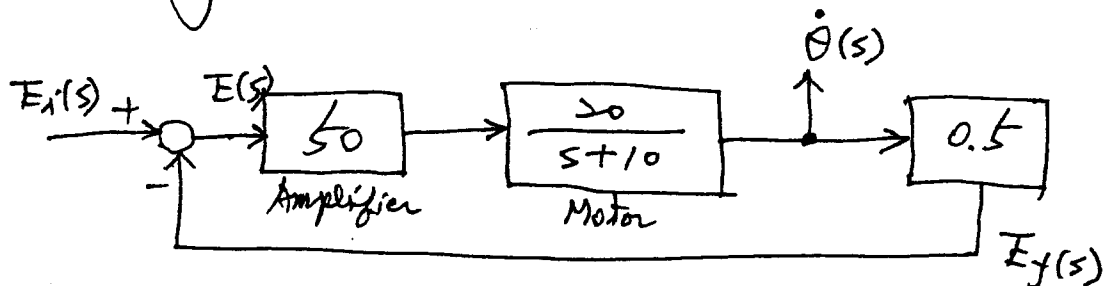


1. Given the Laplace transform  $X(s)$  where  
 [20%] 
$$X(s) = \frac{3s^3 + 17s^2 + 33s + 15}{s^3 + 6s^2 + 11s + 6}$$

find  $x(t)$ .

2. A block diagram of a velocity servomechanism  
 [20%] is shown below. For the input voltage 5V, determine the steady-state error in the velocity  $\dot{\theta}$ .



3. Sketch the root locus for a type 2 system  
 [20%] with a forward transfer function

$$G_1(s) = \frac{k}{s^2(s + \frac{1}{T_1})}$$

Discuss the stability of the system.

Suppose a zero was added at  $s = -\frac{1}{T_2}$  between the origin and the pole at  $-\frac{1}{T_1}$  into  $G_1(s)$ ,

$$\text{or } G_2(s) = \frac{k(s + \frac{1}{T_2})}{s^2(s + \frac{1}{T_1})} \text{ with } \frac{1}{T_1} > \frac{1}{T_2} > 0,$$

Sketch the new root locus with  $G_2(s)$  and determine the stability of the system.

4. The system is described by  
 [20%]  $\ddot{y} + 6\dot{y} + 11y + 6y = 6u$

obtain a state equation for the system in diagonal form.

5. (a) The matrices A and B are

[10%]  $A = \begin{bmatrix} 0 & 1 & -1 \\ 1 & 0 & 1 \\ 0 & 1 & -1 \end{bmatrix}, B = \begin{bmatrix} 1 & 0 \\ 0 & 1 \\ 0 & 0 \end{bmatrix}$

Determine if  $[A, B]$  is a controllable pair.

(b) Examine the controllability of the system

[10%]  $\frac{X(s)}{V(s)} = \frac{K(s+a)(s+b)}{(s+a)(s+b)(s+c)(s+d)}$