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Krzysztof Smykla

Lab 2 Report

Problem 1 – Discrete Time Signal:

Generate the discrete function

y[n] = 1.90 * y[n - 1] – y[n - 2]

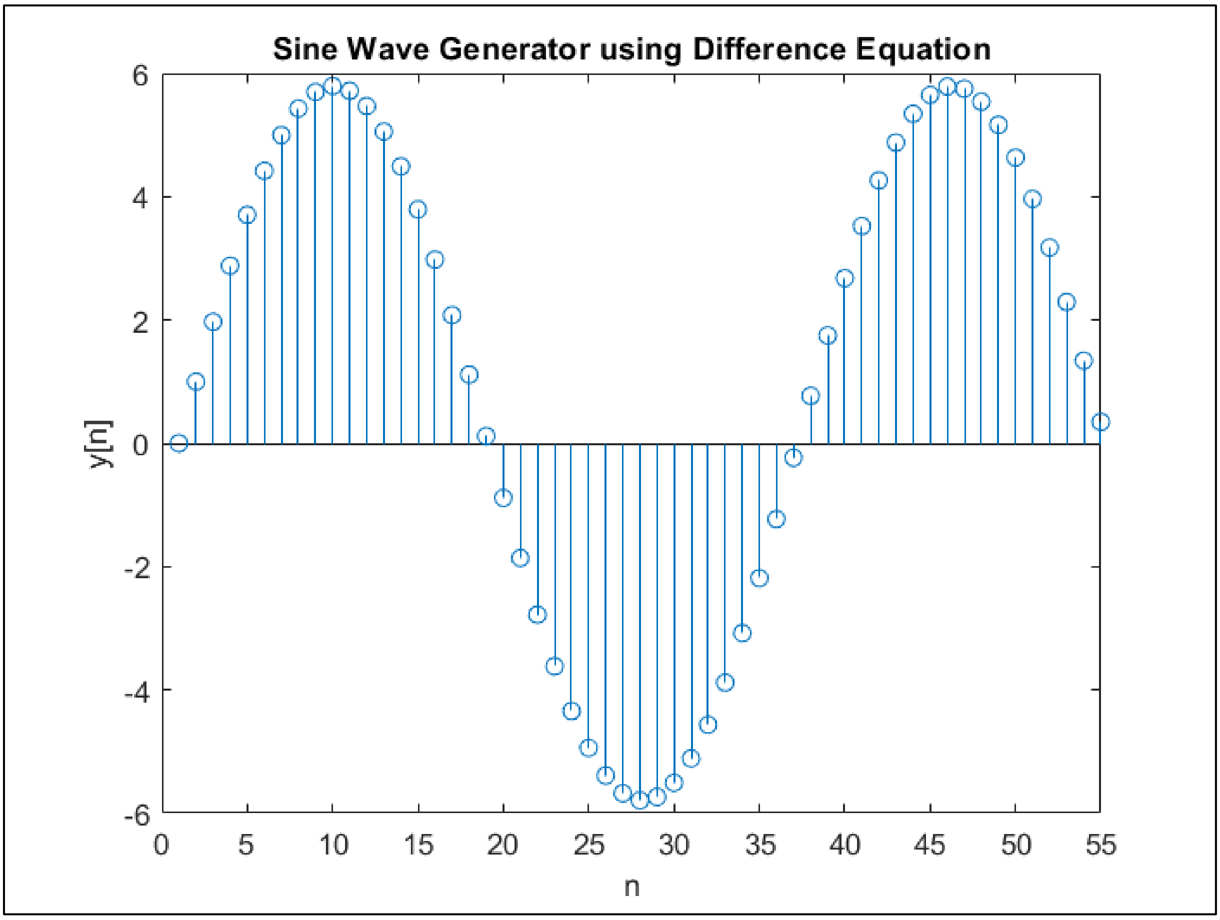
Plot the result (using the stem() command) with the initial conditions y[1] = 1 and y[0] = 0.

Solution:

I generated the discrete signal using the difference equation
y[n] = 1.90 * y[n - 1] – y[n – 2], which works by recursively calculating the values of function y.

Plotting the equation generates the following graph:

Fig. 1



MATLAB Code:

```
% A1.2

% y[n] = 1.90*y[n-1]-y[n-2]

clc, clearvars



y = [0, 1, zeros(1, 98)];





for n = 3:100

    y(n) = 1.90*y(n-1) - y(n-2);

end



figure(2)

stem(1:100, y);

xlabel('n')     % Label for x-axis

ylabel('y[n]')  % Label for y-axis

title('Sine Wave Generator using Difference Equation')

axis([0,55,-6, 6])
```

Problem 2 - Feedback System:

The response y[n] is fed back through two delays and gains b and c and combined with the excitation x[n].

Use MATLAB to generate discrete feedback systems with different parameters a, b and c, plot results.

Solution:

I used the general form of a second-order difference equation:

y[n] = a*x[n] + b*y[n-1] + c*y[n-2] (1)

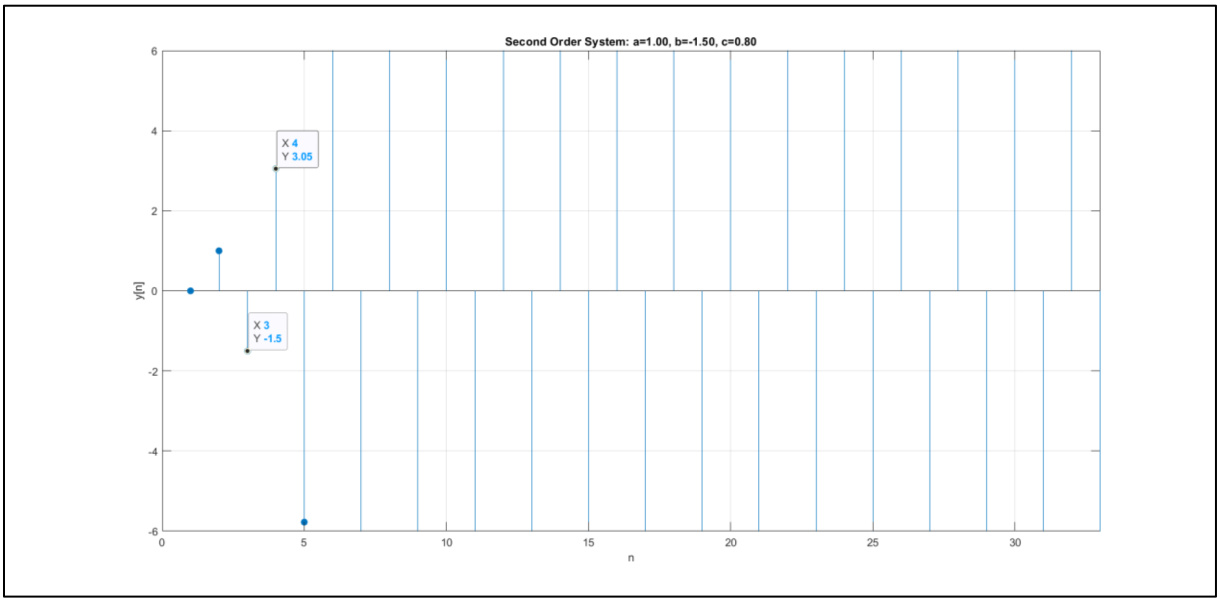
I defined the coefficients a, b and c in the form of a matrix. Each column of the matrix *cases* corresponds to the coefficient a, b and c respectively.

Every row of the matrix is a separate case of equation (1). The individual cases are generated with a *for* loop in the MATLAB code:

```
for i = 1:size(cases,1)

   figure(i); % Create a separate figure for each case



   % Extract parameters

   a = cases(i, 1);  % First column

   b = cases(i, 2);  % Second column

   c = cases(i, 3);  % Third column
```

The following plots are then generated on separate figures in MATLAB:

Fig. 2

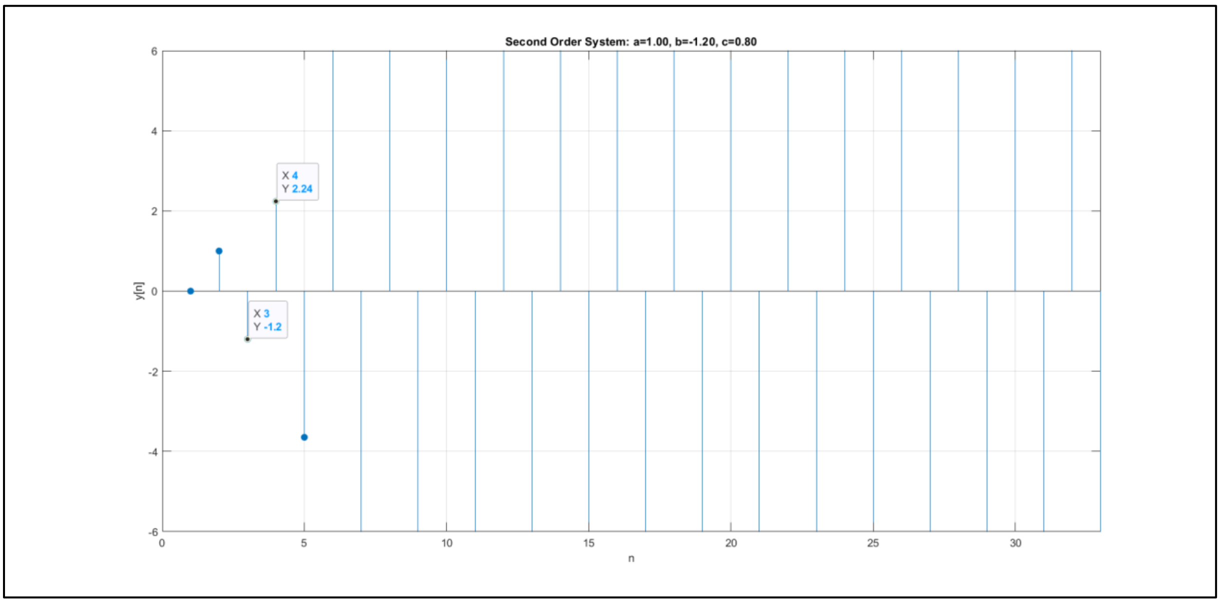


Coefficients: a = 1; b = -1.50; c = 0.80

Sample solutions:

(x, y) = {(3, -1.5); (4, 3.05)}

Fig. 3

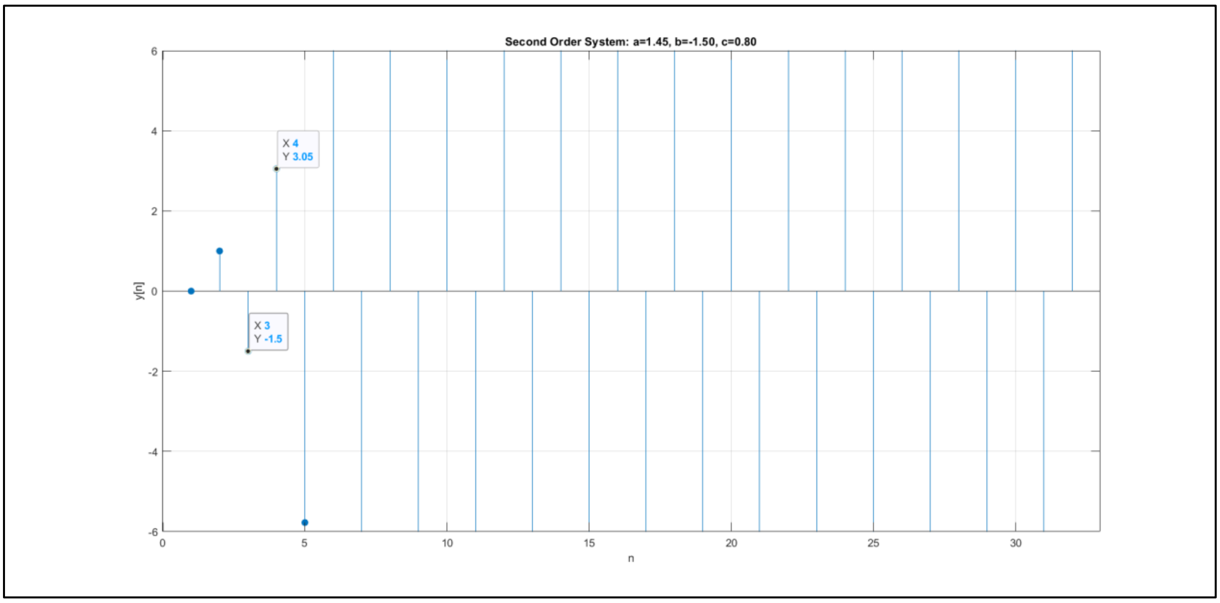


Coefficients: a = 1; b = -1.20; c = 0.80

Sample solutions:

(x, y) = {(3, -1.2); (4, 2.24)}

Fig. 4

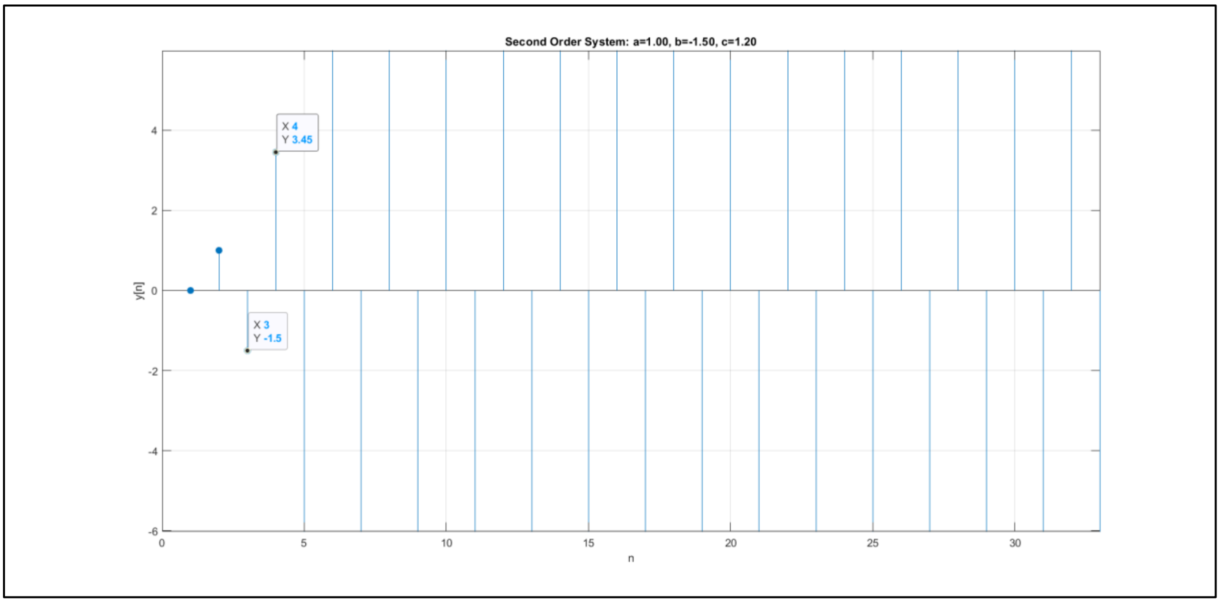


Coefficients: a = 1.45; b = -1.50; c = 0.80

Sample solutions:

(x, y) = {(3, -1.5); (4 ,3.05)}

Fig.5



Coefficients: a = 1; b = -1.50; c = 1.20

Sample solutions:

(x, y) = {(3, -1.5); (4 ,3.45)}

MATLAB code:

```
% A2

% Second order system:

% y[n] = ax[n] + by[n-1] + cy[n-2]




clc; clearvars;


% Define simulation parameters

N = 100;        % Number of time steps (must be equal to length of y)

y = [0,1, zeros(1, 98)];


% Modified input parameters a, b, c

cases = [1, -1.5, 0.8;

         1,  -1.2, 0.8;

         1.45, -1.5, 0.8;

         1,  -1.5, 1.2];


x = zeros(1, 100); % Excitation input x[n]


for i = 1:size(cases,1)

    figure(i); % Create a separate figure for each case


    % Extract parameters

    a = cases(i, 1);  % First column

    b = cases(i, 2);  % Second column

    c = cases(i, 3);  % Third column


    % Compute system response iteratively

    for n = 3:N  % Start from n=3 since y(1) and y(2) are given

        y(n) = a*x(n) + b*y(n-1) + c*y(n-2);
```

```
    end



    % Plot results

    stem(1:N, y,'filled'); % discrete-time plot

    xlabel('n');

    ylabel('y[n]');

    title(sprintf('Second Order System: a=%.2f, b=%.2f, c=%.2f', a, b, c));

    axis([0, 33, -6, 6]); % Adjusted axis limits

    grid on;

end
```

Conclusions:

Plotting the discrete signal y[n] = a*x[n] + b*y[n-1] + c*y[n-2] with varying coefficients a, b and c yielded different results for each plot. Since the first two samples in the signal are given:

```
y = [0,1, zeros(1, 98)];
```

I looked at the values for the third and fourth sample generated by signal y. Although the plots generated all have the same general shape, the values of the generated samples are different at each of the points.

Summary:

In the lab I examined discrete-time systems through MATLAB simulations of recursive and feedback-based difference equations. The first part focused on generating a signal using a second-order homogeneous difference equation, highlighting how initial conditions influence the signal's progression. The second part explored a more complex feedback system, where varying the coefficients a, b, and c demonstrated how each parameter affects the output. By analyzing the plots and sample values, the report illustrated the sensitivity of discrete systems to coefficient changes, reinforcing the importance of parameter selection in system design and analysis.