Mini Project 1

Students

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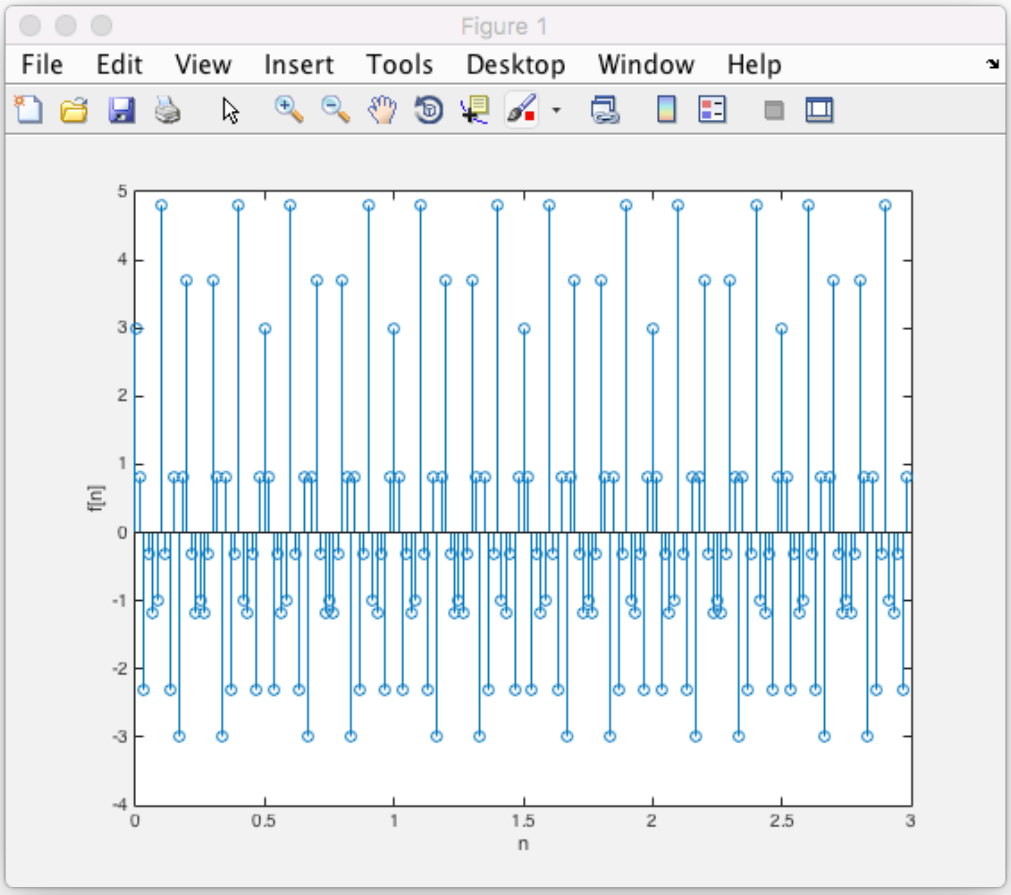
Solution

- **Question 1**: Using MATLAB/SciLab/Octave
  - a. Plot the sampled signal $x(n)$. Label the axes properly. Show your work

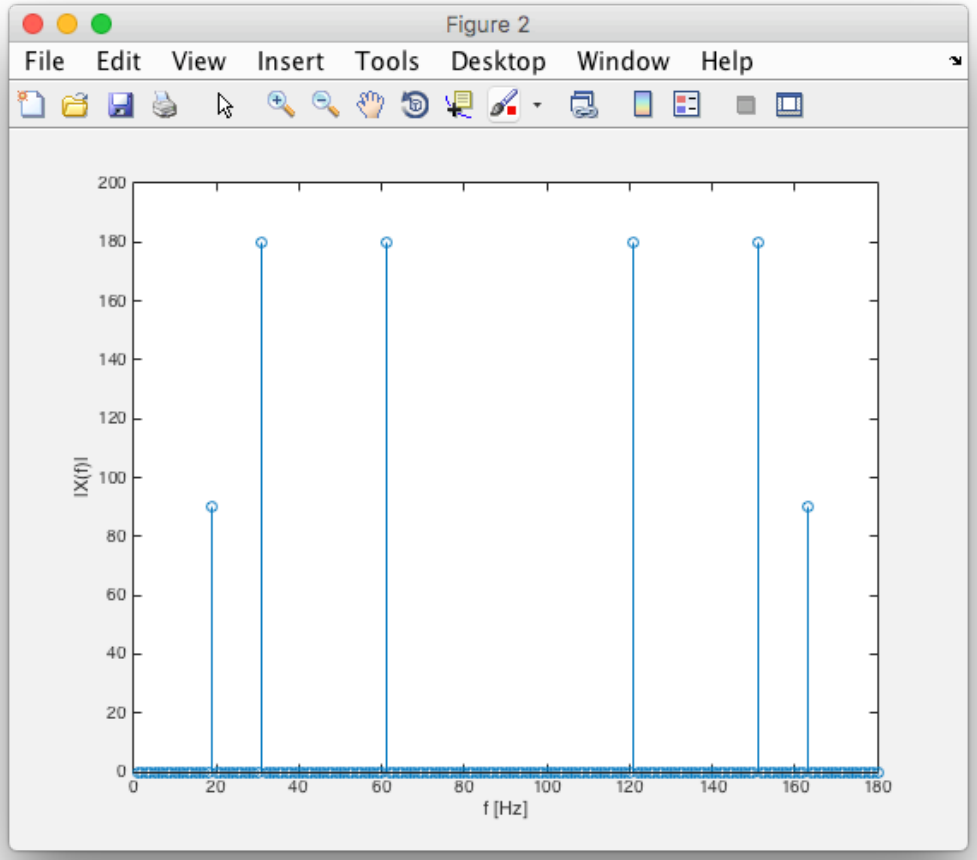
```
% sampling frequency
fs = 60;

% sampling period
t = 1/fs;

% end point on n-axis
ns = 3;

% range of n axis -- it's divided by fs to get the sampled
signal
n = 0:1/fs:(ns-1/fs);

%sampled function
f = cos(2*pi*10*n) + 2*cos(2*pi*20*n) - cos(2*pi*36*n) +
cos(2*pi*50*n);
N = size(f,1);

 % plot sampled signal
figure;
stem(n, f);
xlabel ('n'); ylabel('f[n]');

figure;
f = fftshift(fft(f));

% plot amplitude specturm
stem (abs(f)/N);
xlabel ('f [Hz]'); ylabel ('|X(f)|');
```

Plot



- b. Plot the **amplitude spectrum** of $x(n)$. Label the axes properly. Show your work (**hint**: use the command fftshift).

Plot



- c. What is your conclusion?

We conclude that some of the frequencies could cause aliasing due to the fact they are grater than fs/2.

- **Question 2**: *Discrete-time system*. Consider the following discrete-time system:

$y(n)=1.2y(n-1)-0.31y(n-2)+10x(n-1)+6x(n-2)$

- a. Compute manually the zero-state response to the unit step input, $x(n)=u(n)$.

$$y(z) = 1.2z^-1 - 0.31z^-2Y(z) + 10z^-1X(z) + 6z^-2X(z)$$

$$Y(z)[1 - 1.2z^-1 + 031z^-2] = X(z)[10z^-1 + 6z^-2]$$

$$Y(z) = (\frac{10z^-1+6z^-2}{1-1.2z^-1+031z^-2})X(z)$$

$$Y(z) = \frac{(10z+6)z}{(z^2-1.2z+0.31)} * (z-1)$$

$$=> \frac{Y(z)}{z} = \frac{z*(10z+6)}{z*(z-0.824)*(z-0.376)*(z-1)}$$

$$= \frac{A}{Z} + \frac{B}{z-0.824} + \frac{C}{z-0.376} + \frac{D}{z-1}$$

let $z = 0.824$ => $B = -181$

let $z = 0.376$ => $C = 35$

let $z = 0.1$ => $D = 145.5$

let $z = 0$ => $A = 0$

> $y(n) = [-181(0.824)^n + 35(0.376)^n + 145.5] * u(n)$

- *b*. Plot the step response using MATLAB/SciLab/Octave. Hint: set the ranges $0 \leq n \leq 50$ and $0 \leq y(n) \leq 140$.

```
% initialize range of n-axis
n = (0:50);

%initialize step input function
x = inline('(1.^(n)).*(n>=0)','n');

% coefficients of y(n)/ left side of the difference equation
a = [1 -1.2 0.31];

% coefficients of x(n)/ right side of the difference equation
b = [0 10 6];

% find the zero state response
y = filter (b,a,x(n));

% f is the function we have got manually
f = inline('(145.5 - 181*(0.824.^(n)) + 35*(0.376.^(n))).*
(n>=0)','n');

subplot(2,1,1);

% plot the zero state response we got by using matlab
stem(n,y);
ylabel('y[n] using matlab');

subplot(2,1,2);

% plot zero state response we got manually to compare them
together
stem(n, f(n));
xlabel ('n'); ylabel('f[n] - manually');
```

> *Plot*

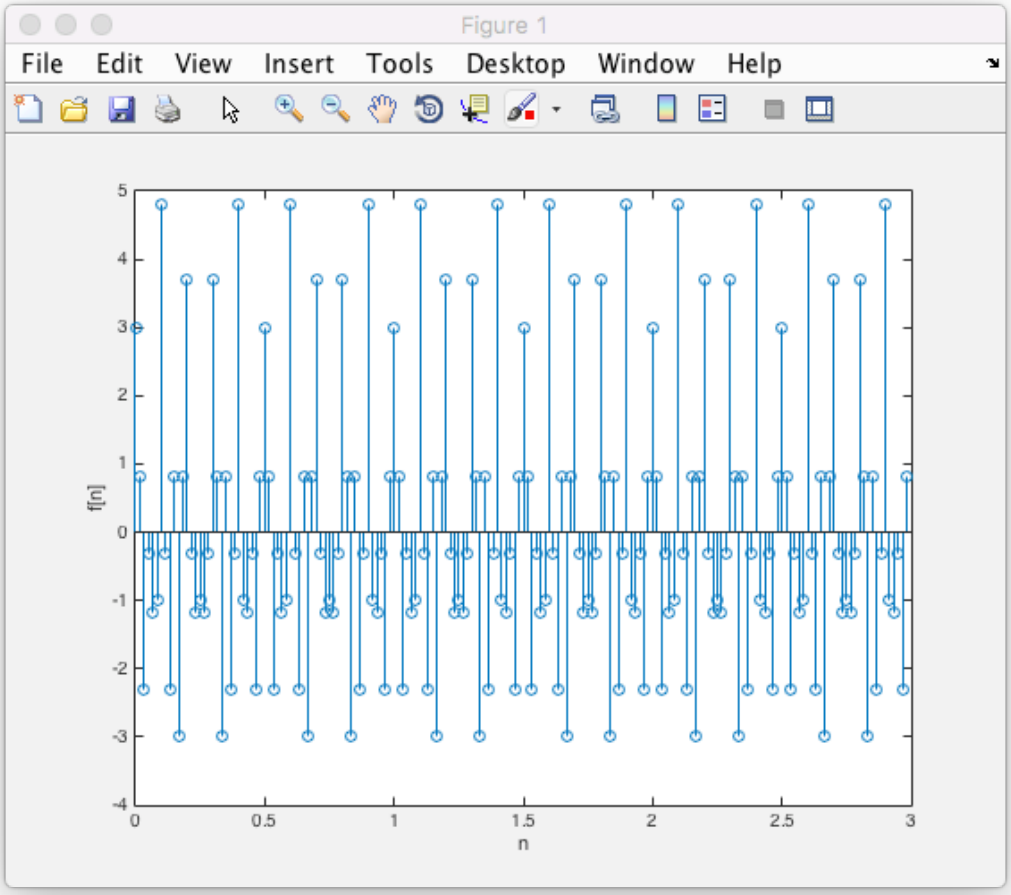


Figure 1
File Edit View Insert Tools Desktop Window Help
f[n]
n
5
4
3
2
1
0
-1
-2
-3
-4
0
0.5
1
1.5
2
2.5
3

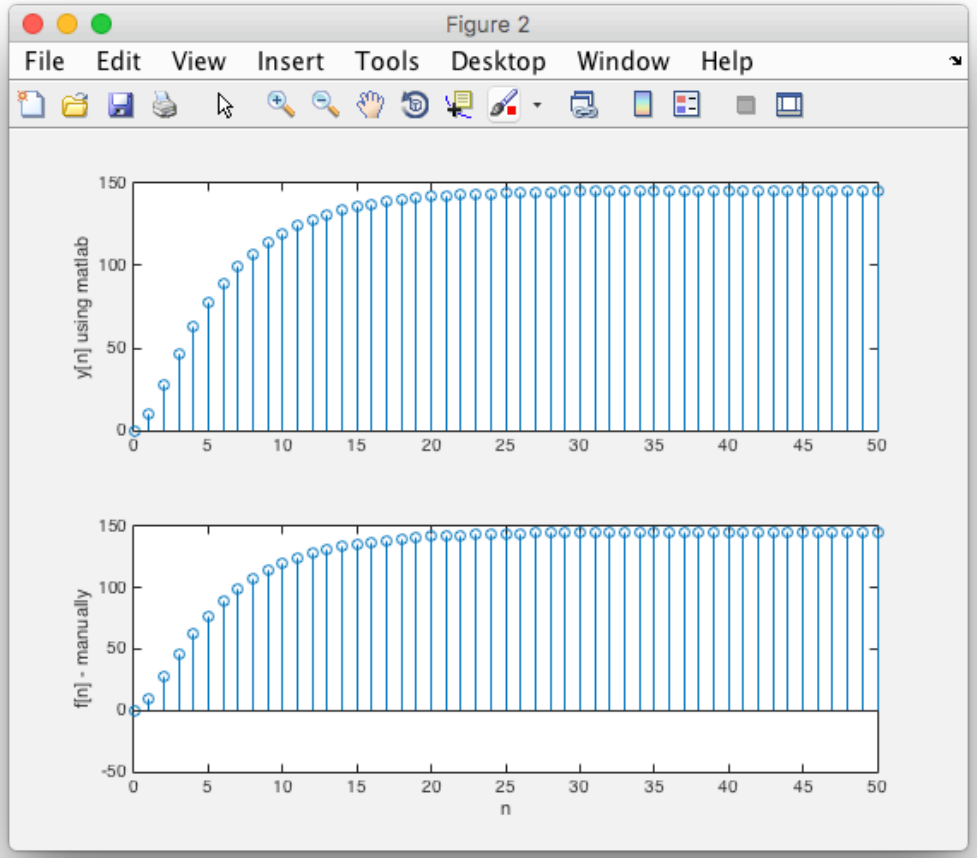


Figure 2
File Edit View Insert Tools Desktop Window Help
y[n] using matlab
f[n] - manually
n
150
100
50
0
-50
0 5 10 15 20 25 30 35 40 45 50