Kathmandu University

Department of Computer Science and Engineering

Dhulikhel, Kavrepalanchowk

A Lab Report
on
"Control System"
Lab No: III

[Code No: COEG304**]**

Submitted by:

Royas Shakya

CE 2022

Roll No: 55

Submitted to:

Ms. Supriya Pandeya

Department of Electrical and Electronics. Engineering

Submission Date: 19/06/2025

Title: To visualize the response of a Second Order System

Theory:

A second order system is given by the following transfer function:

$$T(s) = \frac{kw^2}{s^2 + 2\xi\varpi s + \varpi^2}$$

Task 1: Impulse Response of System

Editor - C:\Users\LOQ\Documents\MATLAB\CE_55_1.m

CE_55_2.m | CE_55_3.m | CE_55_4.m | CE_55_1.m

```
clc
close all
clear
wn = input('Enter Frequency: ');
zeta = input('Enter Damping factor: ');
num = wn^2;
den = [1 2*zeta*wn wn^2];
impulse(num,den); %Getting impulse graph
```

Figure 1: Impulse Response of System Code

The impulse response of a second order system shows how the system reacts to a very short input applied at time 0. It typically exhibits oscillations whose amplitude and decay depend on the damping factor and natural frequency. Underdamped condition means system gradually decays whereas overdamped means system returns to equilibrium without oscillations.

Results:

For frequency = 1000 Hz, Damping Factor = 0.5

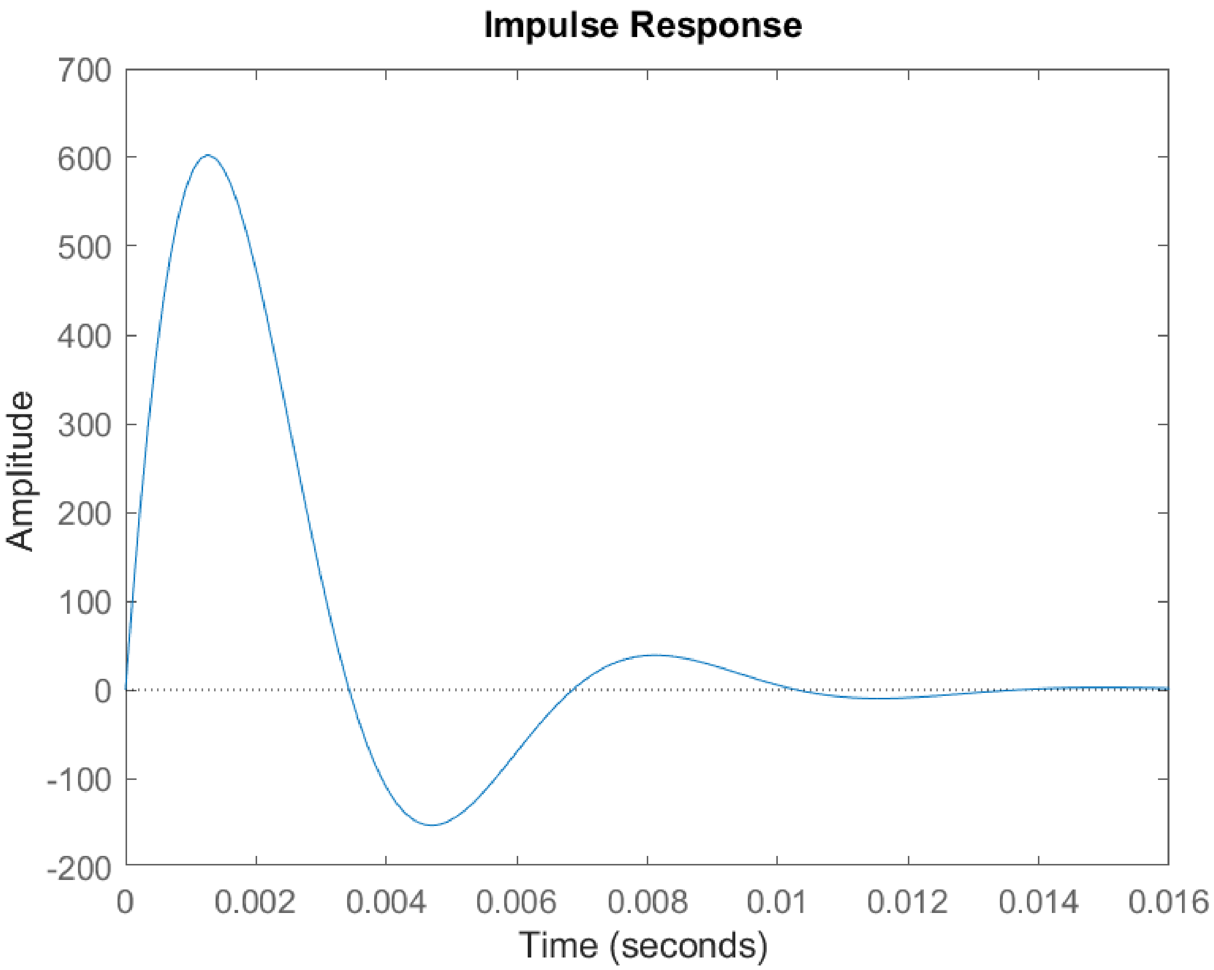

Figure 2: Underdamped Impulse Response

For frequency = 1000 Hz, Damping Factor = 1

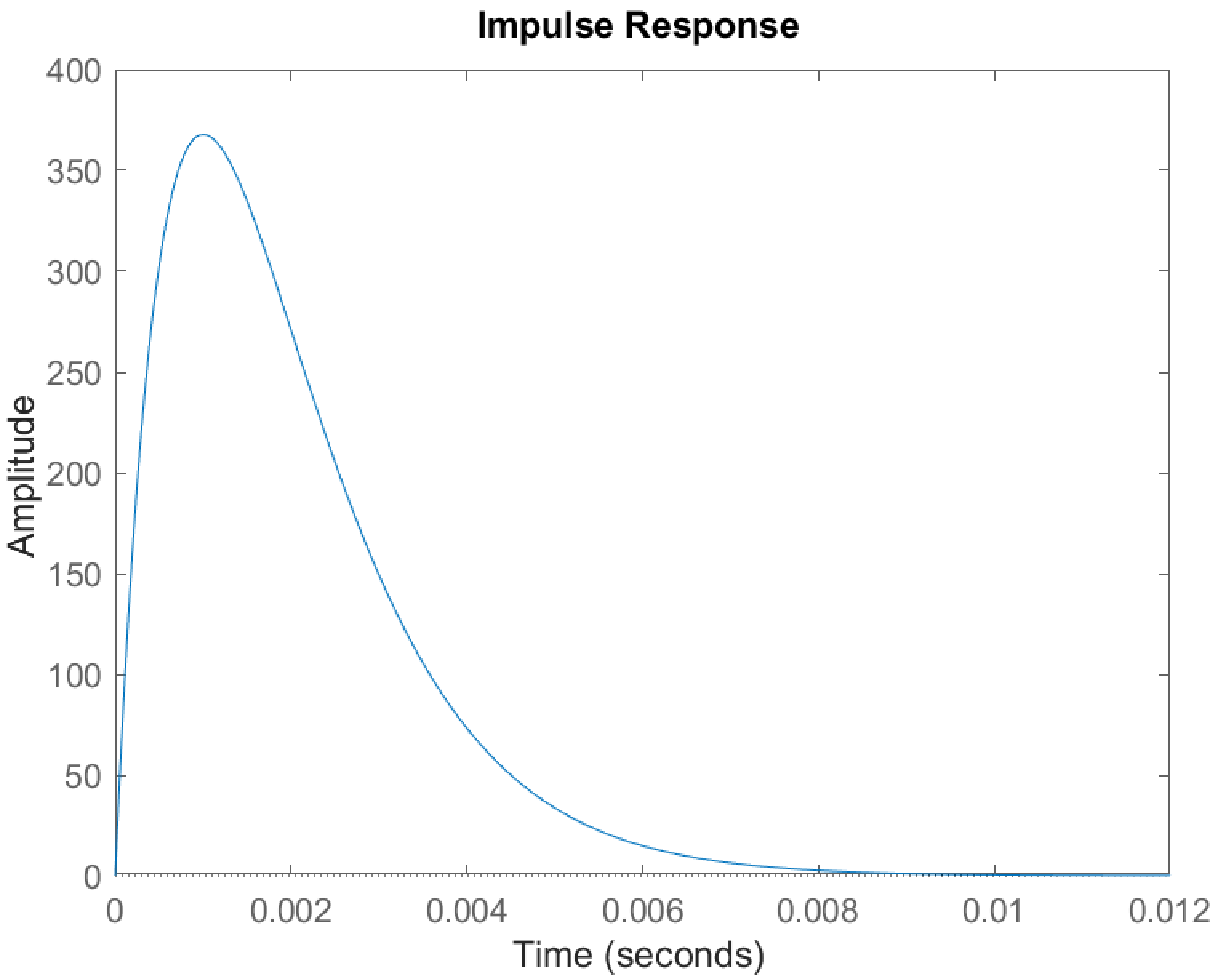

Figure 3: Critically Damped Response

For Frequency = 1000 Hz, Damping Factor = 1.4

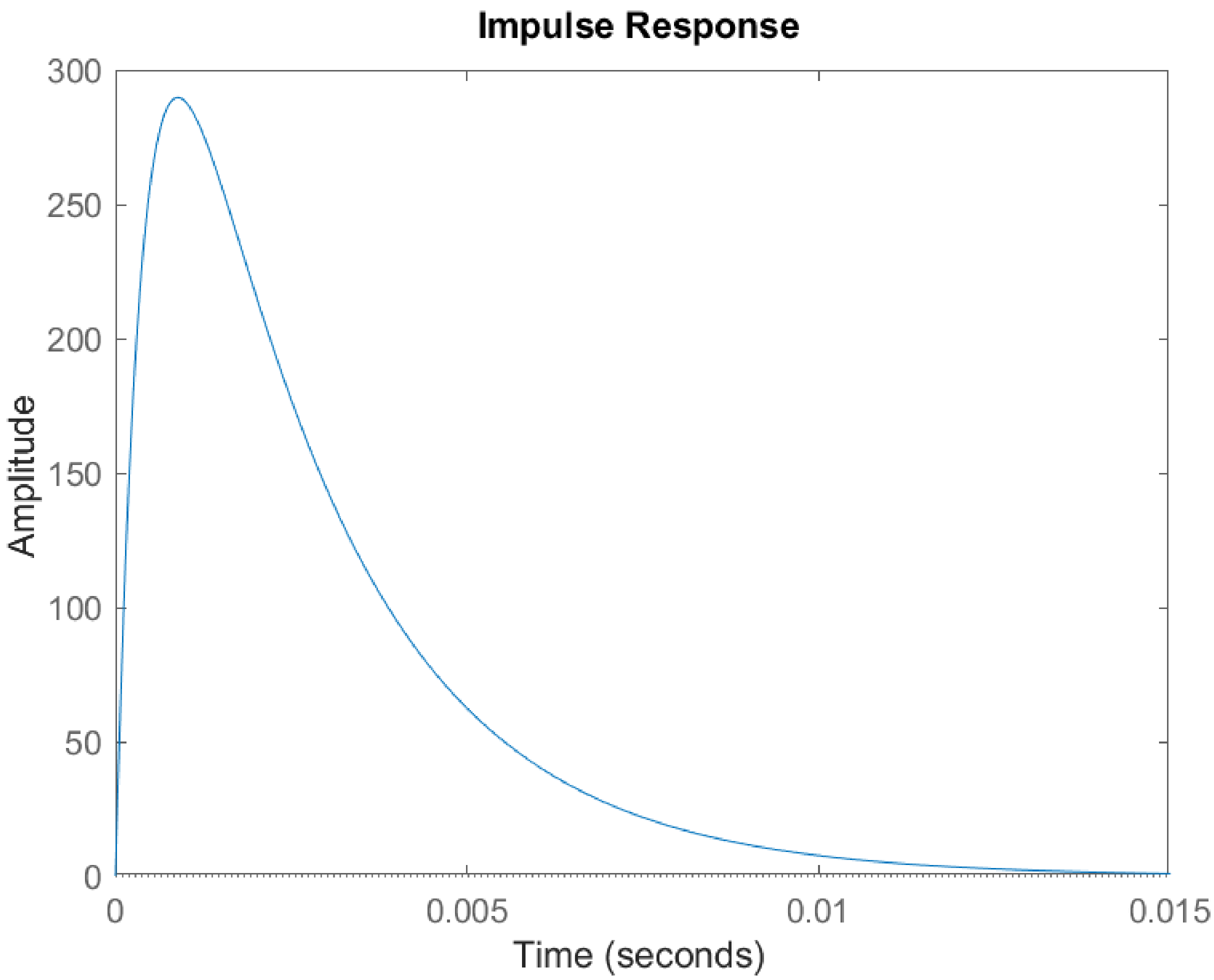

Figure 4: Overdamped Impulse Response

Task 2: Step Response of System

```
clc
close all
clear
wn = input('Enter Frequency: ');
zeta = input('Enter Damping factor: ');
num = wn^2;
den = [1 2*zeta*wn wn^2];
step(num,den); %Getting step graph
```

Figure 5: Step Response of System Code

The step response of a second order system shows how the system reacts to a sudden, sustained input. Depending on the damping factor, the response may overshoot (underdamped), smoothly rise to final value (overdamped) or quickly reaches the final value without overshoot (critically damped)

Results:

For Frequency = 1000 Hz, Damping Factor = 0.7

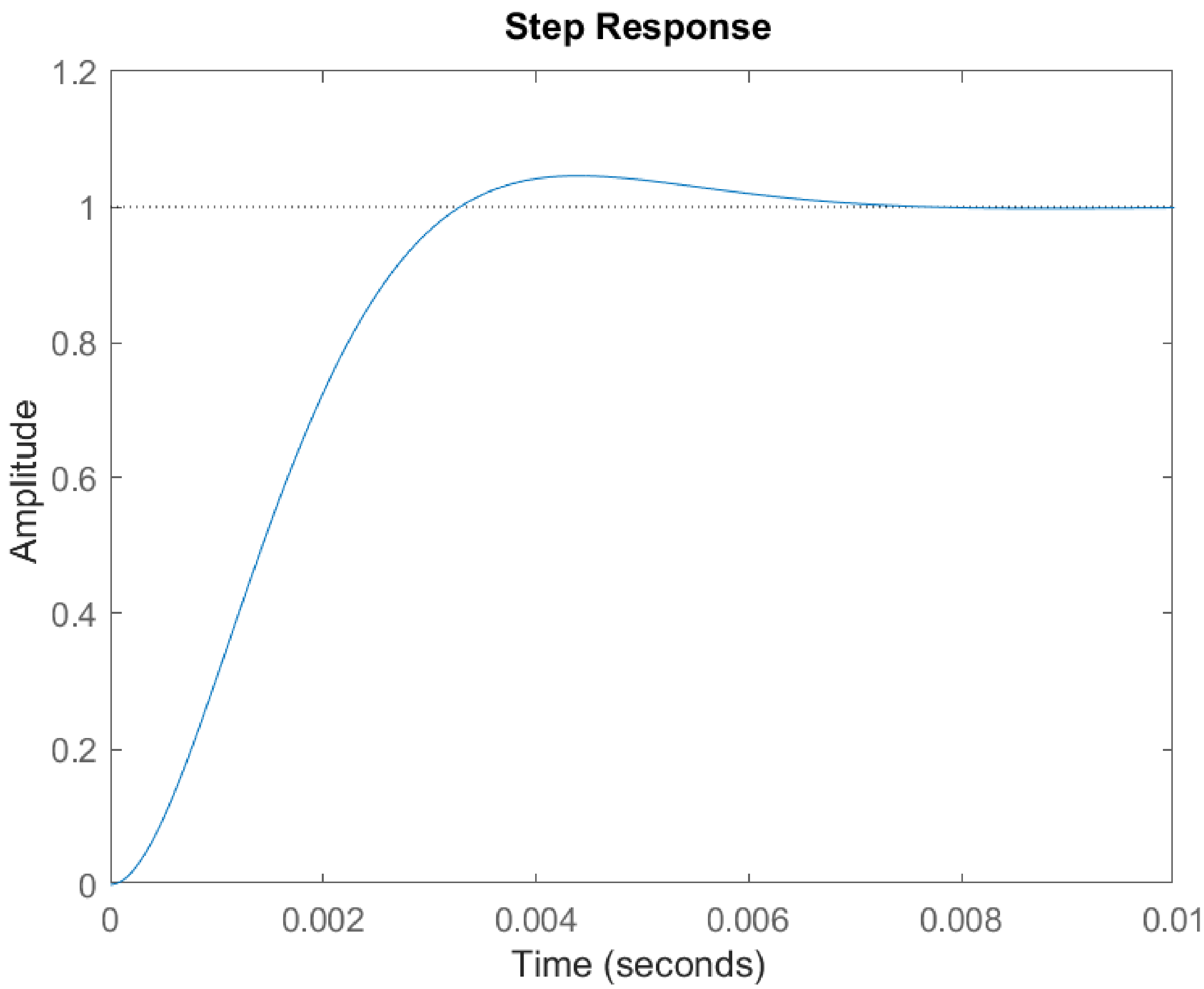

Figure 6: Underdamped Step Response

For Frequency = 1000 Hz, Damping Factor = 1

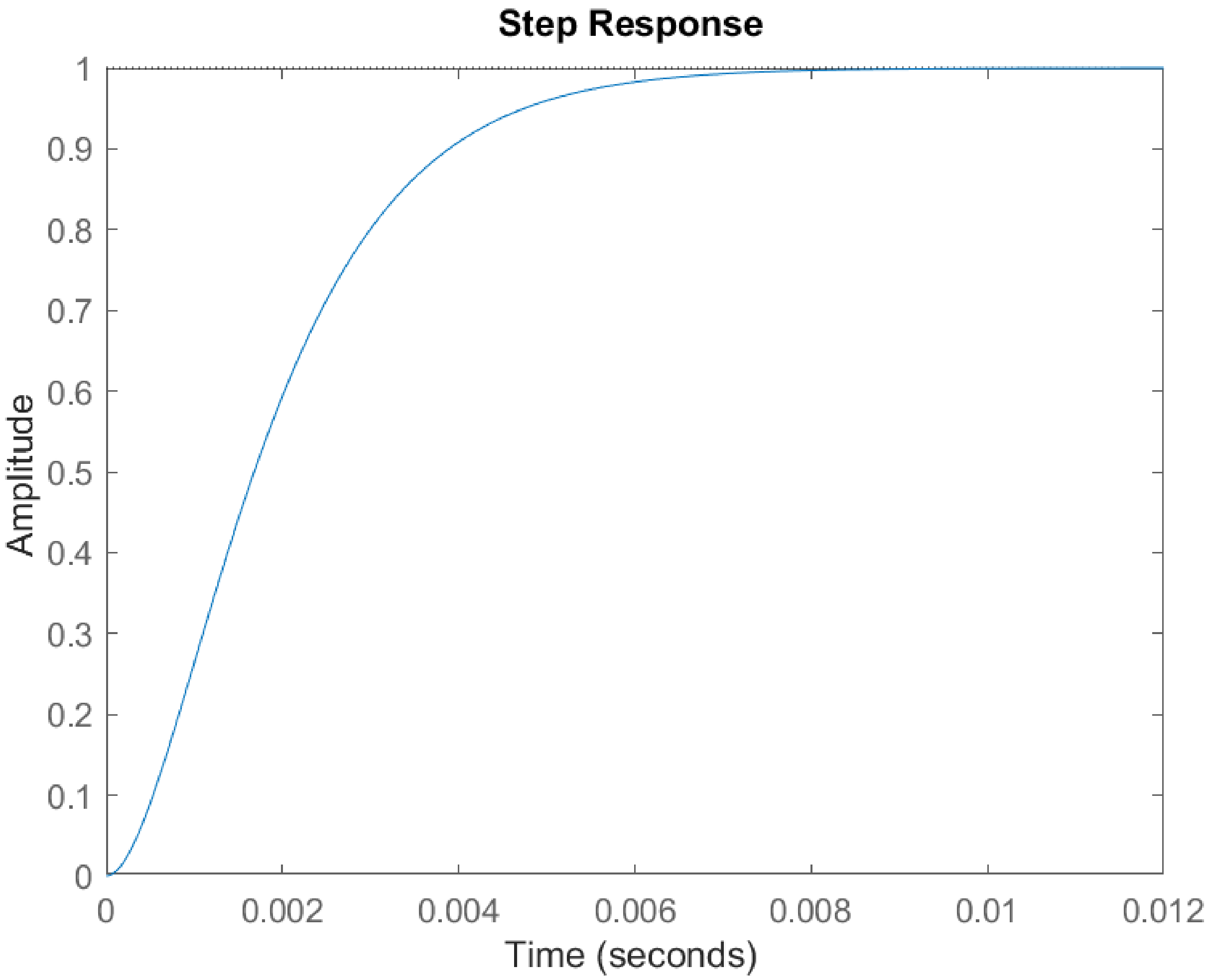

Figure 7: Critically Damped Step Response

For Frequency = 1000 Hz, Damping Factor = 1.7

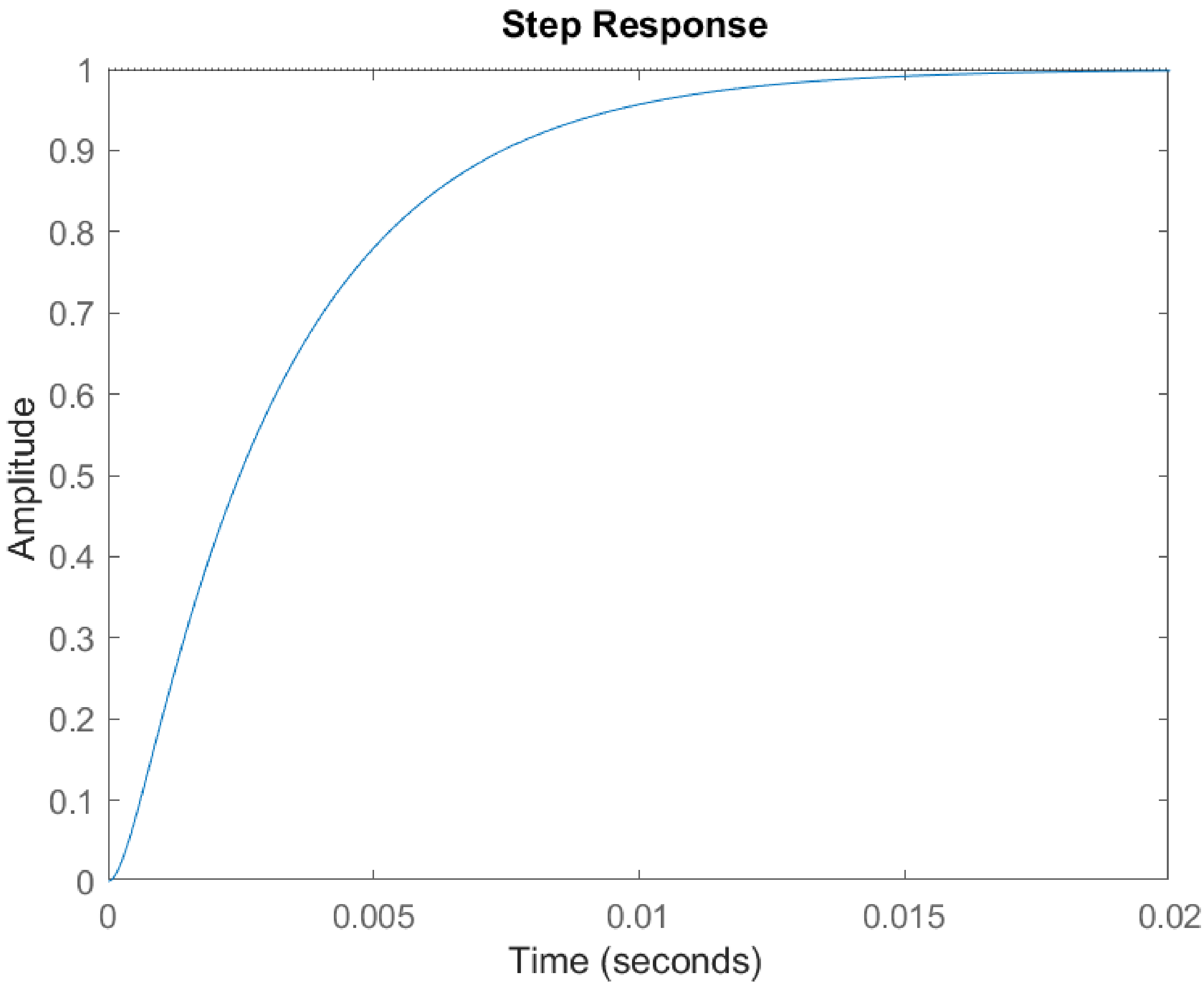

Figure 8: Overdamped Step Response

Task 3: Impulse/Step Response of System

```
clc
close all
clear
wn = input( 'Enter Frequency: ')
zeta = input( 'Enter Damping Factor:' )
num = wn ^ 2;
den = [1 2*zeta*wn wn^2];
subplot(1,2,1)
impulse (num, den)
grid ON
subplot (1,2,2)
step (num, den)
grid ON
```

Figure 9: Impulse/Step System Code

For Frequency = 60 Hz, Damping Factor = 0.3

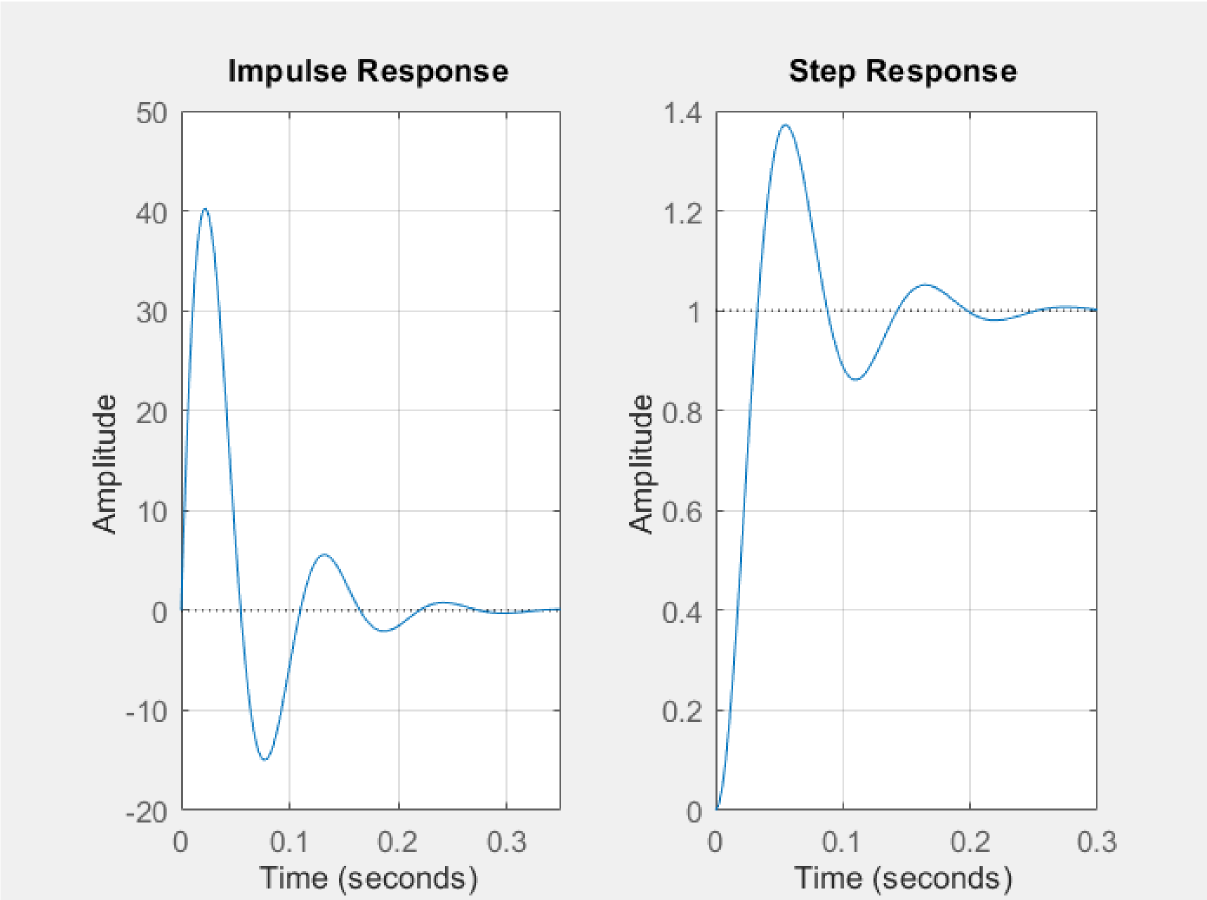

Figure 10: Underdamped Response

For Frequency = 60 Hz, Damping Factor = 1

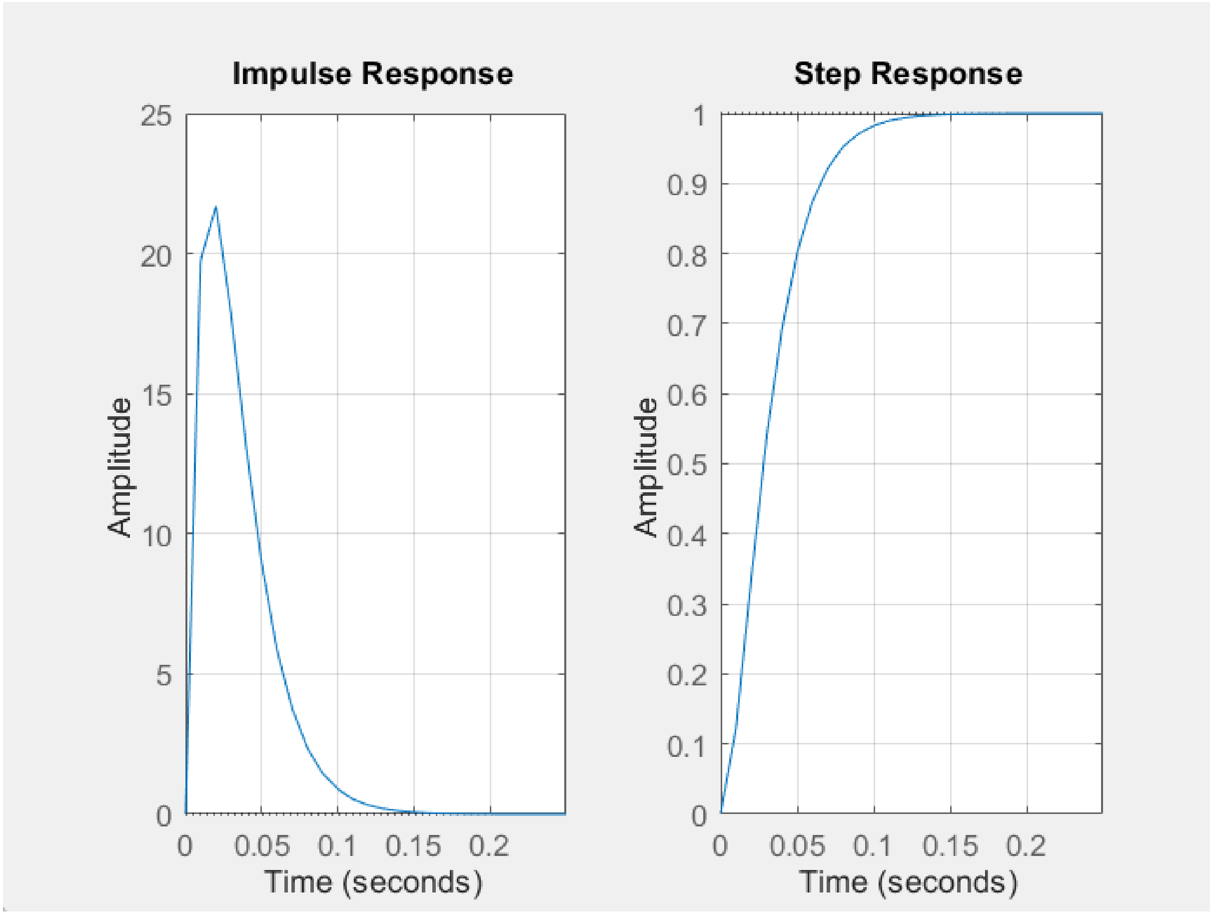

Figure 11: Critically Damped Response

For Frequency = 60 Hz, Damping Factor = 2.3

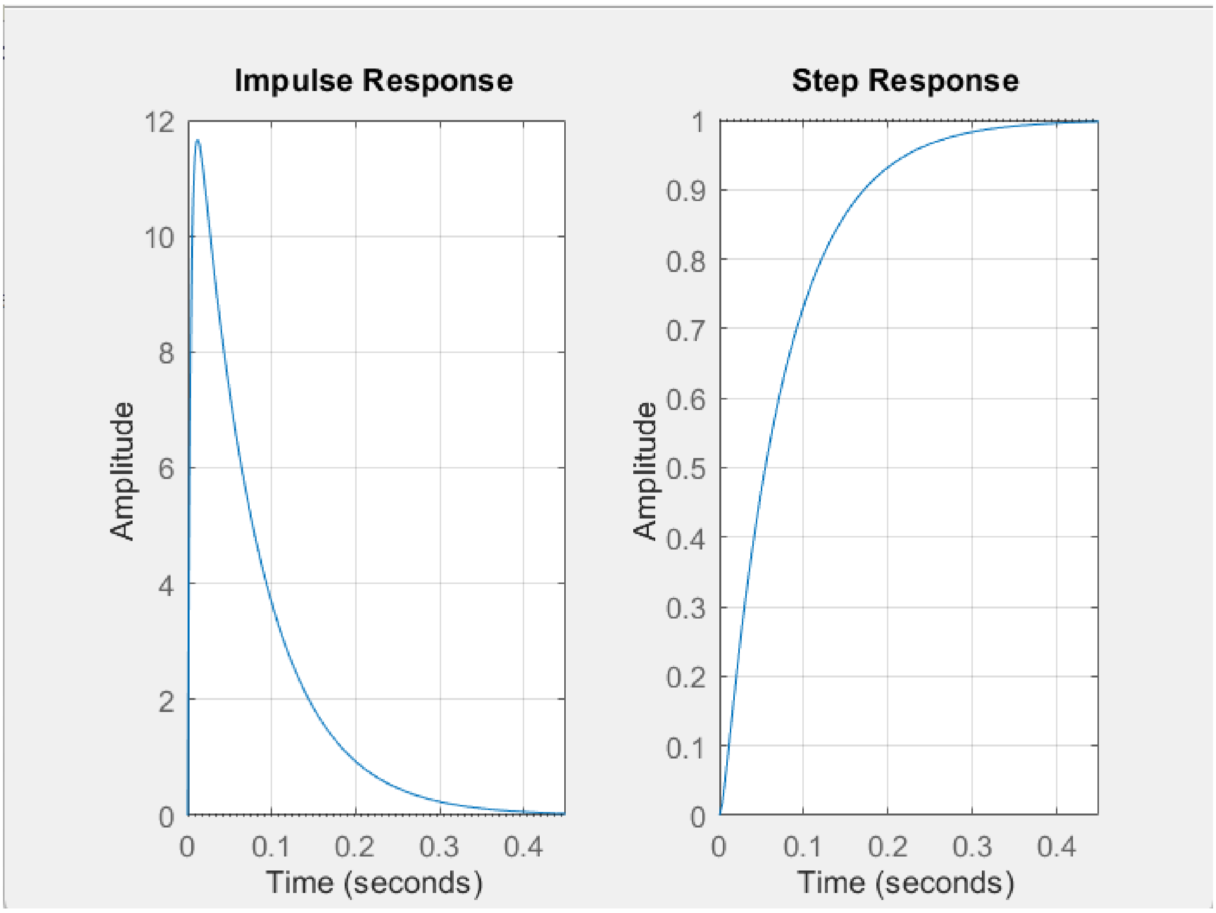

Figure 12: Overdamped Response

Here, with constant frequency, increasing the damping reduces oscillations and overshoot, leading to a slower but smoother response. Lower damping results in more pronounced oscillations and overshoot before settling.

For Frequency = 30 Hz, Damping Factor = 0.3

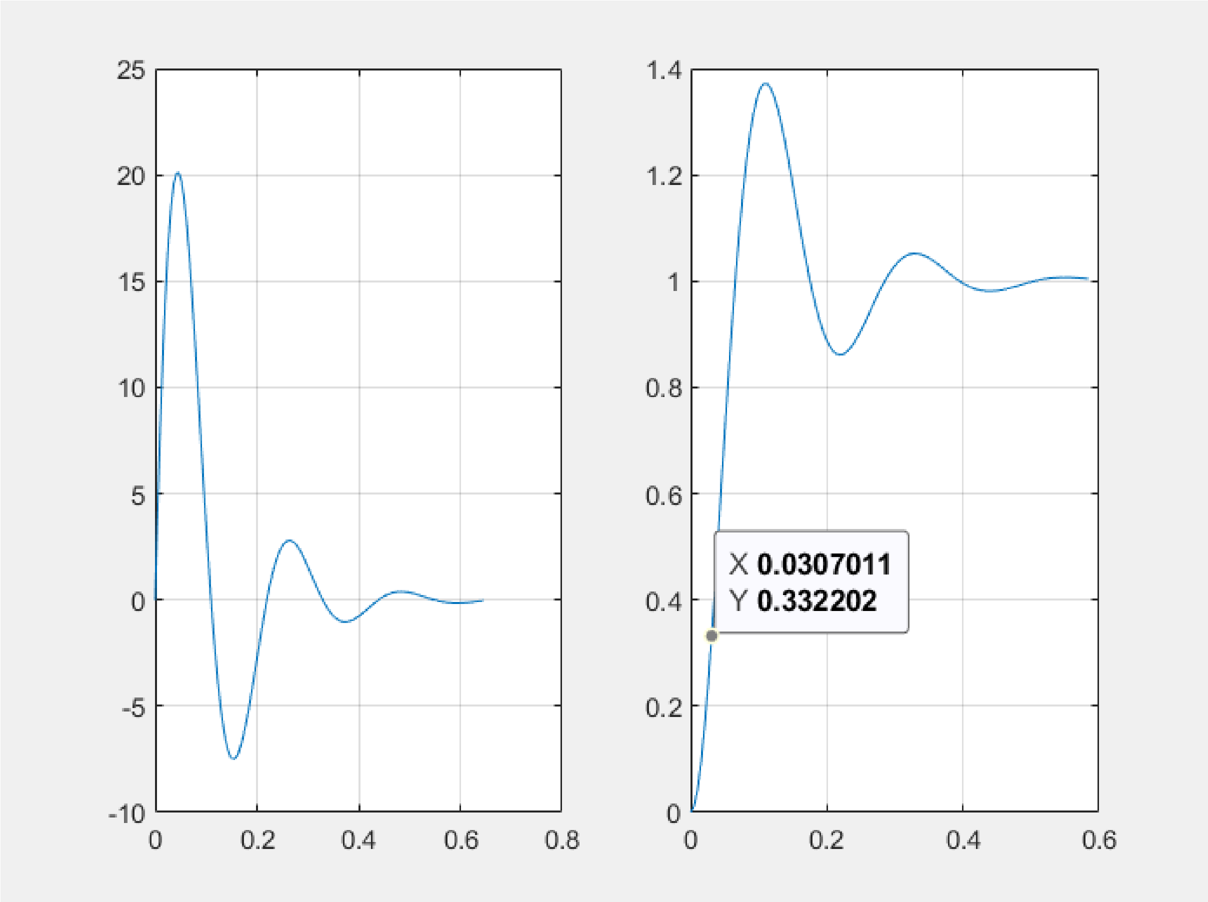

Figure 13: Underdamped Response at 30Hz

For Frequency = 60 Hz, Damping Factor = 0.3

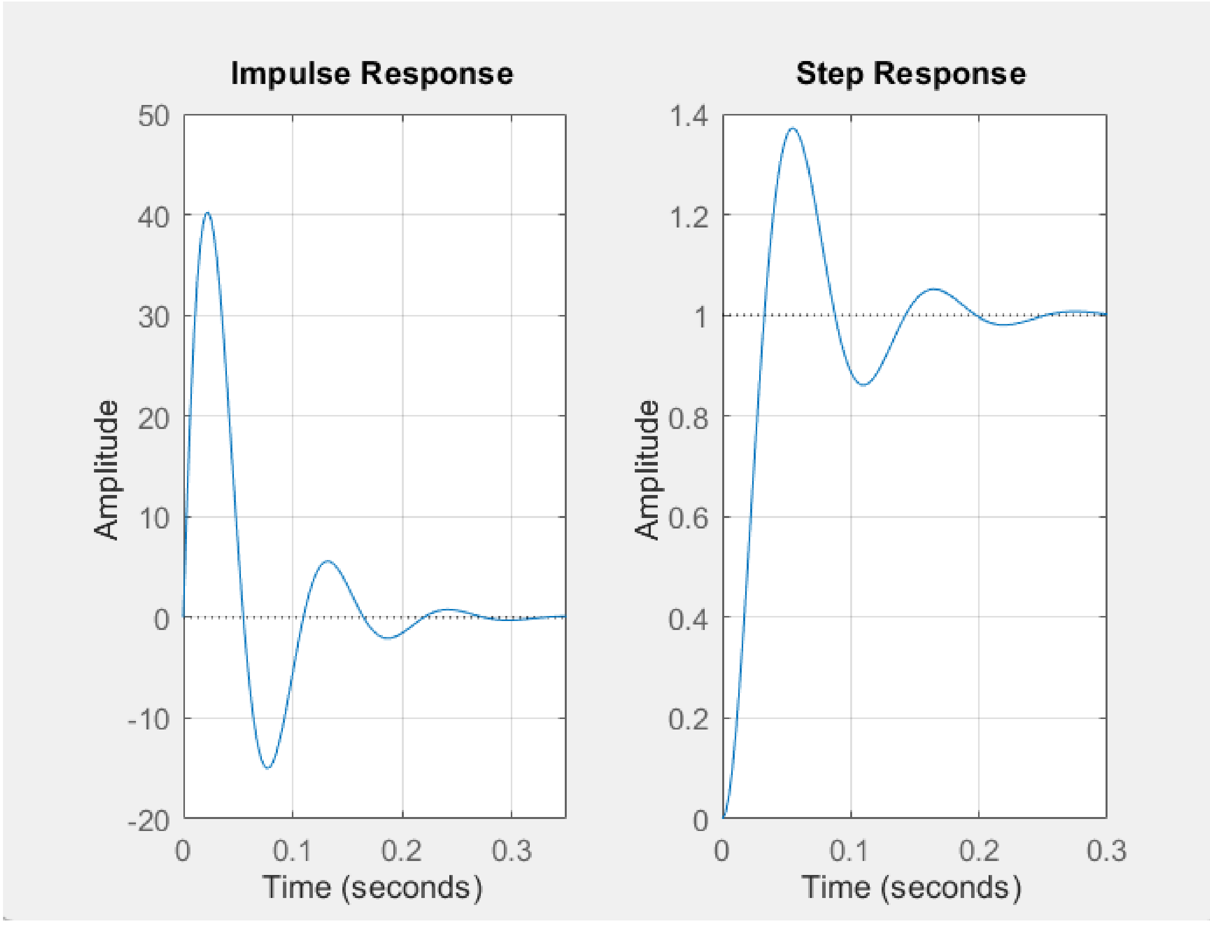

Figure 14: Underdamped Response at 60Hz

For Frequency = 90 Hz, Damping Factor = 0.3

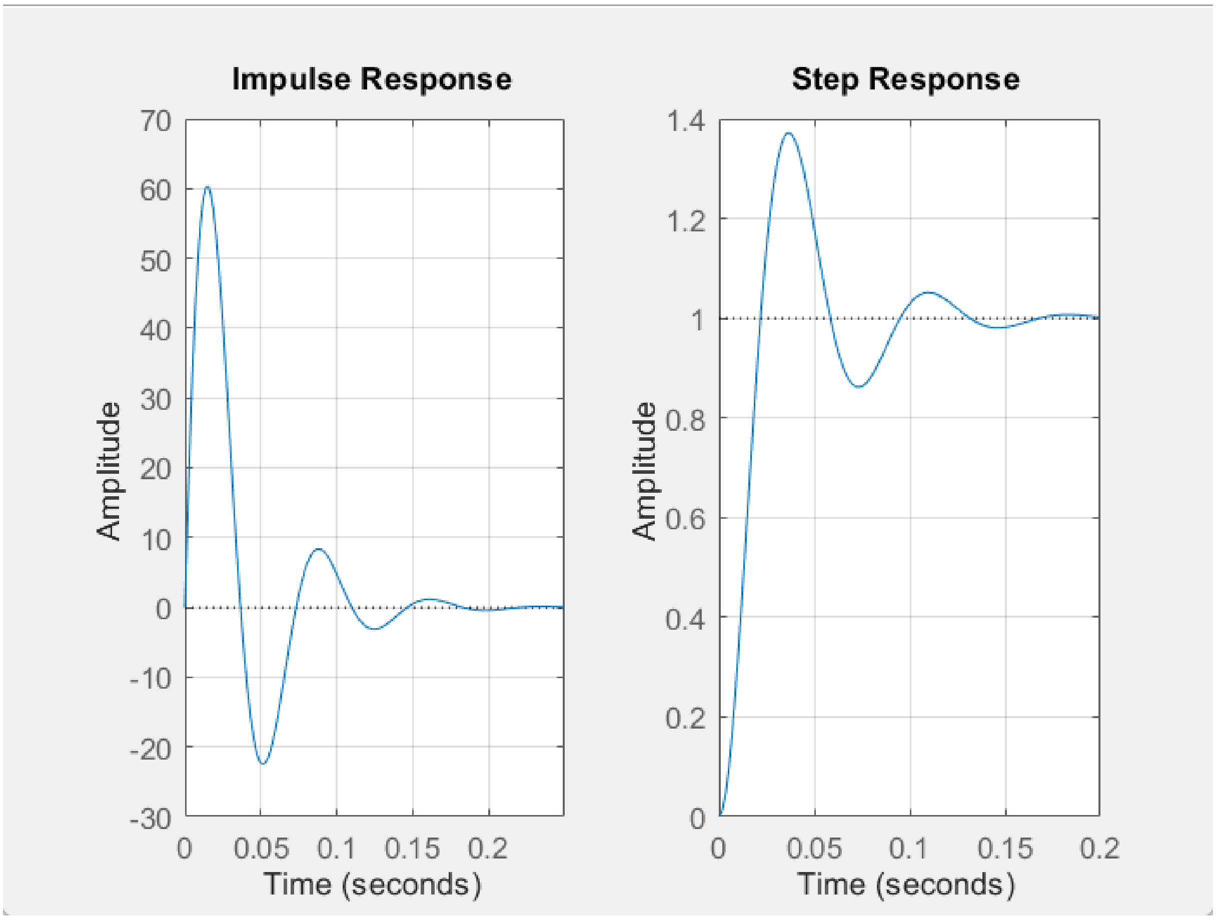

Figure 15: Underdamped Response at 90 Hz

At constant damping, increasing frequency results in faster oscillations and a quicker system response. Lower frequencies produce slower system movements and longer settling times.

Task 4: MATLAB SIMULINK

Q: Find the step and impulse response of second order system with natural frequency being last two digits of your roll number(55) and damping factor 0.5.

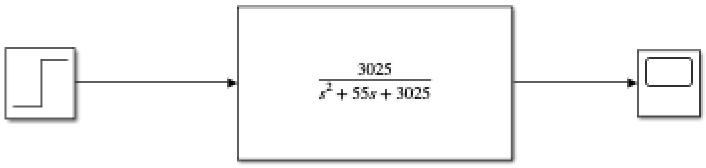

Figure 16: Step Response SIMULINK Block

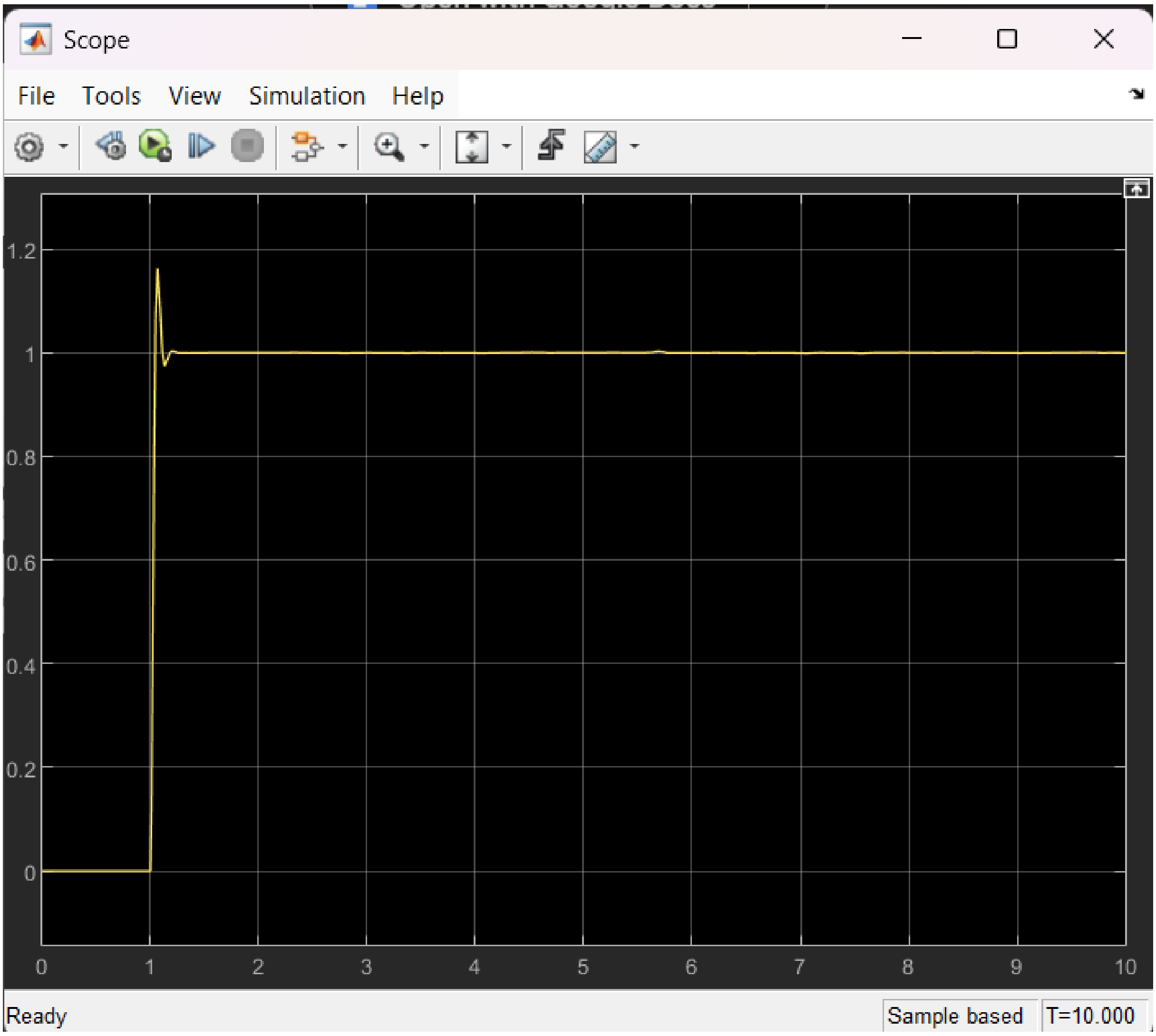

Figure 17: Step Response SIMULINK

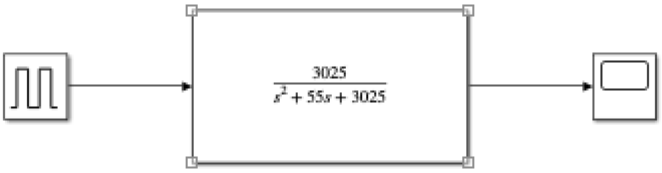

Figure 18: Impulse Response SIMULINK Block

Figure 19: Impulse Response SIMULINK Block

Conclusion

The lab successfully demonstrated the behavior of a second-order system to both step and impulse inputs using MATLAB and Simulink. System parameters like damping and frequency heavily influence time-domain responses like overshoot, rise time, and settling time.