Control System Laboratory Report

Name and ID no. of the Student:

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Title of the Experiment:

Second order Dynamic systems

Model/Simulation:

Case 1: Under damped

```
num1 = [10];
den1 = [1 2 10];
disp('Transfer Function of the system');
g = tf(num1,den1);
[Wn, Z, P] = damp(g);   % Wn, Z, P are column vectors
Wn = Wn(1);
t = 0: 0.1: 20;
figure(1);
step(num1, den1, t);    % step(g, t) also works
stepinfo(g)
title('Under Damped Second Order System Response for Step Input');
grid on;
```

Case 2: No damping

```
num2 = [10];
den2 = [1 0 10];
figure(2);
step(num2, den2, t);
title('Undamped Second Order System Response for Step Input');
grid on;
stepinfo(tf(num2,den2));
```

Case 3: Critically damped

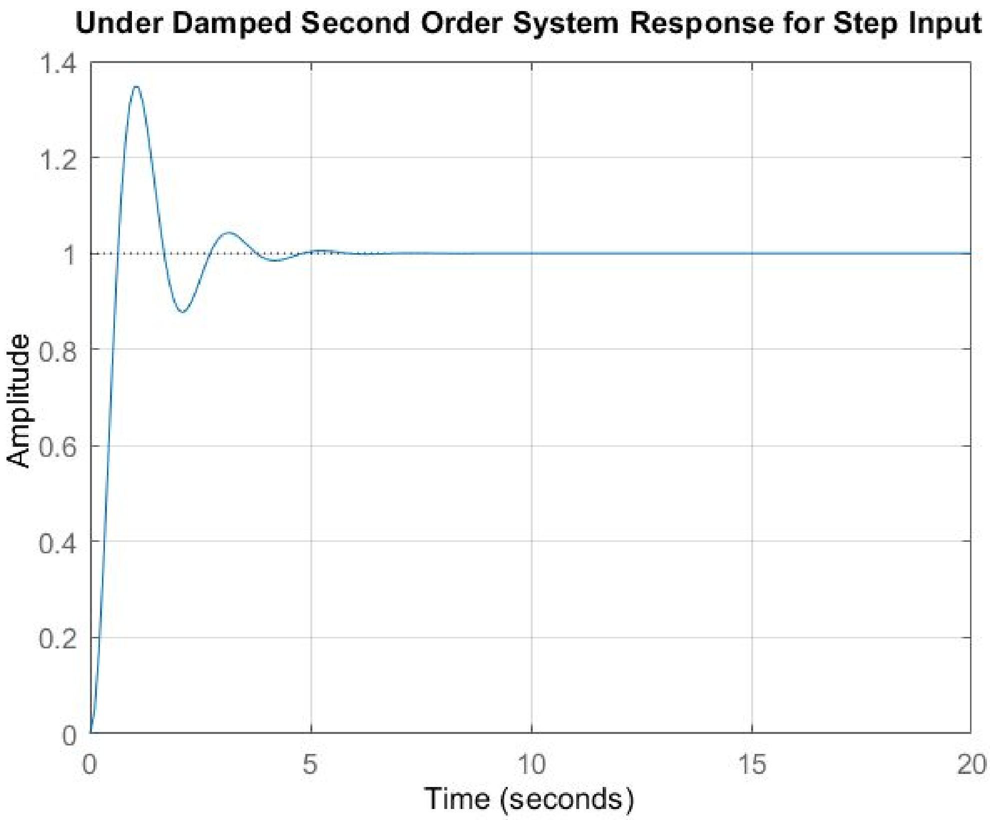
```
num3= [10];
den3=[1 7.32 10];
figure(3);
step(num3, den3,t)
title('Critically Damped Second Order System Response for Step Input');
grid on;
stepinfo(tf(num3,den3));
```

Case 4: Over damped

```
num4= [10];
den4= [1 12.6 10];
figure(4);
step (num4, den4, t)
title ('Over Damped Second Order System Response for Step Input');
grid on;
stepinfo(tf(num4,den4));
```

Results:

1.



RiseTime: 0.4259s

SettlingTime: 3.5359s

SettlingMin: 0.8772s

SettlingMax: 1.3507s

Overshoot: 35.0670

Undershoot: 0

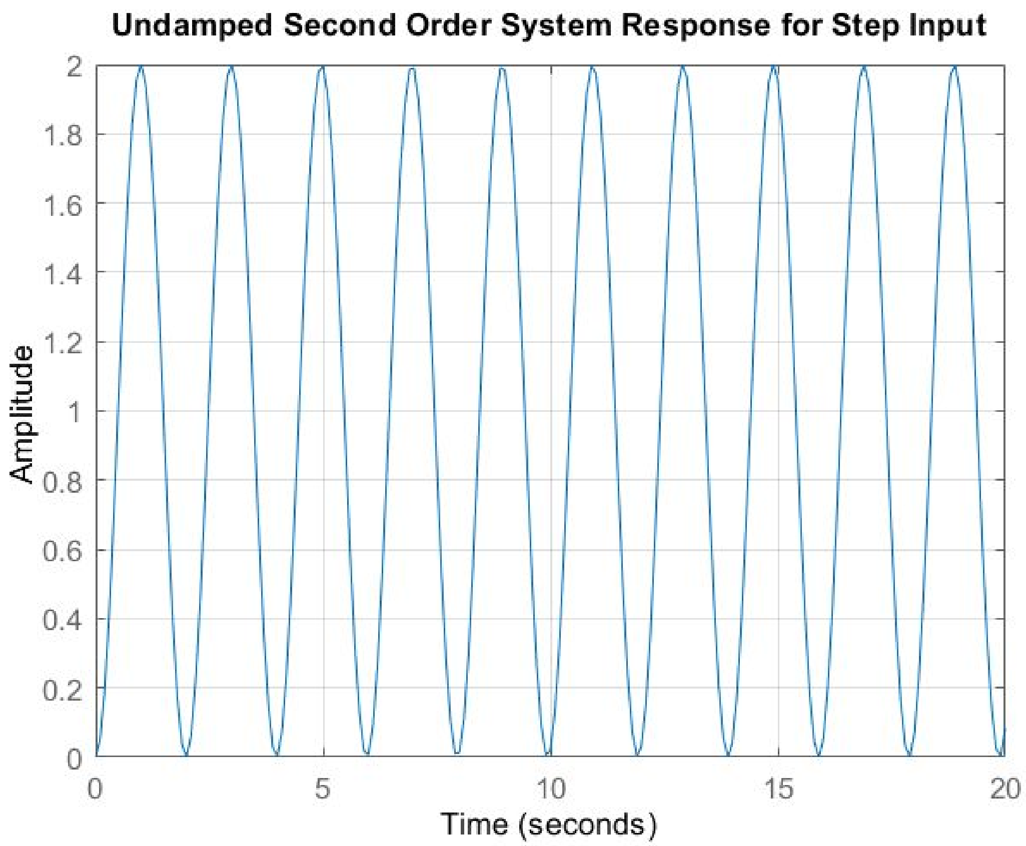
Peak: 1.3507

PeakTime: 1.0592s

Natural Frequency (ω_n) : 3.1623 rad/sec

Damping Ratio (ζ) : 0.31623

2.



RiseTime: NaN

SettlingTime: NaN

SettlingMin: NaN

SettlingMax: NaN

Overshoot: NaN

Undershoot: NaN

Peak: Inf

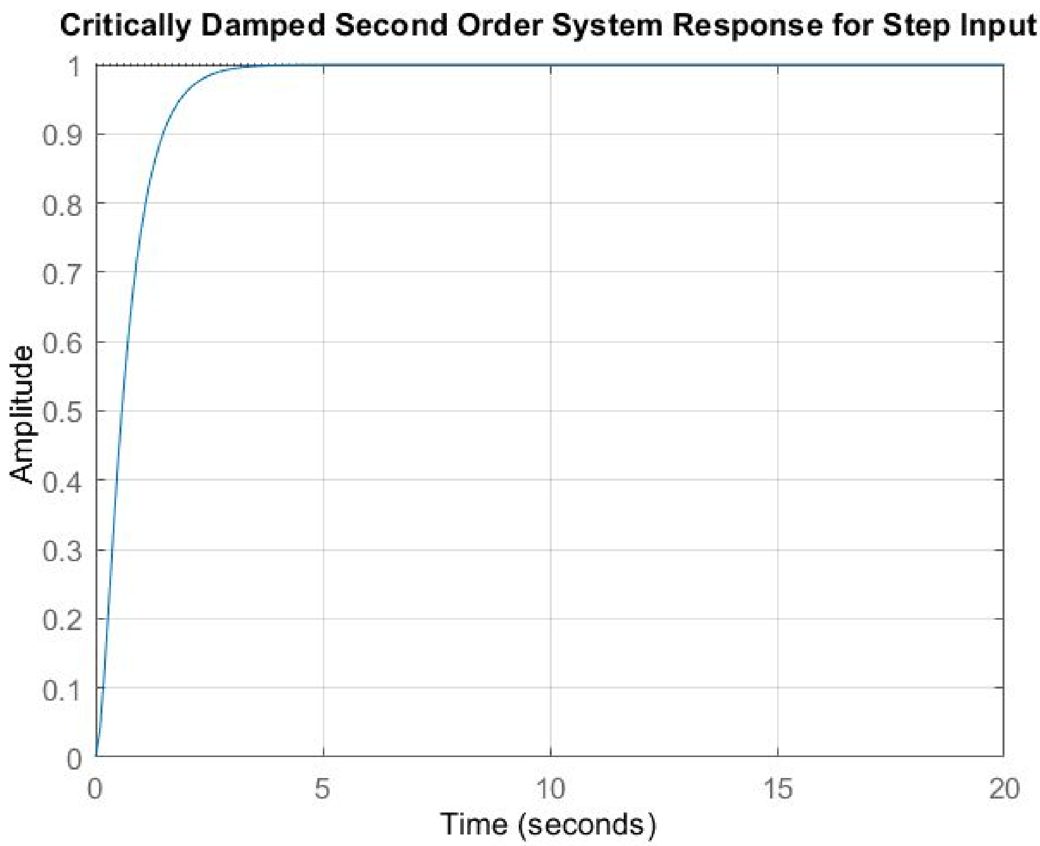
PeakTime: Inf

Since the system is undamped there is no rise time, settling time, overshoot,peak time, peak.

Natural Frequency (ω_n) : 3.1623 rad/sec

Damping Ratio (ζ) : 0

3.



RiseTime: 1.3140s

SettlingTime: 2.3733s

SettlingMin: 0.9005s

SettlingMax: 0.9994s

Overshoot: 0

Undershoot: 0

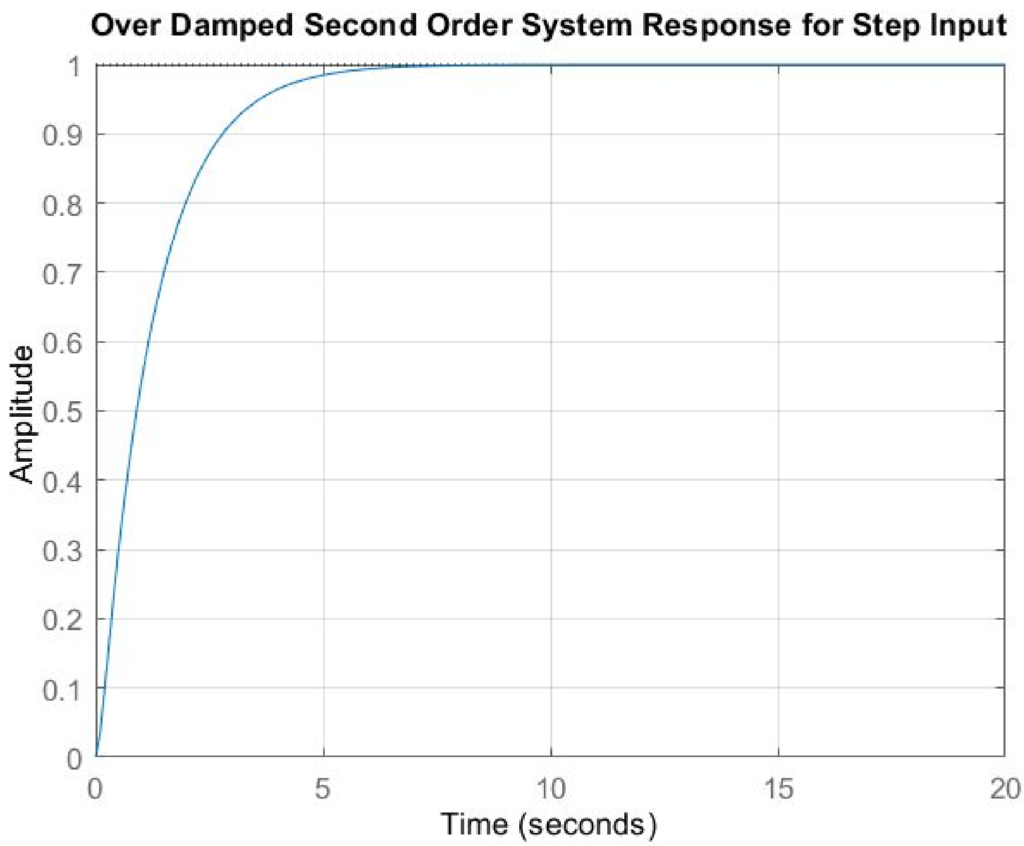
Peak: 0.9994

PeakTime: 4.3351s

Natural Frequency (ω_n) : 3.1623 rad/sec

Damping Ratio (ζ) : 1.157

4.



RiseTime: 2.5913s

SettlingTime: 4.6848s

SettlingMin: 0.9017s

SettlingMax: 0.9993s

Overshoot: 0

Undershoot: 0

Peak: 0.9993

PeakTime: 8.6028s

Natural Frequency (ω_n) : 3.1623 rad/sec

Damping Ratio (ζ) : 2

Conclusive remarks:

The systems' output characteristics entirely depend on how the damping ratio or zeta(ζ) values vary and decide whether the system is in the under-damped state , un-damped state, critically damped or overdamped system.

Variation of damping ratio(ζ) affects the system stability very much and makes the system less stable or makes the system take more time to reach the steady state response.

Varying the damping ratio we can change the transient parameters such as rise time, peak time and overshoot value according to our specifications.

From the above simulation results we can show that the critically damped system is most stable when compared to the other systems since it reaches the steady state faster and without overshoot.

So the systems need to try to come as close as to the critically damped system since in the real world scenario all the systems are mostly underdamped.

For the underdamped system, from the stepinfo, we get OS% as 35.06% and peak time(T_p) as 1.05s. Using the formulae given, we can calculate these parameters manually: we get OS% as 35.09% and peak time(T_p) as 1.047s.