INTERNATIONAL UNIVERSITY OF EAST AFRICA

'Learning to Succeed'

**FACULTY OF ENGINEERING**

**END OF SEMESTER EXAMINATIONS - APRIL 2025**

**PROGRAMME: BACHELOR OF ELECTRICAL AND CONTROL ENGINEERING**

**YEAR/SEM: YEAR 3/SEMESTER 2**

**COURSE CODE: ELE3212**

**NAME: CONTROL SYSTEMS I**

**DATE: 2025-04-17**

**TIME: 2:00-5:00PM**

**INSTRUCTIONS TO CANDIDATES:**

1. Read the instructions very carefully
2. The time allowed for this examination is STRICTLY three hours
3. Read each question carefully before you attempt and allocate your time equally between all the Sections
4. Write clearly and legibly. Illegible handwriting cannot be marked
5. Number the questions you have attempted
6. Use of appropriate workplace examples to illustrate your answers will earn you bonus marks
7. Any examination malpractice detected will lead to automatic disqualification.

**DO NOT WRITE ANYTHING ON THE QUESTION PAPER**

## Section A CHOOSE ANY TWO QUESTIONS FROM THIS SECTION

**Question 1:**

**Total: 25 Marks**

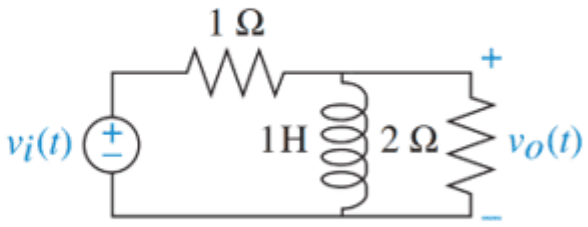
For the transfer function shown below, find the locations of the poles and ***Marks]***, and then write an expression for the general form of the step res inverse Laplace transform ***[15 Marks]***. State the nature of each response underdamped, and so on).

$$T(s) = \frac{5}{(s+3)(s+6)}$$

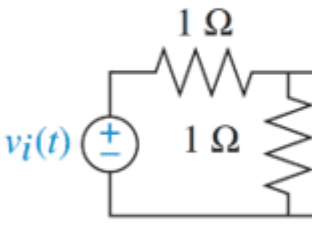
**Question 2:**

**Total: 25 Marks**

Find the transfer function, $G(s) = V_o(s)/V_i(s)$, for each network **(a) [12**




(a)

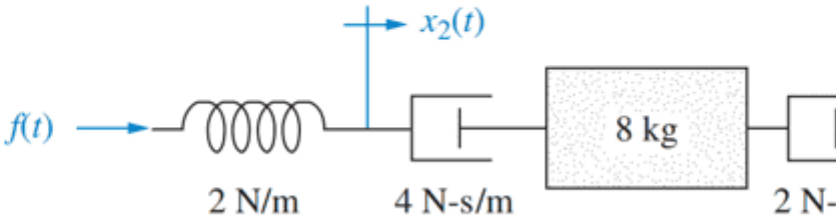



(b)

**Question 3:**

**Total: 25 Marks**

Find the transfer function, $G(s) = X_2(s)/F(s)$, for the translational me (Hint: place a zero mass at $\boldsymbol{x}_2(\boldsymbol{t})$.)




**Question 4:**

**Total: 25 Marks**

1) Name the performance specification for first-order systems. ***[2 M***
2) What does the performance specification for a first-order system
3) In a system with an input and an output, what poles generate the
4) In a system with an input and an output, what poles generate the
5) The imaginary part of a pole generates what part of a response? *[*
6) The real part of a pole generates what part of a response? ***[2 Ma***
7) What is the difference between the natural frequency and the dar oscillation? ***[4 Marks]***
8) If a pole is moved with a constant imaginary part, what will the re common? ***[2 Marks]***
9) If a pole is moved with a constant real part, what will the respons
10) What pole locations characterize (a) the underdamped system, (b system, and (b) the critically damped system? ***[3 Marks]***
11) Name two conditions under which the response generated by a p

## Section B CHOOSE ANY TWO QUESTIONS FROM THIS SECTION

**Question 1:**

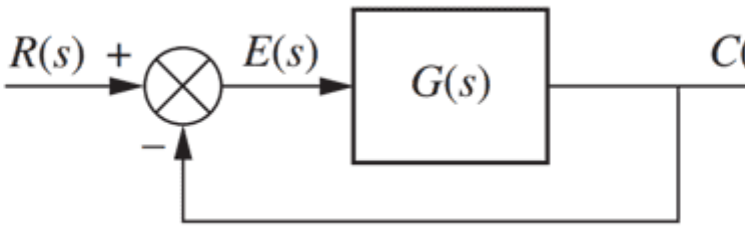
**Total: 25 Marks**

1) Name two sources of steady-state errors. ***[2 Marks]***
2) A position control, tracking with a constant difference in velocity position error in the steady state? ***[4 Marks]***
3) Name the test inputs used to evaluate steady-state error. ***[3 Ma***
4) How many integrations in the forward path are required in orde steady-state error for each of the test inputs listed in **3)** above? *[*
5) Increasing system gain has what effect upon the steady-state erro
6) For a step input, the steady-state error is approximately the reci constant if what condition holds true? ***[2 Marks]***
7) What is the exact relationship between the static error constant errors for ramp and parabolic inputs? ***[4 Marks]***
8) What information is contained in the specification $K_p = 10000$?

**Question 2:**

## Total: 25 Marks

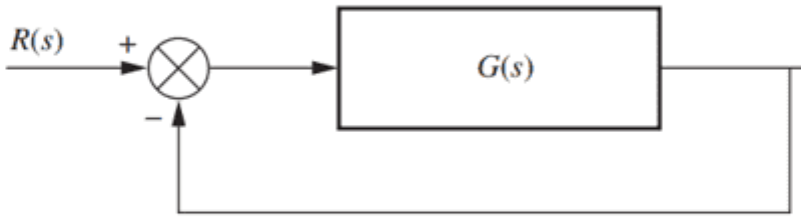
For the unity feedback system shown in the figure below, where $G(s)$
steady-state errors for the following test inputs: $\mathbf{25}u(t)$; $\mathbf{37}tu(t)$; $\mathbf{47}$




**Question 3:**

## Total: 25 Marks

Sketch the root locus for the unity feedback system shown in the figure b
functions:




a) $G(s) = \dfrac{K(s+2)(s+6)}{s^2+8s+25}$

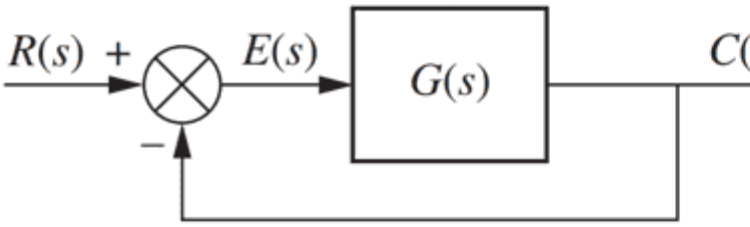
b) $G(s) = \dfrac{K}{(s+1)^3(s+4)}$

**Question 4:**

**Total: 25 Marks**

For the unity feedback system shown in the figure below, where $G(s) =$

Given $\%OS = e^{-\left(\frac{\zeta\pi}{\sqrt{1-\zeta^2}}\right)} \times 100$ ; $T_s = \frac{4}{\zeta\omega_n}$




a) what is the expected percent overshoot for a unit step input? ***[5 Marks]***
b) What is the settling time for a unit step input? ***[5 Marks]***
c) What is the steady-state error for an input of $5u(t)$? ***[5 Marks]***
d) What is the steady-state error for an input of $5tu(t)$? ***[5 Marks]***
e) What is the steady-state error for an input of $5t^2u(t)$? ***[5 Mark***