EEE302 Control Systems
Pre-Laboratory Report

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Assignment Number : **5**

Objectives of the Laboratory Assignment:

Objectives of this lab are learning parabolic, step, ramp input for the systems and calculating steady state errors and error constants by both hand and MATLAB m-file.

Question-1

```
% For (a)
clc
clear all
syms s
G1 = 1/(3*s^2+4*s+1); % System Transfer Function

Kp = limit(G1,s,0) % when input is step, error constant, Kp is calculated
Es = 1/(1+Kp)      % form of steady state error, Ess for step input

Kv = limit(s*G1,s,0) % when input is ramp, error constant, Kv is calculated
Er = 1/(Kv)        % form of steady state error, Ess for ramp input

Ka = limit(G1*s^2,s,0) % when input is parabolic, error constant, Kp is calculated
Ep = 1/(Ka)        % form of steady state error, Ess for step parabolic

% Command Window

Kp = 1
Es = 1/2

Kv = 0
Er = Inf

Ka = 0
Ep = Inf
```

```
% For (b)
clc
clear all
syms s
G2 = (s+1)*(s+7)/((s+2)*(s+5)); % System Transfer Function

Kp = limit(G2,s,0) % when input is step, error constant, Kp is calculated
Es = 1/(1+Kp)      % form of steady state error, Ess for step input

Kv = limit(s*G2,s,0) % when input is ramp, error constant, Kv is calculated
Er = 1/(Kv)        % form of steady state error, Ess for ramp input

Ka = limit(G2*s^2,s,0) % when input is parabolic, error constant, Kp is calculated
Ep = 1/(Ka)        % form of steady state error, Ess for step parabolic

% Command Window

Kp = 7/10
Es = 10/17

Kv = 0
Er = Inf

Ka = 0
Ep = Inf
```

```
% For (c)
clc
clear all
syms s
G3 = (s^2+12*s+35)/(s^4+5*s^3+4*s^2); % System Transfer Function

Kp = limit(G3,s,0) % when input is step, error constant, Kp is calculated
Es = 1/(1+Kp)      % form of steady state error, Ess for step input

Kv = limit(s*G3,s,0) % when input is ramp, error constant, Kv is calculated
Er = 1/(Kv)        % form of steady state error, Ess for ramp input

Ka = limit(G3*s^2,s,0) % when input is parabolic, error constant, Kp is calculated
Ep = 1/(Ka)        % form of steady state error, Ess for step parabolic

% Command Window

Kp = Inf
Es = 0

Kv = Inf
Er = 0

Ka = 35/4
Ep = 4/35
```

QUESTION-2

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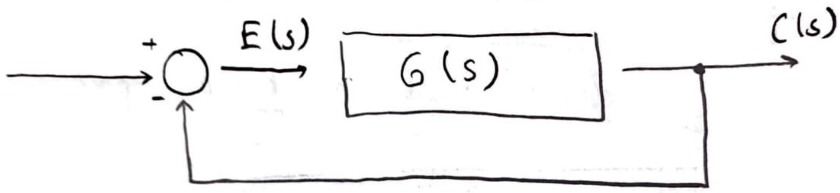
→

a) $G(s) = \dfrac{1}{(s+1)(3s+1)}$

b) $G(s) = \dfrac{(s+1)(s+7)}{(s+2)(s+5)}$

c) $G(s) = \dfrac{(s+5)(s+7)}{s^2(s+1)(s+4)}$

* For given control system apply step, ramp, parabolic inputs and observe the steady state error.



Solution =

Steady state Error for Different Types of System

Type	Step Input	Ramp Input	Parabolic Input
0	$A/1+K_p$	∞	∞
1	0	A/K_v	∞
2	0	0	A/K_a

* All are given unity feedback system, so $H(s)=1$. Therefore transfer function $\Rightarrow G(s)H(s) = G(s)$

A (1) $G(s)H(s) = \dfrac{1}{(s+1)(3s+1)}$, $K_p = \lim_{s \to 0} \dfrac{1}{(s+1)(3s+1)} = 1$

* Steady state error for step input $\Rightarrow K_p = 1$

$\hookrightarrow e_{ss} = \dfrac{1}{1+K_p} = \dfrac{1}{2} = 0.5$

② $K_v = \lim_{s\to 0} s\,G(s)H(s) = \lim_{s\to 0} \frac{s}{(s+1)(3s+1)} = \underline{\underline{0}}$

* Steady state error for Ramp Input $\Rightarrow K_v = 0$

$\hookrightarrow e_{ss} = \frac{1}{K_v} = \frac{1}{0} = \underline{\underline{\infty}}$

③ $K_a = \lim_{s\to 0} s^2 G(s)H(s) = \lim_{s\to 0} \frac{s^2}{(s+1)(3s+1)} = \underline{\underline{0}}$

* Steady state error for parabolic input $\Rightarrow K_a = 0$

$\hookrightarrow e_{ss} = \frac{1}{K_a} = \frac{1}{0} = \underline{\underline{\infty}}$

* Type = 0 system →

error	step	ramp	parabolic
ess	0.5	∞	∞

⑤ $\boxed{G(s) = \frac{(s+1)(s+7)}{(s+2)(s+5)}}$

① $K_p = \lim_{s\to 0} \frac{(s+1)(s+7)}{(s+2)(s+5)} = \underline{\underline{0.7}}$

* $e_{ss} = \frac{1}{1+K_p} = \underline{\underline{\frac{10}{17}}}$

step

② $K_v = \lim_{s\to 0} \frac{s(s+1)(s+7)}{(s+2)(s+5)} = \underline{\underline{0}}$

* $e_{ss} = \frac{1}{0} = \underline{\underline{\infty}}$

ramp

③ $K_a = \lim_{s\to 0} \frac{s^2(s+1)(s+7)}{(s+2)(s+5)} = \underline{\underline{0}}$

* $e_{ss} = \frac{1}{0} = \underline{\underline{\infty}}$

parabolic

→ Type = 0 system →

error	step	ramp	parabolic
ess	$\frac{10}{17}$	∞	∞

c) $\boxed{G(s)H(s) = \frac{(s+5)(s+7)}{s^2(s+1)(s+4)}}$

① $K_p = \lim_{s \to 0} G(s)H(s) = \lim_{s \to 0} \frac{(s+5)(s+7)}{s^2(s+1)(s+4)} = \infty$

$* \; e_{ss} = \frac{1}{1+K_p} = \frac{1}{1+\infty} = 0$

step

② $K_v = \lim_{s \to 0} \frac{s(s+5)(s+7)}{s^2(s+1)(s+4)} = \infty$

$* \; e_{ss} = \frac{1}{\infty} = 0$

ramp

③ $K_a = \lim_{s \to 0} \frac{s^2(s+5)(s+7)}{s^2(s+1)(s+4)} = \frac{35}{4}$

$* \; e_{rr} = \frac{1}{K_a} = \frac{1}{\frac{35}{4}} = \frac{4}{35}$

parabolic

→ $\boxed{\text{Type} = 2 \text{ system}}$ ↳

error	step	ramp	parabolic
ess	0	0	0.11420