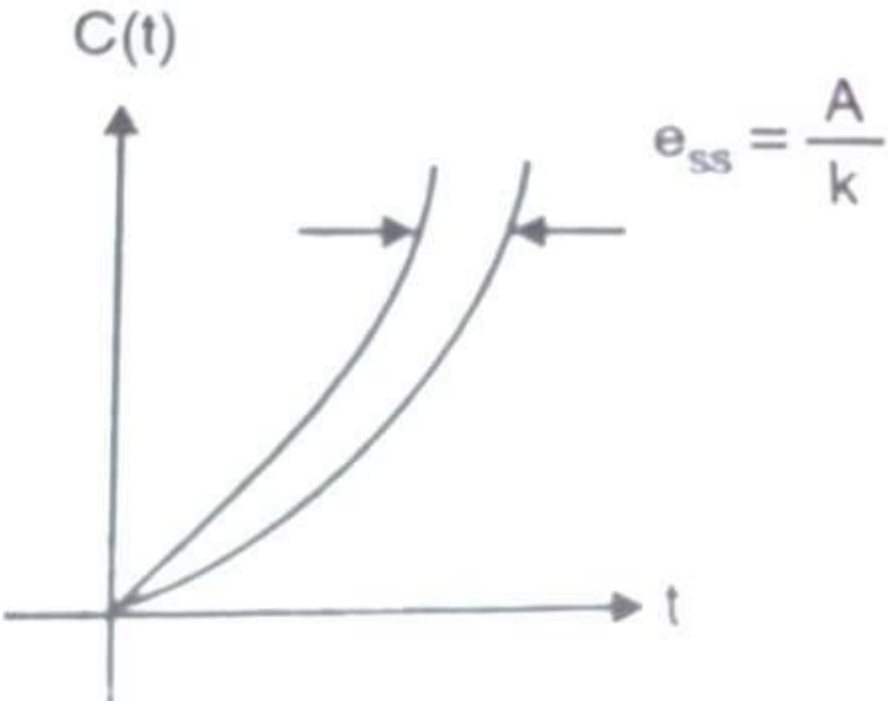
$$e_{ss}(t) = \frac{A}{K_a}$$

$$e_{ss}(t) = \frac{A}{K}$$

Steady state error for Parabolic input for Type 2 system

$$e_{ss}(t) = \frac{A}{K}$$

There is finite steady state error for type two system



Relation between steady state error and Type of system

Summary:

Sr. No.	Type of System	Step Input		Ramp Input		Parabolic Input	
		K_p	e_{ss}	K_v	e_{ss}	K_a	e_{ss}
1	Zero	K	$\frac{A}{1+K}$	0	∞	0	∞
2	One	∞	0	K	$\frac{A}{K}$	0	∞
3	Two	∞	0	∞	0	K	$\frac{A}{K}$