



Problem 1: (20 points)

- a) What are the advantages and disadvantages of open-loop and closed-loop control systems? [10 points]
 b) Determine the transfer function C/R for the block diagram shown in Fig. 1 by signal flow graph (SFG) techniques. [10 points]

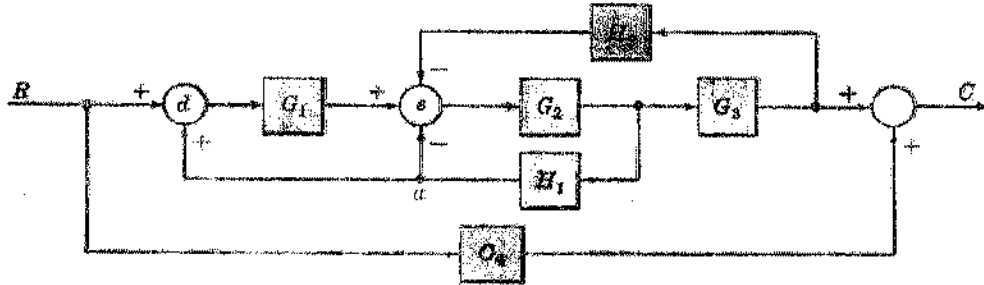


Fig. 1.

Problem 2: (30 points)

- a) Obtain the transfer functions $X_1(s)/U(s)$ and $X_2(s)/U(s)$ of the mechanical system shown in Fig. 2. [10 points]

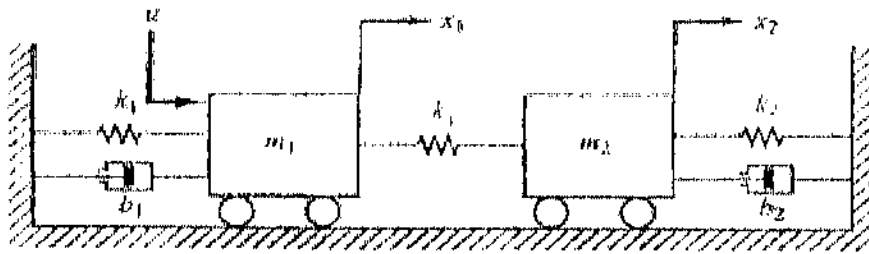
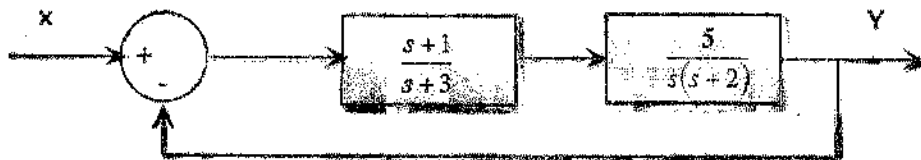
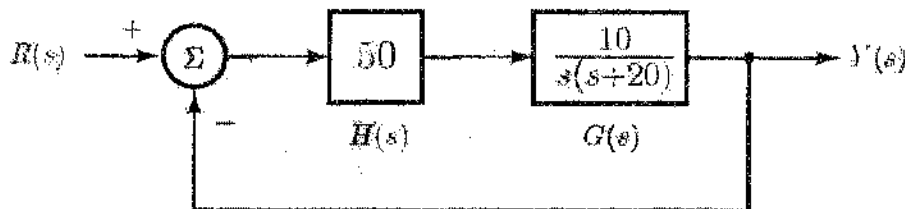


Fig. 2

- b) Find the steady-state error for the system given below for (a) a unit-step input, (b) a unit-ramp input, and (c) a unit-parabolic input. (10 points)



- c) You are given the block diagram of a control system shown below. Find the unit-impulse response of this system. In other words, find $y(t)$ when $r(t) = \delta(t)$. (10 points)



Problem 3: (20 points)

- a) What is PID control? Explain the control effects by P, I, and D, respectively. [5 points]
- b) Determine the range of values of K such that the following closed-loop system is stable. [15 points]

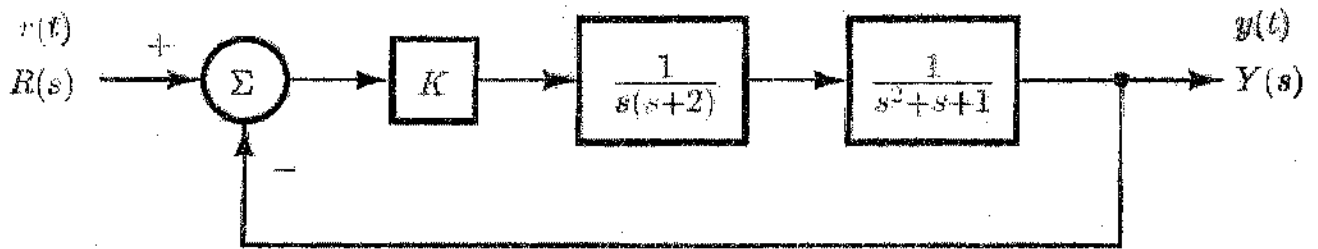
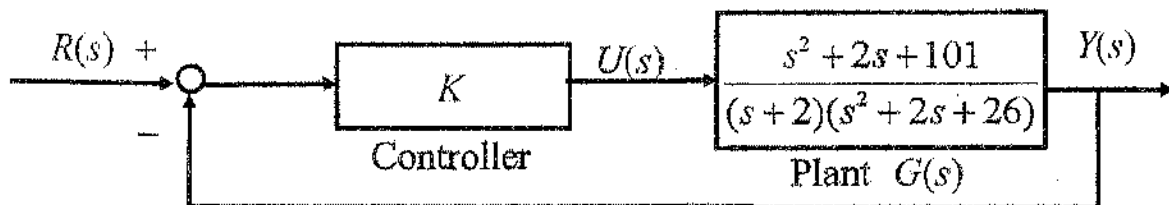


Fig. 3

Problem 4: (20 points)

- a) What is root locus? Why it is used? And summarize the steps for constructing the root loci? (5 points)
- b) A feedback control system is proposed. The corresponding block diagram is: (15 points)



Sketch the root locus of the closed-loop poles as the controller gain K varies from 0 to ∞ .

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