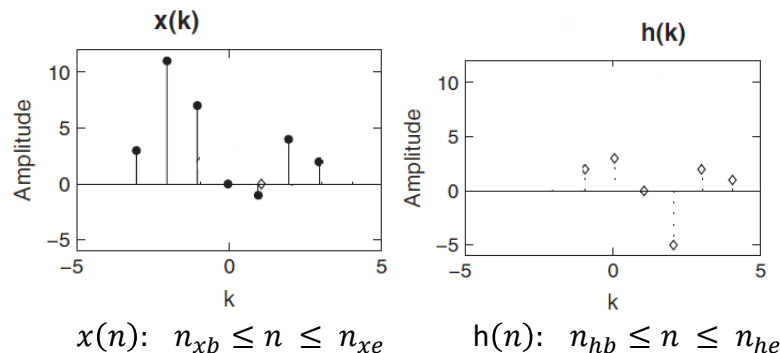# Task: Convolution

Example: Given the two sequences

$$x(n) = \{3, 11, 7, 0, -1, 4, 2\}, \qquad -3 \leq n \leq 3$$

$$h(n) = \{2, 3, 0, -5, 2, 1\}, \qquad -1 \leq n \leq 4$$

determine the convolution $y(n) = x(n) * h(n)$.

x(k)

h(k)

$x(n):\ n_{xb} \leq n \leq n_{xe}$ h(n): $n_{hb} \leq n \leq n_{he}$

1. Folding: Fold $h(k)$ about $k = 0$ → $\boldsymbol{h(-k)}$

2. Shifting: Shift $h(-k)$ by n_0 to the right (left) if n_0 positive (negative) → $\boldsymbol{h(n_0 - k)}$

3. Multiplication: Multiply $x(k)$ by $h(n_0 - k)$ → the product sequence $\boldsymbol{x(k)\,h(n_0 - k)}$

4. Summation: **Sum all the values** of the product sequence $\boldsymbol{x(k)h(n_0 - k)}$ for input at **time $\boldsymbol{n = n_0}$**

$$y(-1) = \sum_k x(k)\,h(-1-k) = 3 \times (-5) + 11 \times 0 + 7 \times 3 + 0 \times 2 = 6$$

$$y(n) = \{6, 31, 47, 6, -51, -5, 41, 18, -22, -3, 8, 2\}$$

$y(n):\ n_{xb} + n_{hb} \leq n \leq n_{xe} + n_{he}$

$y(n):\ -3 + -1 \leq n \leq 3 + 4$

$y(n):\ -4 \leq n \leq 7$

Total length = length (x) + length(h) -1

Example: Matlab script for evaluating convolution sum

```matlab
%define the signals x and h
x= [3, 11, 7, 0, -1, 4, 2]; % amplitude
nx= [-3, -2 ,-1,0 ,1, 2, 3] ; % time-index
h = [2, 3, 0, -5, 2, 1] ;    % amplitude
hn=[-1,0, 1, 2, 3, 4,];      % time-index

%% for the possible range/index of "n" in y(n) = sum_k [x(k) h(n-k)] %%
nyb = nx(1)+hn(1); nye = nx(length(x)) + hn(length(h));
ny = [nyb:nye];
```

```matlab
%% Define an array size of "ny" --> which will hold the "y(n)" values %%
y=zeros(1, length(ny));

j=1;  % for the indexing of y(i)
```

```matlab
for i=1:length(ny) % total index of "n" for which convolution valid

    close all;  %% for plot the original x(k) without any shift
            % subplot(2,2,1); stem(hn, h); xticks([hn]); title('original h(k)');

    % 1. Operation --- folding the h(k)

        [hf, hnf] =sigfold(h,hn);
        % For plot the folded h(k)
        % subplot(2,2,3); stem(hnf, hf); xticks([hnf]); title('folded');

    % 2. shifting the  h(-k + n) --> for different value of n = ny(i)

        [shf, shnf] = sigshift(hf,hnf, ny(i));
        % For plot shifted h(-k +n)
        % subplot(2,2,2); stem(shnf,shf); xticks([shnf]);

    % 3. Multiplication of signals: x(k)  and h(-k+n)
        [xnew, nm] = sigmult(x,nx,shf,shnf);

    % 4. Summation over the product/multiplication signal
                y(j) = sum(xnew);

                j= j+1;

end
```
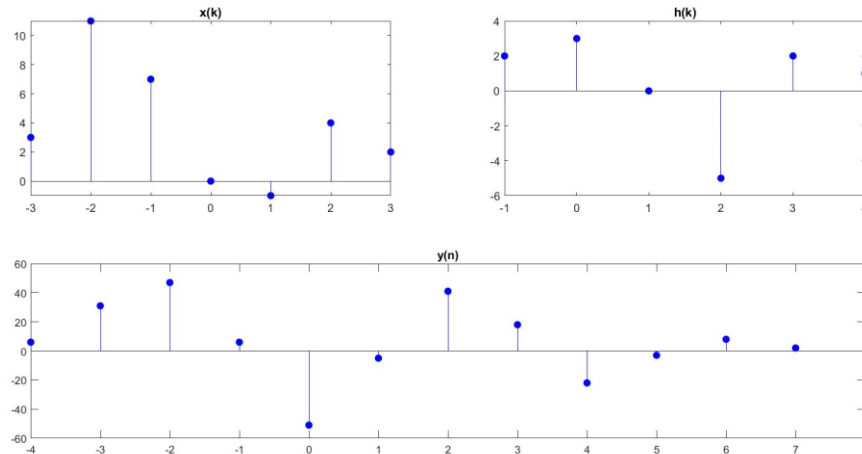
```
% plot the Original and convolution output
 figure;

 subplot(2,2,1);
 stem(nx, x, 'b', 'filled'); xticks([nx]); title('x(k)');

 subplot(2,2,2);
 stem(hn, h, 'b', 'filled'); xticks([hn]); title('h(k)');

 subplot(2,2,[3,4]);
 stem(ny, y,'b', 'filled'); xticks([ny]); title('y(n)');
```

Task: Convolution

A. Determine analytically the convolution $y(n) = x(n) * h(n)$ of the following sequences, and verify your answers by writing a MATLAB script and inbuilt functions.

1. $x(n) = \{2, -4, 5, 3, -1, -2, 6\}$, $h(n) = \{1, -1, 1, -1, 1\}$
   $\uparrow$ $\uparrow$

2. $x(n) = (1/4)^{-n}[u(n+1) - u(n-4)]$, $h(n) = u(n) - u(n-5)$

3. $x(n) = n/4[u(n) - u(n-6)]$, $h(n) = 2[u(n+2) - u(n-3)]$

Structure of lab report

a) Title of the experiment → "Creation a document using MS office"

b) Your name   →   XYZ, Roll-no: 1234

c) About the experiments →

d) Content of the experiment (diagram/programme source code/flowchart) →

e) Your observation/what you learned →

After complementation of the LAB, document has to be uploaded in Google classroom
filename: StudentName_rollNo

Thank you!