Umm Al-Qura Univ.
College of Engineering & Islamic Arch.
Mechanical Engineering Dept.

Automatic Control (804465-3)
Mid-term Exam S1 1436-1437
Time Allowed 2.0 H

Student Name: Fahad Salem Altuwairqy
Student No.: 43103346
Group No.: 1

Question No. 1 Choose the correct answer for the following (**Show your work when Possible**)

1. A control system in which the control action is somehow dependent on the output is known as
(a) Closed loop system
(b) Semi-closed loop system
(c) Open system
(d) None of the above

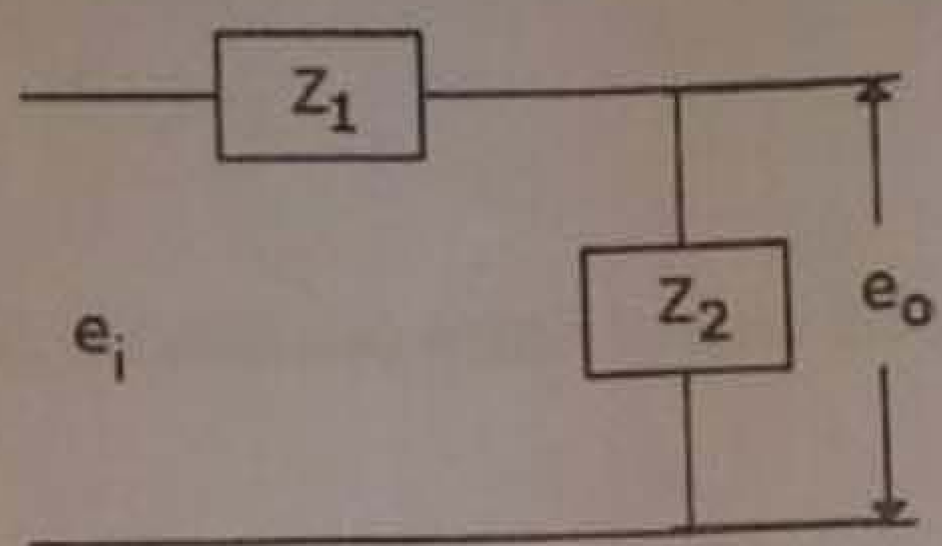
2. For the system of the given figure the transfer function $\frac{E_o(s)}{E_i(s)} =$

(a) $\frac{Z_2(s)}{Z_1(s)}$

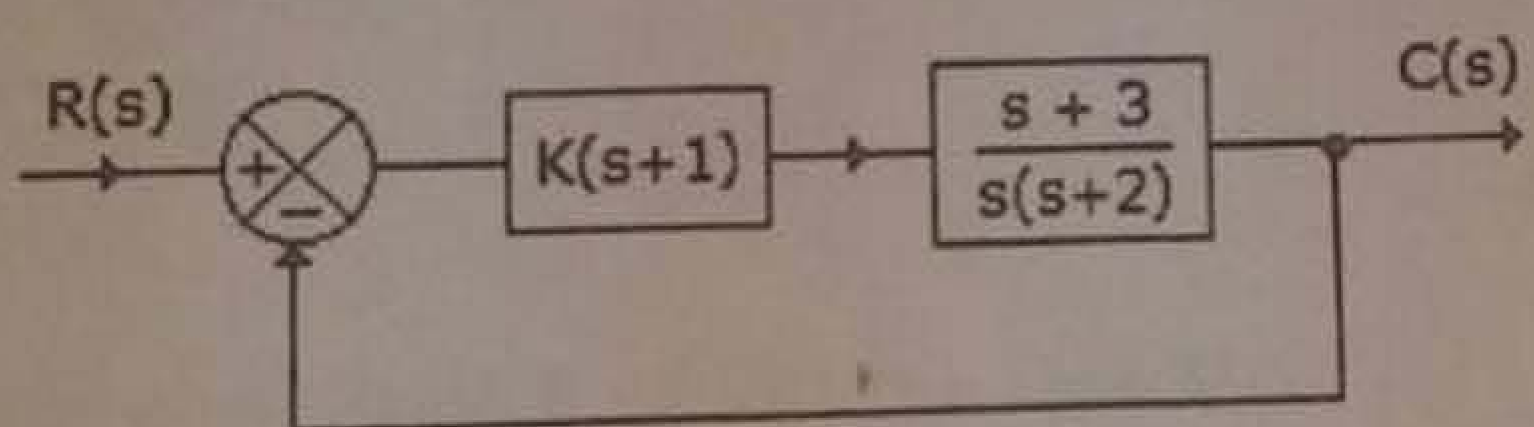
(b) $\frac{Z_2(s)}{Z_1(s) + Z_2(s)}$

(c) $\frac{Z_1(s)}{Z_2(s)}$

(d) $\frac{Z_1(s)}{Z_1(s) + Z_2(s)}$



3. For the system in the given figure the characteristic equation is



$\frac{C(s)}{R(s)} = (K(s+1))\left(\frac{s+3}{s(s+2)}\right)$

(a) $1 + \frac{K(s+1)(s+3)}{s(s+2)} = 0$

(b) $1 + \frac{K(s-1)(s-3)}{s(s-2)} = 0$

(c) $K(s+1)(s+3) = 0$

(d) $s(s+2) = 0$

4. The first column of a Routh array is

s^5	1
s^4	2
s^3	1.5
s^2	-1/3
s^1	10
s^0	2

How many roots of the corresponding characteristic equation are in left half s-pl

(a) 2
(b) 3
(c) 4
(d) 5

5. A signal other than the reference input that tends to affect the value of controlled known as

(a) disturbance
(b) command
(c) control element
(d) reference input

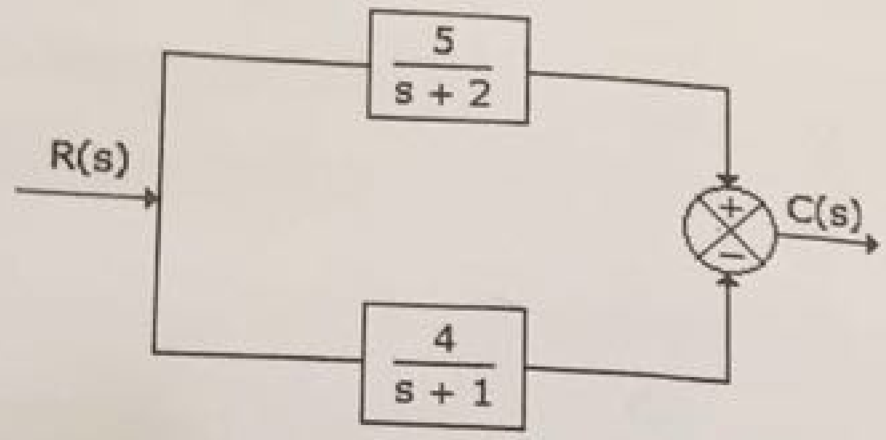
6. By which of the following the control action (actuator) is determined when a ma along a path ?

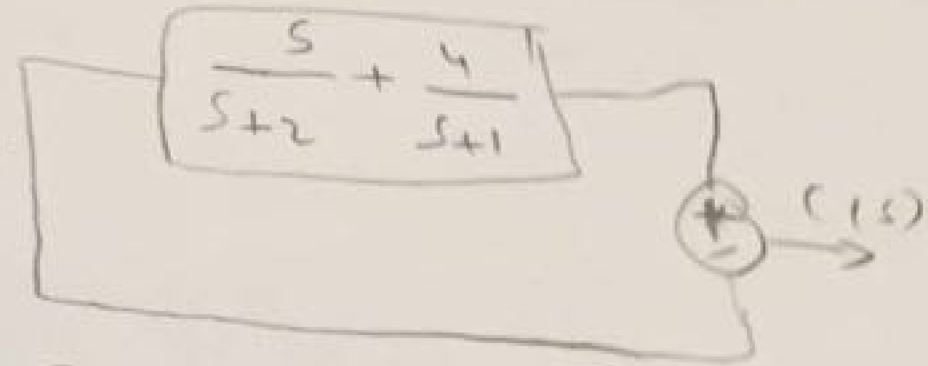
(a) Brain
(b) Hands
(c) Legs
(d) Eyes

7. Which of the following is the input to a controller ?

(a) Servo signal
(b) Desired variable value
(c) Error signal
(d) Sensed signal

8. The system of the given figure





(a) has two poles and one zero in left half plane

(b) has two poles and one zero in right half plane

(c) has two poles in left half plane and zero in right half plane

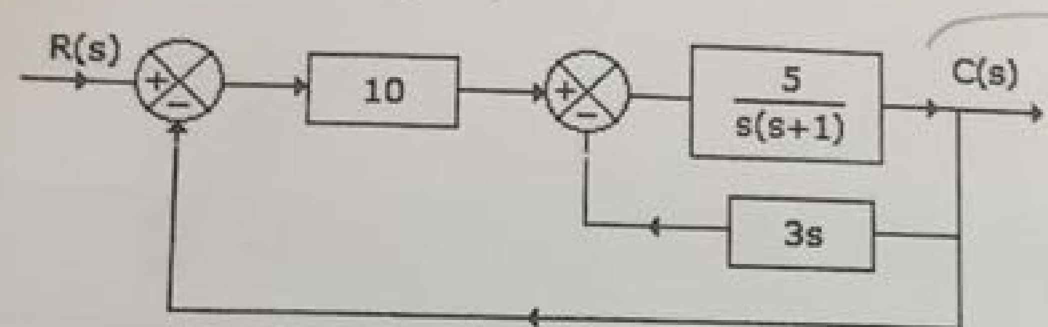
(d) none of the above

$\frac{\text{Zero}}{\text{Poles}} = \frac{5(s+1)+4(s+2)}{(s+2)(s+1)}$

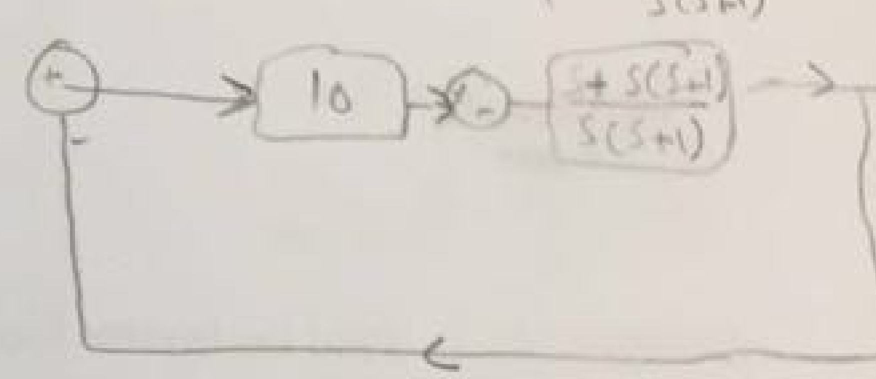
Zero = $-2, -1$

Poles $-2, -1$

9. For the given figure, $\frac{C(s)}{R(s)} =$



$\frac{3s}{1} + \frac{5}{s(s+1)}$



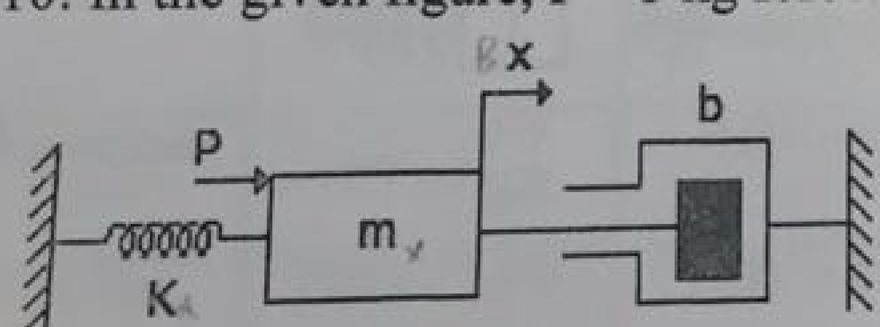
(a) $\frac{50}{s^2 + 50}$

(b) $\frac{50}{s^2 + 16s + 50}$

(c) $\frac{50}{s^2 + 4s + 50}$

(d) $\frac{50}{s^2 + 16s}$

10. In the given figure, P = 3 kg force. Then X(s) =

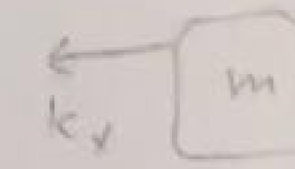


*mechanical system *

① free body digram

② $\Sigma f = ma$

③ T.F



(a) $\frac{3}{ms + b + K}$

(b) $\frac{3}{ms^2 + bs + K}$

(c) $\frac{3}{s(ms^2 + bs + K)}$

(d) $\frac{3}{s^2(ms^2 + bs + K)}$

$\Sigma F = ma$

$m\ddot{x} = -Kx - B\dot{x} + f($

$m\ddot{x} + B\dot{x} + Kx = f(t$

Laplace ?

X(s) 3

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Automatic Control (804465-3)
Mid-term Exam S2 1435-1436
Time Allowed 2.0 H

Student Name: Firas Aziz Alzubaidy
Student No.: 43003131
Group No.: 2

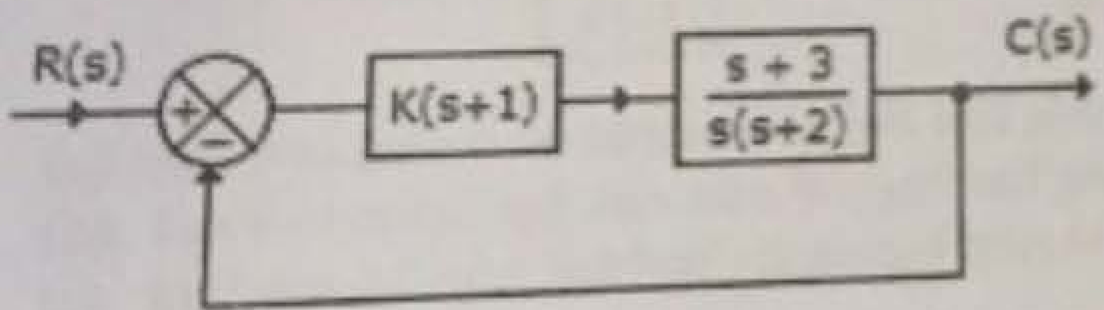
Question No. 1 (8 Marks) Choose the correct answer for the following (Show your work when Possible)

1. A control system in which the control action is somehow dependent on the output is known as
   (a) Closed loop system
   (b) Semi-closed loop system
   (c) Open system
   (d) None of the above

2. The initial response when the output is not equal to input is called
   (a) Transient response
   (b) Error response
   (c) Dynamic response
   (d) Either of the above

3 - The position and acceleration errors of a type-2 system are
   (a) constant, constant
   (b) constant, infinity
   (c) zero, constant
   (d) zero, zero

4. For the system in the given figure the characteristic equation is



(a) $1 + \frac{K(s+1)(s+3)}{s(s+2)} = 0$

(b) $1 + \frac{K(s-1)(s-3)}{s(s-2)} = 0$

(c) $K(s+1)(s+3) = 0$

(d) $s(s+2) = 0$

5. The first column of a Routh array is

s^5	1
s^4	2
s^3	1.5
s^2	-1/3
s^1	10
s^0	2

How many roots of the corresponding characteristic equation are in left half s-plane?

(a) 2 (b) 3

(c) 4 (d) 5

6. A signal other than the reference input that tends to affect the value of controlled variable is known as:

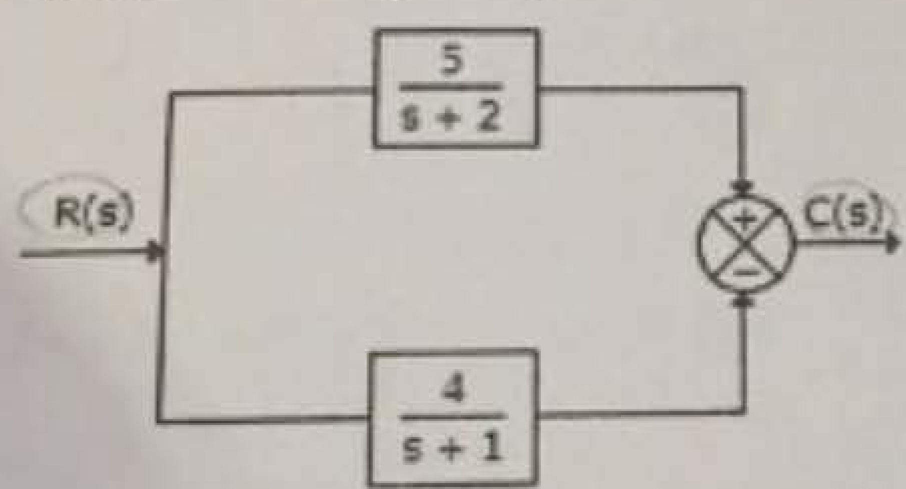
(a) disturbance

(b) command

(c) control element

(d) reference input

7. The system of the given figure



(a) has two poles and one zero in left half plane

(b) has two poles and one zero in right half plane

(c) has two poles in left half plane and zero in right half plane

(d) none of the above

8. If the open loop transfer function of a unity feedback system is $G(s) = \frac{1}{(s+2)^2}$, then the poles of the closed loop system are at

(a) -2, -2

(b) -2, -1

(c) $-2, \pm j\,1$

(d) -2, 2

Question No. $\boxed{4.2}$ A linear time-invariant system with input $r_1(t)$ and outputs $y_1(t)$ and $y_2(t)$ is described by the following set of differential equations. (30+15 Marks)

$$\frac{d^2y_1(t)}{dt^2}+2\frac{dy_1(t)}{dt}+3y_2(t)=r_1(t)$$

$$\frac{d^2y_2(t)}{dt^2}+3\frac{dy_1(t)}{dt}+y_1(t)-y_2(t)=\frac{dr_1(t)}{dt}$$

* Find the transfer function $Y_1(s)/R_1(s)$ using the block diagram method ?

1 (a) Zeros = $s+2=0 \Rightarrow \boxed{s=-2}$

Poles = $(s+3)^2=0$

(a) $(s+3)(s+3)=0 \Rightarrow \boxed{s=-3\,,-3}$

(b) $s+6 \Rightarrow \boxed{s=-6}$

(b) Time Response

$$y(t)=\lim_{s\to 0} \cancel{s}\, G(s)\, \frac{R}{\cancel{s}}$$

$$=\lim_{s\to 0} G(s)$$

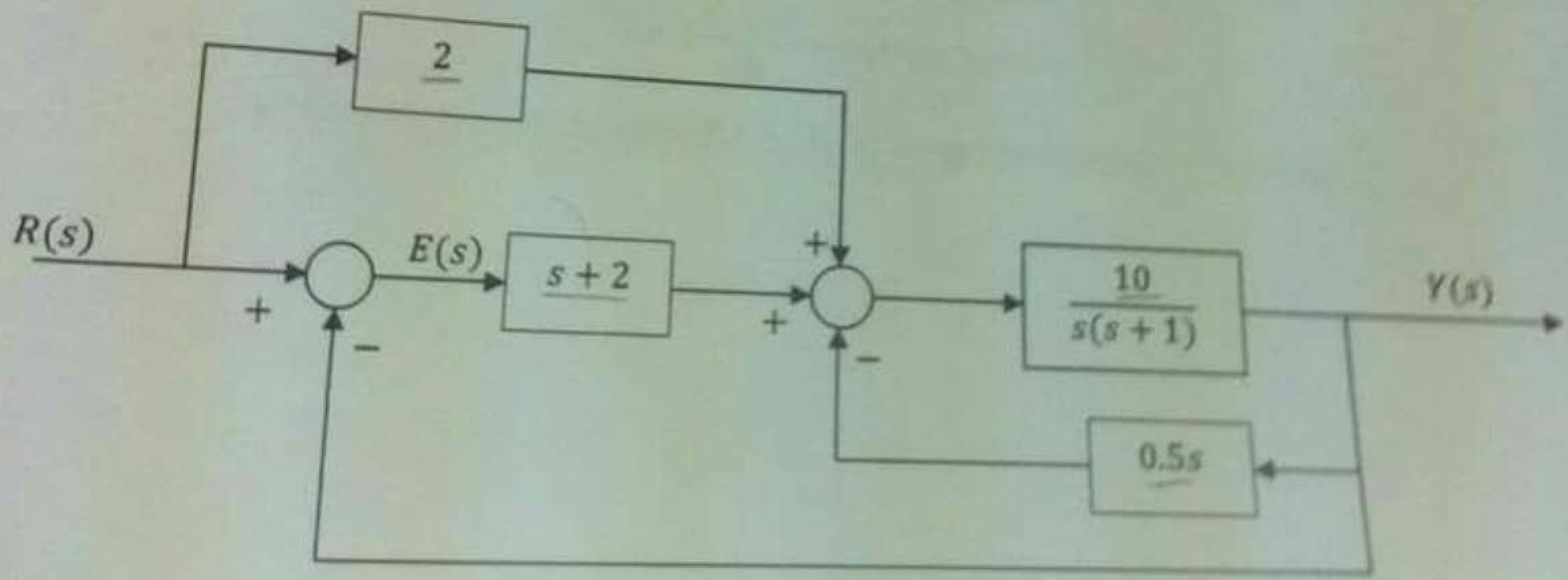
$$=G(0)$$

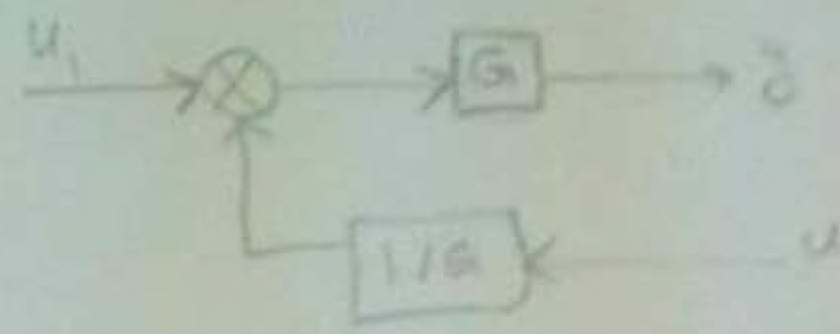
$$=\frac{0+2}{(0+3)^2(0+6)}=\frac{2}{(9)(6)}=\frac{2}{54}$$

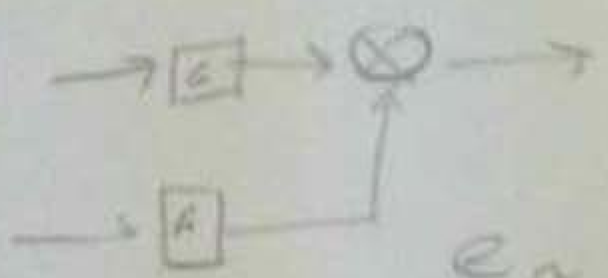
والله أعلم

CHOOSE ONLY ONE OF THE FOLLOWING QUESTIONS (4.1 or 4.2)

Question No. 4.1 The Block diagram of a feedback system is shown below. Find the following transfer function: $\frac{Y(s)}{R(s)}$ (30 Marks)







$e_n = G(u_1 - u_2)$

Sl. No.	Time Domain f(t)	S Domain F(s)
		$F(s) = \int_0^\infty e^{-st} f(t)dt$
1	Unit impulse $\delta(t)$	1
2	Unit step	$\frac{1}{s}$
3	t	$\frac{1}{s^2}$
4	t^n	$\frac{n!}{s^{n+1}}$
5	$f'(t)$	$sF(s) - f(0)$
6	$f''(t)$	$s^2F(s) - sf(0) - f'(0)$
7	e^{at}	$\frac{1}{s-a}; s > a$
8	$t^n e^{at}$	$\frac{n!}{(s-a)^{n+1}}$
9	$\sin at$	$\frac{a}{s^2+a^2}; s > 0$
10	$\cos at$	$\frac{s}{s^2+a^2}; s > 0$
11	$\sinh at$	$\frac{a}{s^2-a^2}; s > \lvert a \rvert$
12	$\cosh at$	$\frac{s}{s^2-a^2}; s > \lvert a \rvert$
13	$e^{at} \sin bt$	$\frac{b}{(s-a)^2+b^2}$
14	$e^{at} \cos bt$	$\frac{(s-a)}{(s-a)^2+b^2}$
15	$e^{at} \sinh bt$	$\frac{b}{(s-a)^2-b^2}$
16	$e^{at} \cosh bt$	$\frac{(s-a)}{(s-a)^2-b^2}$
17	n^{th} derivative	$s^nF(s) - s^{n-1}f(0) - s^{n-2}f'(0) \dots - f^{n-1}(0)$
18	$\int_0^t f(\tau)\, d\tau$	$\frac{1}{s}F(s)$
19	$\int_0^t f(t-\tau)g(\tau)d\tau$	$F(s)G(s)$
20	$f(at)$	$\frac{1}{a}F\left(\frac{s}{a}\right)$
21	$e^{at}f(t)$	$F(s-a)$
22	$\delta(t-a)$	$\frac{1}{s}e^{-as}$
23	$\frac{t^{n-1}}{(n-1)!}$	$\frac{1}{s^n}; n = 1,2,3,\dots$
24	$\frac{t^{n-1}}{(n-1)!}e^{at}$	$\frac{1}{(s+a)^n}; n = 1,2,3,\dots$
25	$\frac{1}{a^2}[1 - \cos at]$	$\frac{1}{s(s^2+a^2)^2}$
26	$e^{-at} \sin \omega t$	$\frac{\omega}{(s+a)^2+\omega^2}$

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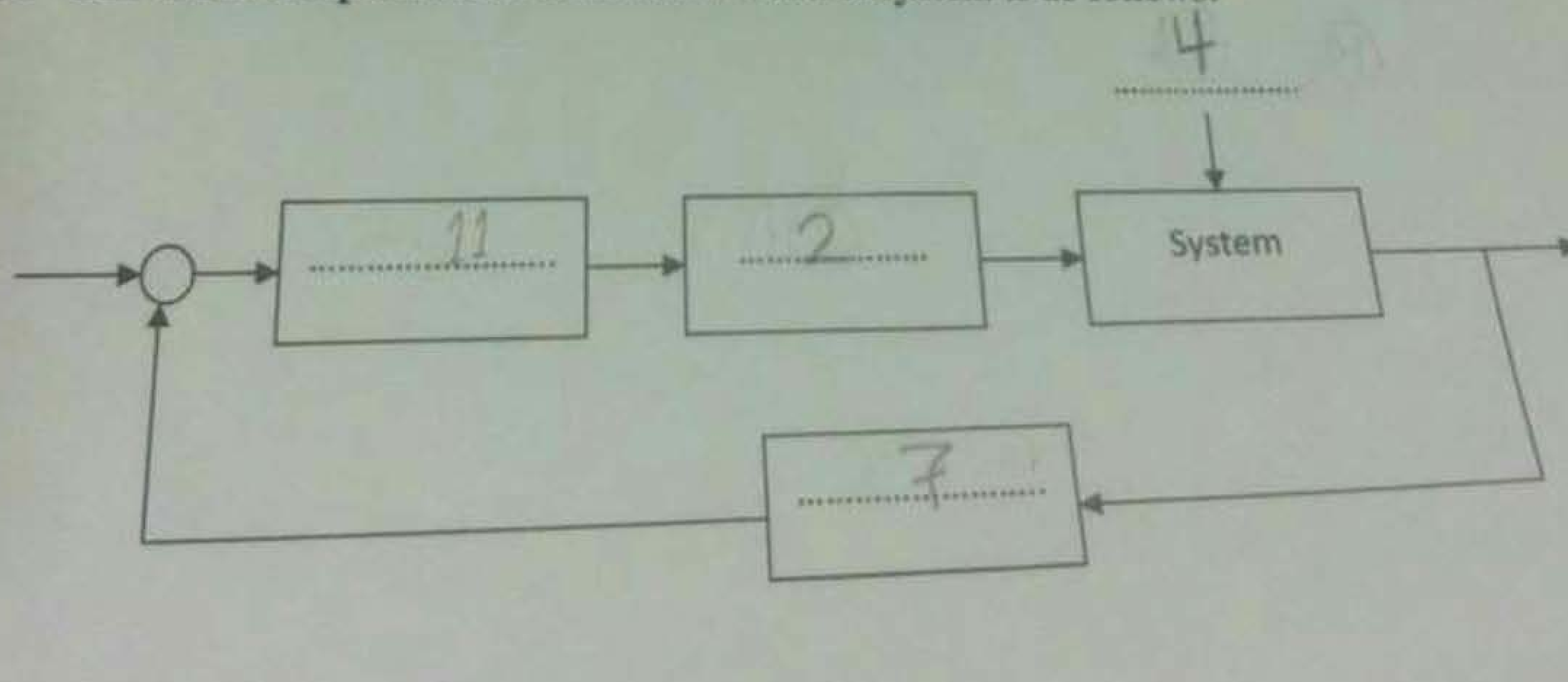
Automatic Control (804465-3)
Mid-term Exam 1434-1435
Time Allowed 2.0 H

Student Name: ....Firas Aziz Alzubaidy....
Student No.: ....43003131....
Group No.: ....

Question No. 1 Choose the correct **number** and write it down in the blanks below (30 Marks)
(Words can be used more than once, others may be ignored)

1	algebraic	5	more	9	Output	13	ordinary differential
2	actuator	6	analysis	10	Design	14	Input
3	feedback	7	sensor	11	Controller	15	Poles
4	disturbance	8	zeros	12	Less	16	System

1. Control is to make some object called ....16.... to behave as we desire.
2. Laplace is used to transform an ....13.... equation to an ....1.... equation.
3. A transfer function is defined by Laplace transform of system ....9.... divided by Laplace transform of the system ....14.... .
4. A model is used for the ....6.... and ....10.... of control systems.
5. Unstable systems have to be stabilized by ....3.... .
6. The more time delay is, the ....5.... difficult it is to control.
7. In control, ...8.... are the roots of the numerator.
8. In control, ...15.... are the roots of the denominator.
9. The main components of a feedback control system is as follows:



Question No. 3 For the following characteristic equations of feedback control systems, determine the range of K so that the system is stable. Find the frequency of oscillation if applicable. (20 Marks)

$$\boxed{s^3 + 20s^2 + 5s + 10K = 0}$$

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Mechanical Engineering Dept.

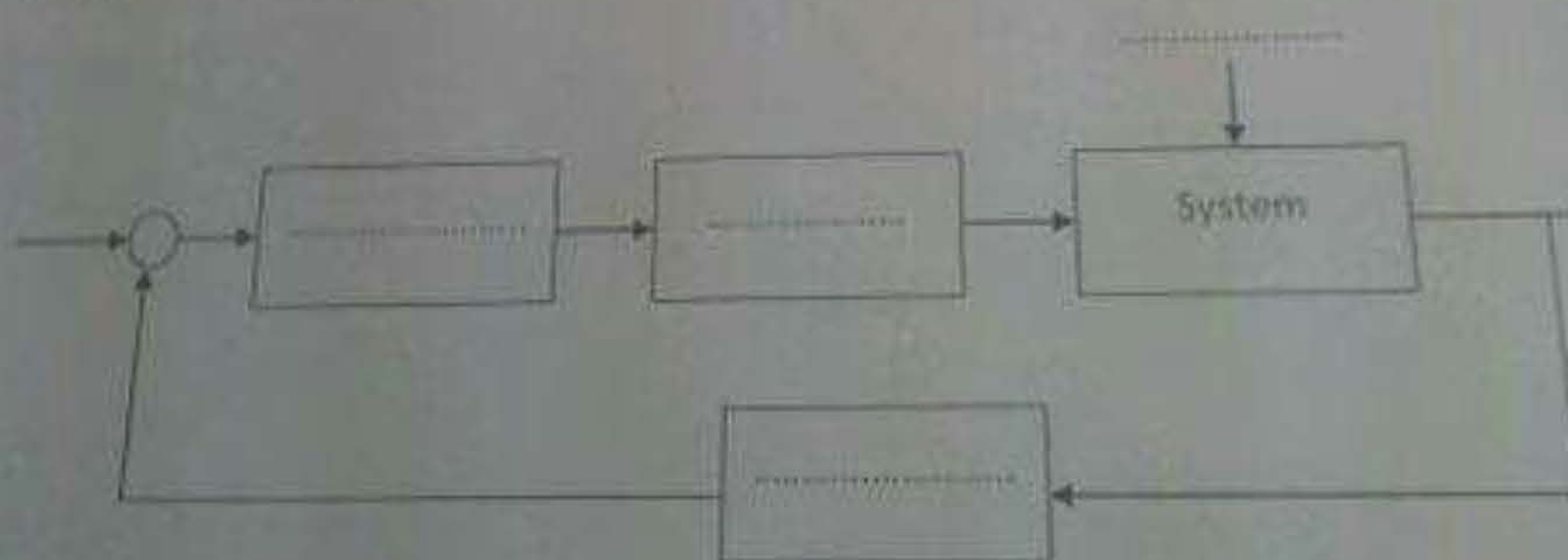
Automatic Control
Mid-term Exam I 1433-1434
Time Allowed 2.0 H

Student Name: Mazen Abdulrhman Ba Abdullah
Student No.: 42810227
Group No.: ....

Question No. 1 Choose the correct **number** and write it down in the blanks below (30 Marks
(Words can be used more than once, others may be ignored)

1	algebraic	2	less	3	input	4	system
5	analysis	6	actuator	7	controller	8	output
9	sensor	10	feedback	11	design	12	numerator
13	disturbance	14	denominator	15	more	16	ordinary differential

1. Control is to make some object called .... to behave as we desire.
2. Laplace is used to transform an .... equation to an .... equation.
3. A transfer function is defined by Laplace transform of system .... divided
   Laplace transform of the system ....
4. A model is used for the .... and .... of control systems.
5. Unstable systems have to be stabilized by ....
6. The more time delay is, the .... difficult it is to control.
7. In control, zeros are the roots of the ....
8. In control, poles are the roots of the ....
9. The main components of a feedback control system is as follows:



Question No. 2 **The following differential equation represents a linear time-invariant system, where $r(t)$ denotes the input and $y(t)$ denotes the output. (30 Marks)**

$$\ddot{y} + 12\dot{y} + 32y = \dot{r} + 5r$$

a) Find the transfer function $Y(s)/R(s)$.

b) If the input is a unit ramp function, obtain the solution $y(t)$ using the Laplace transform method. In other words, find the ramp response of the system.

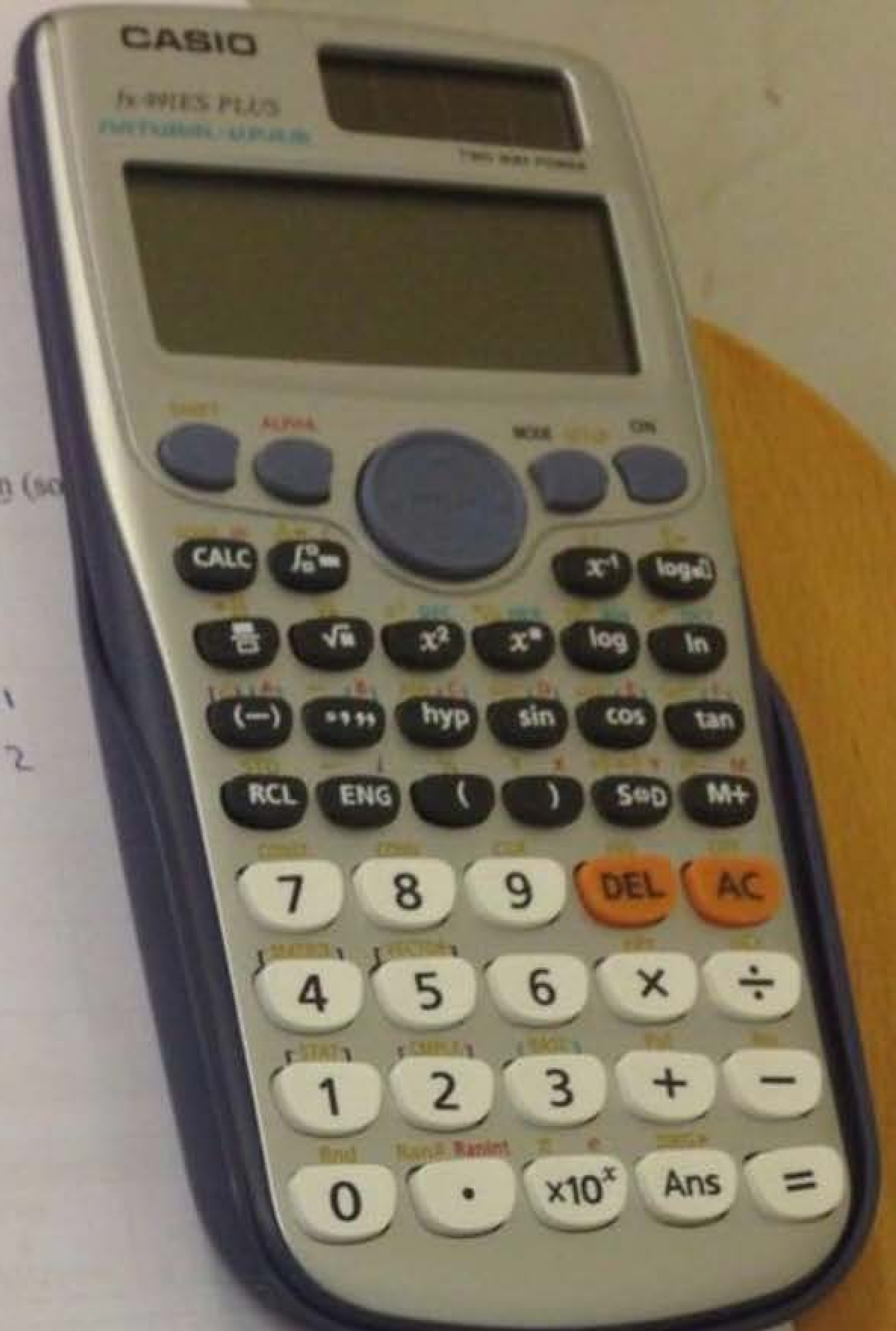
c) Using the transfer function in (a), find the steady-state error for a unit step input.

$\ddot{y} + 12\dot{y} + 32y = \dot{r} + 5r$

Question No. 4 Given the transfer function

$$G(s) = \frac{Y(s)}{U(s)} = \frac{4(s+1)}{s^2+3s+2}$$

a) What are the zeros of this transfer function?
b) What are the poles of this transfer function?
c) What is the partial fraction expansion of this transfer function?
d) What is the impulse response associated with this transfer function (so



a) zeros $\quad s+1=0 \Rightarrow \boxed{s=-1}$

b) Poles $\quad s^2+3s+2 \qquad a=1 \quad b=3 \quad c=2 \qquad -1 \quad -2$

$$\frac{-b \pm \sqrt{b^2-4ac}}{2a}$$

$$\frac{-3 \pm \sqrt{9-4(1)(2)}}{2(1)}$$

$$\therefore \boxed{s=-1} \quad \boxed{s=-2}$$

$$(s+1)(s+2)$$

$$\frac{A}{s} - \frac{B}{s+1} - \frac{C}{s+2}$$

$$A = \left.\frac{4(s+1)}{s^2+3s+2}\right|_{s=0} \quad 4/2 = 2$$

$$B = \left.\frac{4(s+1)}{s^2+3s+2}\right|_{s=-1} = 0$$

$$C = \left.\frac{4(s+1)}{s^2+3s+2}\right|_{-2} = \frac{-4}{-2}$$

Question No. 4 Given the transfer function

$$G(s) = \frac{Y(s)}{U(s)} = \frac{4(s+1)}{s^2+3s+2}$$

a) What are the zeros of this transfer function?
b) What are the poles of this transfer function?
c) What is the partial fraction expansion of this transfer function?
d) What is the impulse response associated with this transfer function (solve)?

(a) Zeros $= 4(s+1) = 0$

$\boxed{\text{Zero } s = -1}$

(b) Poles $= s^2 + 3s + 2 = 0$

$\boxed{\text{Poles} = -1}$

Question No. 2 Find the Laplace Transform of the following function

$$e^{2t}(sin2t + 5t - 2)$$

$$\left(\frac{2}{s^2+4} + \frac{1}{s^2} - \frac{2}{s} \right)$$

Question No. 3 Find the Inverse Laplace Transform of the following function

$$\frac{s+1}{s^2+4}$$

Find transfer Funcition

$$G(s) = \frac{C(s)}{R(s)} = \frac{(s+2)}{(s+3)^2(s+6)}$$

1. Where are the Poles and zeros
2. Determine the time response For a unit step input

$$s^4 + 2s^3 + 15s^2 + 20s + K = 0$$

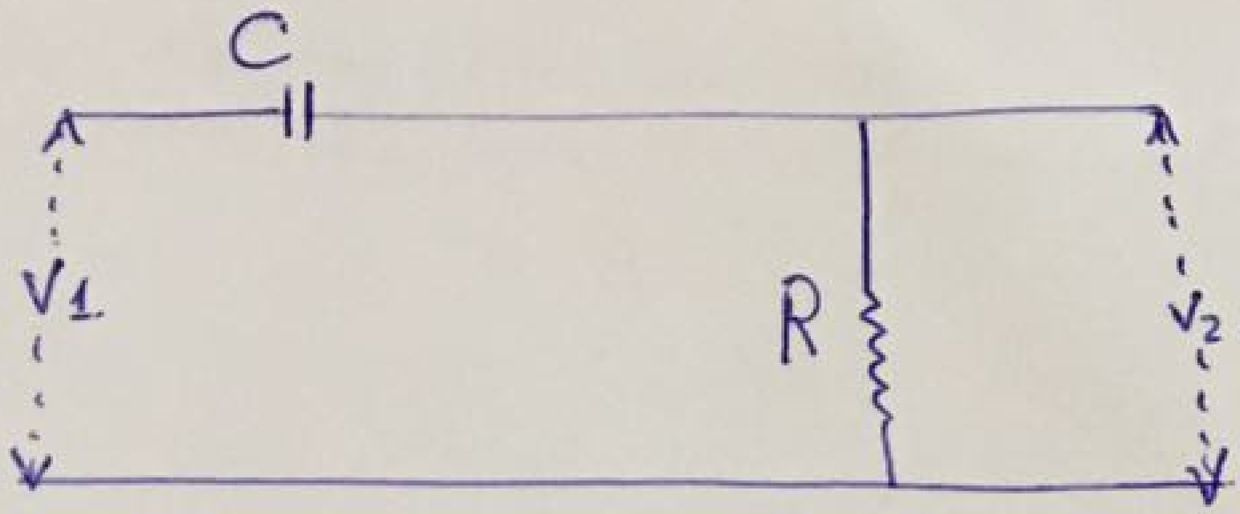
Determine the range of K so that the system in Marginaly stable

$$s^3 + 20s^2 + 5s + 10K = 0$$

" " " K " " " " stable

system

(1) For Following circut Find transfer Function From $V_1(s)$ to $V_2(s)$.

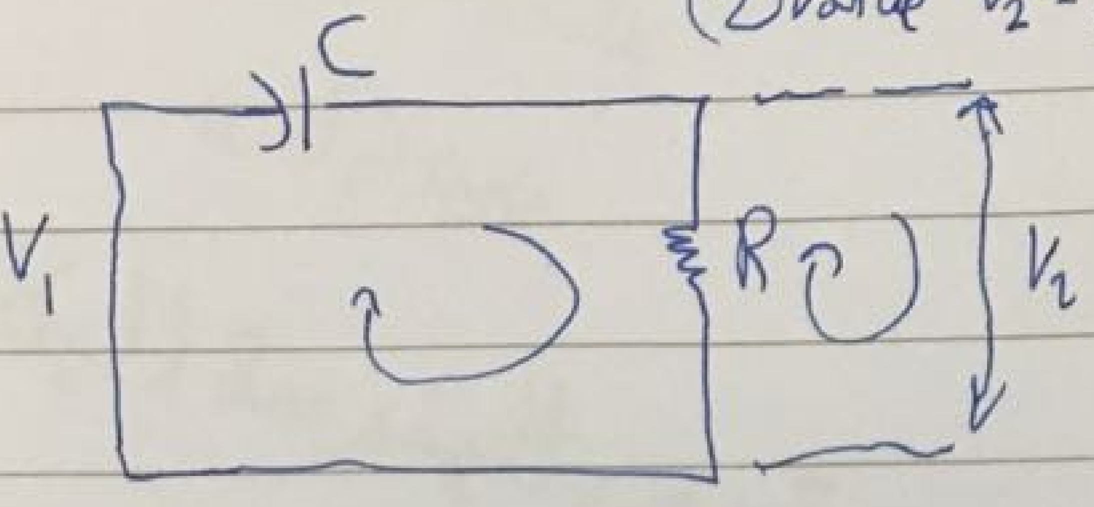


$\underbrace{V_1(t) = 10}_{\text{معطى في السؤال}} \Rightarrow V_1(s) = \frac{10}{s}$

التاريخ / / ١٤

① TF = ??

② value V_2 = ??



using Kirchoff law

$$V_1(s) = \frac{1}{Cs} + R$$

$$V_2(s) = R \qquad ① \therefore TF = \frac{V_2(s)}{V_1(s)} = \frac{R}{\frac{1}{Cs} + R}$$

$$= \frac{RCs}{1 + RCs}$$

$$\text{For } V_1(s) = \frac{10}{s} \Rightarrow V_2(s) = \frac{RC\cancel{s}}{1 + RCs} * \frac{10}{\cancel{s}}$$

$$= \frac{RC(10)}{1 + RCs}$$

②

$$\lim_{s \to 0} sV_2(s) = \frac{s\,RC10}{1 + RCs}$$

$$= \frac{0}{1 + 0} = \underline{\underline{0}}$$

Consider the closed loop system given by

(a) Determine the values ζ and ω_n that the system responds to a step input with approximately 16% overshoot and with a settling time 2 sec (assuming a respones within 5% of the steady state value) $P_o = 0.05$ Write the T.F of the system

(b) Find the steady-state error the T.F found in (a) for a unit step input

$$\boxed{\frac{\omega_n^2}{s^2 + 2\zeta\omega_n s + \omega_n^2}}$$

→ Feed Back تحيا ع و

$\lim_{s \to 0} s\, Y_{(s)}$

سؤال

$\ddot{y} + 12\dot{y} + 32y = \dot{r} + 5r$

$\frac{Y}{R} = ??$

$s^2 Y_{(s)} + 12 s Y_{(s)} + 32 Y_{(s)} = s R_{(s)} + 5 R_{(s)}$

$Y_{(s)} (s^2 + 12s + 32) = R_{(s)} (s + 5)$

$\frac{Y}{R} = \frac{s+5}{\ldots}$

If input = unit r...

$R_{(s)} =$

⑤ Root locus

$$G(s) = \frac{(2s+12)}{2s(s+3)}$$

فقرة يطلب فيها Final Value

الله يوفقكم ولا تنسوني من الدعاء

أخوكم/ عبدالله الطويرقي