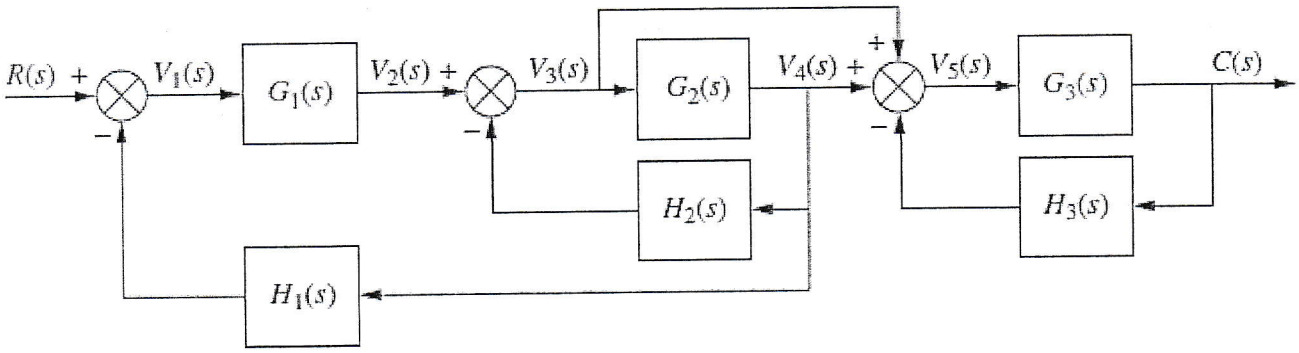
Faculty of Engineering	**Philadelphia University**	Mechanical Eng. Dep.
Course name: Automatic control	**First Quiz**	Course number:620443 class(1)
Instructor: Eng. Laith Batarseh	**Thursday 9/11/2017**	Allowed time: 10 minutes

Student Name: Typical **Student ID number:**

Problem: derive the governing equations for V_1, V_2, V_3, V_4, V_5 and C from the following diagram



$$V_1(s) = R(s) - H_1(s)\, V_4(s)$$

$$V_2(s) = G_1(s)\, V_1(s)$$

$$V_3(s) = V_2(s) - H_2\, V_4(s)$$

$$V_4(s) = G_2(s)\, V_3(s)$$

$$V_5(s) = V_4(s) + V_3(s) - H_3(s)\, C(s)$$

$$C(s) = G_3(s)\, V_5(s)$$

Faculty of Engineering	**Philadelphia University**	Mechanical Eng. Dep.
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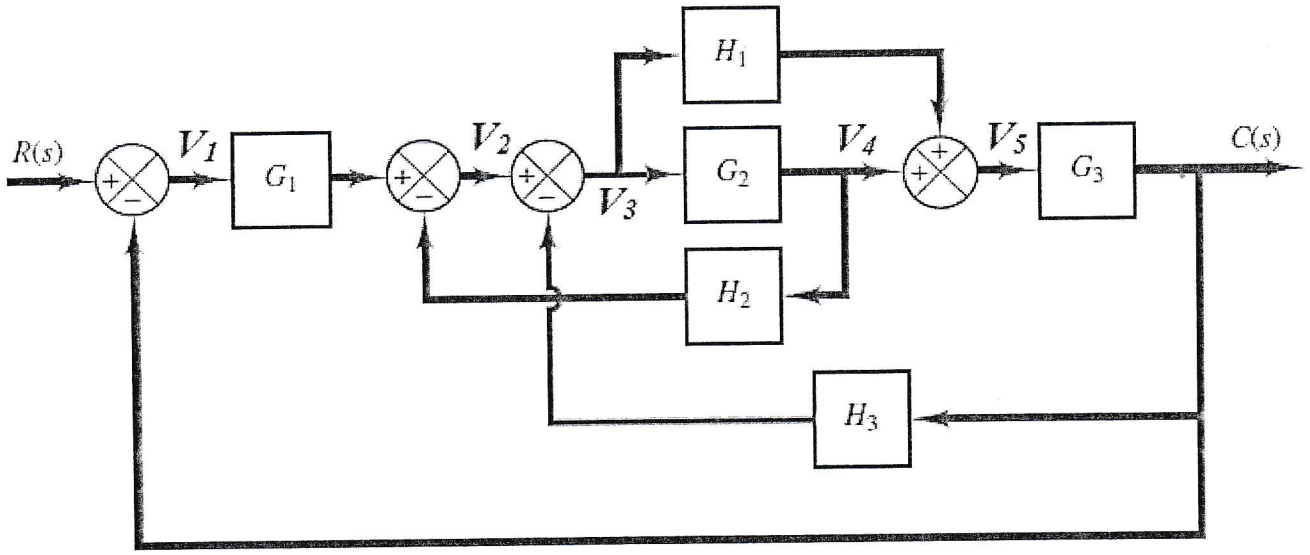

$$V_1 = R(s) - G'(s)$$

$$V_2 = G_1 V_1 - H_2 V_4$$

$$V_3 = V_2 - H_3 G'(s)$$

$$V_4 = G_2 V_3$$

$$V_5 = V_4 + H_1 V_3$$

$$G(s) = G_3 V_5$$

Faculty of Engineering	**Philadelphia University**	Mechanical Eng. Dep.
Course name: Automatic control	**Second Quiz**	Course number:620443 class(1)
Instructor: Eng. Laith Batarseh	**Sunday 3/12/2017**	Allowed time: 10 minutes

Student Name: **Student ID number:**

Problem: find the zeros and poles for the following transfer function:

$$G(s)=\frac{s(s+1)(s^2-4)}{s^2(s^2+s-6)(s-6)^2}$$

Solution :-

Zeros :- $-1, 2, -2, \pm\infty$

Poles : $0, 2, -3, 6, 6$

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other Form :

$$G(s)=\frac{(s^2+5s)(s^3-27)}{s^2(s^2+2s-8)(s-8)^2}=\frac{s(s+5)(s^3-27)}{s^2(s^2+2s-8)(s-8)^2}$$

Zeros :- $-5, 3, 3, 3, \pm\infty$

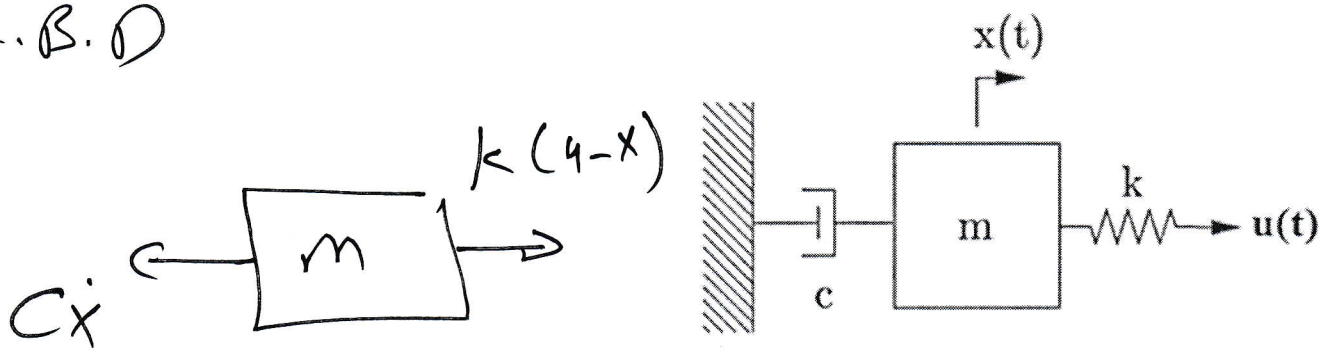
Poles : $0, 2, -4, 8, 8$.

Faculty of Engineering	**Philadelphia University**	Mechanical Eng. Dep.
Course name: Automatic control	**Third Quiz**	Course number:620443 class(1)
Instructor: Eng. Laith Batarseh	**Sunday 24/12/2017**	Allowed time: 10 minutes

Student Name: **Student ID number:**

Problem: Problem: consider the following mechanical system. Derive the transfer function X(s)/U(s). Assume u (t) > x (t)

F.B.D



$$\Sigma F = m\ddot{x} \Rightarrow m\ddot{x} = k(u-x) - C\dot{x}$$

$$\Rightarrow m\ddot{x} + C\dot{x} + kx = ku$$

Take Laplace with IC = 0

$$(ms^2)X(s) + (Cs)X(s) + (k)X(s) = (k)U(s)$$

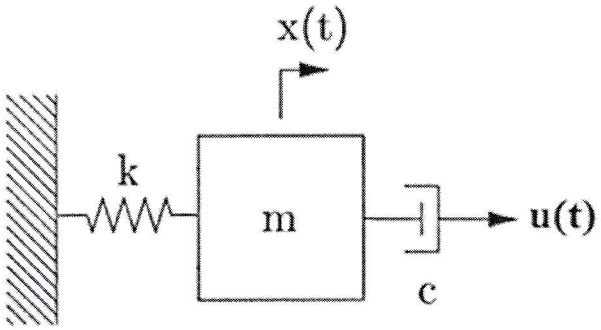
$$\frac{X(s)}{U(s)} = \frac{k}{ms^2 + Cs + k}$$

Faculty of Engineering	**Philadelphia University**	Mechanical Eng. Dep.
Course name: Automatic control	**Third Quiz**	Course number:620443 class(1)
Instructor: Eng. Laith Batarseh	**Sunday 24/12/2017**	Allowed time: 10 minutes

Student Name: **Student ID number:**

Problem: Problem: consider the following mechanical system. Derive the transfer function X(s)/U(s). Assume u (t) > x (t)

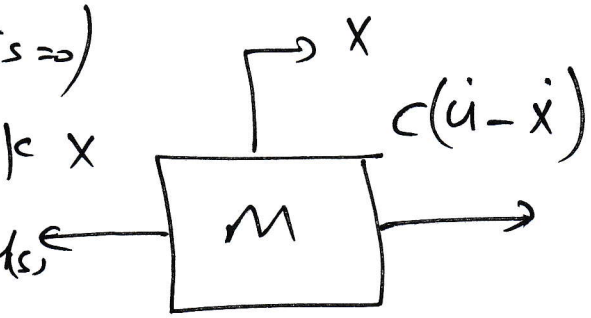
$\xrightarrow{+}\sum F = M\ddot{x}$



$M\ddot{x} = C\dot{u} - C\dot{x} - Kx$

$\Rightarrow M\ddot{x} + C\dot{x} + Kx = C\dot{u}$

take Laplace (assume I.C's = 0)



$Ms^2X(s) + CsX_s + KX(s) = CsU(s)$

$\Rightarrow X(s)[Ms^2 + Cs + K] = Cs\,U(s)$

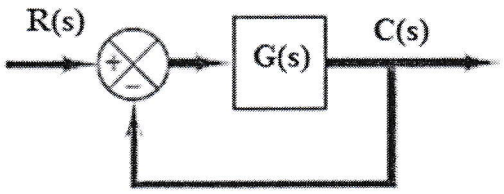
$$\frac{X(s)}{U(s)} = \frac{Cs}{Ms^2 + Cs + K}$$

Faculty of Engineering	**Philadelphia University**	Mechanical Eng. Dep.
Course name: Automatic control	**4th and 5th Quiz**	Course number:620443 class(1)
Instructor: Eng. Laith Batarseh	**Tuesday 9/1/2018**	Allowed time: 30 minutes

Student Name: **Student ID number:**

Problem 1: consider the following unity feedback system. find the steady state error

$$G(s)=\frac{1}{s^2+s+10} \text{ and } R(s)=\frac{10}{s^2}$$



Solution :-

this is Ramp input with $R = 10$

$$e_{ss} = \frac{R}{K_v} \; ; \; K_v = \lim_{s\to 0} s\,G(s) = \lim \frac{s}{s^2+s+10} = 0$$

$$\Rightarrow e_{ss} = \frac{10}{0} = \infty$$

Problem2: using Routh stability method, find if the following characteristic equation is stable or not. And if not, determine the number of roots in the right side of s-plane.

$$2S^4 - 2S^3 + 2S^2 + 2S + 2 = 0$$

one Change	S^4	2	2	2
2nd Change	S^3	-2	2	0
	S^2	4	2	0
	S^1	3	0	0
	S^0	2	0	0

1) This System is unstable because there are two Changes in Sign in the First Coulmn

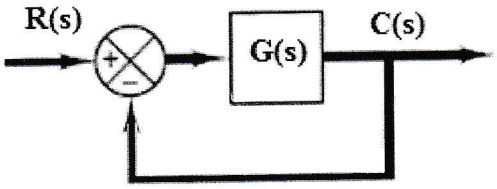
2) Because there are two Singn Changes, There are two Roots in the Right Side of S-Plane

Faculty of Engineering	**Philadelphia University**	Mechanical Eng. Dep.
Course name: Automatic control	**4th and 5th Quiz**	Course number:620443 class(1)
Instructor: Eng. Laith Batarseh	**Thursday 11/1/2018**	Allowed time: 20 minutes

Student Name: **Student ID number:**

Problem 1: consider the following unity feedback system. find the steady state error

$$G(s)=\frac{s(s+1)}{(s+10)(s+2)^2(s-5)} \text{ and } R(s)=\frac{4}{s^3}$$



for Parabolic:

$$e_{ss}=\frac{R}{K_a} \; ; \; K_a=\lim_{s\to 0} s^2 G(s)$$

$$K_a=\lim_{s\to 0}\frac{s^2\, s(s+1)}{(s+10)(s+2)^2(s-5)}=0$$

$$\Rightarrow e_{ss}=\frac{R}{0}=\infty$$

Problem2: using Routh stability method, find if the following characteristic equation is stable or not. And if not, determine the number of roots in the right side of s-plane.

$$7S^7 - 7S^6 + 7S^5 + 7S^4 + 7S^3 + 7S^2 - 7S + 7 = 0$$

①	S^7	7	7	7	-7
	S^6	-7	7	7	7
②	S^5	14			
	S^4	14			
	S^3	7			
③	S^2	21			
	S^1	-9.33			
④	S^0	7			

1) Unstable :- Sign Change

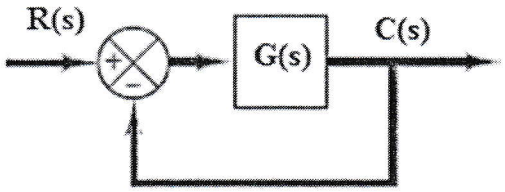
2) 4 Sign Changes ≡ 4 Roots.

Faculty of Engineering	**Philadelphia University**	Mechanical Eng. Dep.
Course name: Automatic control	**4th and 5th Quiz**	Course number:620443 class(1)
Instructor: Eng. Laith Batarseh	**Tuesday 9/1/2018**	Allowed time: 20 minutes

Student Name: **Student ID number:**

Problem 1: consider the following unity feedback system. find the steady state error

$G(s)=\frac{1}{s+10}$ and $R(s)=\frac{5}{s}$



Solution :-

Step input with $R=5$

$$e_{ss}=\frac{R}{1+K_p} \quad ; \quad K_p=\lim_{s\to 0} G(s)=\lim_{s\to 0}\frac{1}{s+10}=\frac{1}{10}$$

$$e_{ss}=\frac{5}{1+0.1}=\frac{5}{1.1}=4.55$$

Problem2: using Routh stability method, find if the following characteristic equation is stable or not. And if not, determine the number of roots in the right side of s-plane.

$$5S^4 - 5S^3 + 5S^2 + 5S + 5 = 0$$

S^4	5	5	5
S^3	-5	5	0
S^2	10	5	0
S^1	17.5=8		
S^0	5		

1) Unstable : Sign Change

2) two Sign changes = two Roots in Right side of S-Plane