



IIT ROORKEE



NPTEL ONLINE
CERTIFICATION COURSE

STABILITY AND STEADY STATE ERROR

STATIC ERROR CONSTANTS

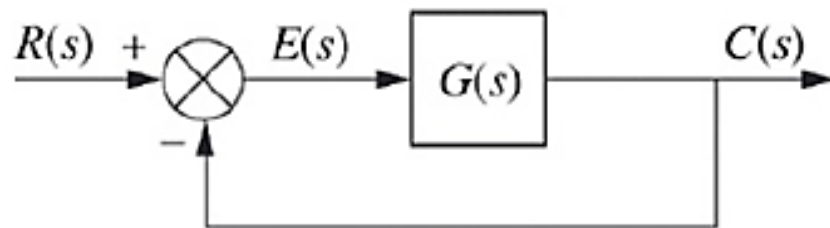
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STATIC ERROR CONSTANTS

- The ss error decreases as the value of static error constants increase
- Position constant, K_p
- Velocity constant, K_v
- Acceleration constant, K_a



$$K_p = \lim_{s \rightarrow 0} G(s)$$

$$K_v = \lim_{s \rightarrow 0} sG(s)$$

$$K_a = \lim_{s \rightarrow 0} s^2 G(s)$$

SS ERROR AND STATIC ERROR CONSTANT

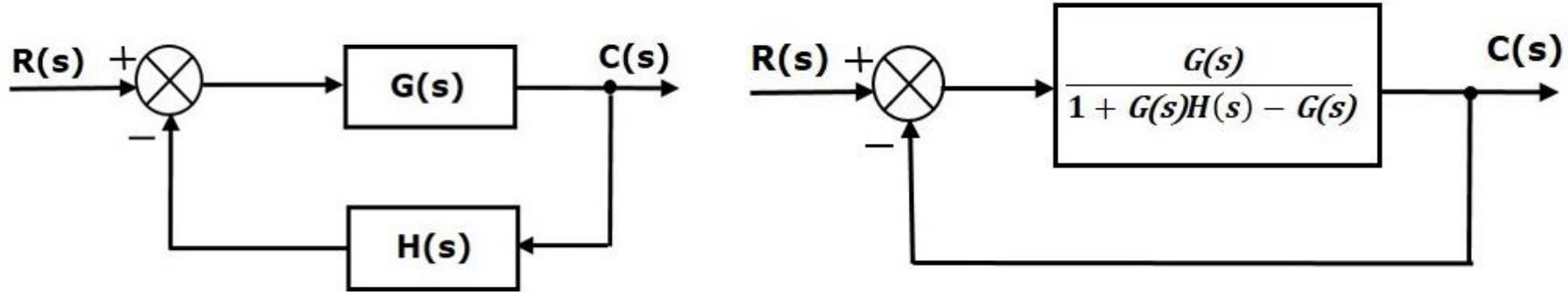
Input	Steady-state error formula	Type 0		Type 1		Type 2	
		Static error constant	Error	Static error constant	Error	Static error constant	Error
Step, $u(t)$	$\frac{1}{1 + K_p}$	$K_p = \text{Constant}$	$\frac{1}{1 + K_p}$	$K_p = \infty$	0	$K_p = \infty$	0
Ramp, $tu(t)$	$\frac{1}{K_v}$	$K_v = 0$	∞	$K_v = \text{Constant}$	$\frac{1}{K_v}$	$K_v = \infty$	0
Parabola, $\frac{1}{2}t^2u(t)$	$\frac{1}{K_a}$	$K_a = 0$	∞	$K_a = 0$	∞	$K_a = \text{Constant}$	$\frac{1}{K_a}$

SS ERROR AND SYSTEM TYPE

- Steady state error refers to the long-term behavior of a dynamic system.
- The Type of a system is significant to predict the nature of this error.
- A system having no pole at the origin is referred as Type-0 system.
- Thus, Type-1, refers to one pole at the origin and so on.
- We will consider three common commands: namely, step, ramp and parabolic ramp and find out the steady state response/error of a system to follow these commands.
- A closed loop control system shows remarkable performance in reducing the steady state error of a system.

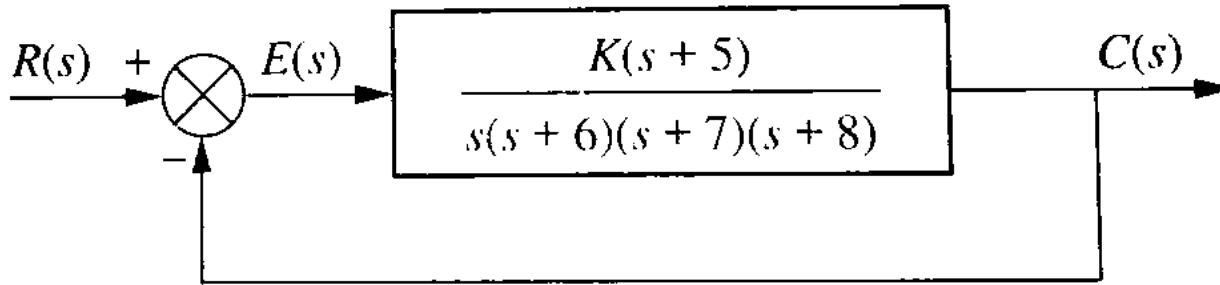
SS ERROR OF NONUNITY FEEDBACK SYSTEM

- Convert to a unity feedback system



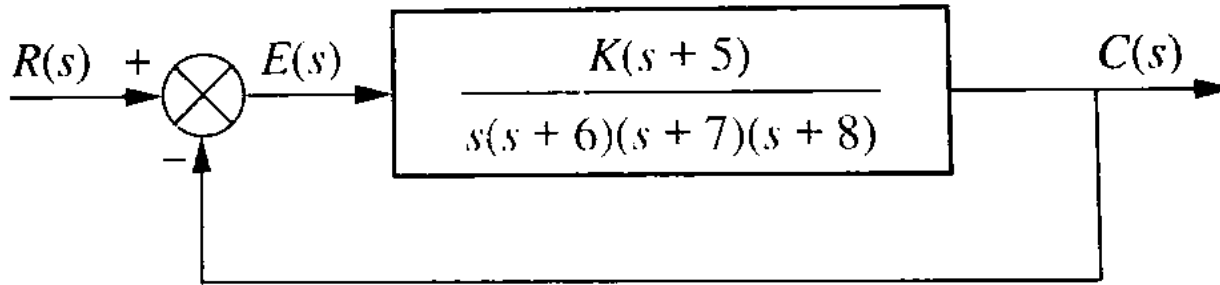
NUMERICAL EXAMPLE

- Find the value of K so that there is 10 % error in the steady state



NUMERICAL EXAMPLE

- Find ss error for inputs of $5 u(t)$, $5t u(t)$ and $5t^2 u(t)$.



REFERENCE BOOKS

- Norman S. Nise, Control Systems Engineering, Wiley, 2013
- Katsuhiko Ogata, Modern Control Engineering, Prentice Hall, 2010.

