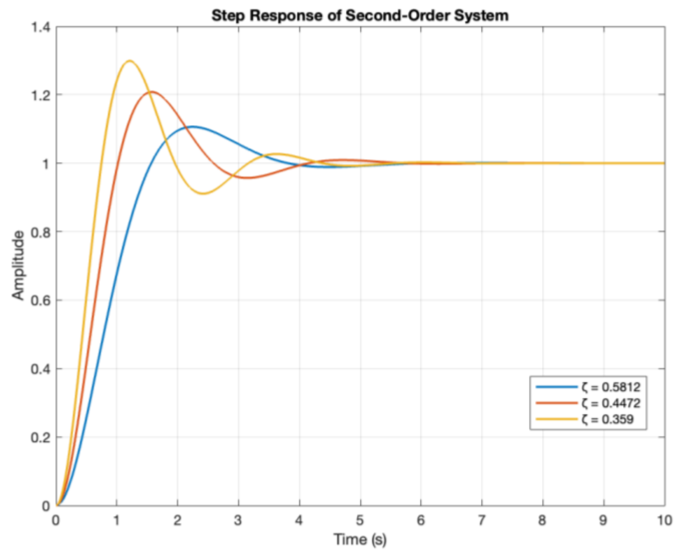
EE3331C Feedback Control Systems Assignment 1

Code

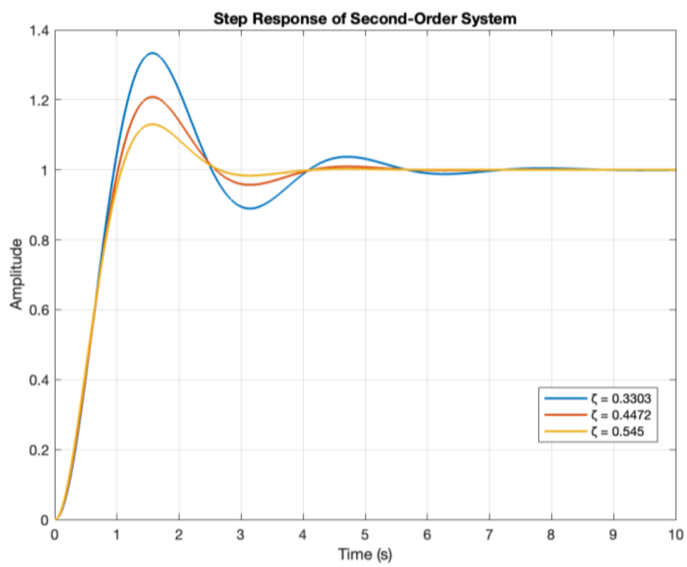
```
%% SET MODE!
% a=1   b=2   c=3
MODE = 1;

% Define constants
syms s
a = 1;
b = 2;
c = 1;

% Set up system vars
if MODE == 1
    a_values = [a, a, a];
    b_values = [0.7*b, 1*b, 1.3*b];

    wn_results = zeros(1, 3);
    zeta_results = zeros(1, 3);
elseif MODE == 2
    a_values = [0.7*a, 1*a, 1.3*a];
    b_values = [b, b, b];

    wn_results = zeros(1, 3);
    zeta_results = zeros(1, 3);
elseif MODE == 3
    a_values = [a, a, a];
    b_values = [b, b, b];
    wn_values = [0.7*b, 1*b, 1.3*b];
    zeta = 0.1*a;

    wn_results = zeros(1, 3);
    zeta_results = zeros(1, 3);
end

% Solve for wn and zeta
for i = 1:3
    if MODE == 3
        term1 = s + zeta*wn_values(i) + wn_values(i)*sqrt(1-zeta^2)*1i;
        term2 = s + zeta*wn_values(i) - wn_values(i)*sqrt(1-zeta^2)*1i;
    else
        term1 = s + a_values(i) + b_values(i)*1i;
        term2 = s + a_values(i) - b_values(i)*1i;
    end

    % Multiply the terms
    result = term1 * term2;

    % Expand resulting polynomial
    expanded_result = expand(result);
```

```matlab
    % Get coefficients for x^1 and x^0
    coeffs_result = coeffs(expanded_result);
    coeff_x1 = coeffs_result(2);
    coeff_x0 = coeffs_result(1);

    % Calculate and store wn and zeta
    wn_results(i) = sqrt(coeff_x0);
    zeta_results(i) = coeff_x1 / (2 * wn_results(i));
end

% Create a time vector for simulation and a figure for plotting
t = 0:0.01:10;
figure;

% Loop through values of wn and zeta
for i = 1:3

    % Local vars
    zeta = zeta_results(i);
    wn = wn_results(i);
    K = c * wn;

    % Calculate the closed-loop transfer function
    num = K * wn;
    den = [1, 2 * zeta * wn, wn * wn];
    sys = tf(num, den);

    % Simulate the step response
    y = step(sys, t);

    % Plot the step response
    plot(t, y, 'LineWidth', 1.5, 'DisplayName', ['ζ = ', num2str(zeta)]);
    hold on;
end

% Format the figure
xlabel('Time (s)');
ylabel('Amplitude');
title('Step Response of Second-Order System');
legend('Location', 'best');
grid on;
hold off;
```

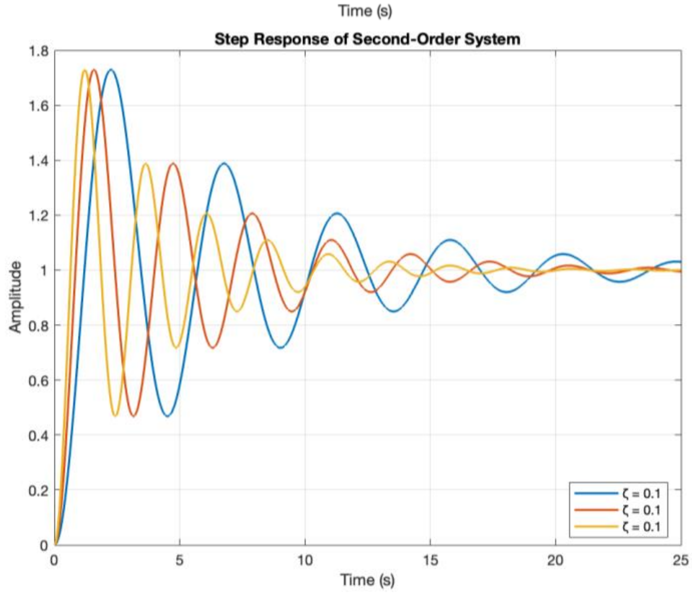
Plots


Step Response of Second-Order System
Amplitude
Time (s)
ζ = 0.5812
ζ = 0.4472
ζ = 0.359

a


Step Response of Second-Order System
Amplitude
Time (s)
ζ = 0.3303
ζ = 0.4472
ζ = 0.545

b


Step Response of Second-Order System
Amplitude
Time (s)
ζ = 0.1
ζ = 0.1
ζ = 0.1

c