Q 1:(a) Let $f(t) = \exp(-\alpha|t|)$ where ... Find unilateral L.T. of $g(t)$.
Now, consider $g(t) = \int_{-\infty}^{t} f(\tau)\,d\tau$.

$e^{-\alpha t}\, e^{-st}$

(b) Consider rotational mech. system shown in Fig 1 where $T(t)$ is input torque and $\theta(t)$ output displacement. The gear N_2 is lossy with damping D. Find D such that for unit step torque input, the output angular displacement has 30% max^m overshoot. (5)

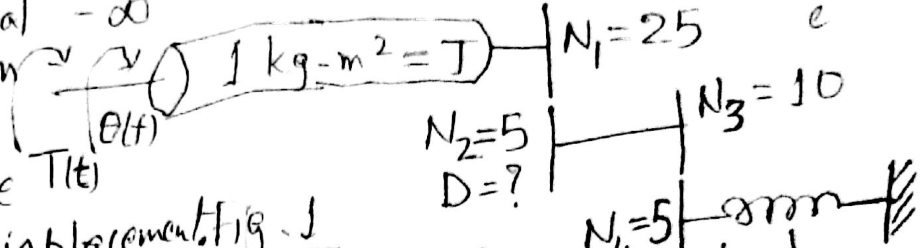


Fig. 1

Q2 :- For the unity feedback shown in fig. 2, construct a parameter plane $K_1 - K_2$ where K_1 is horizontal axis in $K_1 - K_2$ plane and show the following regions in $K_1 - K_2$ plane:

(i) Stable and unstable region.
(ii) Region in which system is overdamped ($\xi > 1$)
(iii) Region in which natural undamped frequency is greater than 5 and system is underdamped and stable. (5)

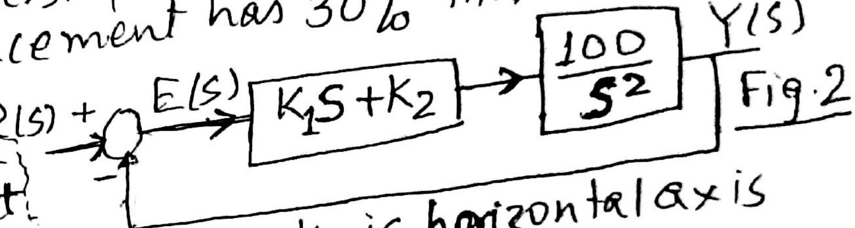


Fig. 2

Q.3 :- A controlled process is represented by following equations:

$$\frac{dx_1}{dt} = -x_1(t) + 5x_2(t)$$

$$\frac{dx_2}{dt} = -6x_1(t) + u(t)$$

$$y = x_1(t)$$

where control input is obtained from: $r(t)$ is reference input.

$$u(t) = -k_1 x_1 - k_2 x_2 + r(t)$$

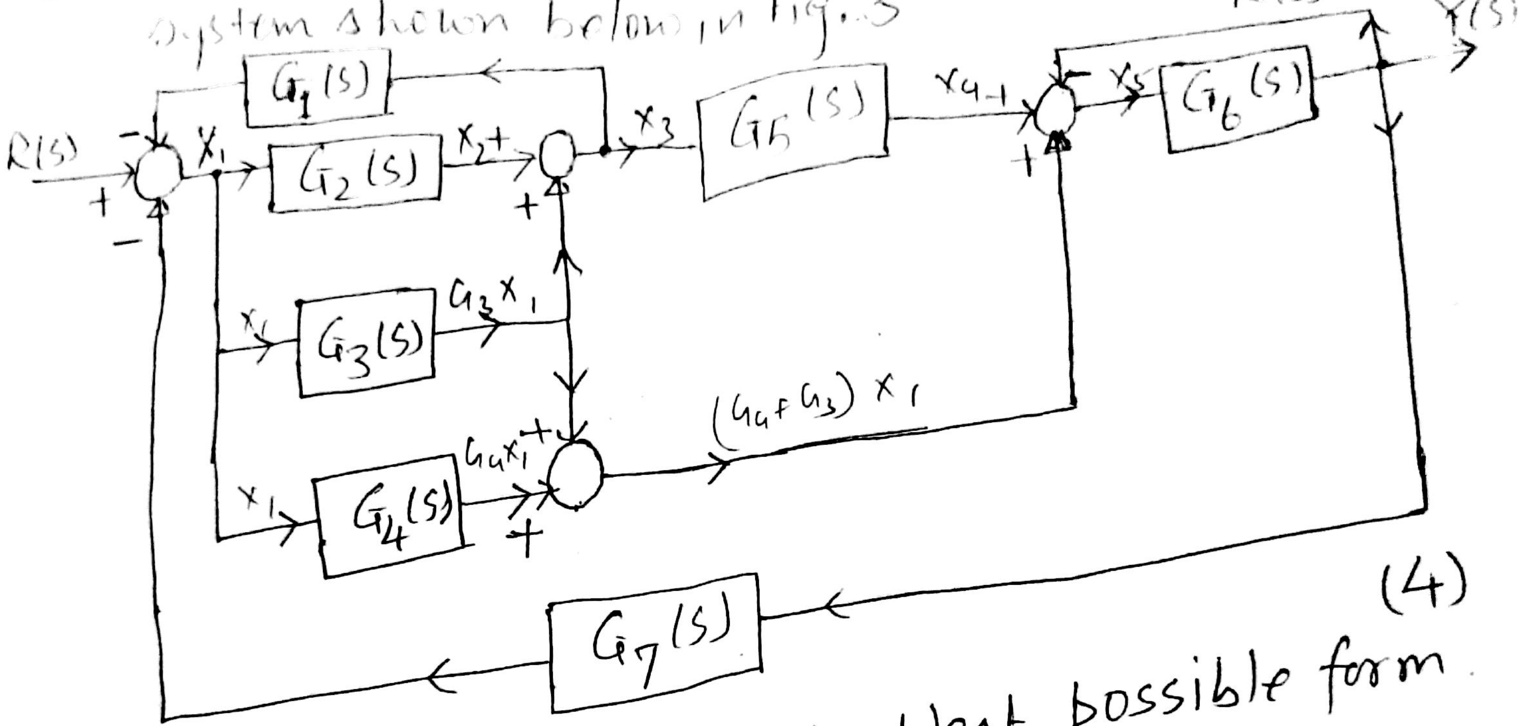
$k_1 \quad N_1$

$N_2 \quad k_2$

$k_1 = \frac{k_2 N_1}{N_2}$

(a) Find the region in $k_1 - k_2$ plane (k_1 = vertical axis) such that overall system has damping ratio $0 < \xi < 0.707$
(b) Find values of k_1 and k_2 such that $\xi = 0.707$ and $\omega_n = 10$
(c) Find the locus in $k_1 - k_2$ plane such that $\lim_{t\to\infty} y(t) = 1$ when $r(t)$ is a unit step signal. (6)

Q 4 :- Find the overall transfer function $T(s) = \frac{Y(s)}{R(s)}$ for system shown below in Fig. 3



(4)

Give answer in the simplest possible form using block diagram ~~red~~ reduction technique.

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