# *Systems Thinking*

## *Assignment 1*

**NOTE:** Any kind of copying or plagiarism, within peers or online sources will lead to a strict penalty. Please give proper steps and explanations for all the questions, highlighting final results.

Deadline: 18/09/2024 11.59 PM

# Questions

1. ***Do Laplace Transformation of the Following:***

   - Ramp function
   $$y(t) = \begin{cases} 0, & \text{if } t < 0 \\ At, & \text{if } t > 0 \end{cases}$$

   - Sinusoidal function
   $$y(t) = \begin{cases} 0, & \text{if } t < 0 \\ A \sin wt, & \text{if } t > 0 \end{cases}$$

   - Pulse Functions
   $$y(t) = \begin{cases} \frac{A}{t_0}, & \text{if } 0 < t < t_0 \\ 0, & \text{if } t < 0, t_0 < t \end{cases}$$

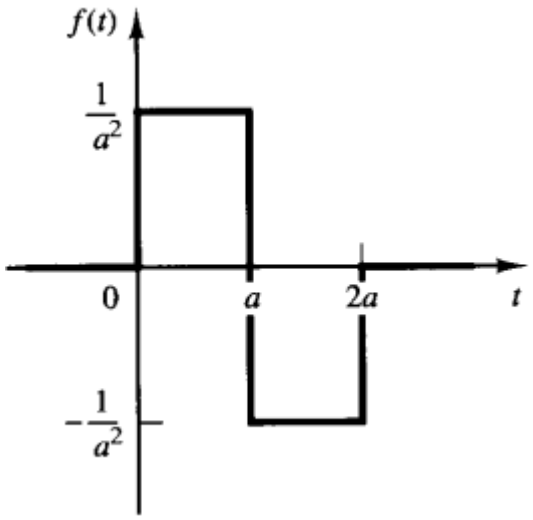
   - Given Function
   $$y(t) = \begin{cases} 0, & \text{if } t < 0 \\ te^{-3t}, & \text{if } t \geq 0 \end{cases}$$

- Given Function, $\theta$ is constant

$$y(t) = \begin{cases} 0, & \text{if } t < 0 \\ \sin(wt + \theta), & \text{if } t \geq 0 \end{cases}$$

2. ***Given*** $\mathscr{L}[f(t)] = \frac{1}{s(s+1)}$***, What is*** $\lim_{t\to\infty} f(t)$***?***

3. ***Find the Laplace Transform of the Function Given Below and Also Find the Limiting Value as*** $a$ ***Approaches Zero:***




4. ***Find Time Domain Functions for the Following:***

- $Y(s) = \frac{2s}{(s+1)(s+2)}$
- $Y(s) = \frac{2s}{(s+1)^2(s+2)}$
- $Y(s) = \frac{2}{3s^4}$
- $Y(s) = \frac{3s+2}{s^2+25}$
- $Y(s) = \frac{1}{3-4s} + \frac{3-2s}{s^2+49}$
- $Y(s) = \frac{4(s-1)}{(s-1)^2+4}$

5. ***Find Transfer Functions of Following Systems:***

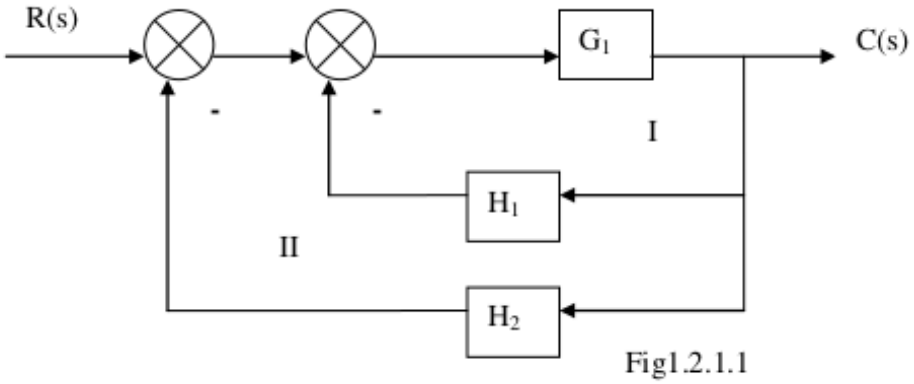
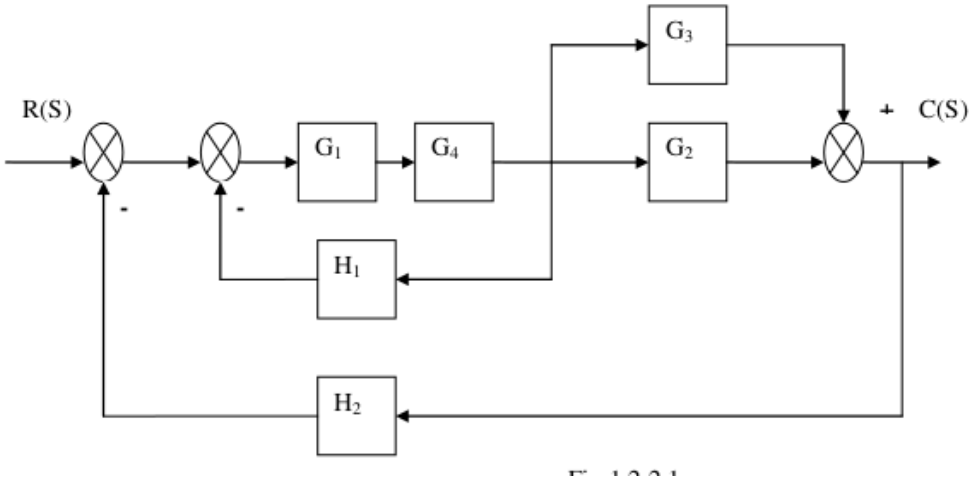
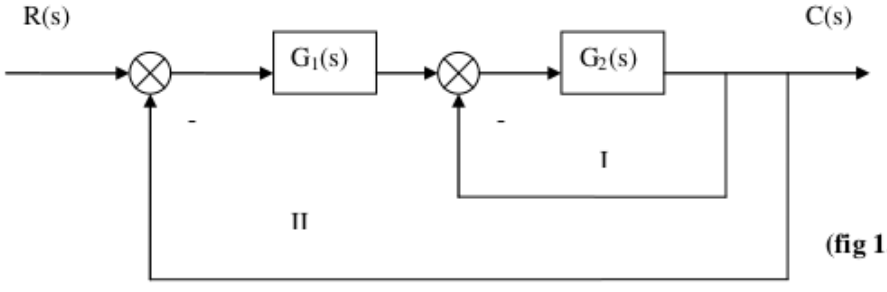


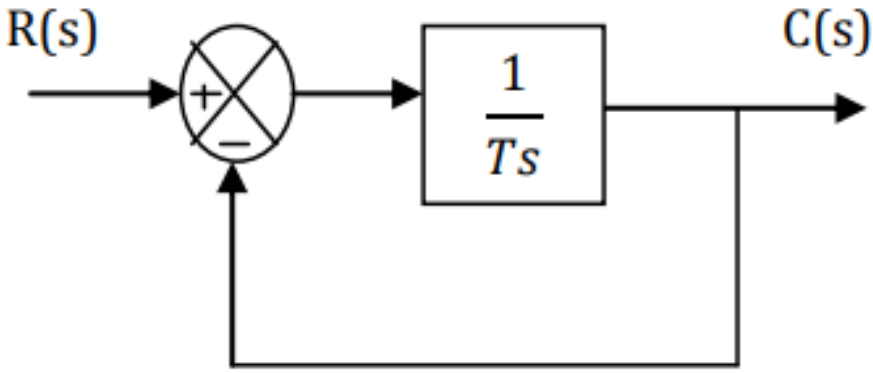

Fig1.2.1.1



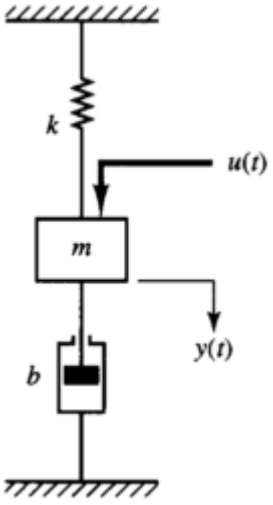




**(fig 1.2.3.1)**

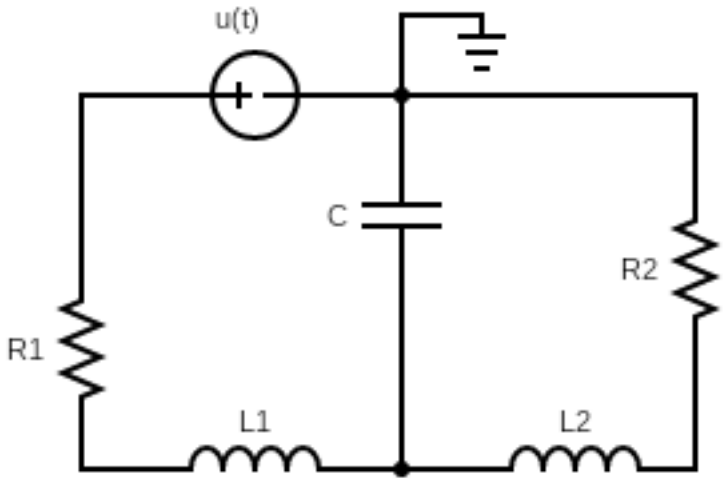
6. ***Derive the Expressions and Draw the Response of First Order System for Unit Step Input:***




7. ***Consider the Following Mechanical System. Assume That It's a Linear System. Derive Its State Equation and Output Equation:***



8. ***Give a State-Space Model for the given electrical network. Give proper State and Output equations. Voltage across R2 is the output of the system.***

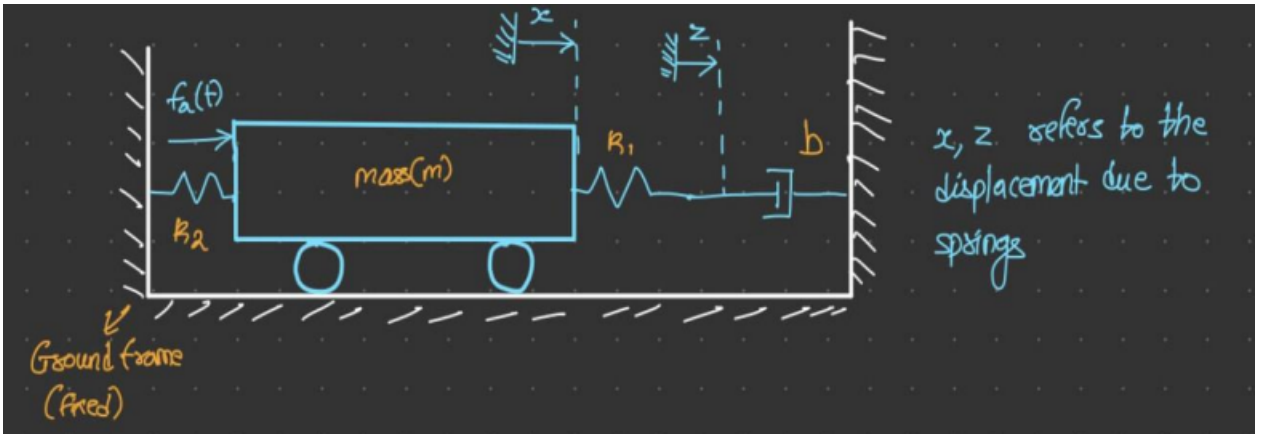



9. ***Construct a state model for a system given by the differential equation:***

$$\frac{d^3y}{dt^3} + 6\frac{d^2y}{dt^2} + 11\frac{dy}{dt} + 6y + u = 0$$

***Also, give block diagram for the state representation.***

10. ***Derive the state space model for the mechanical system shown in the figure considering fa(t) as the input and z as the output.***




11. ***Consider a system having open loop transfer function***

$$G(s) = \frac{150(s+1)}{(s+5)(s+3)}$$

***For the above unity feedback system, find the steady-state errors for the inputs***

(i) $tu(t)$

(ii) $t^2u(t)$

where $u(t)$ is the step input.

12. ***Prove the following relation. Here*** $A, B, C, D$ ***denote the usual state variables for the state space equations and*** $G(s)$ ***denotes a single input - single output transfer function.***

$$G(s) = C(sI - A)^{-1}(B + D)$$