# Independent University Bangladesh

Department of Electrical and Electronics Engineering

# Lab Report 04

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Course code: EEE 321L

Couse name: Digital Signal Processing Lab

Lab no: 04

Lab title: Study of signal decomposition, downsampling, folding and shifting

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a) Function definitions

i. Even and odd components

```
% function to determine even/odd component
function [xe,xo,m] = evenodd(x,n)
m = n;
xe = 0.5*(x + fliplr(x));    % fliplr -> x(-n)
xo = 0.5*(x - fliplr(x));
end
```

ii. Down-sampling

```
% function to downsample a signal by factor M
function [y,m] = dnsample(n, x, M)
m = min(n./M):max(n./M);
y = x(1:length(m));
end
```

b) Signal operations

i. Decomposition of x[n] = u(n) – u(n-10) where -10 ≤ n ≤ 10

Code:

```
% even/odd components
n = -10:10;
x = stepseq(0,-10,10) - stepseq(10,-10,10);
stem(n,x)
figure(2)
[xe,xo,m] = evenodd(x,n);
stem(m,xe)
figure(3)
stem(m,xo)
```

Outputs:

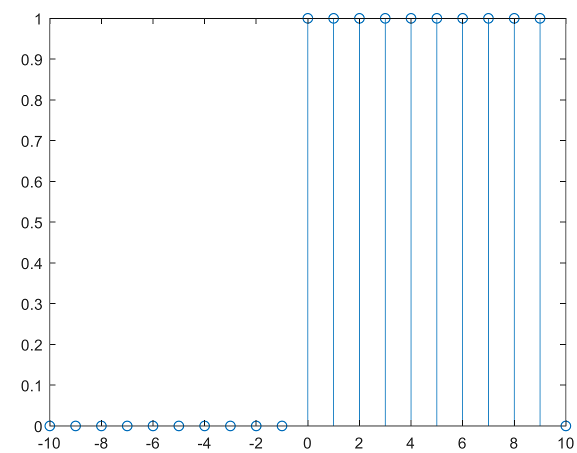



Figure: Original signal

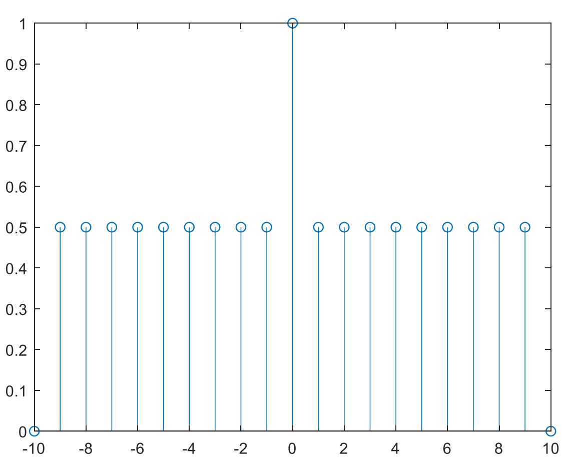



Figure: Even component

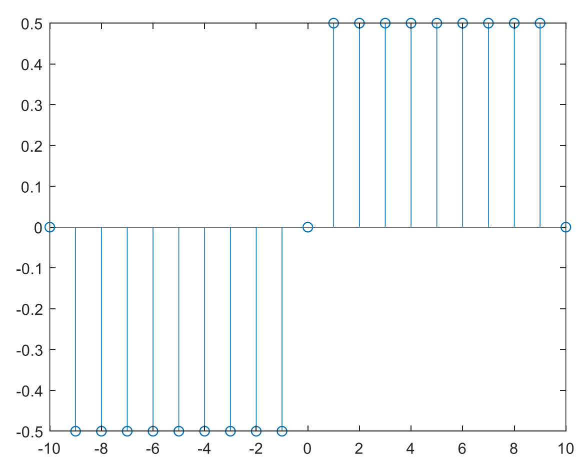



Figure: Odd component

ii. Down-sampling x[n] = sin(0.125*pi*n) where -50 ≤ n ≤ 50

Code:

```
% downsampling
n = -50:50;
x = sin(0.125*pi*n);
stem(n,x)
figure(2);
[y,m] = dnsample(n,x,4);
stem(m,y)
```

Output:

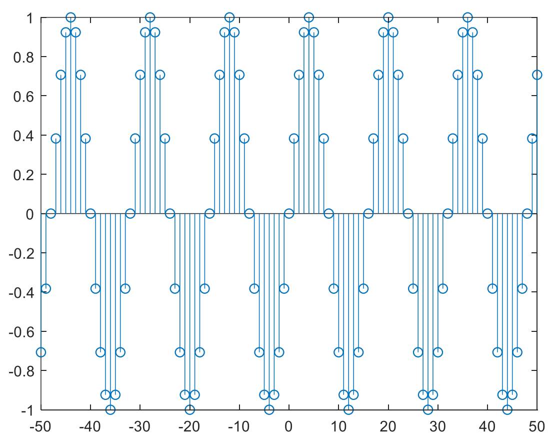



Figure: Original signal

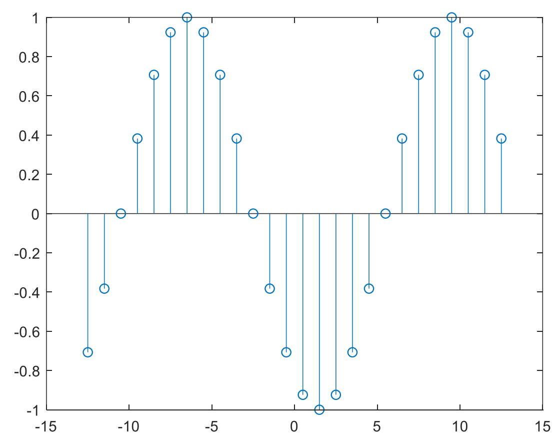



Figure: Down-sampled signal

iii. Time reversal of x[n] = u(n-2) for -10 ≤ n ≤ 10

Code:

```
% find x[-n] given that x[n] = u(n-2)
n = -10:10;
x = stepseq(2,-10,10);
stem(n,x)
figure(2)
y = fliplr(x);
stem(n,y)
```

Output:

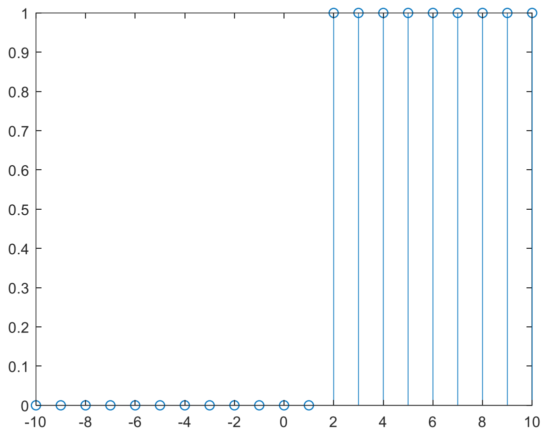



Figure: Original signal x(n)

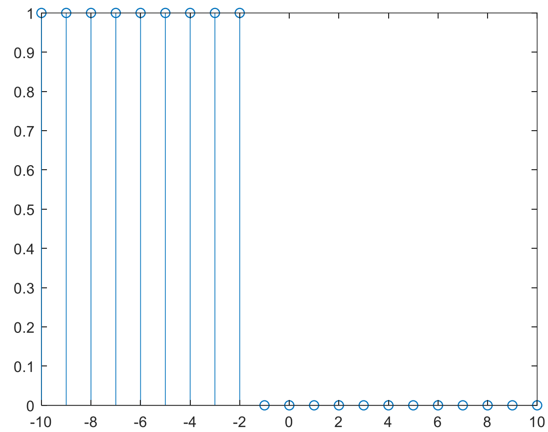



Figure: Time reversed signal x(-n)

c) Assignment

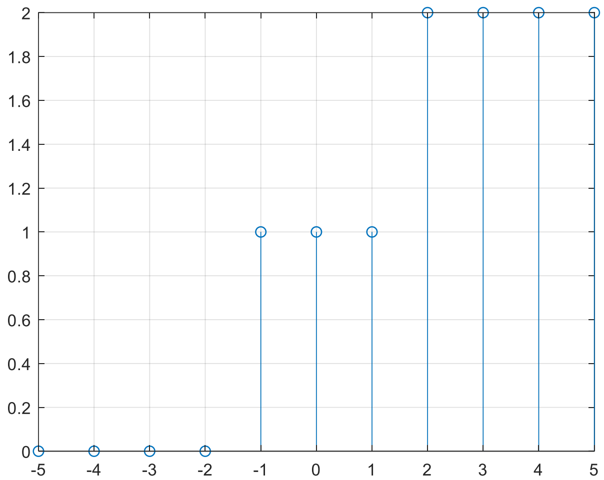
i. Function definition

```
% function to generate x(n^2) from x(n)
function [y, m] = n_square(x, n)
    m = [];      % domain
    y = [];      % range
    c = abs(min(n));    % to set reference value (0)
    % iterate over positive domain (>0) for square numbers
    for i=1:max(n)
        r = sqrt(i);
        if floor(r) == r    % check for perfect square
            % append m (absolute) and y (relative to reference)
            m(end+1) = r;
            y(end+1) = x(c+i+1);
        end
    end
    % correct for negative and 0 positions
    m = [-fliplr(m) 0 m];
    y = [fliplr(y) x(c) y];
end
```

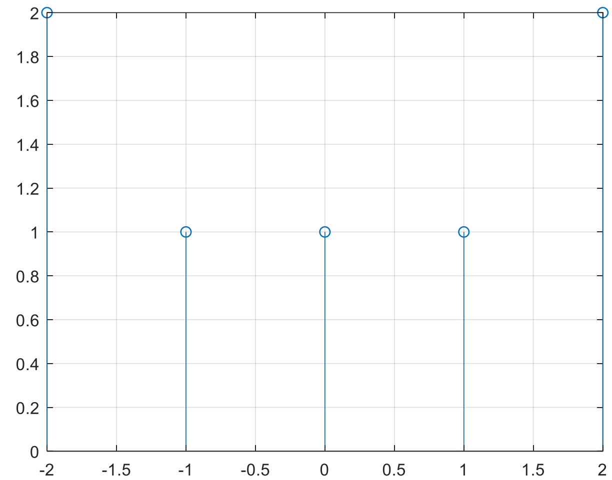
ii. Calls and outputs

<u>Example 1</u>

```
% x(n) = u(n+1) + u(n-2), -5:5
n = -5:5;
x = stepseq(-1,-5,5) + stepseq(2,-5,5);
stem(n,x); grid;
[y, m] = n_square(x,n);
figure(2); stem(m,y); grid;
```



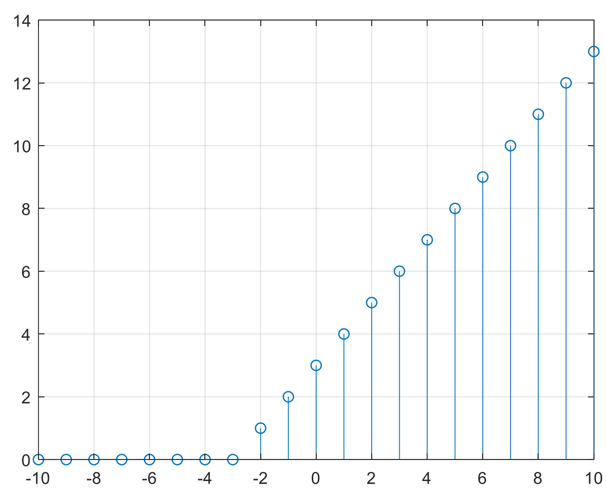

x(n)



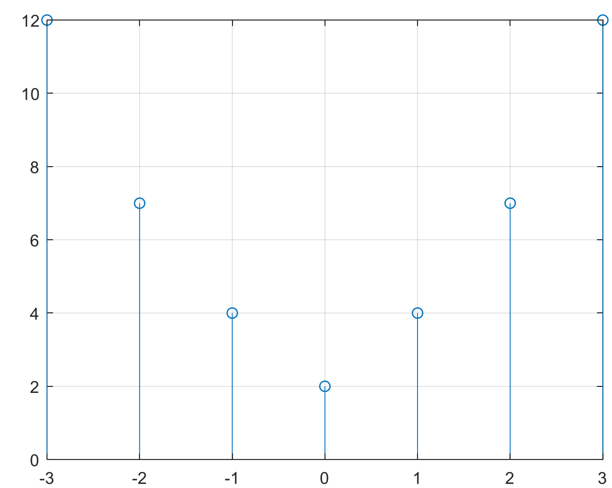

$x(n^2)$

## Example 2

```
% x(n) = rampseq delayed by -3, -10:10
n = -10:10;
x = rampseq(-3,-10,10);
stem(n,x); grid;
[y, m] = n_square(x,n);
figure(2); stem(m,y); grid;
```

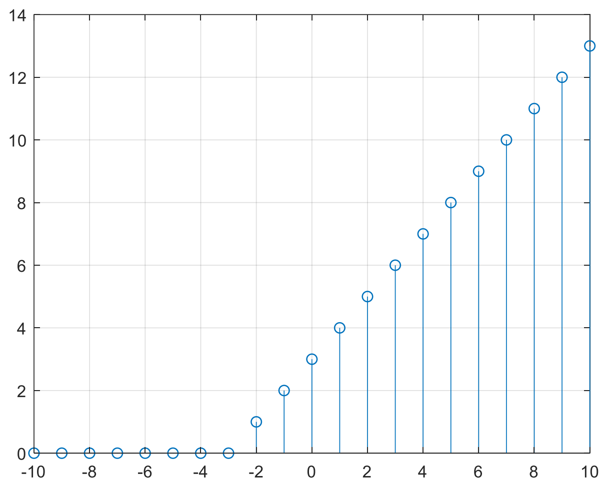



x(n)

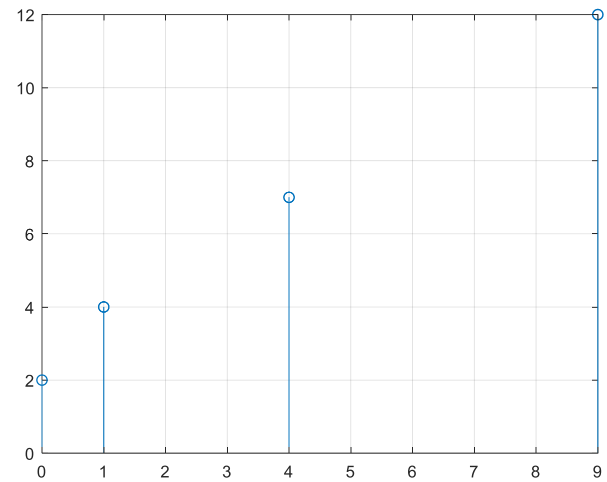



$x(n^2)$

** Some references show only **positive** and **square** values on of *n* (1, 4, 9 instead of 1, 2, 3), to do so change the negative sign before the *fliplr* should be removed and the m array should be appended with *i* instead of *r* in the function definition. Example 2 output in this format is shown below.




x(n)




$x(n^2)$