Department of Biomedical Engineering

Course Name: Biocontrol System

II Year : IV Semester

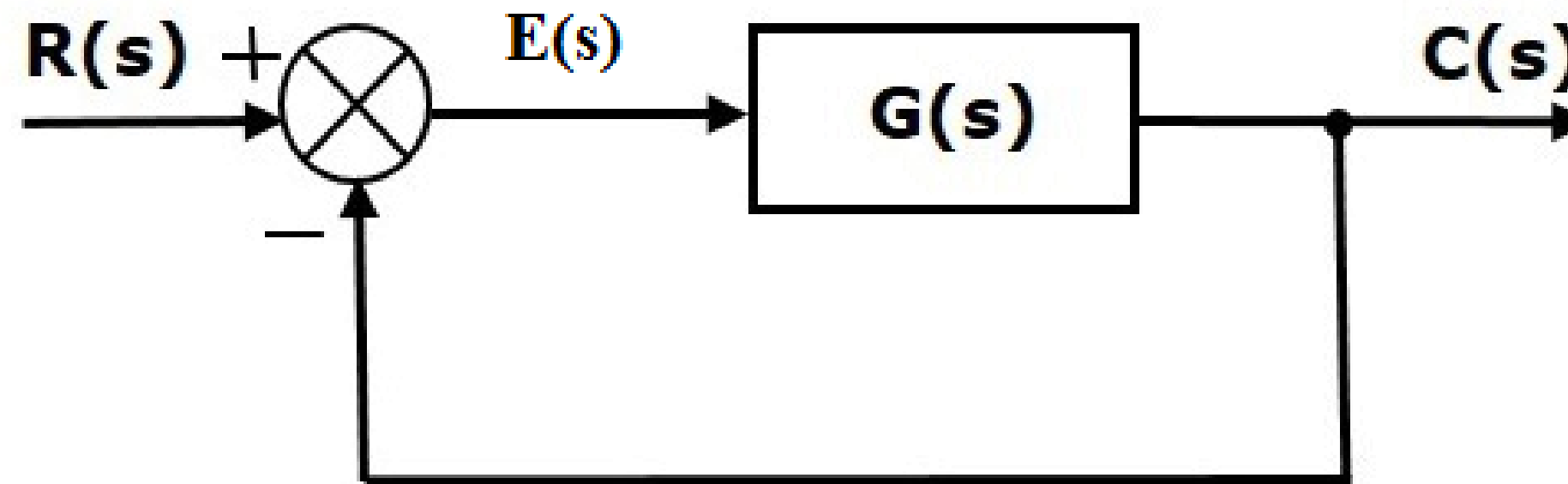**Unit II –Time Response Analysis**

Topic : Steady State Errors

Introduction

The deviation of the output of control system from desired response during steady state is known as steady state error. It is represented as e_{ss} .

$$e_{ss} = \lim_{t \to \infty} e(t) = \lim_{s \to 0} E(s)$$

Steady State Errors

$$\frac{C(s)}{R(s)} = \frac{G(s)}{1 + G(s)}$$

$$\Rightarrow C(s) = \frac{R(s)G(s)}{1 + G(s)}$$

$$E(s) = R(s) - C(s)$$

$$\Rightarrow E(s) = \frac{R(s)}{1 + G(s)}$$

$$e_{ss} = \lim_{s \to 0} \frac{sR(s)}{1 + G(s)}$$

Steady State Errors

- The following table shows the steady state errors and the error constants for standard input signals like unit step, unit ramp & unit parabolic signals.

Input signal	Steady state error e_{ss}	Error constant
unit step signal	$\frac{1}{1+k_p}$	$K_p = \lim_{s \to 0} G(s)$
unit ramp signal	$\frac{1}{K_v}$	$K_v = \lim_{s \to 0} sG(s)$
unit parabolic signal	$\frac{1}{K_a}$	$K_a = \lim_{s \to 0} s^2 G(s)$

- Where Kp, Kv, Ka are the position error constant, velocity error constant and acceleration error constant respectively.

Steady State Errors

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