



**Course Title: Control Systems**  
**Course No: (610414+620443+640344)**  
**Lecturer: Dr. Mohammed Mahdi**

**Date: 2/6/2024**  
**Time allowed: 2 hours**  
**No. of Pages: 6**

Q1 / 10	Q2 / 10	Q3 / 10	Q4 / 10	Total / 40

**Question 1:** **(10 Marks)**

**Objectives: Multiple choices about control systems concepts.**

1. PID effect is used in:
 

A) Existing of oscillation	B) Existing of steady state error
C) Existing of low speed response	D) All of the given choices
2. Given the characteristics equation  $1+G(s) = s^3 + s^2 + 2s + 24 = 0$ . The number of unstable roots are:
 

A) 1	B) 2
C) 3	D) None of the given
3. The system characteristics equation of  $1 + k \frac{1}{s(s+1)(s+5)}$  has the breakaway point on x-axis at:
 

A) - 3.527	B) - 0.472
C) - 2.5486	D) None of the given
4. For the system  $\frac{C(s)}{R(s)} = \frac{0.5}{(s^2+6s+9)}$  the settling time  $t_s(2\%)$  sec. equals:
 

A) 0.115	B) 1.15
C) 11.5	D) None of the given
5. Given  $\frac{Y(s)}{R(s)} = \frac{5}{s^2+2s+25}$  then for unit step input:
 

A) $Y(0) = 0.2, Y(\infty) = 0$	B) $Y(0) = 0.2, Y(\infty) = \infty$
C) $Y(0) = 0, Y(\infty) = 0.2$	D) None of the given

## Question 2:

**(10 Marks)**

**Objectives:** This question is about calculating time response specifications and PID controller.

Given transfer function:  $\frac{C(s)}{R(s)} = \frac{25}{s^2 + 5s + 25}$  It is required to calculate:

1. Kind of step response using **two methods**. (4 Ms).
2. Calculate **rising time**, **peak time**, ( $M_p\%$ ), and **settling time (5%)**. (4 Ms).
3. Which of the **PID controller combination** is better to use for unit step change in input?

**Why?** (2 Ms).

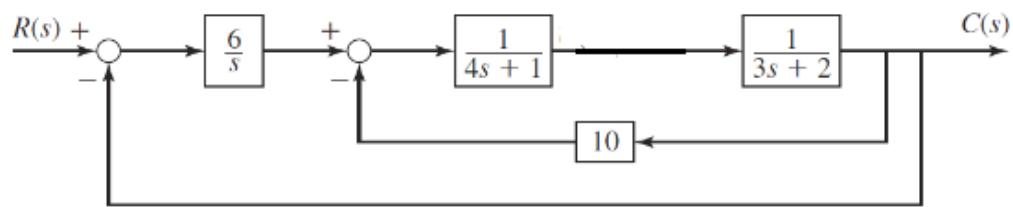
**Question 3:**

**(10 Marks)**

**Objectives: This question is about 1<sup>st</sup> order system response and Mason's Gain formula.**

A) Given transfer function of first order control systems  $\frac{Y(s)}{R(s)} = \frac{1}{s+2}$  It is required to **directly find** its unit impulse and unit step responses. **(5 Marks)**

B) Given the following block diagram, apply Mason's Gain Formula to find transfer function  $C(s) / R(s)$ . (5 Marks)



**Question 4:**

**(10 Marks)**

**Objectives: This question is about absolute stability and Root Locus.**

A) For the following characteristics equation, apply **Routh-Herwitz criterion to find the range of the gain k for stability.** (5 Marks)

$$s^4 + 3s^3 + 4s^2 + s + k = 0$$

B) Given:  $1 + k \frac{(s+1)}{s(s+2)(s+4)(s+6)} = 0$  it is required to calculate **the first three steps of root locus.** (5 Marks)

