Kathmandu University

Department of Computer Science and Engineering

Dhulikhel, Kavrepalanchowk

A Lab Report

on

"Control System"

Lab No: I & II

[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 learn to use MATLAB Models and SIMULINK

Theory:

Mathematical models are extremely important to understand the behaviour of system to be controlled, MATLAB serves as an excellent software tool to develop and analyze these models.

Task 1: Step Input Response

Editor - C:\Users\LOQ\Documents\MATLAB\CE_55_4.m

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

```matlab
%Lab-1: Mathematical modeling of a simple mass spring damper system
s=tf('s');
M=100; %kg
fv=300; %Nm
K=50; %N/m
F=100; %N

G=1/(M*s^2+fv*s+K);
step (G) ; %The default step input is of 1 amplitude
%xlabel ('Time (s)') ;
ylabel('Displacement(m)');

%Suppose I want to change the step input amplitude to F
opt = stepDataOptions('InputOffset',0,'StepAmplitude',F);
step (G, opt) ;
hold on; %command to make the graph wait to plot a new one in it
grid;
%To calculate the impact of another force too
opt = stepDataOptions('InputOffset',0,'StepAmplitude',110);
step(G,opt);
```

Figure 1: Step Input Response Code

This model represented a standard second-order system using a transfer function block. It was tested with a step input to observe time-domain characteristics such as rise time, overshoot, and settling behavior. This helped us understand how a second-order system responds to a sudden and sustained input.

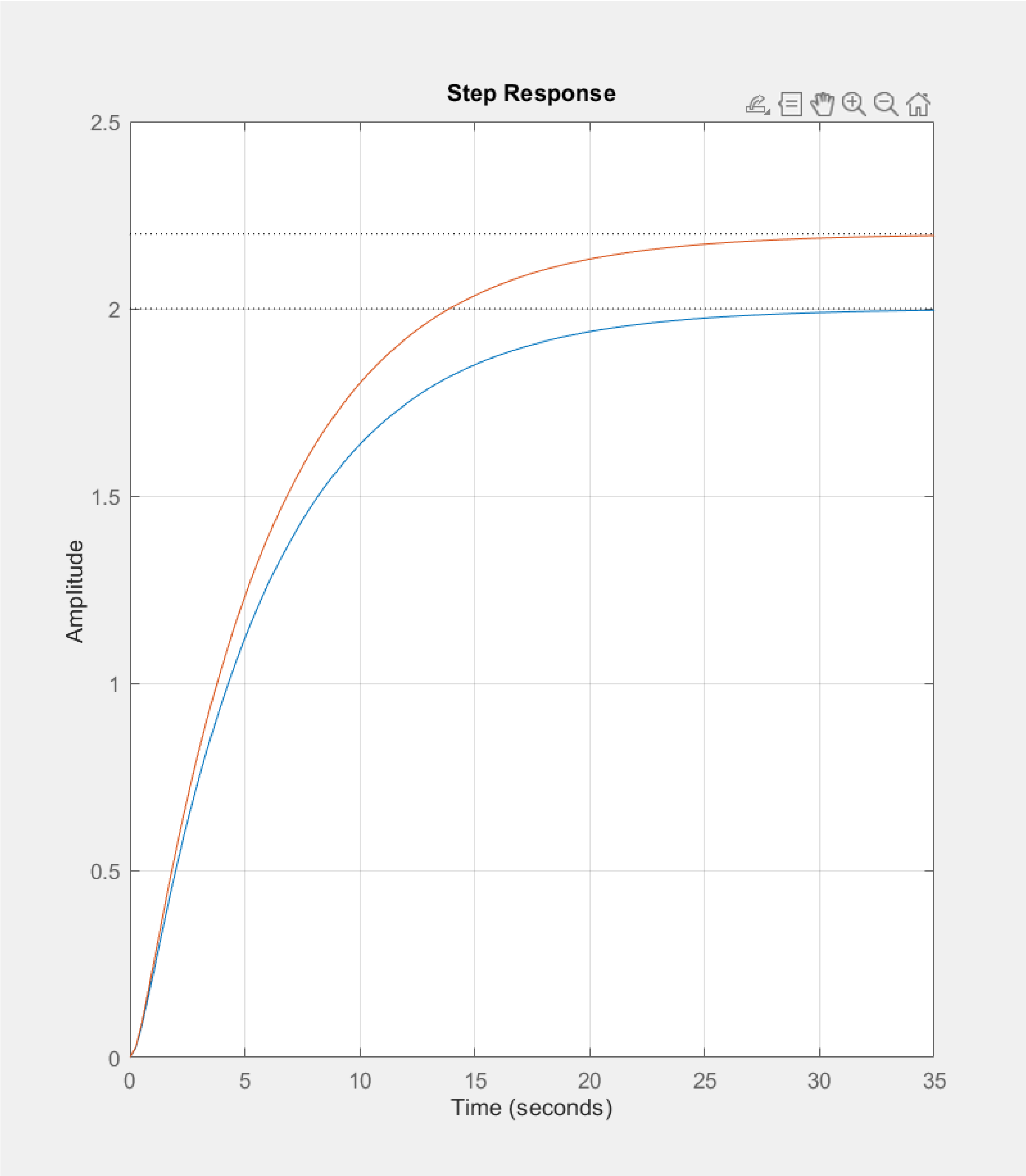


Figure 2: Step Input Response Output

Task 2: SIMULINK Execution

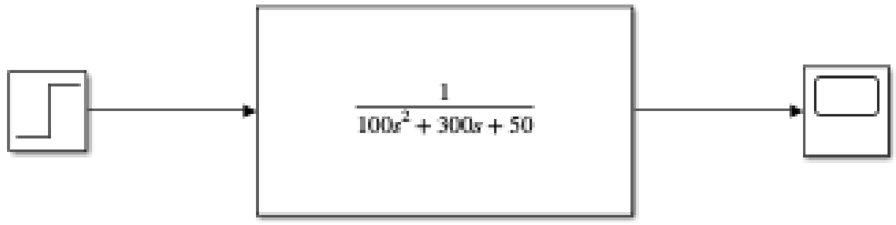


Figure 3: SIMULINK model

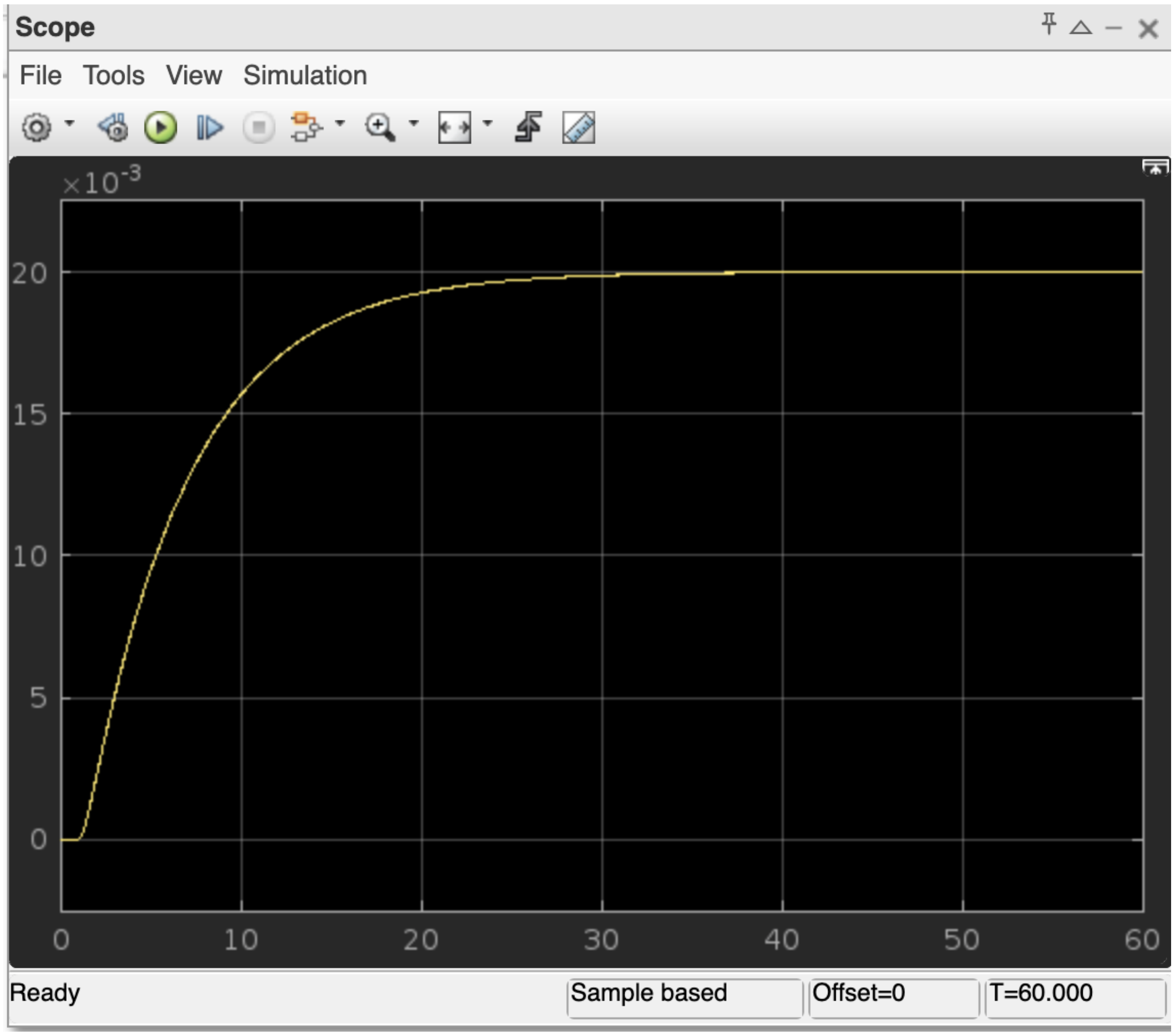


Figure 4: SIMULINK response

The second model used the same second-order system but with an **impulse input**, simulated using a short, high-amplitude pulse. This input represents a brief disturbance, allowing us to observe the system's **natural response** without continuous forcing. The output revealed key properties like damping and oscillation, helping us understand how the system reacts and stabilizes after a sudden shock.

Conclusion

This experiment helped us understand the dynamic behavior of control systems by modeling and simulating their responses in Simulink. Through step and impulse tests, we observed how parameters like damping and natural frequency influence system performance. The use of Simulink helped us to understand theoretical concepts and highlighted the value of simulation in control system analysis.

Kathmandu University

Department of Computer Science and Engineering

Dhulikhel, Kavrepalanchowk

A Lab Report
on
"Control System"
Lab No: I & II

[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 learn to use MATLAB Models and SIMULINK

Theory:

Mathematical models are extremely important to understand the behaviour of system to be controlled, MATLAB serves as an excellent software tool to develop and analyze these models.

Task 1: Step Input Response

Editor - C:\Users\LOQ\Documents\MATLAB\CE_55_4.m

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

```
%Lab-1: Mathematical modeling of a simple mass spring damper system
s=tf('s');
M=100; %kg
fv=300; %Nm
K=50; %N/m
F=100; %N

G=1/(M*s^2+fv*s+K);
step (G) ; %The default step input is of 1 amplitude
%xlabel ('Time (s)') ;
ylabel('Displacement(m)');

%Suppose I want to change the step input amplitude to F
opt = stepDataOptions('InputOffset',0,'StepAmplitude',F);
step (G, opt) ;
hold on; %command to make the graph wait to plot a new one in it
grid;
%To calculate the impact of another force too
opt = stepDataOptions('InputOffset',0,'StepAmplitude',110);
step(G,opt);
```

Figure 1: Step Input Response Code

This model represented a standard second-order system using a transfer function block. It was tested with a step input to observe time-domain characteristics such as rise time, overshoot, and settling behavior. This helped us understand how a second-order system responds to a sudden and sustained input.

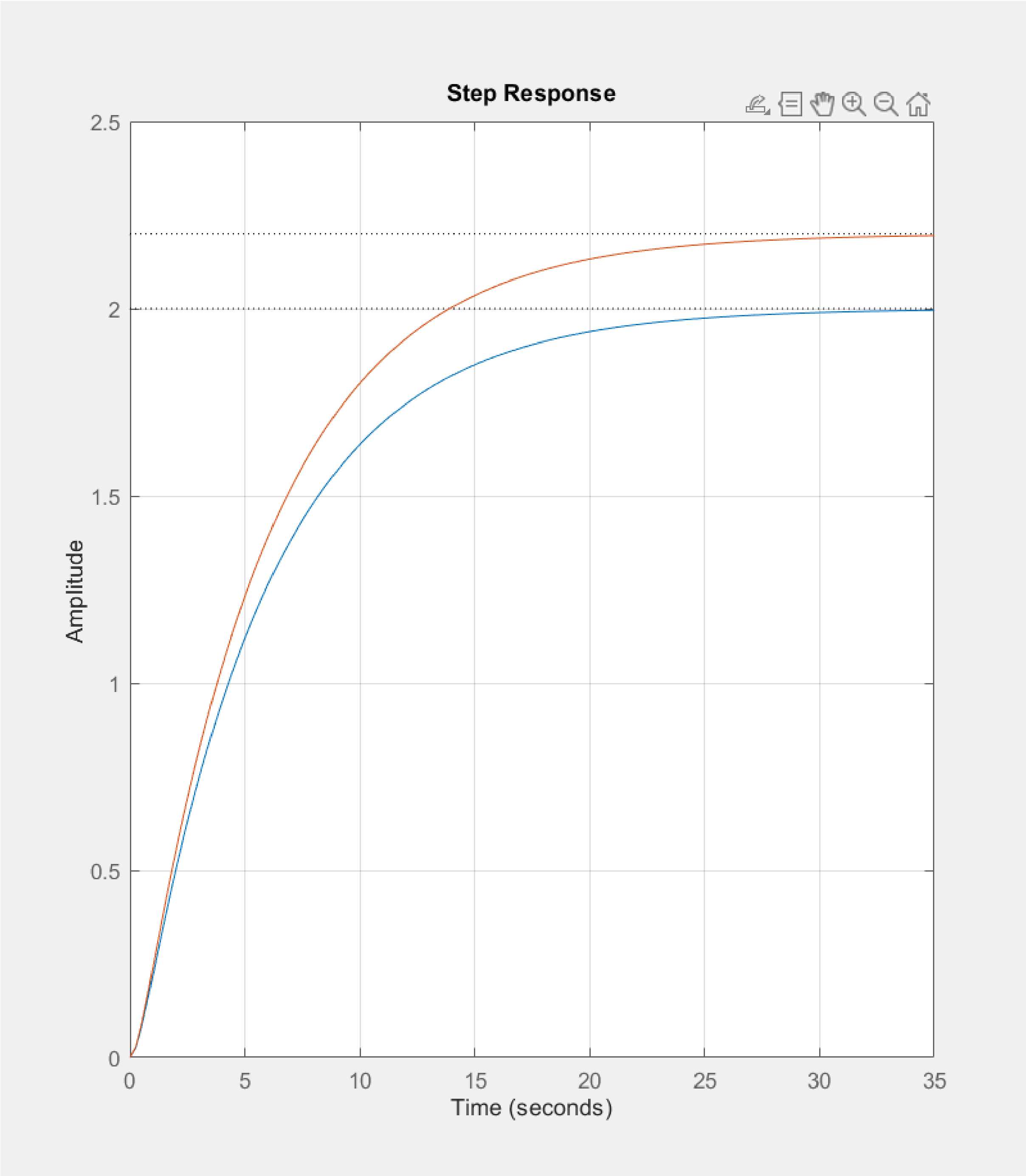


Figure 2: Step Input Response Output

Task 2: SIMULINK Execution

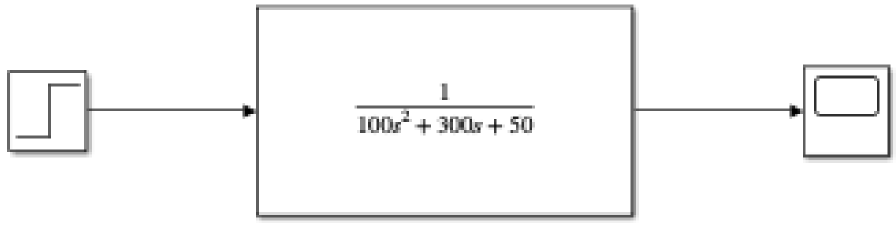


Figure 3: SIMULINK model

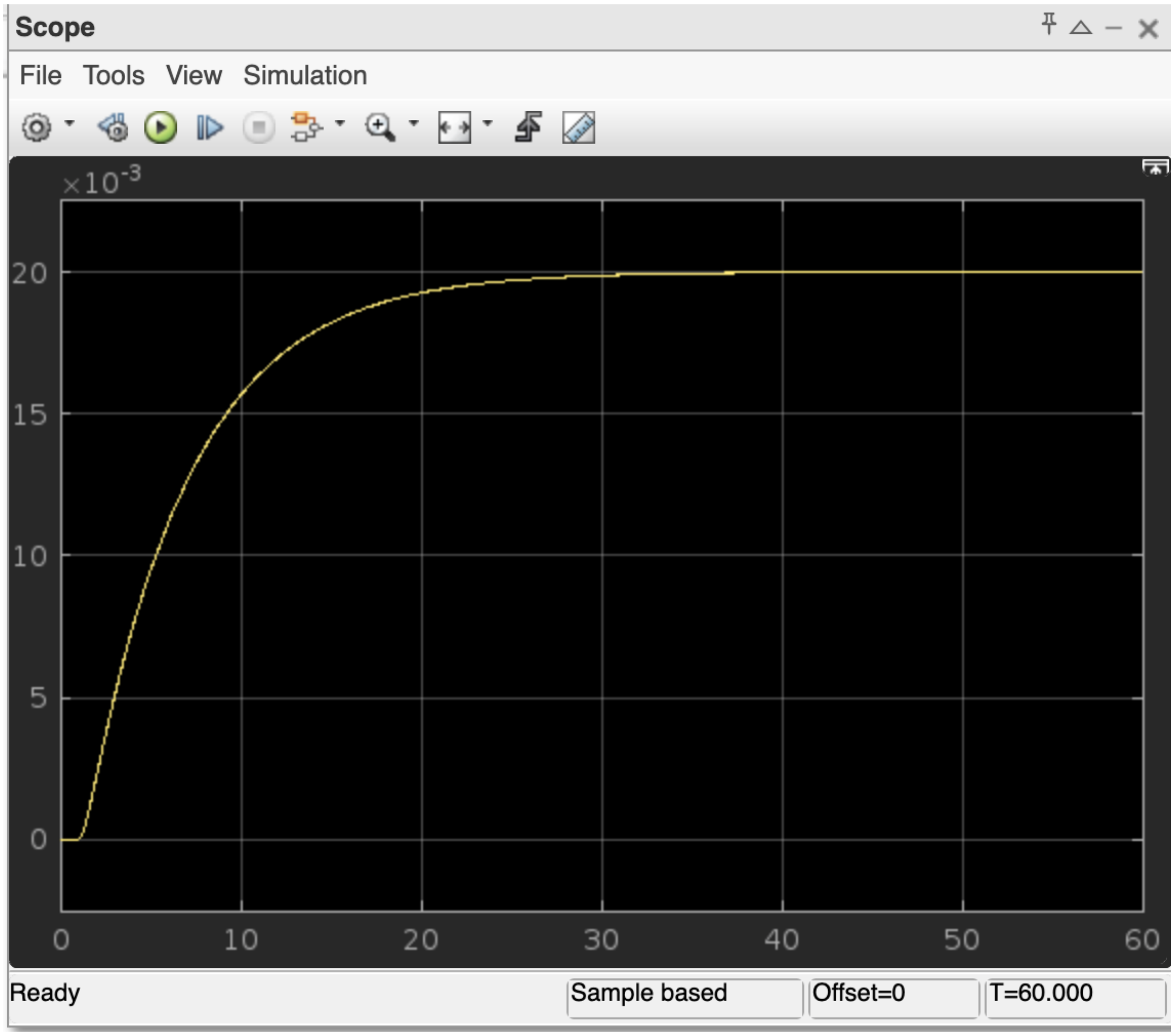


Figure 4: SIMULINK response

The second model used the same second-order system but with an **impulse input**, simulated using a short, high-amplitude pulse. This input represents a brief disturbance, allowing us to observe the system's **natural response** without continuous forcing. The output revealed key properties like damping and oscillation, helping us understand how the system reacts and stabilizes after a sudden shock.

Conclusion

This experiment helped us understand the dynamic behavior of control systems by modeling and simulating their responses in Simulink. Through step and impulse tests, we observed how parameters like damping and natural frequency influence system performance. The use of Simulink helped us to understand theoretical concepts and highlighted the value of simulation in control system analysis.

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

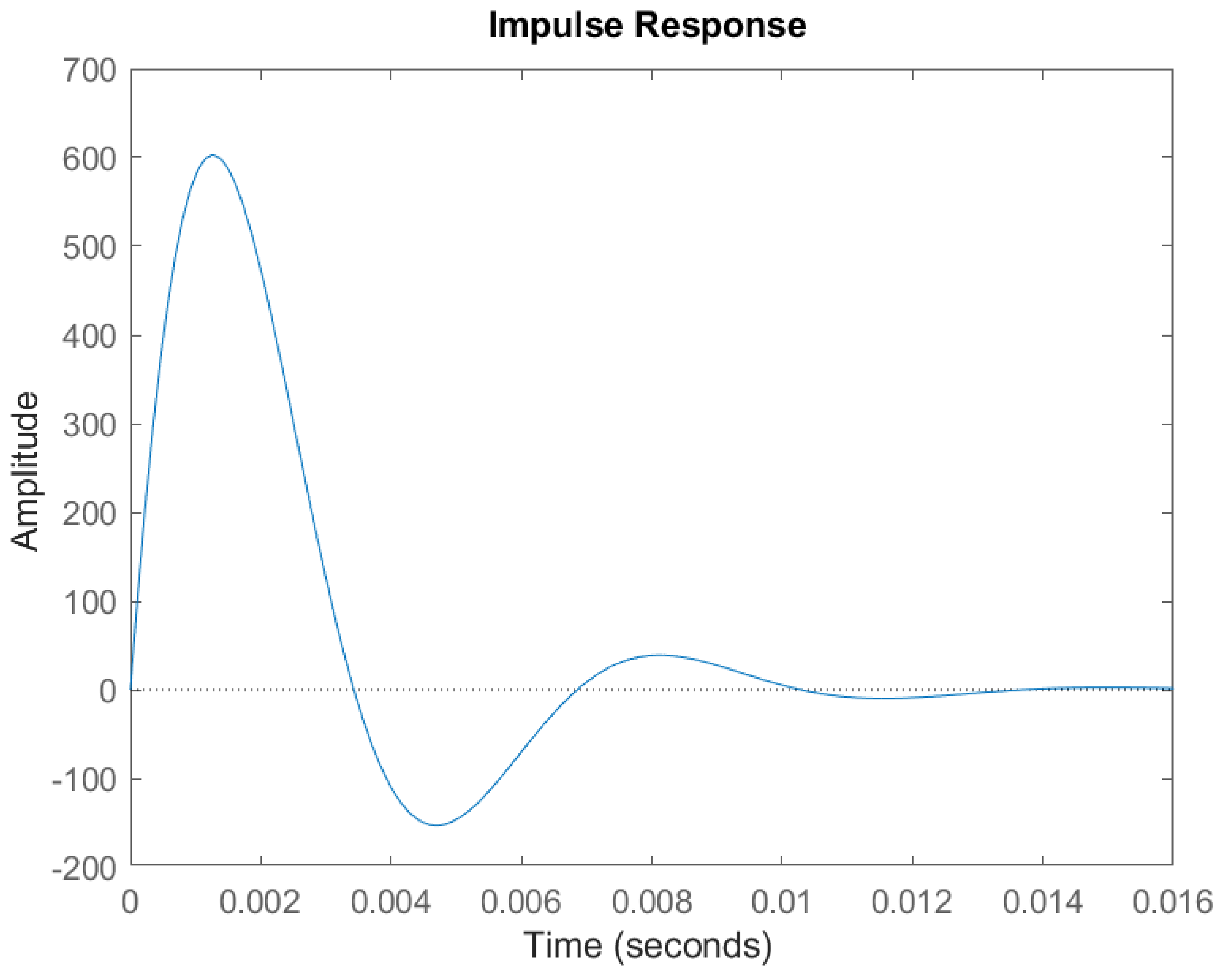


Figure 2: Underdamped Impulse Response

For frequency = 1000 Hz, Damping Factor = 1

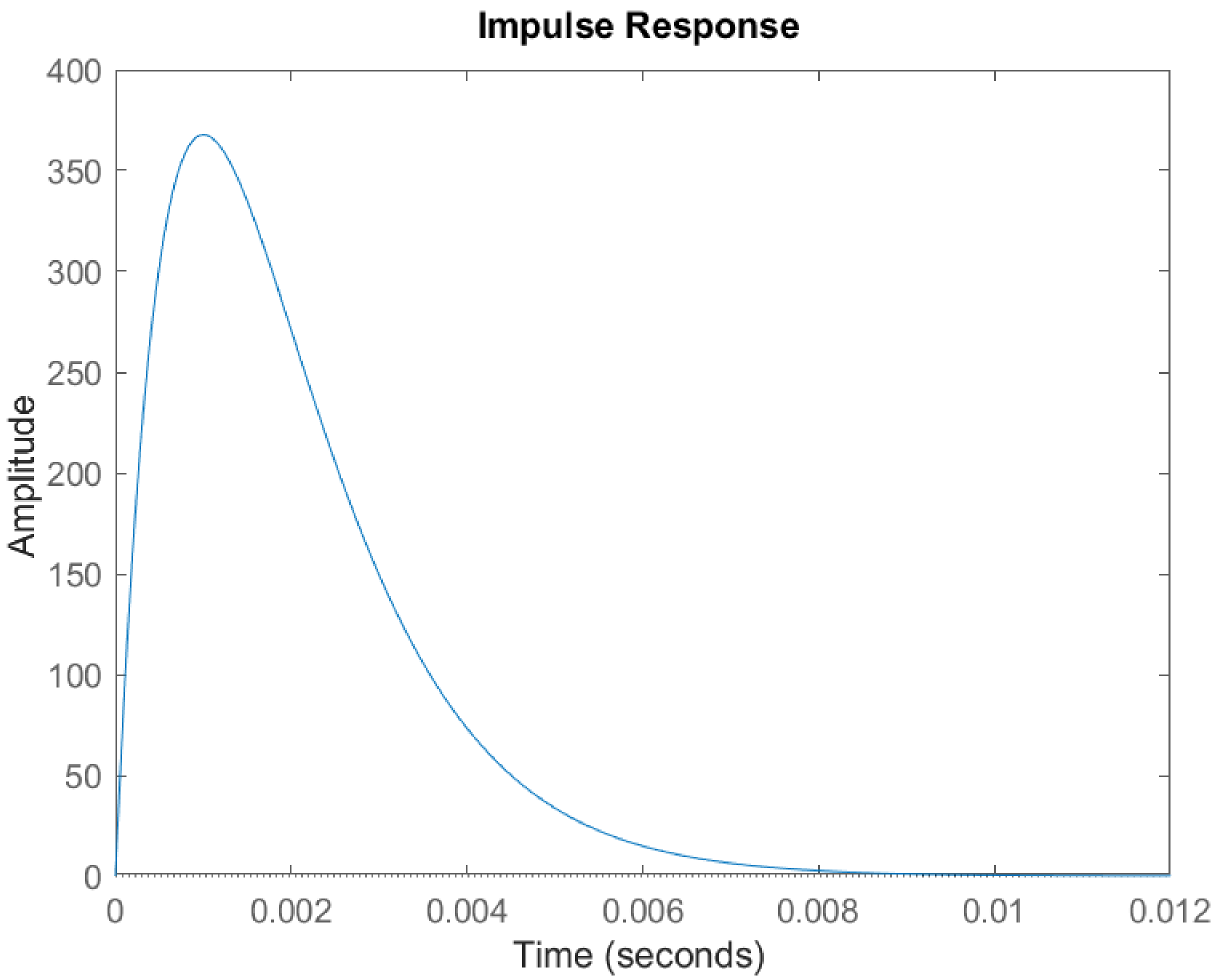


Figure 3: Critically Damped Response

For Frequency = 1000 Hz, Damping Factor = 1.4

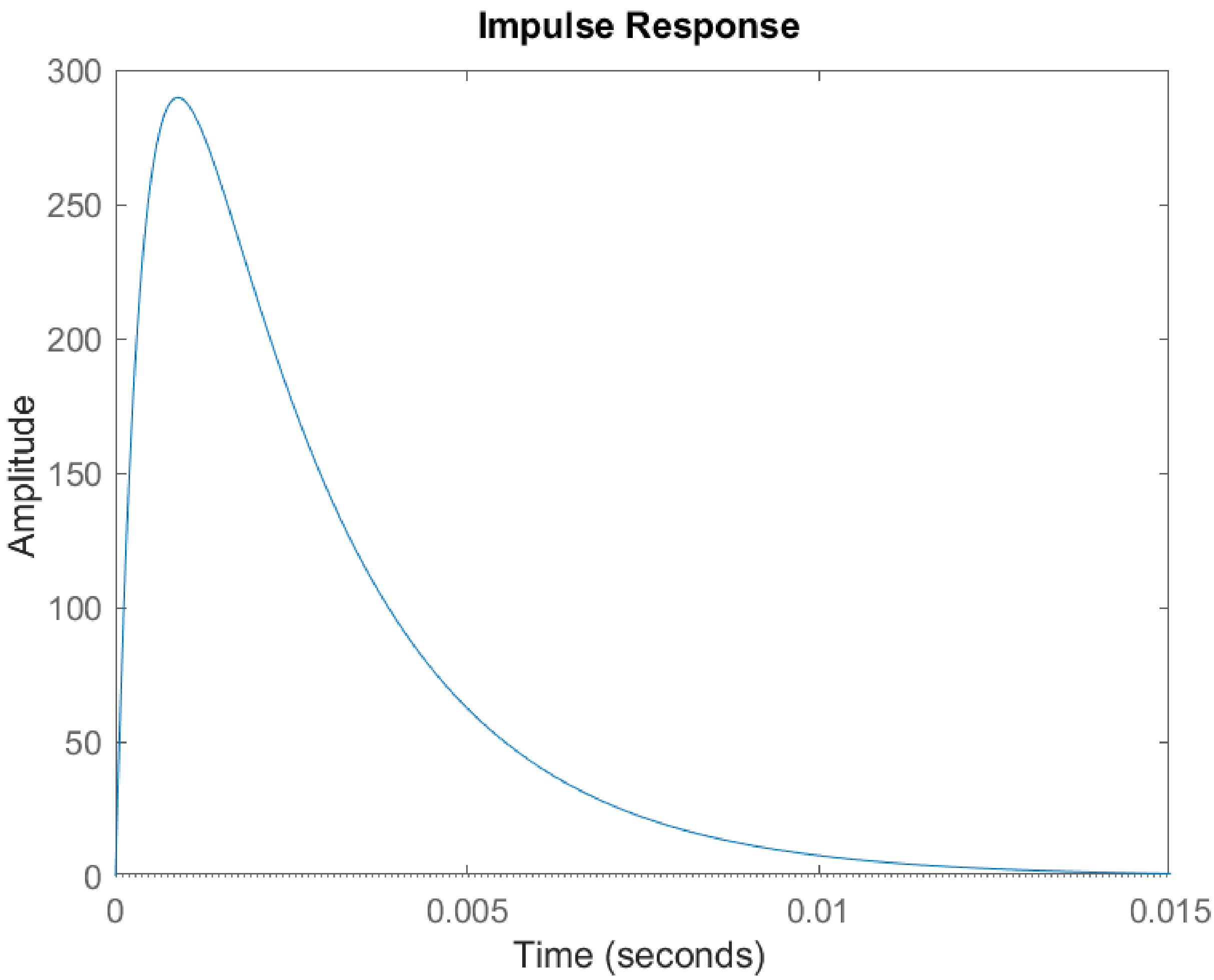
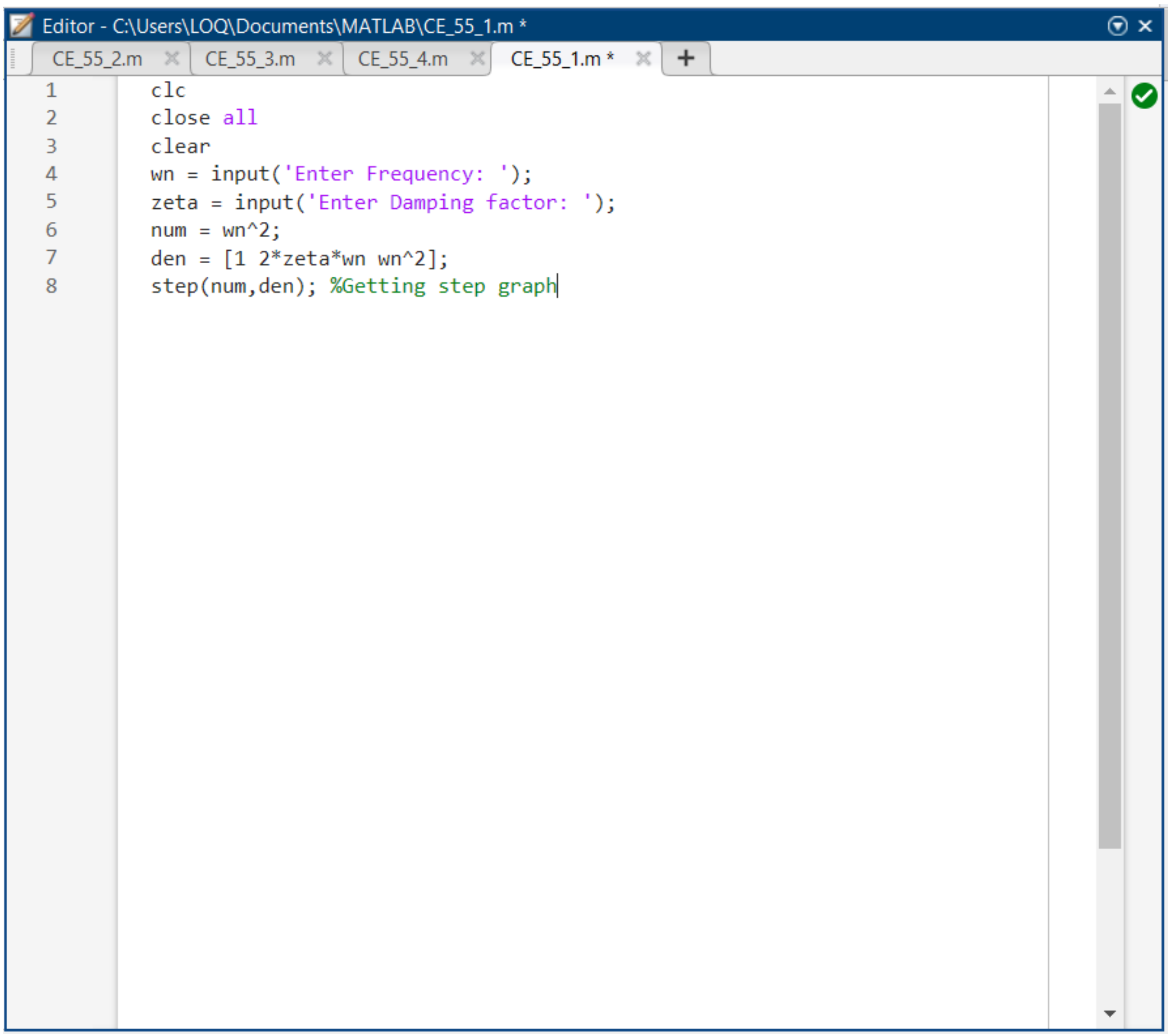


Figure 4: Overdamped Impulse Response

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

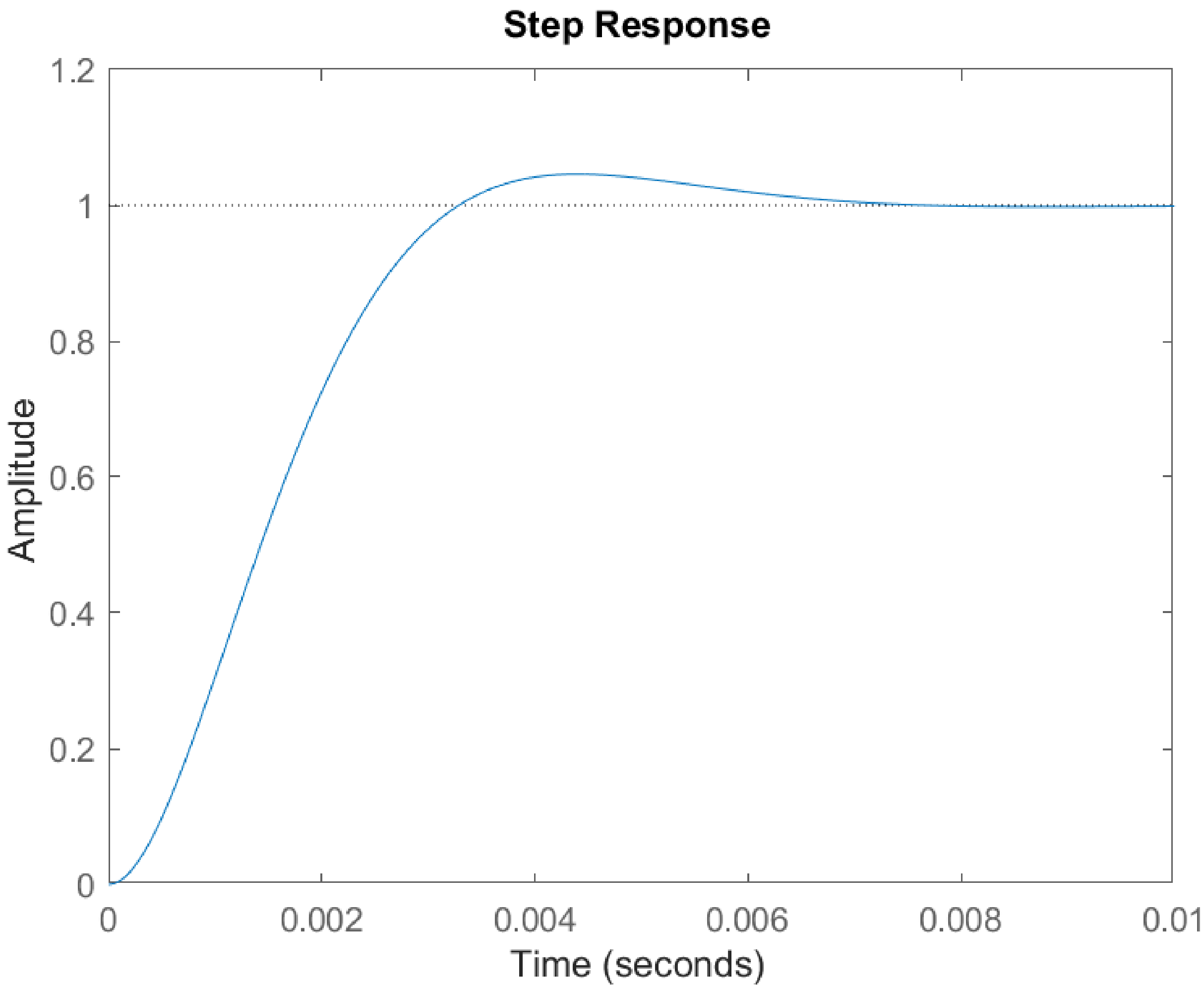


Figure 6: Underdamped Step Response

For Frequency = 1000 Hz, Damping Factor = 1

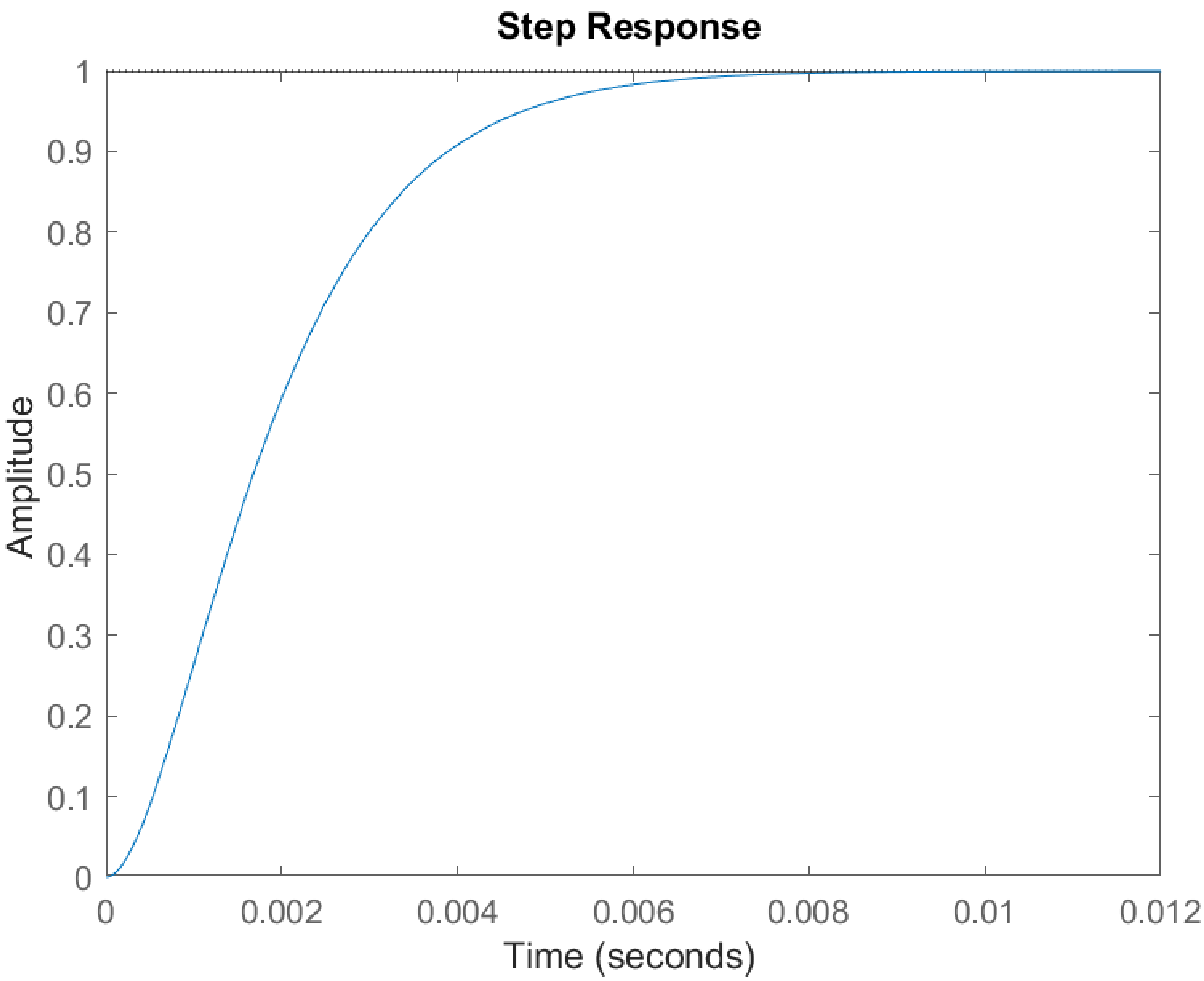


Figure 7: Critically Damped Step Response

For Frequency = 1000 Hz, Damping Factor = 1.7

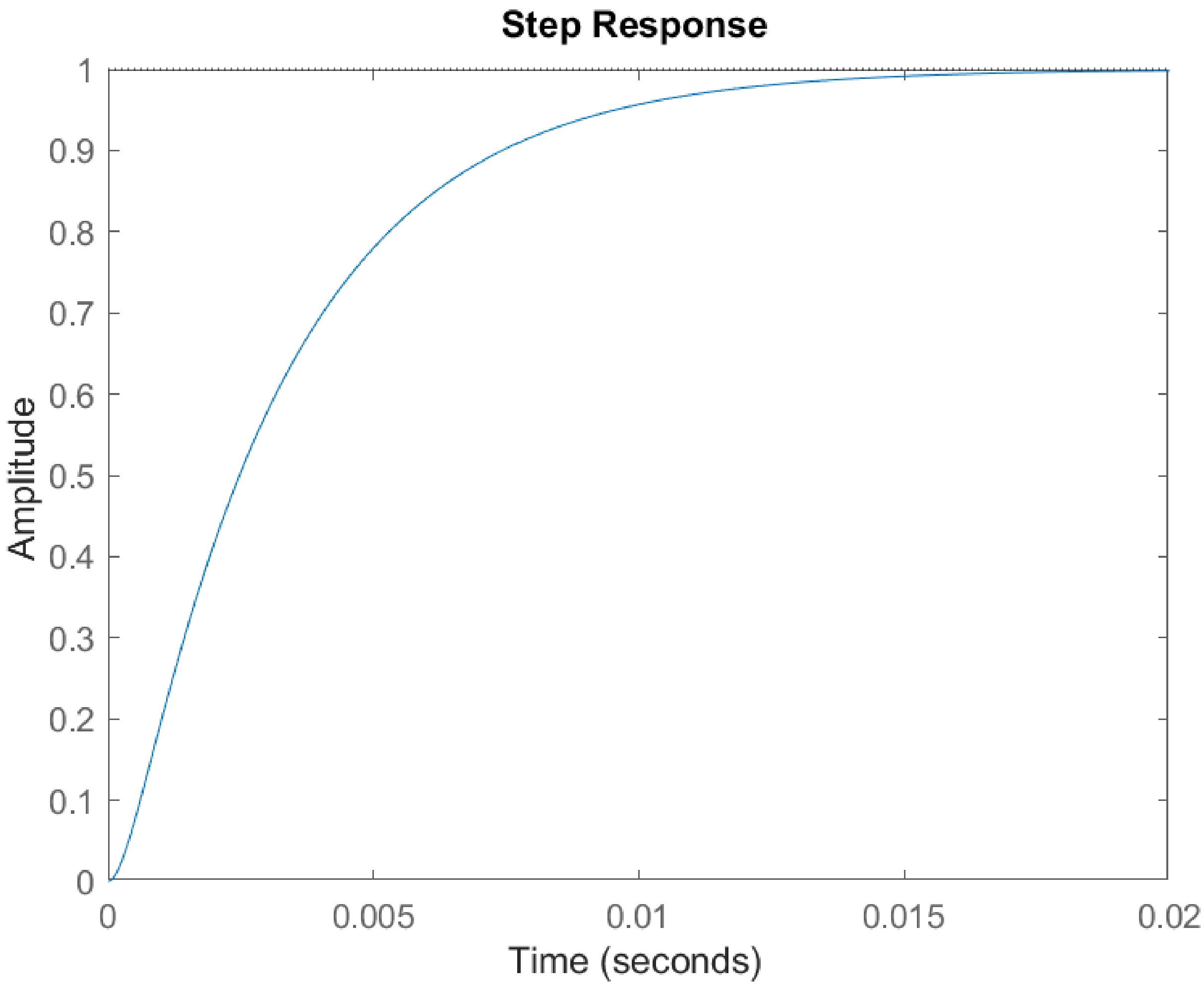


Figure 8: Overdamped Step Response

Task 3: Impulse/Step Response of System

Editor - C:\Users\LOQ\Documents\MATLAB\CE_55_3.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];
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

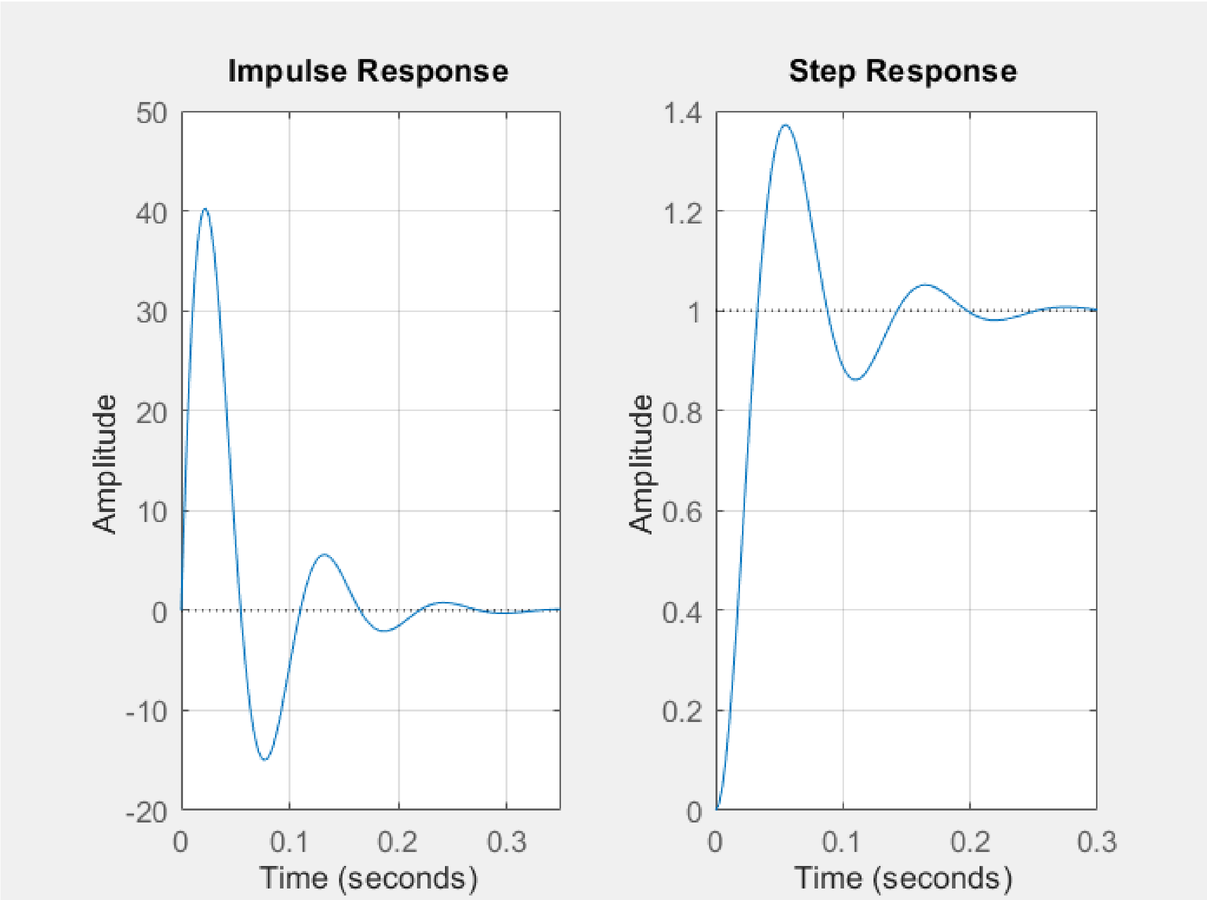


Figure 10: Underdamped Response

For Frequency = 60 Hz, Damping Factor = 1

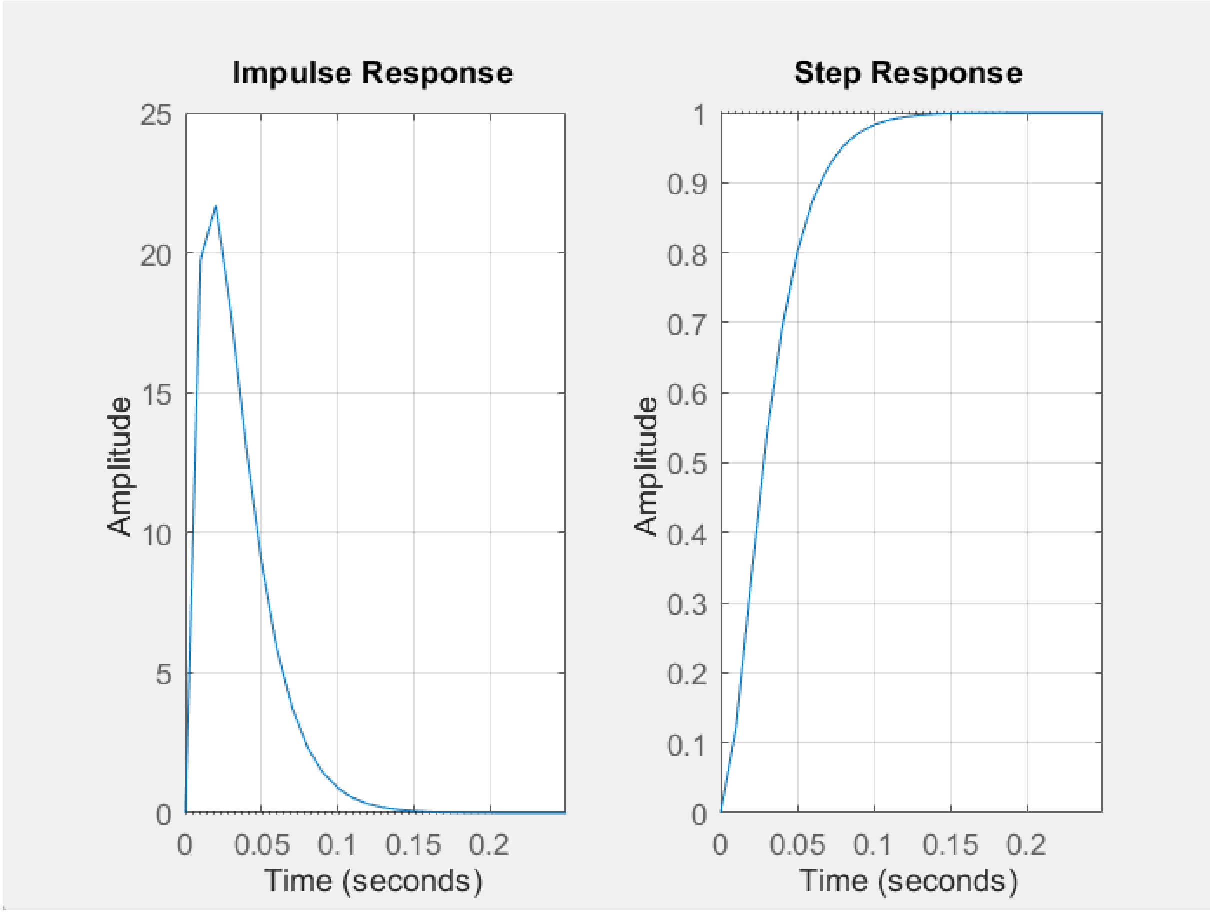


Figure 11: Critically Damped Response

For Frequency = 60 Hz, Damping Factor = 2.3

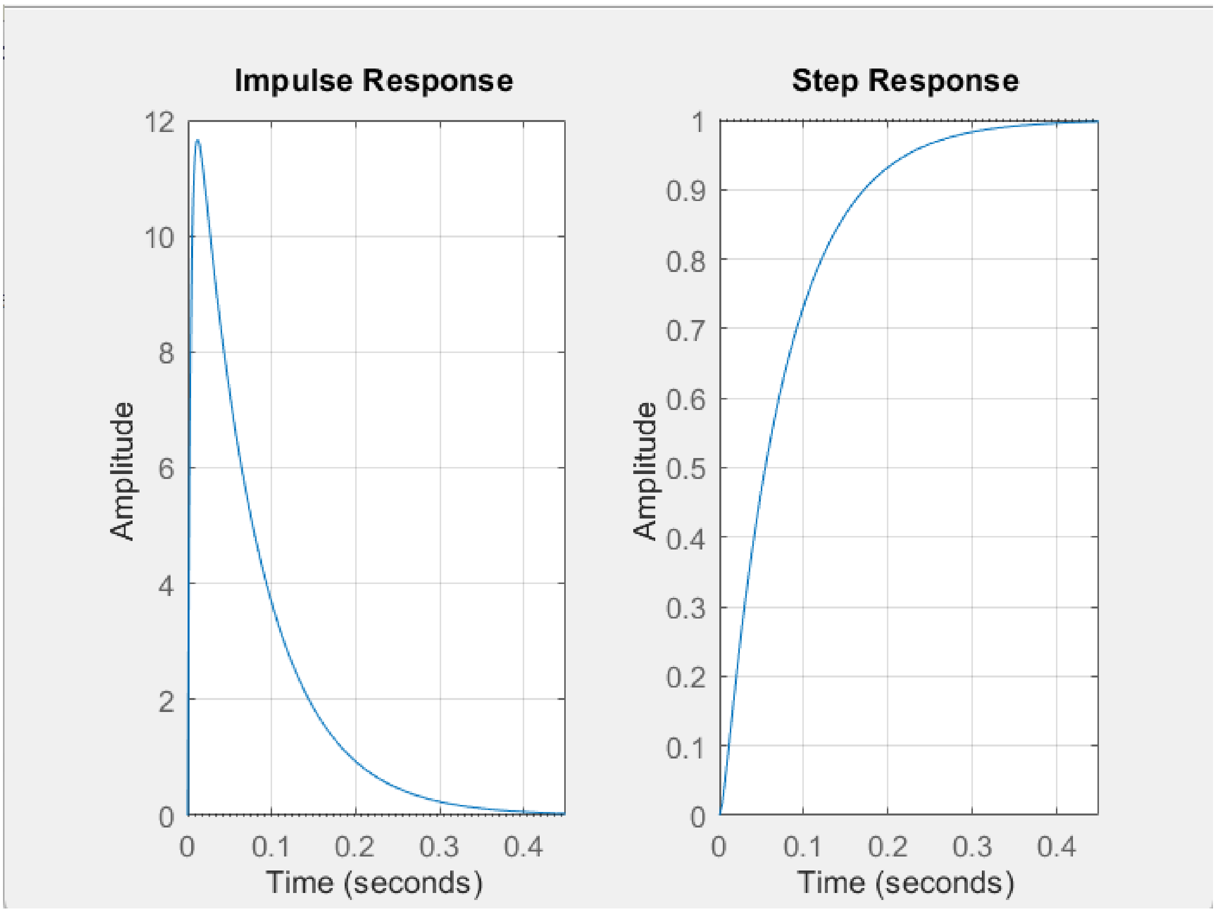


Figure 12: Overdamped Response

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

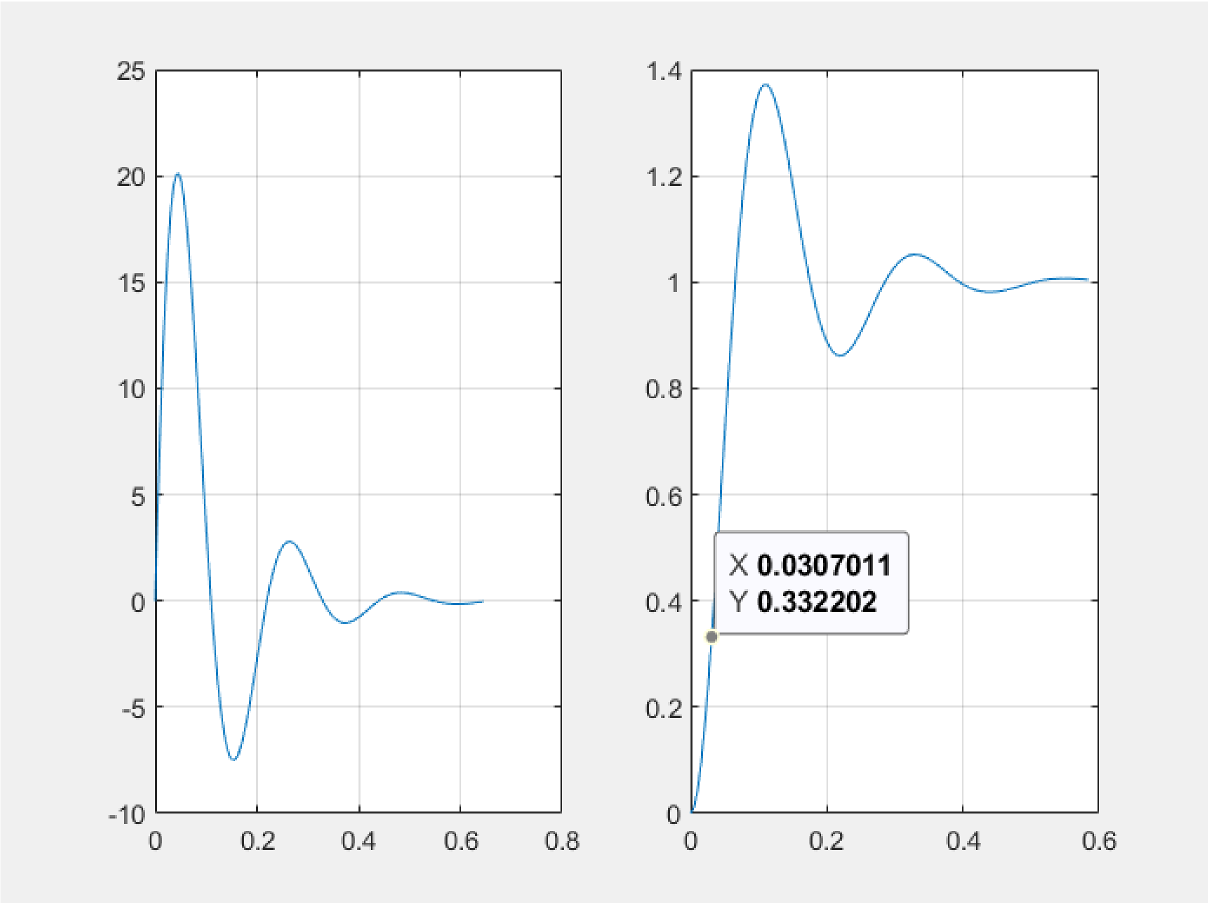


Figure 13: Underdamped Response at 30Hz

For Frequency = 60 Hz, Damping Factor = 0.3

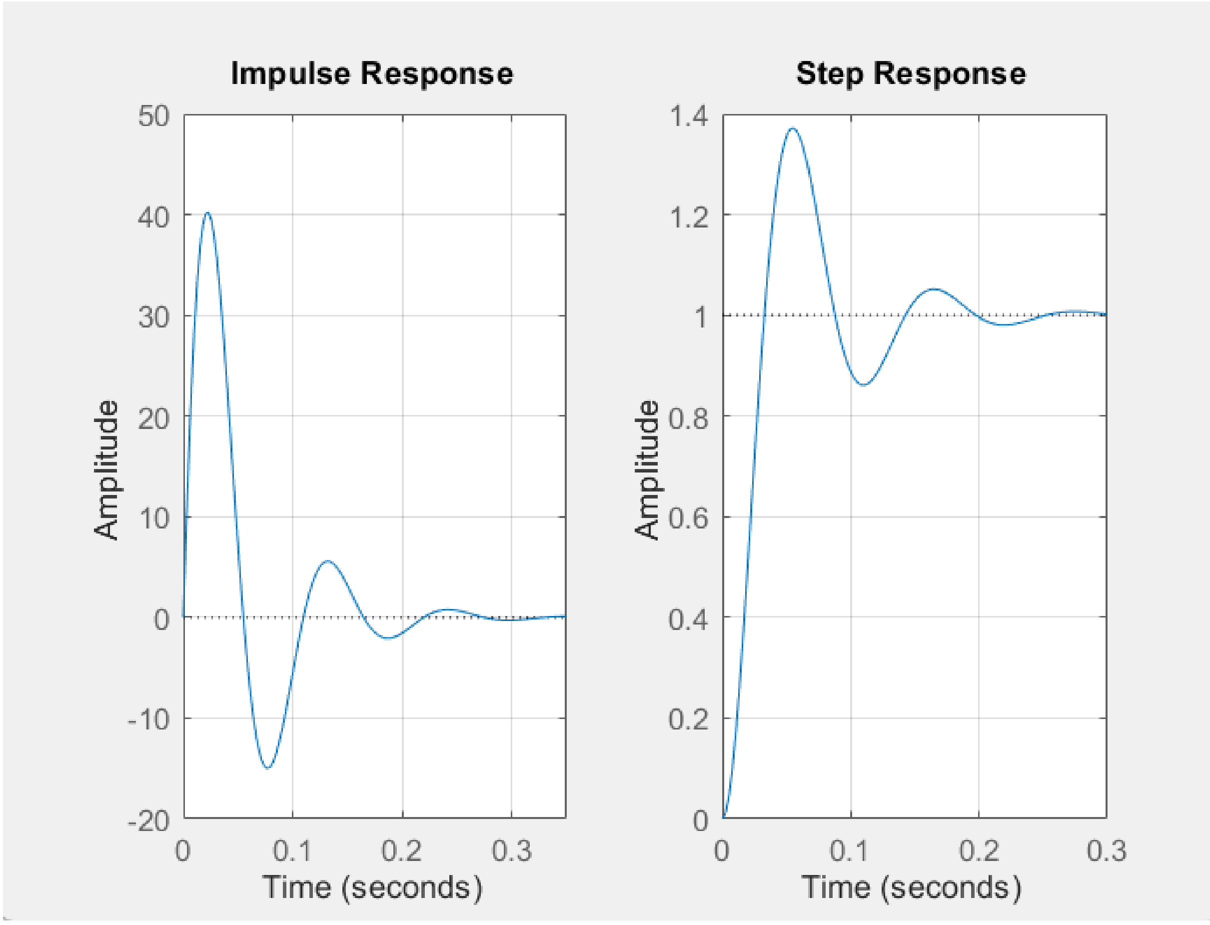


Figure 14: Underdamped Response at 60Hz

For Frequency = 90 Hz, Damping Factor = 0.3

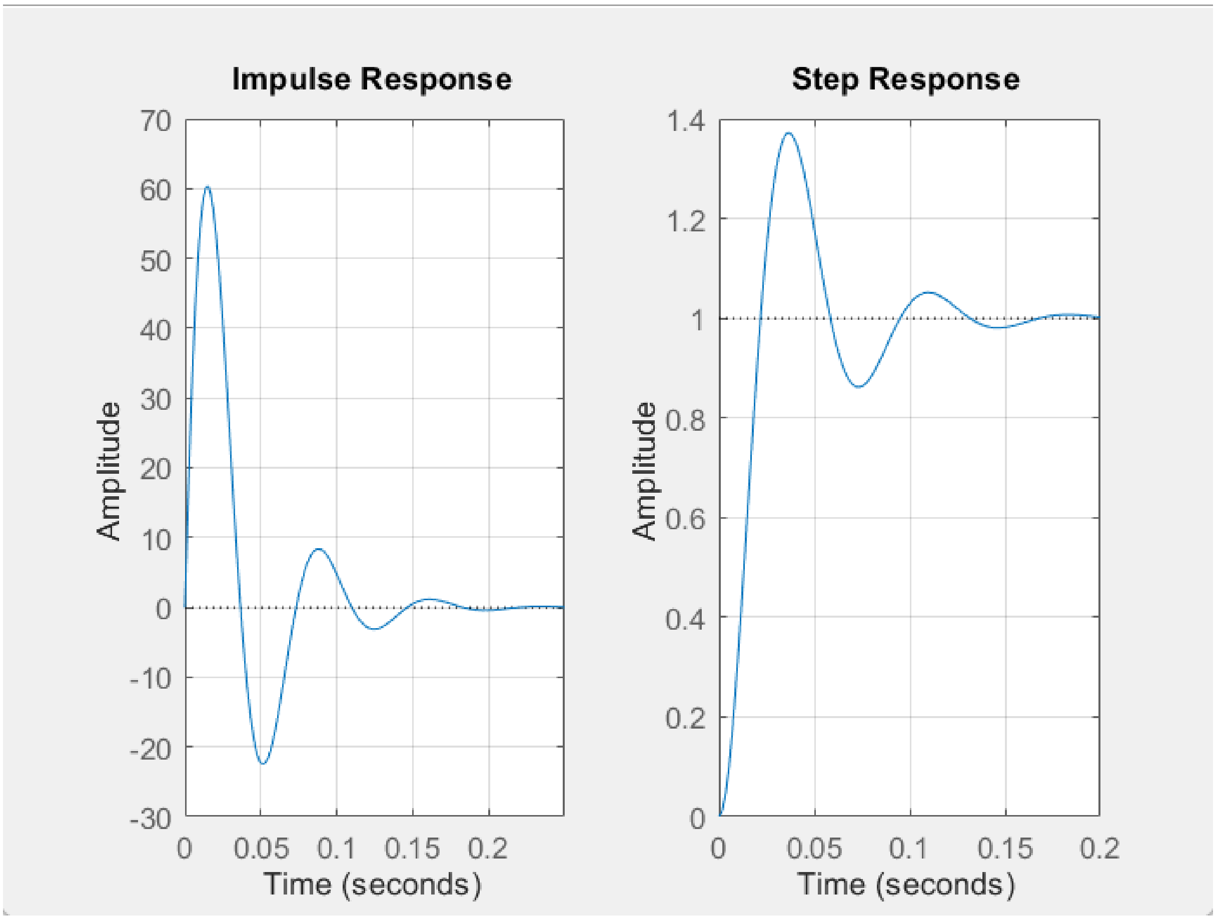


Figure 15: Underdamped Response at 90 Hz

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.

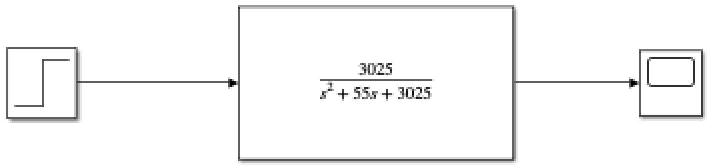


Figure 16: Step Response SIMULINK Block

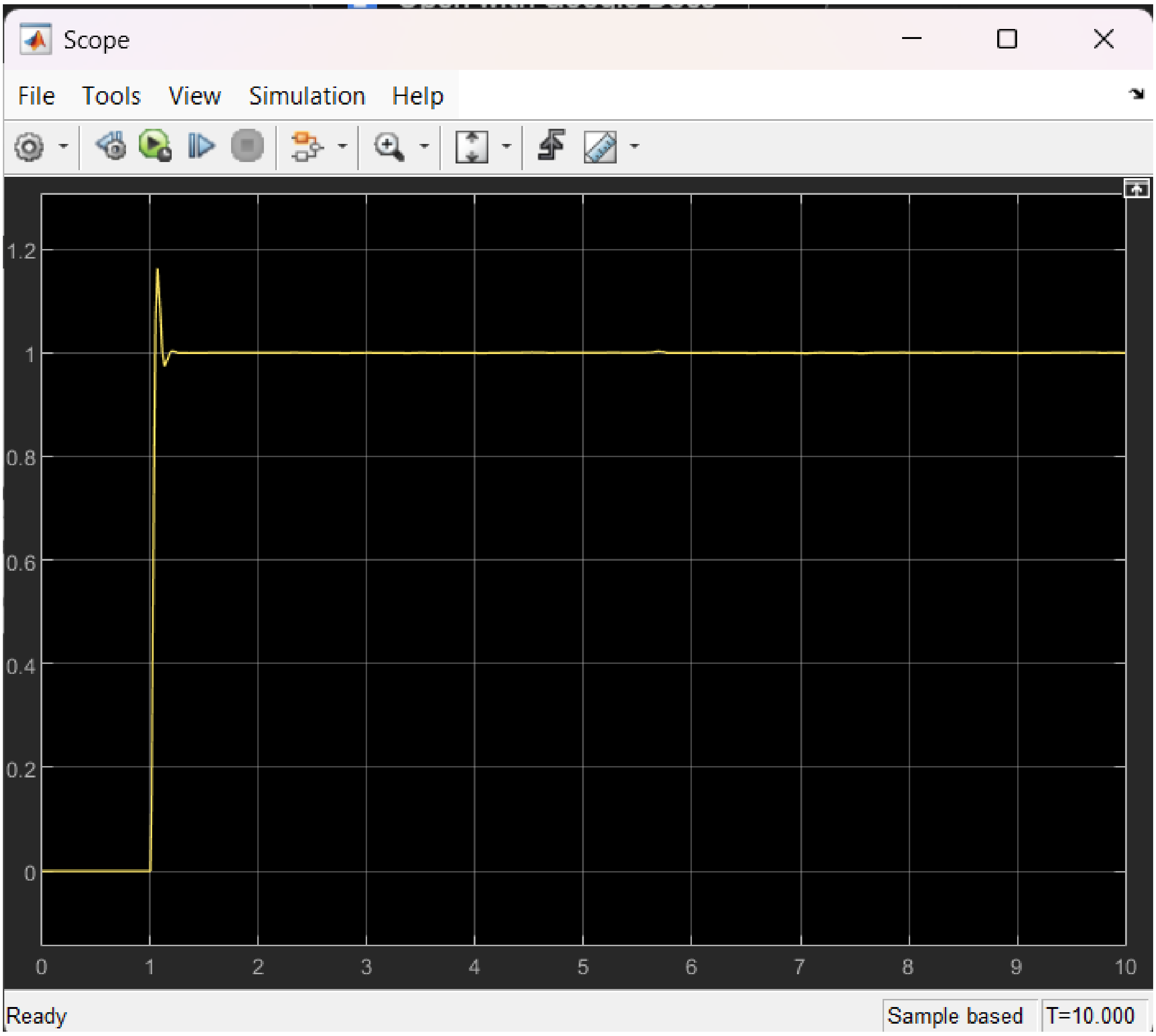


Figure 17: Step Response SIMULINK

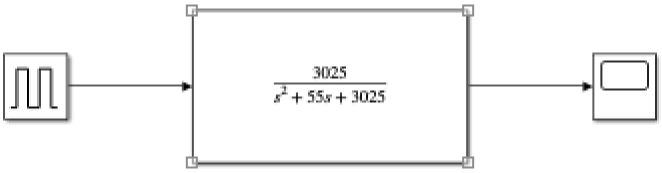


Figure 18: Impulse Response SIMULINK Block

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.