SRM Institute of Science and Technology
College of Engineering and Technology
Department of Electronics and Communication Engineering

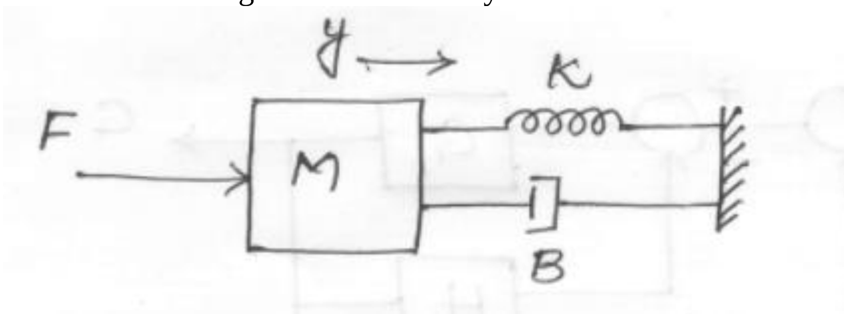
Subject code: 18ECS201T Semester: III
Subject Name: Control Systems Year: II

QUESTION BANK
UNIT 1

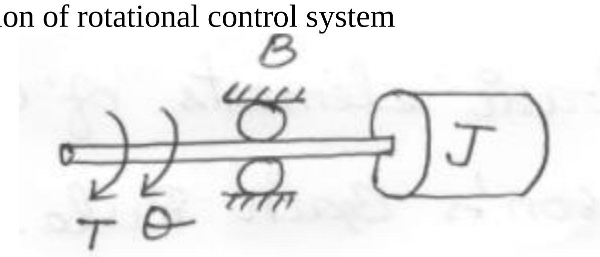
CO1: Determine Transfer function of a system by mathematical modeling, block diagram reduction and signal flow graphs

Part B questions (4 marks)

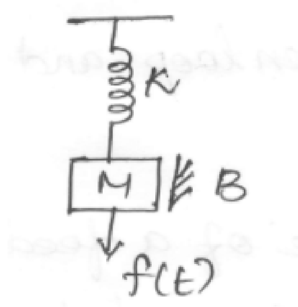
1. Distinguish between open loop and closed loop systems
2. What are the advantages and disadvantages of closed loop system?
3. Find the transfer function of the given mechanical systems



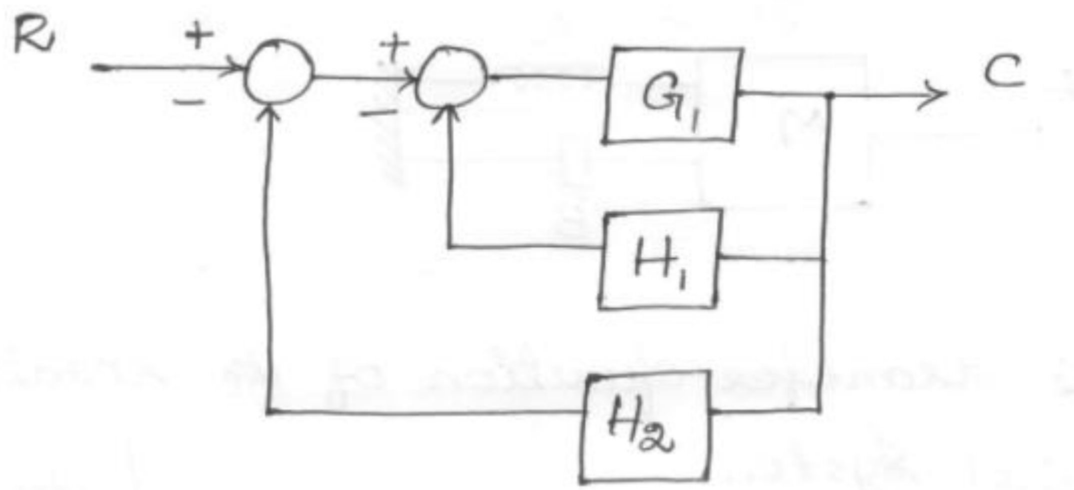
4. Find the transfer function of rotational control system



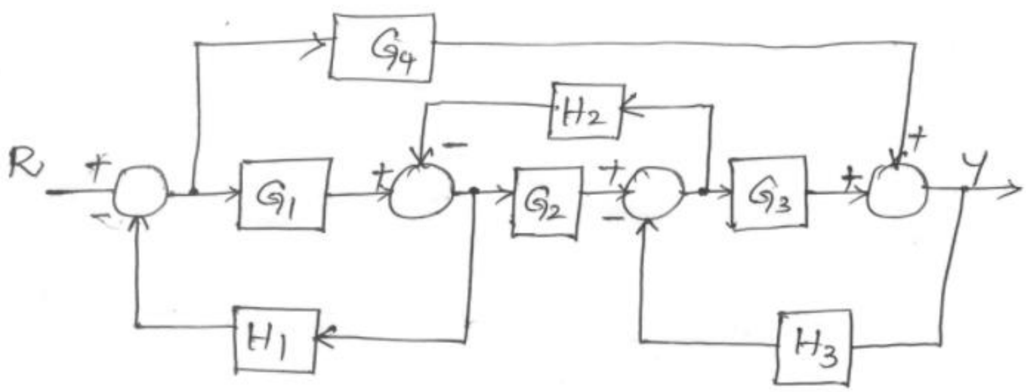
5. List the analogous quantities in Force Voltage Analogy and Current Analogy.
6. List the analogous quantities in Torque Voltage Analogy and Torque Current Analogy.
7. List out the block diagram reduction rules.
8. Write the differential equations governing the mechanical system shown in the figure. Draw the force voltage and force current electrical analogous circuits



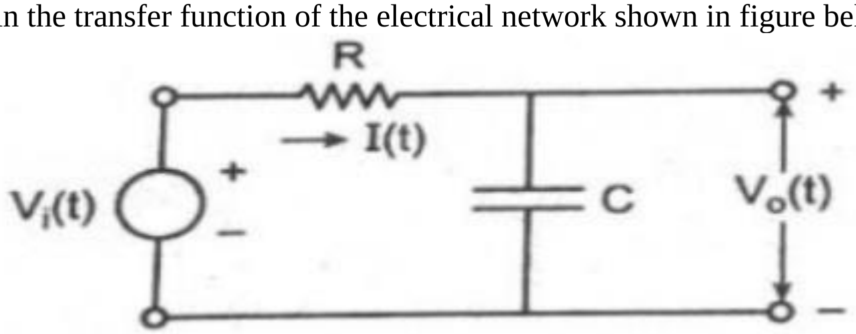
9. Find the overall transfer function of the system using block diagram reduction method



10. Mention the basic elements of signal flow graph
11. What is signal flow graph? Write the Mason's Gain rule
12. Convert the given block diagram into signal flow graph



13. Obtain the transfer function of the electrical network shown in figure below



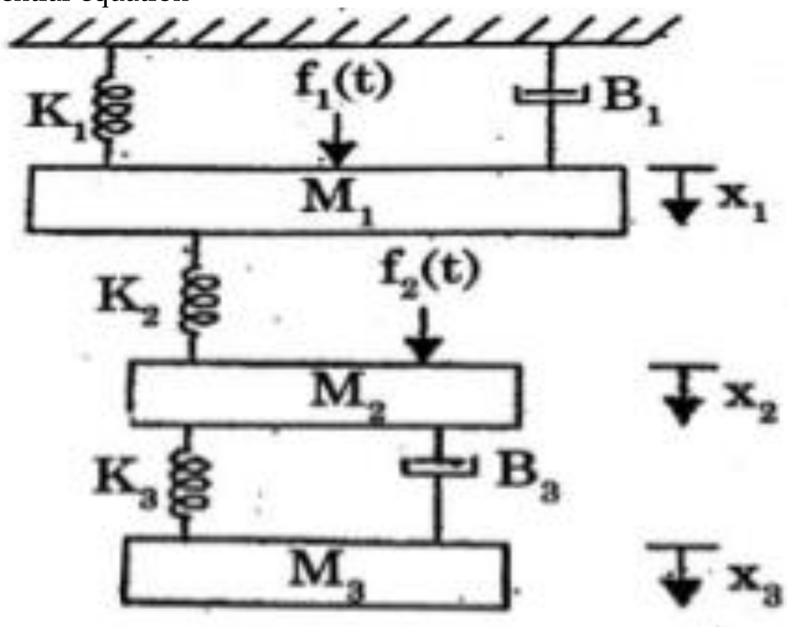
14. Construct the signal flow graph for set of equations shown below

$$X_2 = X_1 - X_4$$

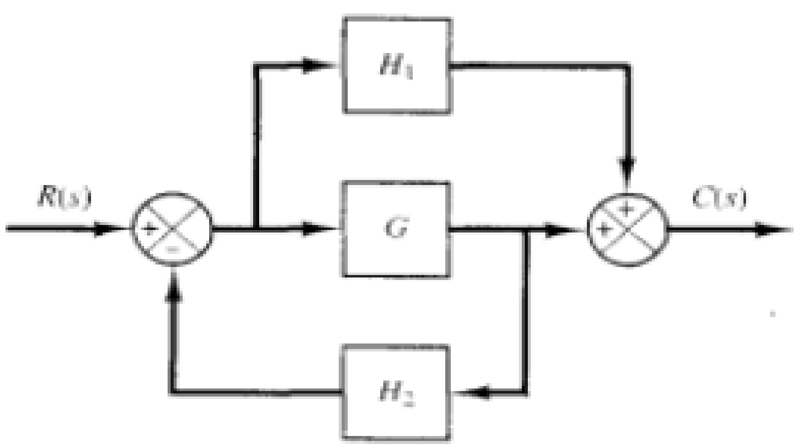
$$X_3 = G_1X_2 - H_2X_4\,; \quad X_4 = G_2X_3$$

15. Write down the block diagram reduction rules
    a) moving summing point after the block
    b) moving branch point before the block

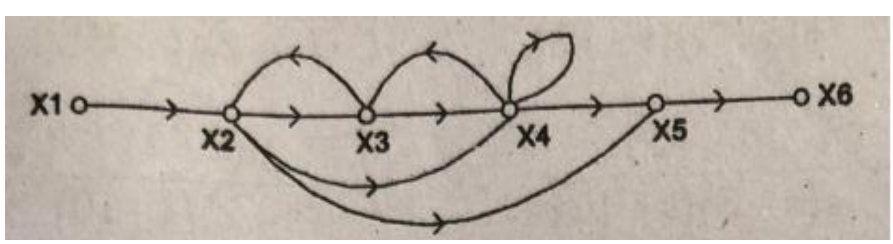
16. For the given Mechanical translational system, draw the free body diagram and write down the differential equation



17. Using the block diagram reduction technique, derive the transfer function of the system given below

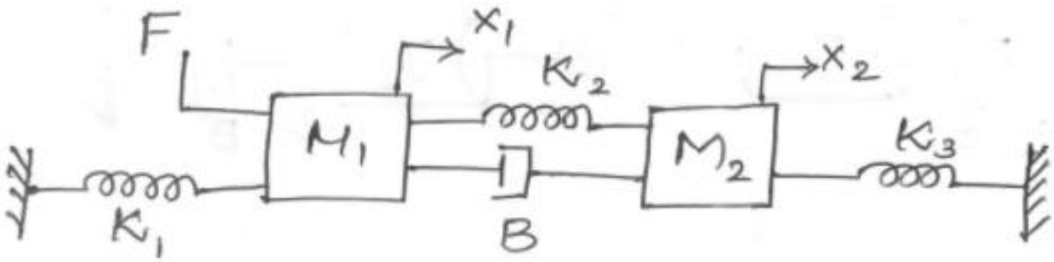


18. Find the Δ value for the signal flow graph given below

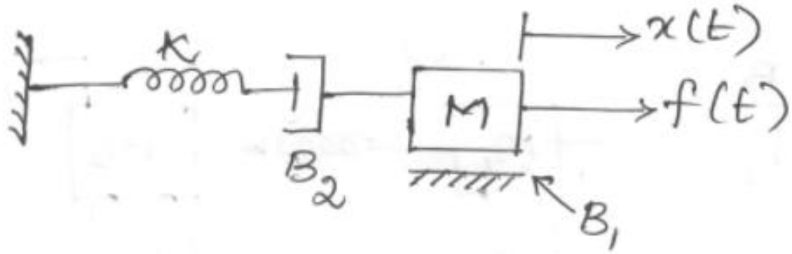


Part C questions (12 marks)

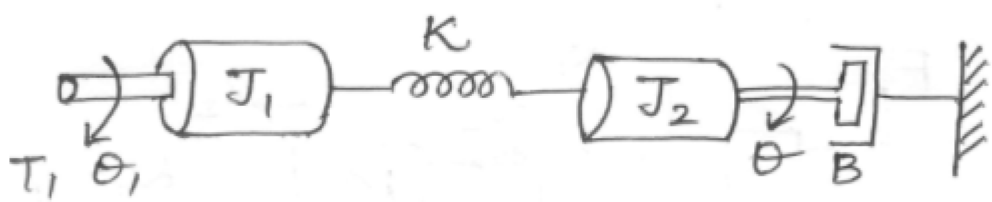
1. Find the transfer function of the given mechanical system



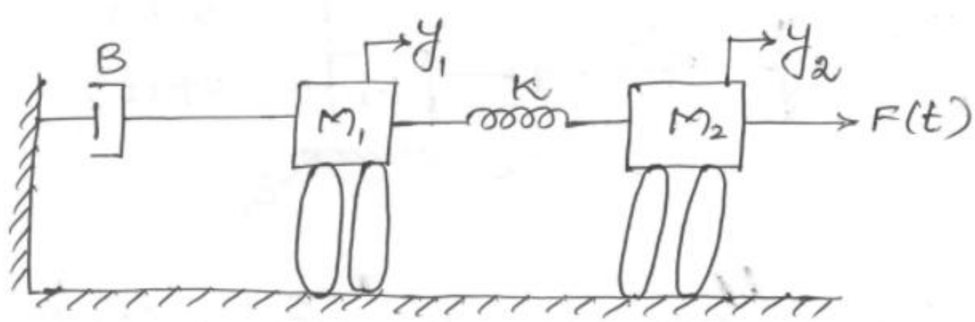
2. Write the equations of motion in S-domain for the system shown in figure. Determine the transfer function of the system



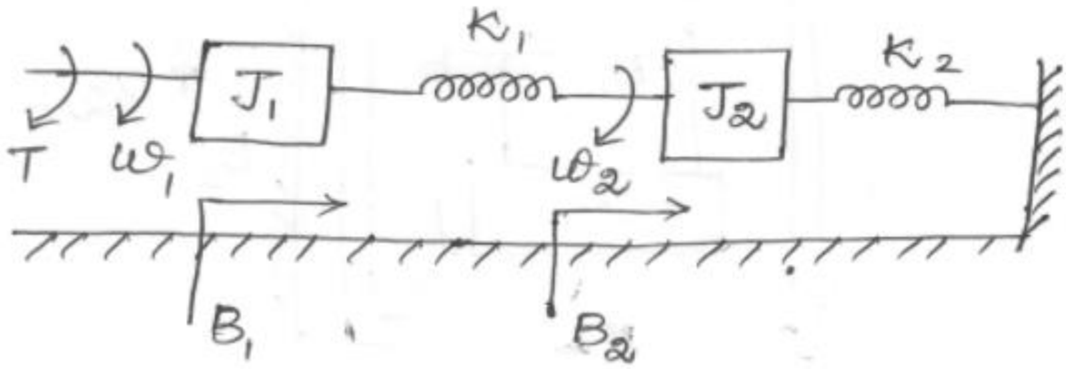
3. Write the differential equations governing the mechanical system shown in the figure. Obtain the transfer function of the systems θ (s) / T(s)



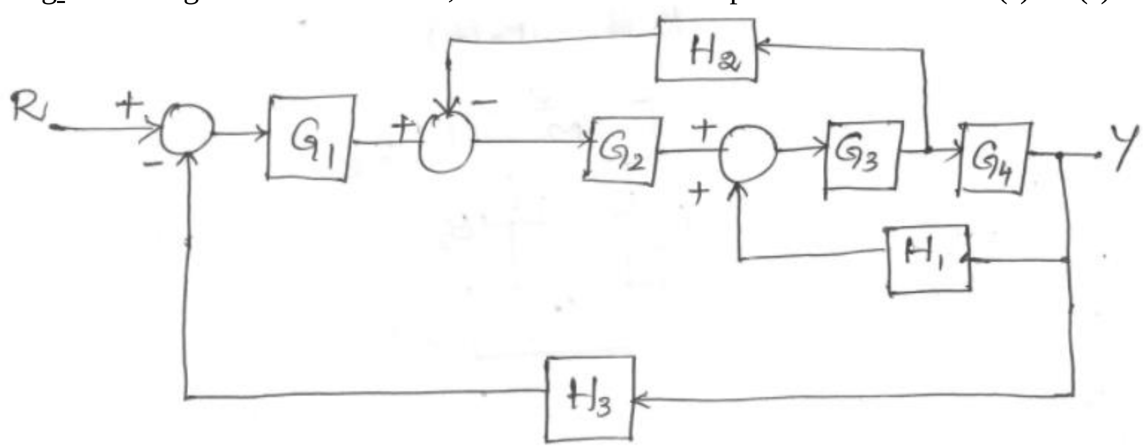
4. Write the differential equations governing the mechanical system shown in the figure. Draw the Force-voltage and Force-current electrical analogous circuits



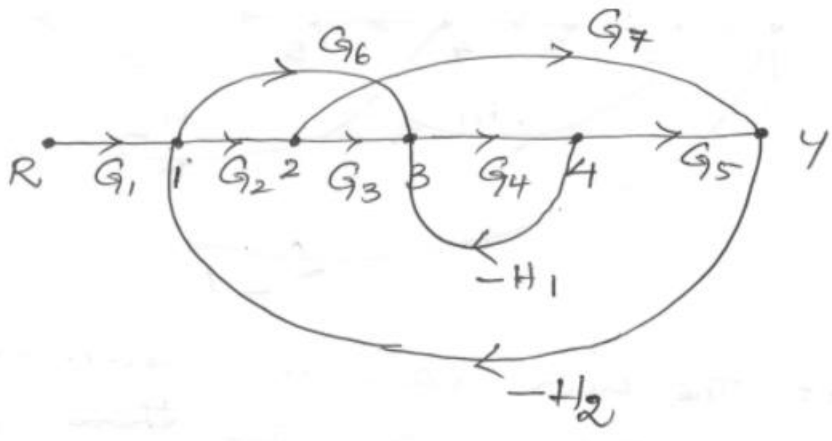
5. Write the differential equations governing the mechanical system shown in the figure. Draw the Torque-voltage and Torque-current electrical analogous circuits.



6. Using block diagram reduction rules, obtain the closed loop transfer function Y(s) / R(s)



7. Consider the signal flow graph model of a feedback system shown in figure. Obtain the closed loop transfer function Y(s)/R(s) using Mason's gain formula



8. The system described by the following set of algebraic equations

$$X_2 = G_{12}X_1 + G_{32}X_3 + G_{42}X_4 + G_{52}X_5$$

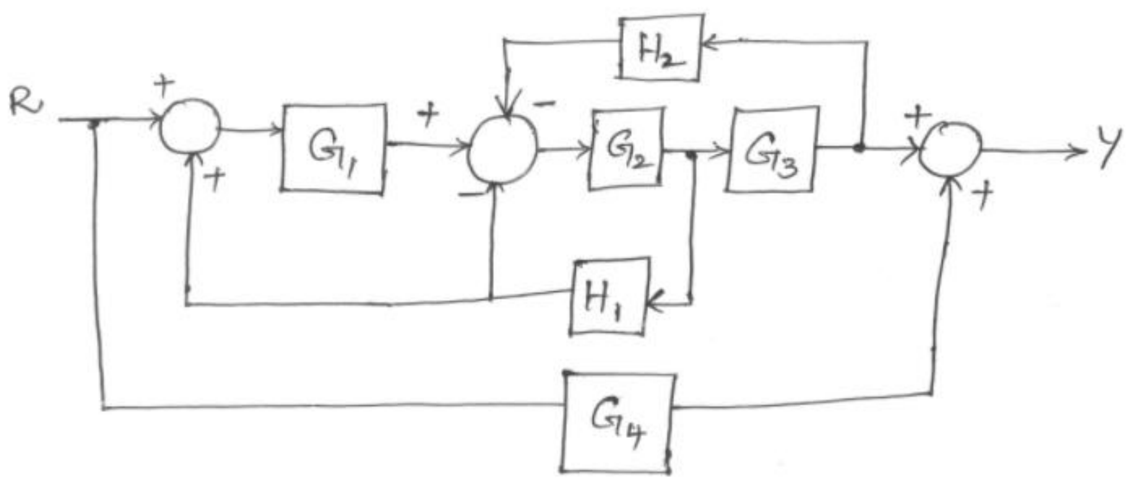
$$X_3 = G_{23}X_2$$

$$X_4 = G_{34}X_3 + G_{44}X_4$$

$$X_5 = G_{35}X_3 + G_{45}X_4$$

Draw the signal flow graph for this system and find the overall gain of the system using Mason’s gain formula

9. Convert the given block diagram into signal flow graph and obtain the overall transfer function using Mason’s gain rule



UNIT II

CO2: Identify the standard test inputs, time domain specifications and calculate steady state error

Part B questions (4 marks)

1. Derive the static error constants for step and parabolic inputs to a system.
2. Derive the expression for unit ramp response of a standard first order system
3. The open loop transfer function of a system with unity feedback is given by

$$G(s) = \frac{K(s+2)}{s^2(s^2+7s+12)}$$

For a unit step signal applied to the system determine the static error constants and steady state error

4. The open loop transfer function of a system with unity feedback is given by

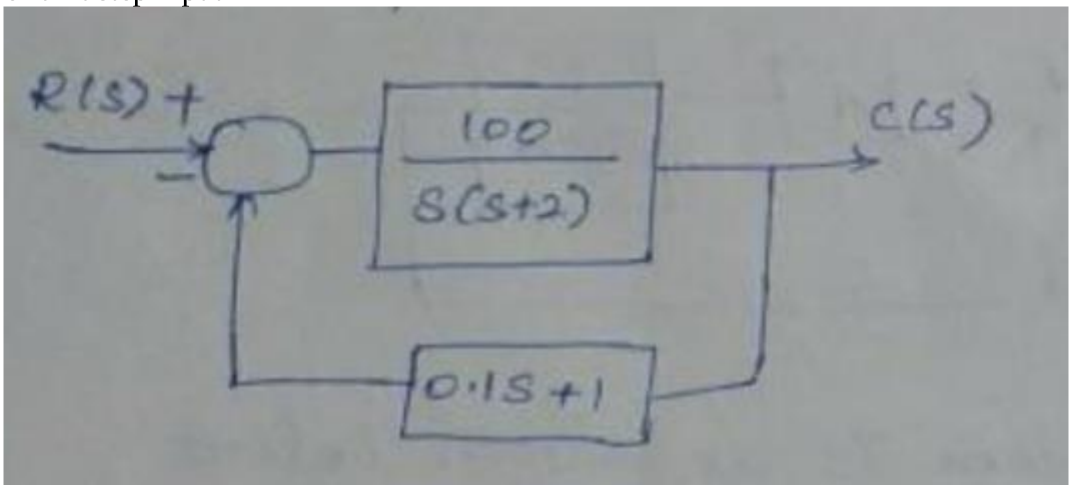
$$G(s) = \frac{1}{(s+2)(s+3)}$$

Determine the type of system and calculate constant steady state error.

5. Measurements conducted on a servo mechanism shows the system response to be $c(t) = 1+0.2e^{-60t} - 1.2e^{-10t}$ when subjected to a unit step input. Obtain the expression for closed loop transfer function.
6. Define settling time and rise time of a control system with its expression.
7. Obtain the response of unity feedback system whose open loop transfer function $G(s) = \frac{4}{s(s+5)}$ when input is step signal.
8. Obtain the unit impulse response of the system having $\frac{C(S)}{R(S)} = \frac{1}{(s^2+0.2s+1)}$
9. Define damping ratio. How the system is classified depending on it?
10. What are static error constants? Define steady state error
11. Give the characteristic equation of standard first order and second order systems
12. For the following differential equation $2\frac{d^2y}{dt^2} + 4\frac{dy}{dt}+8y=0$, determine the damping ratio
13. For a second order system with natural frequency of oscillation as 5 rad/sec and damping ratio =0.4. Determine Maximum peak overshoot.
14. Calculate static error constants for $G(s) = \frac{10}{s(0.1s+1)}$

Part C questions (12 marks)

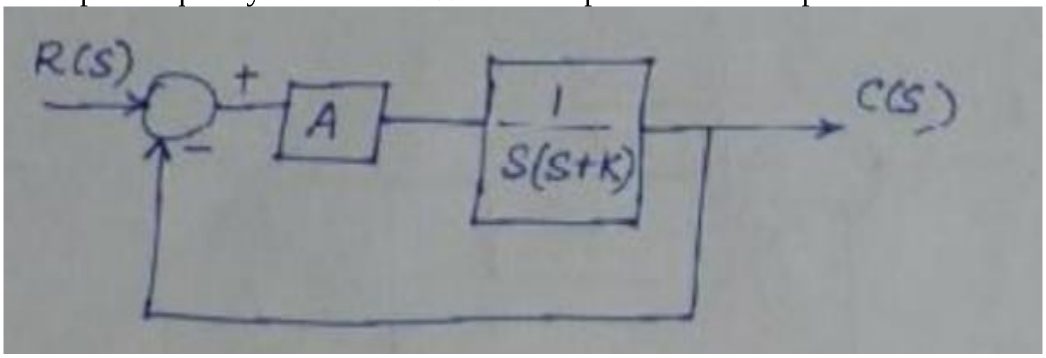
1. A positional control system with velocity feedback shown in figure. What is the response of the system for unit step input



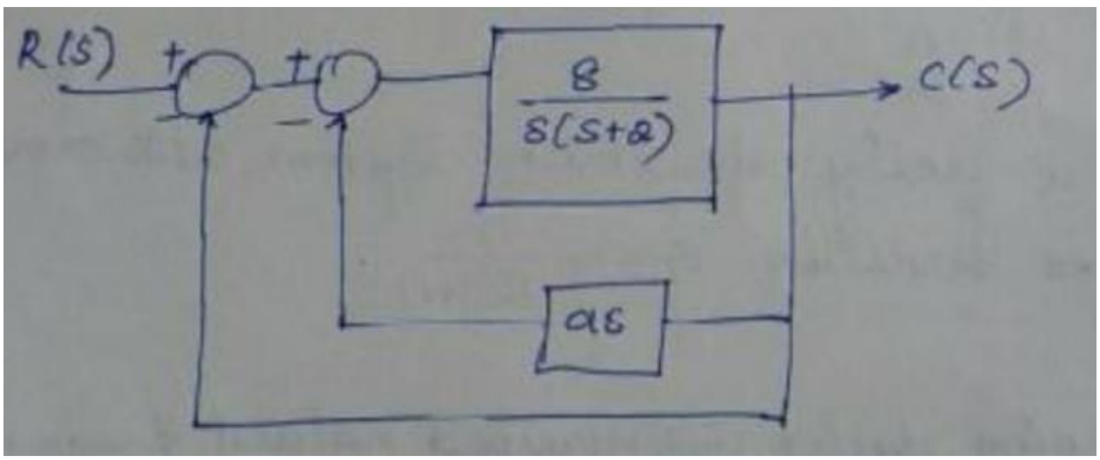
2. Obtain the response of unity feedback system whose open loop transfer function $G(s) = \frac{4}{s(s+5)}$ and input signal is unit step.
3. For a unity feedback system with overall transfer function $G(s) = \frac{1}{s(s+1)}$.

   Find a) damping factor b)Undamped natural frequency c)peak time d)Maximum overshoot and e)settling time.

4. A step of 2 volt is applied to unity feedback system given, find A and K so that damping factor= 0.6 and damped frequency is 8 rad/sec. What is the peak value of response?



5. A system is as shown below. Find a) damping factor and damped frequency b) value of ‘a’ when ζ =0.7 c) Find M_p in both cases



6. A unity feedback system has G(s) = $\dfrac{K(s+2)}{s^2(s+2)(s+5)}$.

Find a) Type of the system b) Error constants c)steady state error for unit step, ramp, parabolic inputs

7. Find static error constants for G(s) = $\dfrac{10}{s(s+1)}$ and unity feedback. Also find steady state error for r(t)= 1+t

8. Find generalized error constants for G(s) = $\dfrac{10}{s(s+1)}$ and unity feedback. Also find steady state error for r(t)= 1+t

9. Find generalized error constants for G(s) = $\dfrac{10(s+2)}{s^2(s+1)}$ and unity feedback. Also find steady state error for R(s)= $\dfrac{2}{s} - \dfrac{2}{s^2} + \dfrac{1}{3s^3}$

10) Derive the time domain response of first order system for unit step, unit ramp, unit impulse inputs.

11) Derive the time domain response of underdamped second order system for unit step input.

12) Derive the time domain response of critically damped second order system for unit step input.

13) Derive the time domain response of over damped second order system for unit step input.

Unit III

CO3: Plot a root locus curve and analyze the system stability using Routh array

Part B questions (4 marks)

1. Write short note on break away and break in points
2. Find the closed loop poles if the open loop transfer function of a unity feedback system is given by $G(s)=\dfrac{1}{(s+2)^2}$
3. What is the need for angle of asymptotes? Give its expression.
4. Determine the range of K for stability of unity feedback system using Routh Hurwitz criteria whose open loop transfer function is given as $G(s)=\dfrac{K}{s(s+1)(s+2)}$
5. Determine the stability of system using Routh Hurwitz for the following characteristic equation $(s^2+4s+13)=0$
6. Determine the angle of departure of open loop transfer function $G(s)H(s)=\dfrac{K}{s(s+0.5)(s^2+0.6s+10)}$
7. Find the number of breakpoints for the open loop transfer function $G(s)H(s)=\dfrac{K}{s(s+0.5)(s^2+0.6s+10)}$
8. Find the number of zeroes and poles, centroid for open loop transfer function $\dfrac{K}{s(s+4)(s^2+4s+20)}$
9. Find the angle of asymptotes for open loop transfer function $\dfrac{K}{s(s+4)(s^2+4s+20)}$
10. Discuss how the roots of the characteristics equation are related to the stability of the system.

Part C questions (12 marks)

1. Sketch the root locus for a control system with $G(s)H(s) = \dfrac{K(s^2 + 2s + 10)}{s^2 + 6s + 10}$

2. Consider a unity feedback system with the characteristics equation $1 + \dfrac{K}{(s+1)(s+2)} = 0,\ K \geq 0$. Draw the root locus and determine the value of K that yields a damping ratio of 0.5 for the dominant closed loop poles.

3. Sketch the root locus for a control system with open loop transfer function $G(s) = \dfrac{K}{s(s+2)(s+4)}$

4. Sketch the root locus for a control system with unity feedback system and $G(s) = \dfrac{K(s+2)}{s(s+1)(s+4)}$

5. By Routh Hurwitz criteria, determine the stability of the system represented by the following characteristics equation $s^6 + s^5 + 7s^4 + 6s^3 + 31s^2 + 25s + 25 = 0$. Comment on the location of the roots of the characteristic's equation.

6. Using Routh stability criteria, determine the stability of the system represented by the following characteristics equation
   a) $s^6 + 2s^5 + 8s^4 + 12s^3 + 20s^2 + 16s + 16 = 0$
   b) $s^5 + 3s^4 + 2s^3 + 6s^2 + 6s + 9 = 0$