Department of Electrical, Computer, & Biomedical Engineering
Faculty of Engineering & Architectural Science

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Instructor:	Dimitri Androutsos

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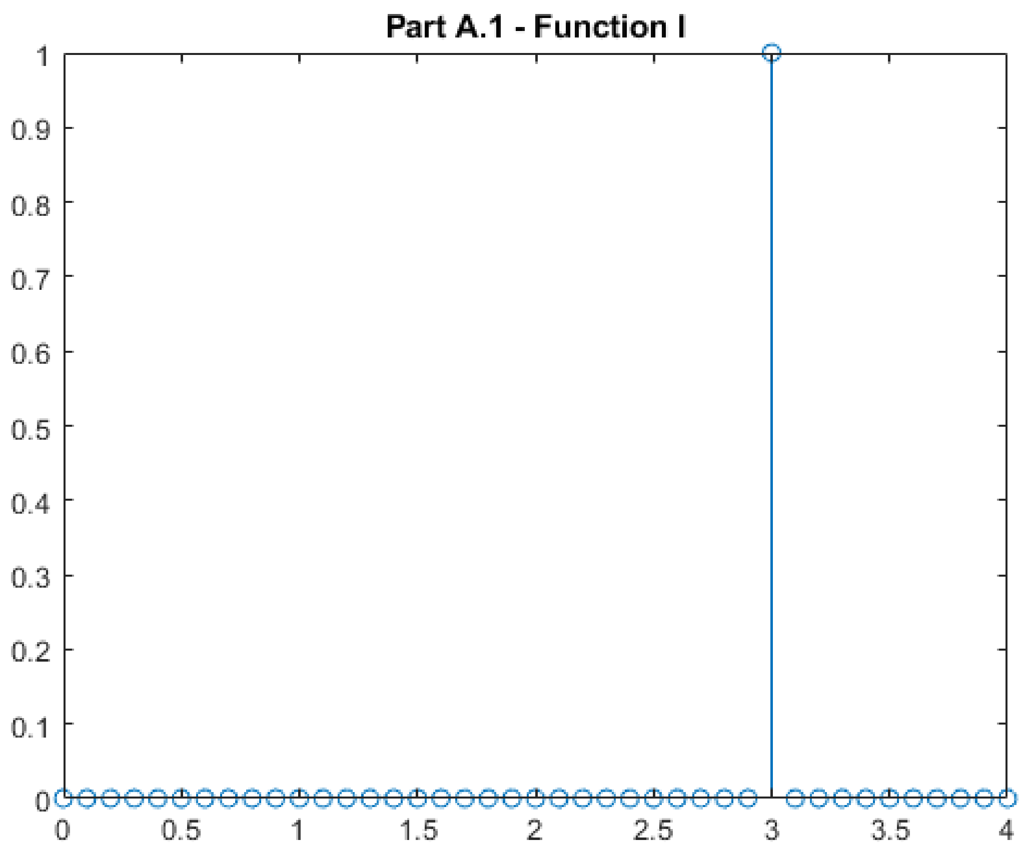
A) Signal Transformation

Part 1 - Plotting Discrete Time Signals

Function I

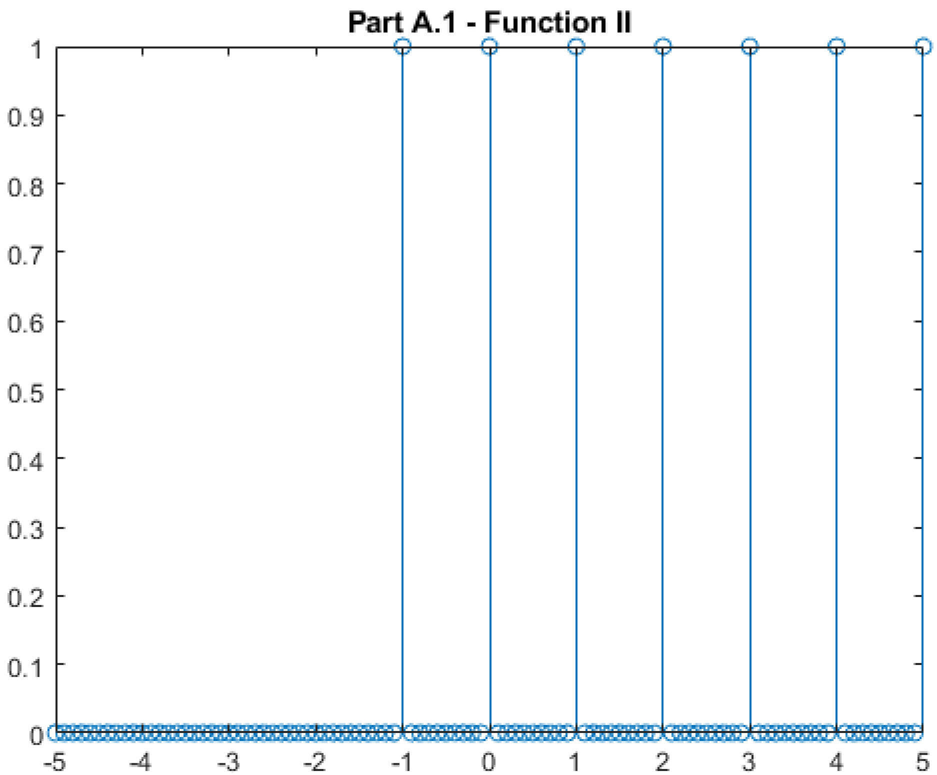
```
x = 0:0.1:4;
y = dirac(x-3);
idx = y == Inf;
y(idx) = 1;
figure;
stem(x,y)
title('Part A.1 - Function I');
```



Function II

```
n = -5:0.1:5;
u = (mod(n,1)==0)*1.0.*(n>=-1);
```

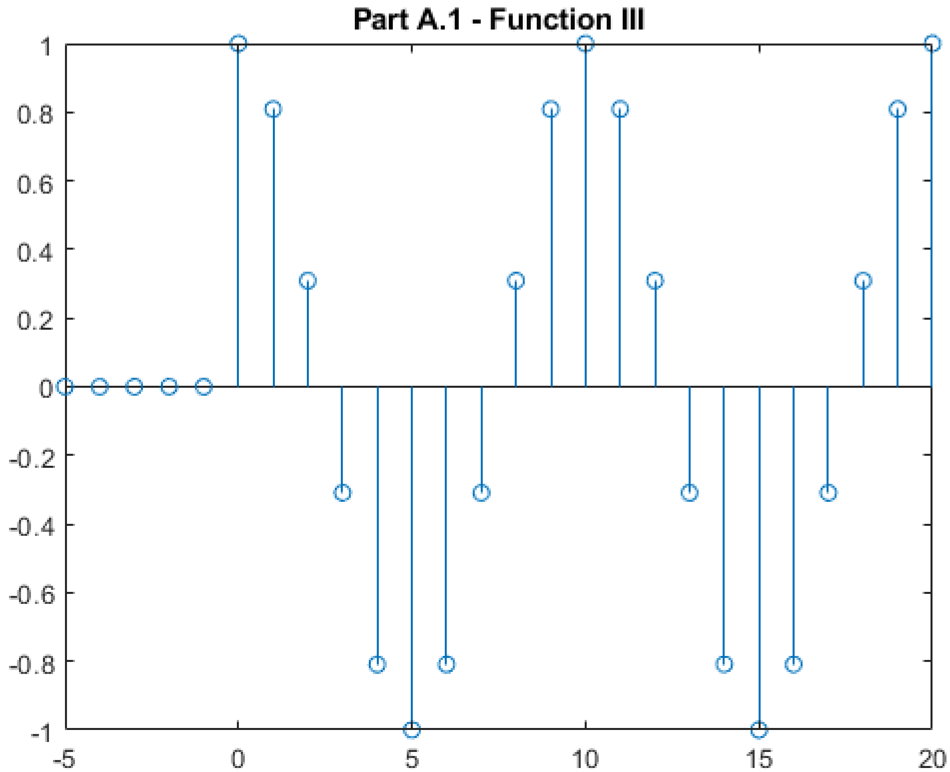
```
figure;
stem(n,u);
title('Part A.1 - Function II');
```

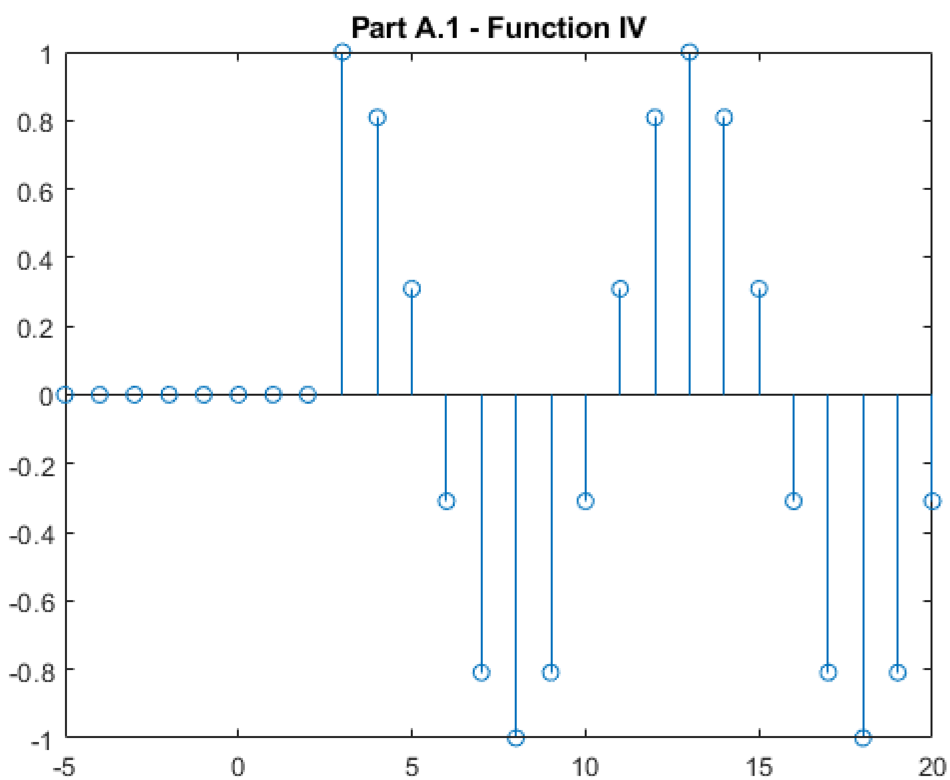


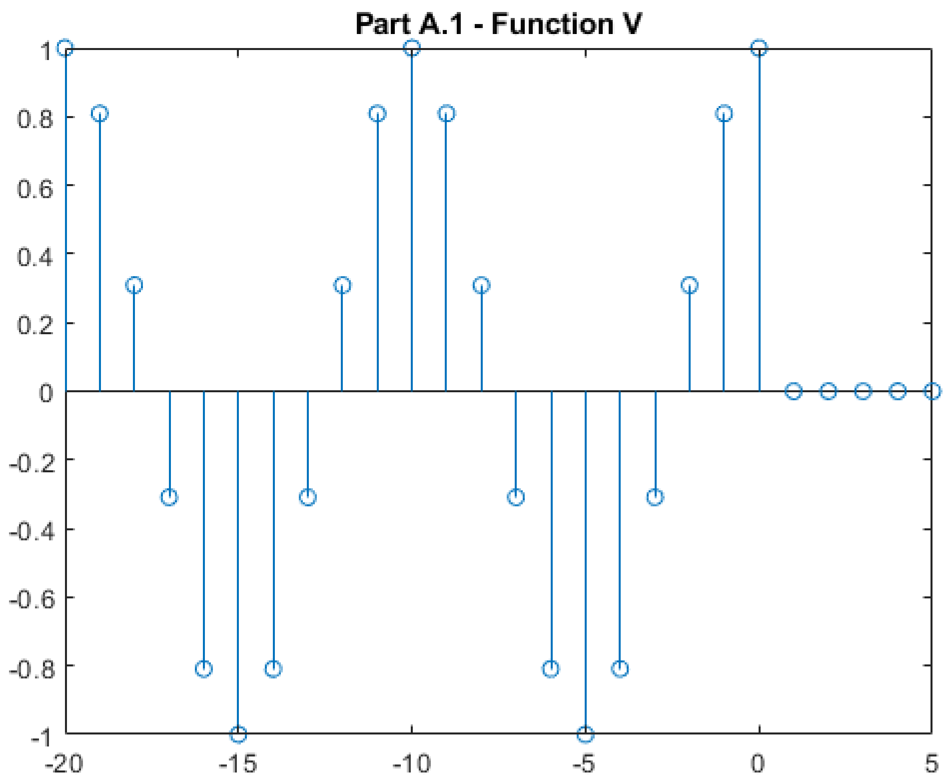
Function III

```
x = -5:20;
u = (mod(x,1)==0)*1.0.*(x>=0);
y = cos(pi.*x./5).*(u);
figure;
stem(x,y)
title('Part A.1 - Function III')



% % * Function IV
u = (mod(x,1)==0)*1.0.*(x>=3);
```

```
y = cos(pi.*(x-3)./5).*(u);
figure;
stem(x,y)
title('Part A.1 - Function IV')



% % * Function V
x = -20:5;
u = (mod(x,1)==0)*1.0.*(x<=0);
y = cos(pi.*(-x)./5).*(u);
figure;
stem(x,y)
title('Part A.1 - Function V')

%
% %The transformation performed in Function IV was a rightward-shift of 3
% %units along the x-axis on Function III.
% %The transformation performed in Function V was a mirrored flip along the
% %y-axis on Function III.
```


Part A.1 - Function III
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-5
0
5
10
15
20

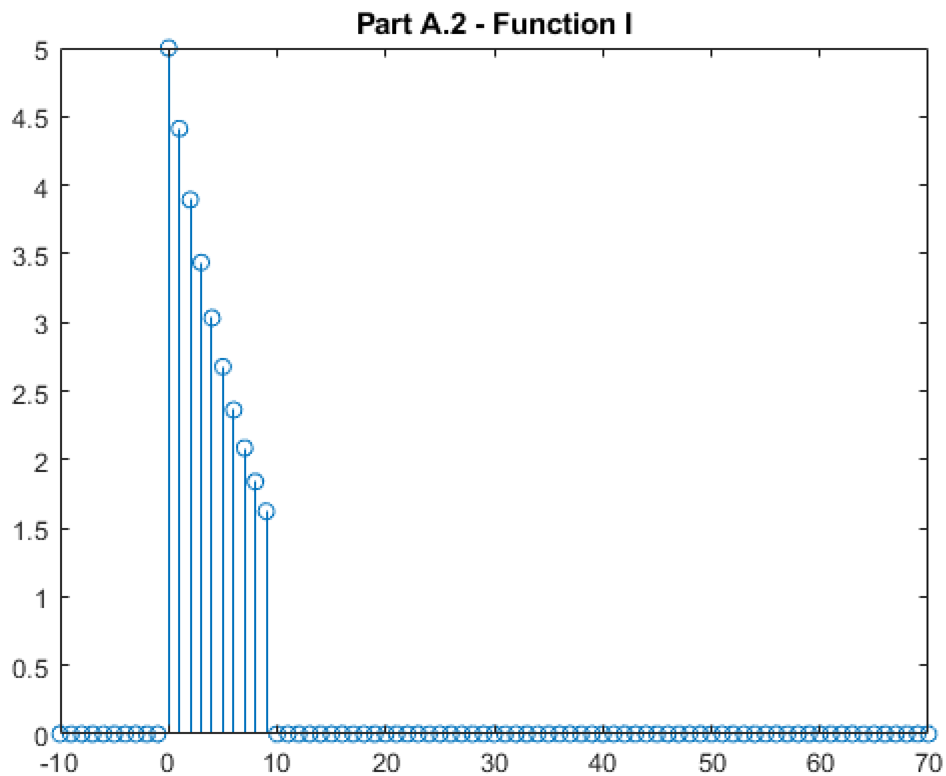

Part A.1 - Function IV
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-5
0
5
10
15
20

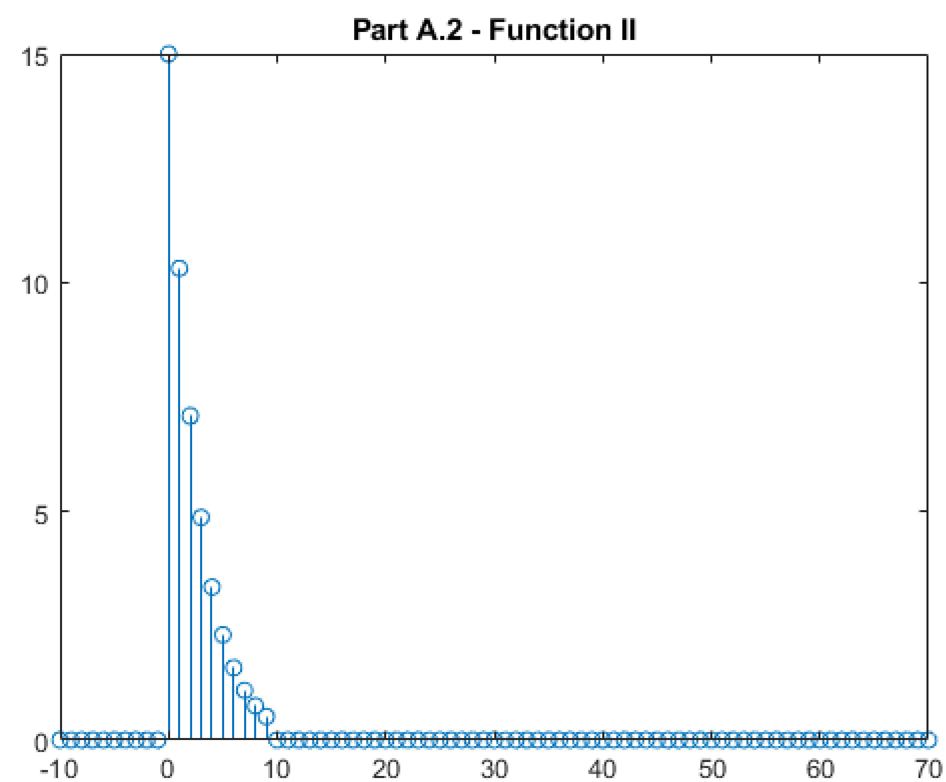


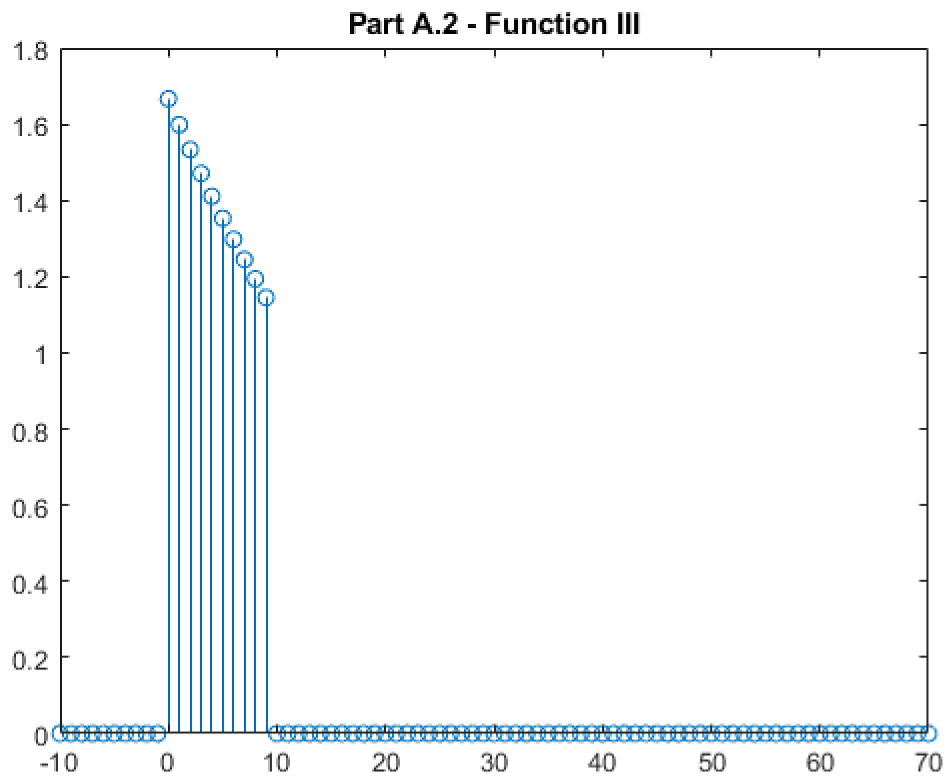
Part 2 - Scaling Discrete Time Signals

```
x = -10:70;
u = (mod(x,1)==0)*1.0.*(x>=0);
u2 = (mod(x,1)==0)*1.0.*(x>=10);
d=(mod(x,1)==0)*1.0;
y = 5.*exp(-x/8).*(u-u2);
figure;
stem(x,y);
title('Part A.2 - Function I')

% * Section II
u = (mod(x,1)==0)*3.0.*(x>=0);
u2 = (mod(x,1)==0)*3.0.*(x>=10);
y = 5.*exp(-3.*x/8).*(u-u2);
figure;
```

```
stem(x,y);
title('Part A.2 - Function II')

% * Section III
u = (mod(x,1)==0)*(1.0./3).*(x>=0);
u2 = (mod(x,1)==0)*(1.0./3).*(x>=10);
y = 5.*exp(-x/(8.*3)).*(u-u2);

figure;
stem(x,y);
title('Part A.2 - Function III')

%The transformation performed in Function II was a horizontal compression on Function I,
%however, since the exponential function is being multiplied by the difference of two
%unit step functions the result was a vertical stretch by 3 from x = [0:10]
%then back to 0 since the two unit step functions result in a
%multiplication by 0.
%The transformation performed in Function III was a horizontal stretch on
%Function I, however, since the exponential function is being multiplied by the difference of
two
%unit step functions the result was a vertical compression by 3 from x = [0:10]
%then back to 0 since the two unit step functions result in a
%multiplication by 0.
```


Part A.2 - Function I
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
-10
0
10
20
30
40
50
60
70

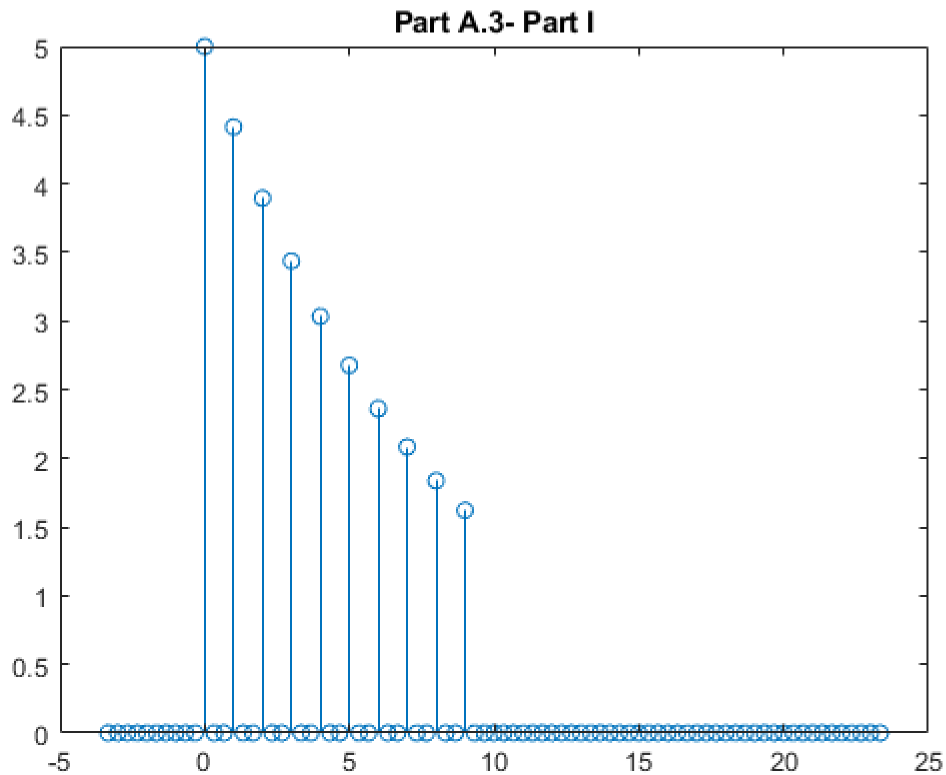

Part A.2 - Function II
15
10
5
0
-10
0
10
20
30
40
50
60
70



Part 3 - Sampling Continuous Signals

```
x = -10:70;
x=x./3;
u = (1.0).*(x>=0);
u2 = (1.0).*(x>=10);
z =  5.*exp(-x/(8)).*(u-u2);
d=(mod(x,1)==0)*1.0;
z = z.*d;
figure;
stem(x,z);
title('Part A.3- Part I')

% * Section II
% The reason y2[n] from PII and y3 from PIII are not the same is because
% the signal in PII was sampled first, then had a transformation applied
```

```
% Whereas, PIII was transformed then sampled which resulted in the
% possibility of new discrete integer values being added after the transform
% and old discrete integer values that are no longer integers being removed
```

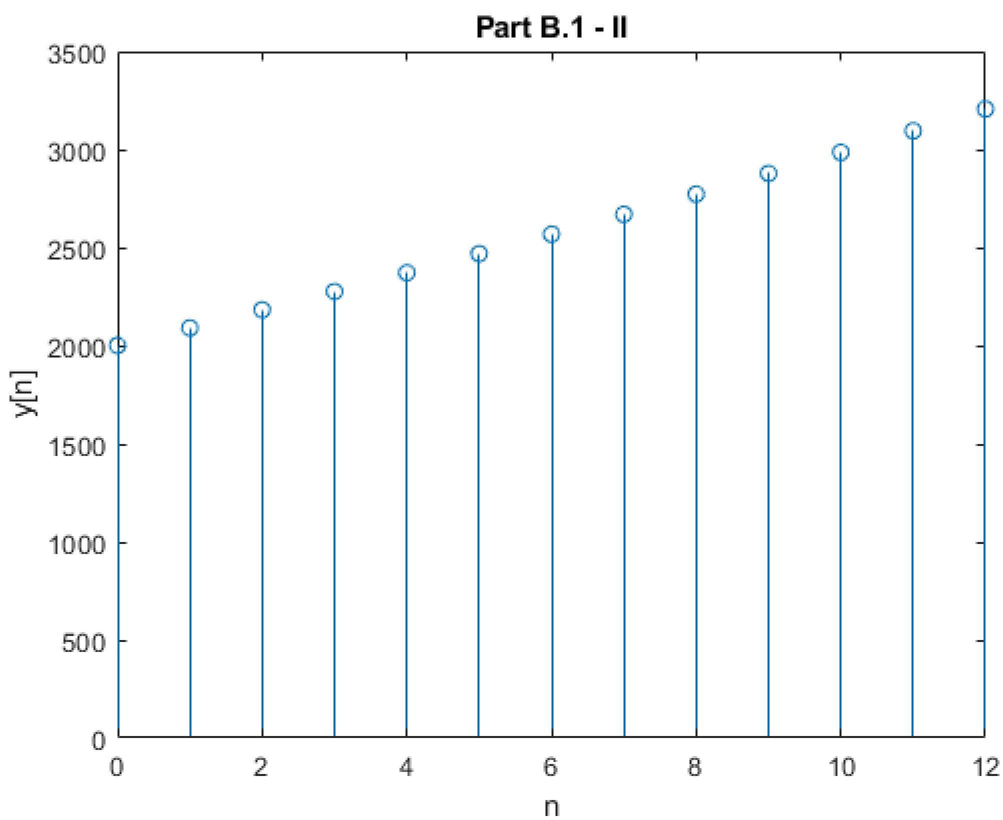


B) Recursive Solution of Difference Equation

Part I - Compound Interest of Balance with Monthly Contributions

```
r = 0.02;
n=0:12;
y = [2000 0 0 0 0 0 0 0 0 0 0 0 0];
x = [0 50 50 50 50 50 50 50 50 50 50 50 50];

for k =2:length(n)
    y(k)=(1+r).*y(k-1)+x(k);
end
```

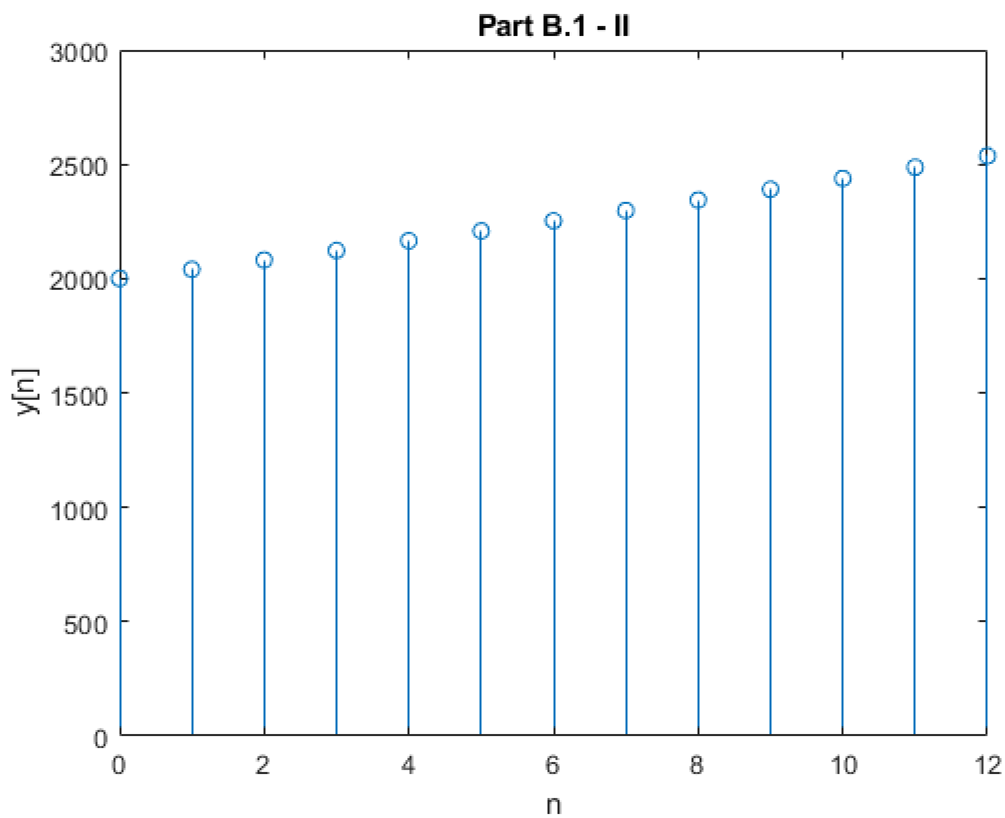
```
figure;
stem(n, y);
title('Part B.1 - II')
xlabel('n')
ylabel('y[n]')
```



Part II - Compound Interest of Balance, Zero Input Response

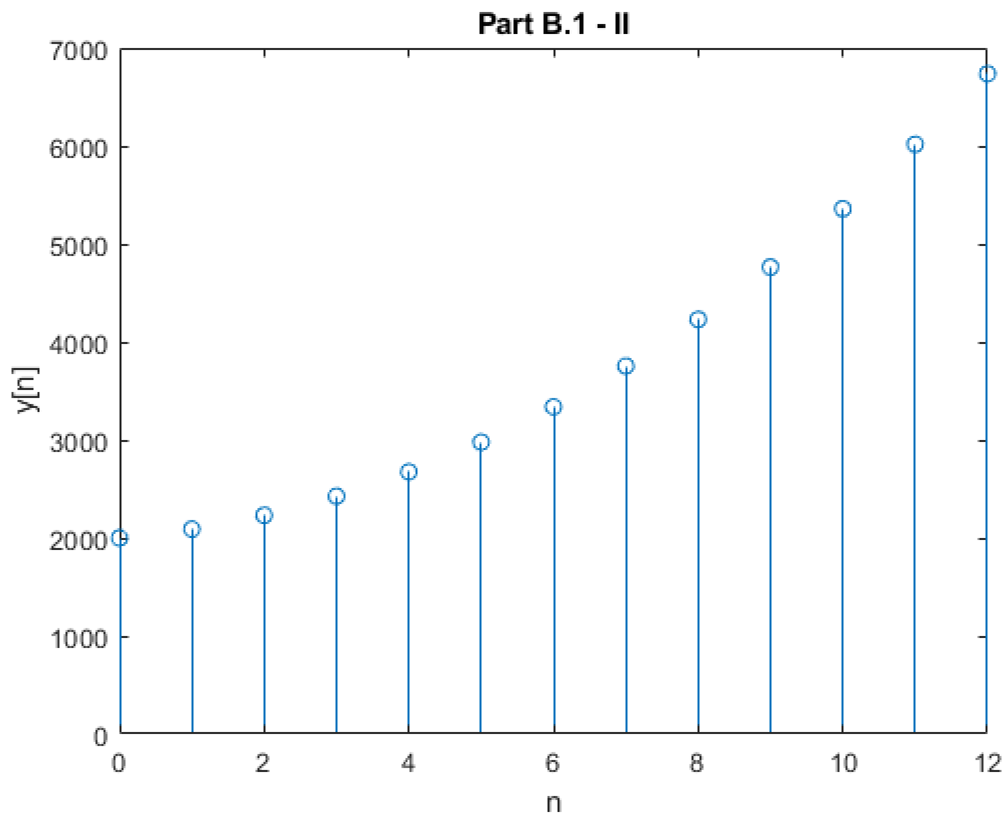
```
r = 0.02;
n=0:12;
y = [2000 0 0 0 0 0 0 0 0 0 0 0 0];
% x = [0 50 50 50 50 50 50 50 50 50 50 50 50];
x = [0 0 0 0 0 0 0 0 0 0 0 0 0];

for k =2:length(n)
    y(k)=(1+r).*y(k-1)+x(k);
```

```
end


%zero input response CE is:
% y0[n] = c1[1/a]^n
% y0[n] = (0)[1/a]^n
% y0[n] = 0



figure;
stem(n, y);
title('Part B.1 - II')
xlabel('n')
ylabel('y[n]')
```



Part III - n Growth Deposits

```
r = 0.02;
n=0:12;
y = [2000 0 0 0 0 0 0 0 0 0 0 0 0];
x = [0 50 100 150 200 250 300 350 400 450 500 550 600];

for k =2:length(n)
    y(k)=(1+r).*y(k-1)+x(k);
end

figure;
stem(n, y);
title('Part B.1 - II')
xlabel('n')
ylabel('y[n]')

clc
clear
```

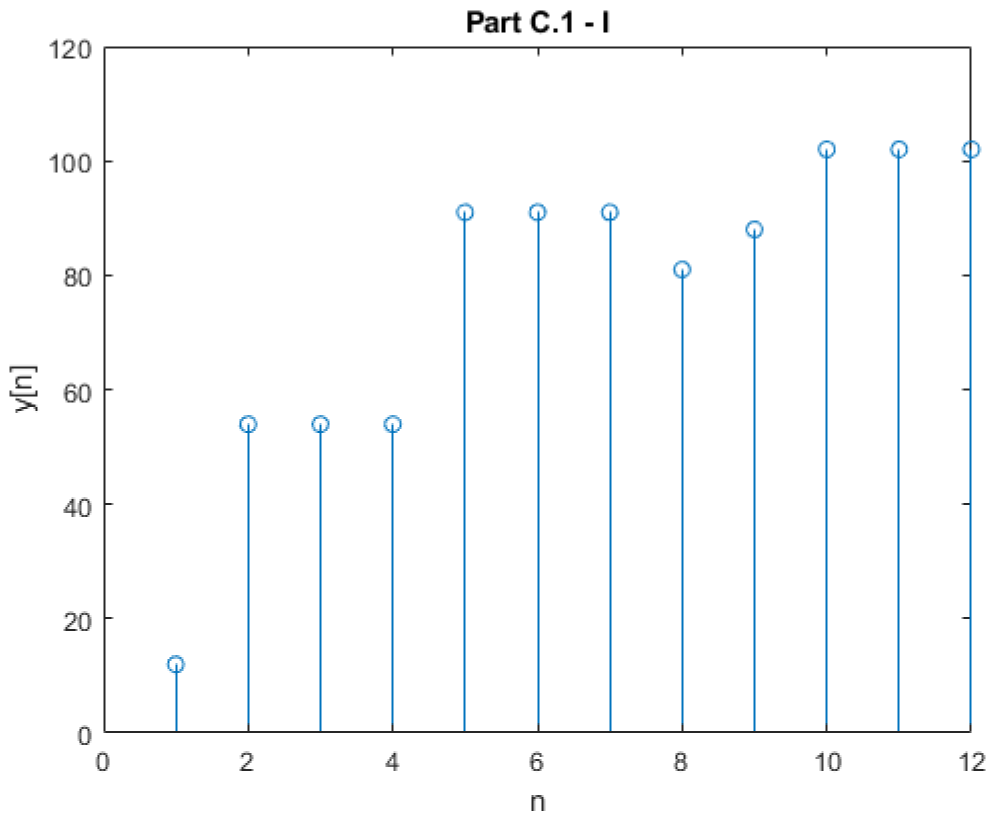


C) Design a filter: casual N-point maximum filter

Part I - maximum filtering

```
filterN = 3;
newval = [12 54 23 10 91 81 30 22 88 102 67 23];
M = length(newval);
x = zeros(1,filterN-1);
for i = 1: M
    x(filterN-1+i) = newval(i);
end


for k=1:M
        temp = x(:, k:k+filterN-1);
    y(k) = max(temp);
end
```

```
n = 1:M;
figure;
stem(n, y);
title('Part C.1 - I')
xlabel('n')
ylabel('y[n]')

clc
clear
```

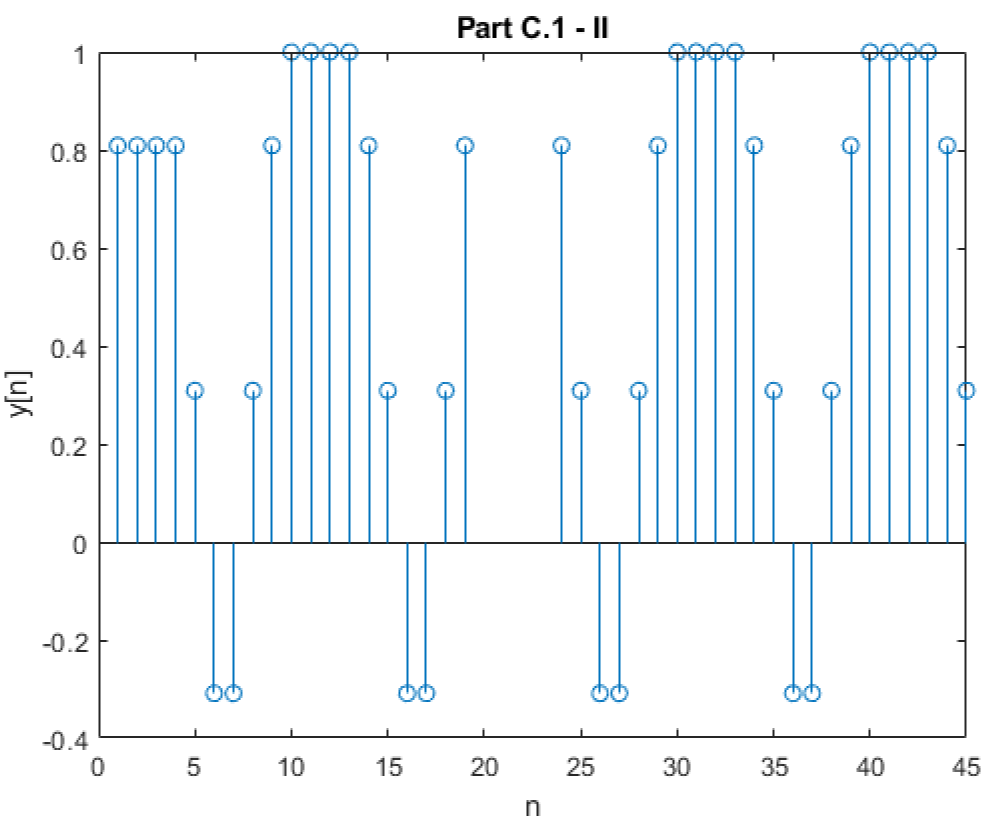


Part II and III - maximum filter with x[n]

```
filterN = 4; %N = 4, 8, 12
M = 45;
n = 1:M;
newval = cos(pi.*n./5)+dirac(n-20)-dirac(n-35);
```

```
x = zeros(1,filterN-1);
for i = 1: M
   x(filterN-1+i) = newval(i);
end

for k=1:M
      temp = x(:, k:k+filterN-1);
   y(k) = max(temp);
end



figure;
stem(n, y);
title('Part C.1 - II')
xlabel('n')
ylabel('y[n]')



%Part III:
%For N = 4, the response of the function begins with 4 units of it's highest
%first x-discrete y-value, the function allows for some negative values
%since the dips are 5 units wide, the high values are held for 4
%units since the next trajectory is negative upholding the high value till
% its no longer in the window, the dirac(n-20) function creates a gap
% starting at x=20 until it's no longer in the window range, and the
% -dirac(n-35) function is immediatly outmaxed since it occurs halfway
% through the dip and there is a higher value within 4 units.

%When N = 8, the initial reponse of the first x-discrete y-value is held
```

```
%for 8 units, the high values are held for the same reason as N=4, the
%negative values dissapear since the window range is larger than the dip
%width allowing there to always be a higher value at the begining of a dip,
%the dirac(n-20) function creates a gap starting at x=20 and creates an
% undefined zone for 8 units, and the -dirac(n-35) function is immediatly
% outmaxed for the same reason as N=4.

%Lastly when N = 12, the initial reponse of the first x-discrete y-value is held
%only for 8 units since the next peak occurs within the window range, the
%initial peak values are only held for 8 units since the dirac(n-20) occurs
%at x=20 and creates an undefined zone for 12 units, beyond the initial
%peak values, the peaks are held until the length of the input vector, and
% the -dirac(n-35) function is immediatly outmaxed for the same reason as N=4.
```



D) Energy and power of a discrete signal

Part I - energy and power of a vector

```
n = 0:20000;
x = (mod(n,1)==0)*1.0.*(n>=10000);
L = length(n);
N = L;
E = (sum(abs(x).^2));
P = (norm(x).^2)./N;

% Since Power is finite, this unit-step function is a power signal, and
% Energy is infinite
```

Part II - energy and power of x[n] (Fig.P3.1-1 (c) of the textbook)

```
x = [0 -9 -6 -3 0 3 6 9 0 0];
L = length(x);
N = L;
E = (sum(abs(x).^2));
P = (norm(x).^2)./N;

% Since Power is finite, this unit-step function is a power signal, and
% Energy is infinite
```