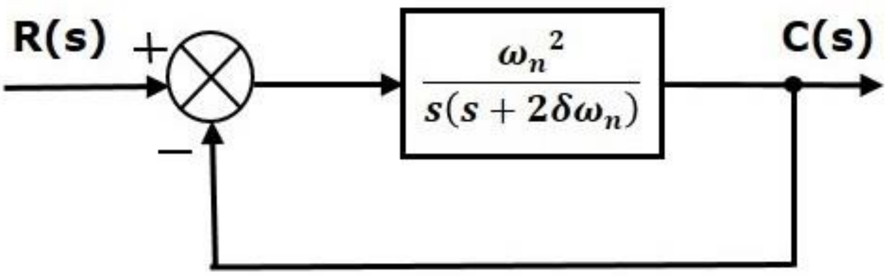
EXPERMINT NO.2

R**esponse **O**f **S**econd **O**rder **S**ystem **W**ith **TF

Consider the second-order feedback system represented, in general, by the block diagram given in Figure 1.



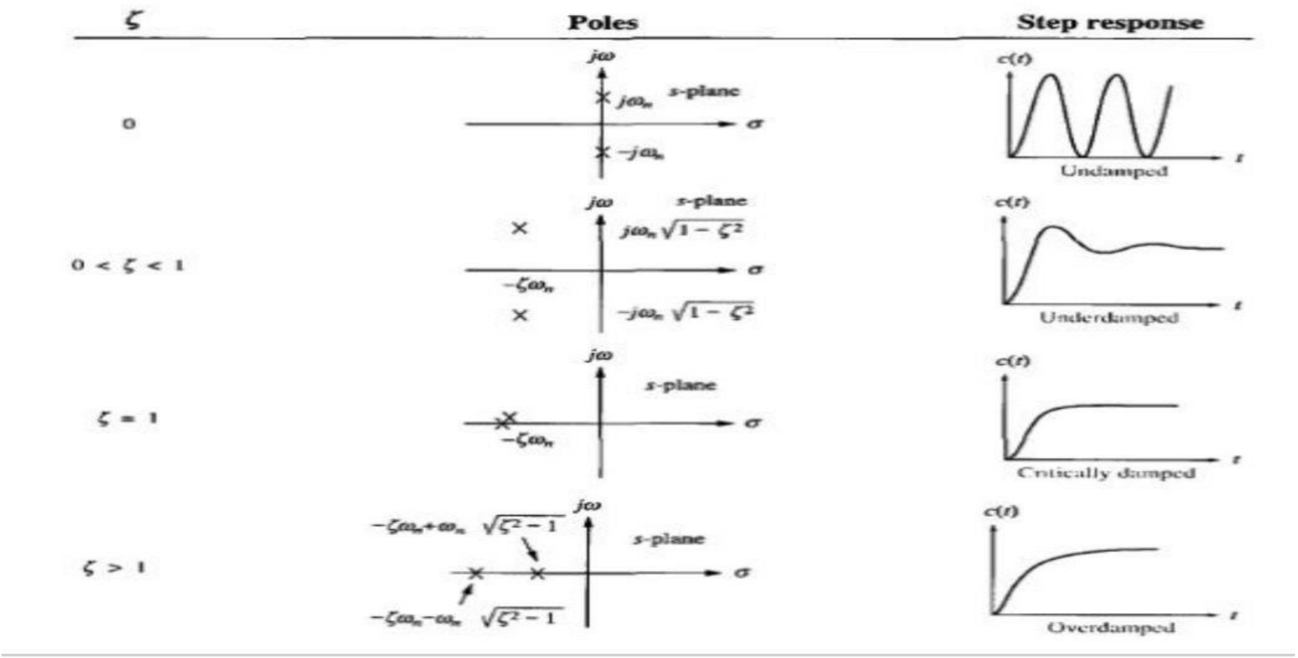
And the closed-loop transfer function C (s) / R (s) given by the equation can be written as:

$$\frac{C(s)}{R(s)} = \frac{\omega_n^2}{s^2 + 2\zeta\omega_n s + \omega_n^2}$$

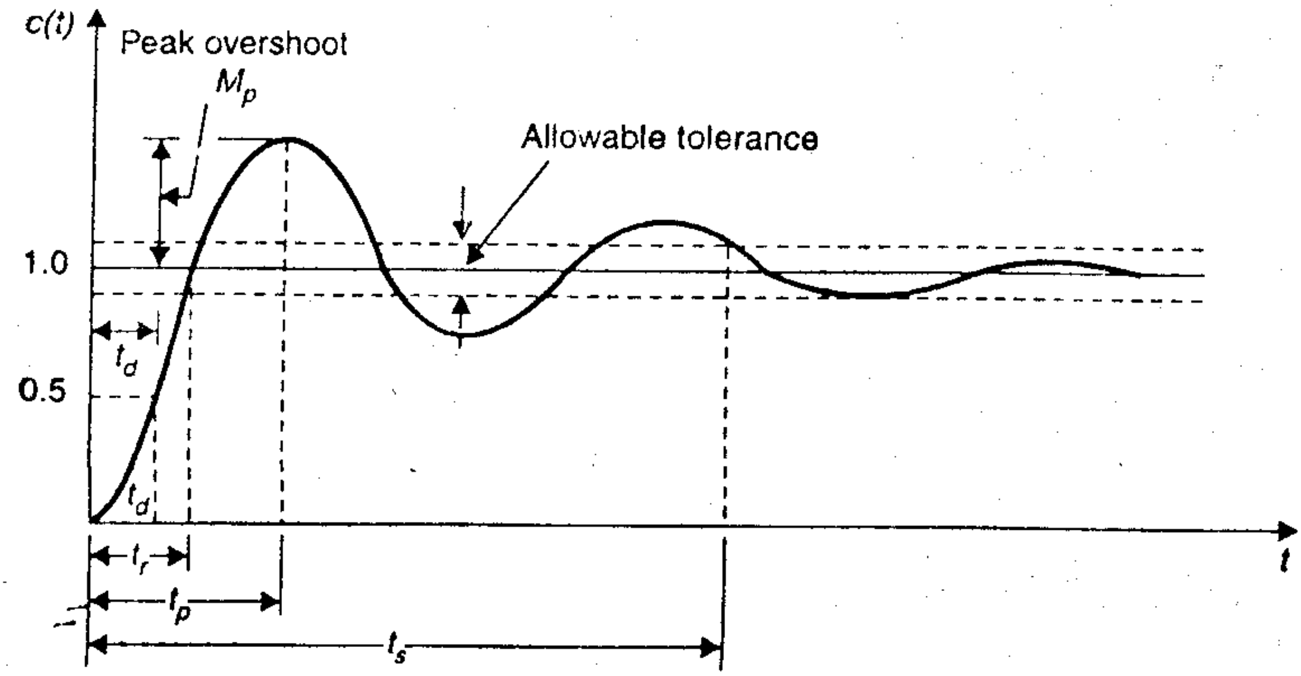
Quantities ζ is called the system damping ratio and **ωn** is called system natural frequency. Their value that determines whether the system is stable or unstable

For any test input, the response of a 2nd order system can be studied in four cases depending on the damping effect created by value of ζ as follows:

1. If $\zeta = 0$, the system is called Undamped.
2. If $0 < \zeta < 1$, the system is then called Underdamped.
3. If $\zeta = 1$, the system is called Critically damped.
4. If $\zeta > 1$, the system is called Overdamped.



The transient response to unit step for a second order control system can be represented in figure 2



Transient response terms are as follows:

Mp = maximum overshoot

Tr = rise time (the time to reach 100 %, 95 % of the input signal).

Ts=settling time (The time required for the response curve to reach and stay within a specified tolerance band of its final value or steady state value).

Td= The time required to reach half the value of the input signal.

Tp= peak time (The time required to reach a value overshoot (above normal value)).

Ex:1 $$G(s)=\frac{25}{s^2+6s+25}$$

t:0-5 ; step 0.005

Ans:

```
clear all
close all
clc
n=[25];
d=[1 6 25];
g=tf(n,d);
t=0:0.005:5;
step(g,t)
[y,x,t]=step(g,t);

%determnation of rise time
r=1;
while y(r)<1.00001
    r=r+1;
end

rise_time=(r-1)*0.005

%determnation of peaktime & overshoot

[ymax,tp]=max(y)
peak_time=(tp-1)*0.005
max_overshoot=ymax-1

%determination of the setteling time

 s=1001;
while
    y(s)>0.98&y(s)<1.02;
    s=s-1;
end
settling_time=(s-1)*0.005
```

Ex:2 from example on page 234

$$G(s) = = \frac{1.42}{s^2+1.09s+1.42}$$

t=0-20 ; step=0.0005

Ans:

```
clear all
close all
clc

n=[1.42];
d=[1 1.09 1.42];
g=tf(n,d)
t=0:0.0005:20;
step(g,t)
[y,x,t]=step(g,t);

%determnation of rise time
r=1;
while y(r)<1.00001
    r=r+1;
end

rise_time=(r-1)*0.0005


%determnation of peaktime & overshoot

[ymax,tp]=max(y)
peak_time=(tp-1)*0.0005
max_overshoot=ymax-1

%determination of the setteling time

 s=40001;
while
    y(s)>0.98&y(s)<1.02;
    s=s-1;
end
settling_time=(s-1)*0.005
```