Experiment - 1

Aim :- To study the time response of a simulated linear system

Software Used : MATLAB

Theory :- If the output of control system for an input varies with respect to time then it is called time response of the system. It consist of two parts :

- **Transient Response** : After applying input to control system, output takes certain time to reach steady state. So the output will be in transient state till it goes to a steady state. Therefore the responses of control system during transient state is known as transient response.

- **Steady State Response** : The part of time response that remains even after the transient response has zero value for large value of 't' is known as steady state response.

Rise Time : Time required for the response to rise from 10% to 90% of the final values in over damped system. It is denoted by 't_r'.

Settling Time : Time required for the response to reach steady state i.e from 0% to 98% of its final value. It is denoted by 't_s'.

Natural Response: It is the system response to initial condition with all external forces set to zero.

Forced response: It is the system response to an external stimulus with zero initial conditions.

Eg let us take $C(s) = \frac{a}{s(s+a)}$ then

$$c(t) = 1 - e^{-at} \rightarrow \text{natural response.}$$

↓ Forced response

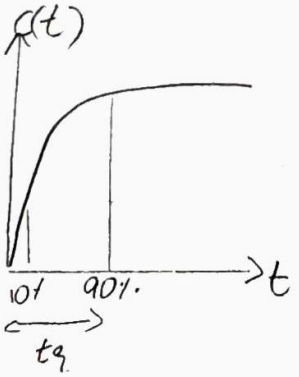
Now $t_q = c(t)_{90\%} - c(t)_{10\%}$

$$= \frac{2.31}{a} - \frac{0.11}{a} = \frac{2.2}{a} = 2.2 \times (\text{Time const})$$

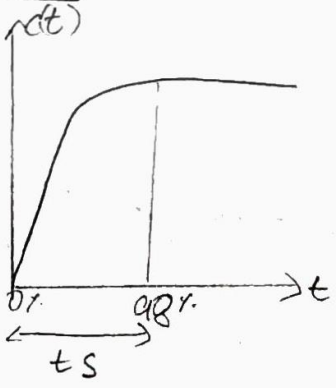
$t_s = c(t)_{98\%} - c(t)_{0.1}$

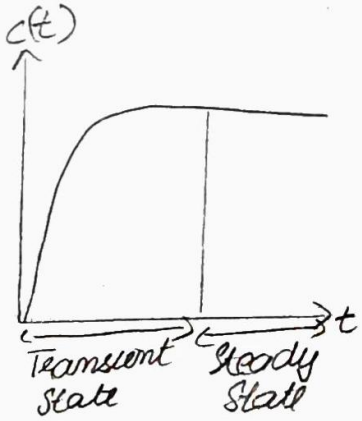
$$= \frac{4}{a} = 4 \times (\text{time const}); \text{ where } a \text{ defines the speed of system}$$

RISE TIME:



SETTLING TIME:





Result: Hence we have studied the time response of a simulated linear system.

Code

```
pkg load control

clc;
clear alll;
close all;

num = [5 25];
deno1 = [2 25];
deno2 = [3 2 25];

sys1 = tf(num, deno1);
sys2 = tf(num, deno2);

subplot(2, 1, 1);
step(sys1);
xlabel('time \rightarrow')
ylabel('amplitude \rightarrow')
title(' Step response for first order system')

subplot(2, 1, 2);
step(sys2);
xlabel('time \rightarrow')
ylabel('amplitude \rightarrow')
title(' Step response for second order system')
```

Output

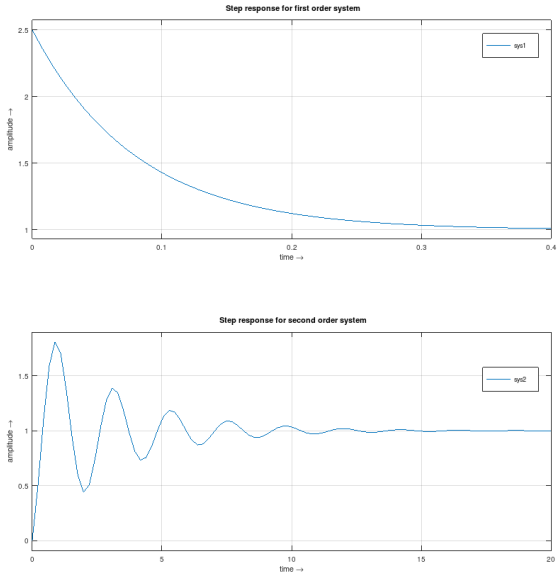


Figure 1: Step Response