EENG/INFE 226 SIGNALS AND SYSTEMS
LAB 4
The Convolution Sum and Integral

Objective

This experiment aims to introduce using MATLAB to perform discrete-time convolution and simulate continuous-time convolution for some common signals.

Convolution:

The convolution of the signals x(t) and h(t) is mathematically defined as:

$$y(t) = x(t) * h(t) = \int_{-\infty}^{+\infty} x(\tau).h(t-\tau)d\tau$$

And for the discrete-time signals x[n] and h[n], it is defined as:

$$y[n] = x[n] * h[n] = \sum_{k=-\infty}^{\infty} x[k].h[n-k]$$

Exercise 1

Use MATLAB to evaluate the convolution of x[n] with itself, where

$$x[n] = \begin{cases} 1 & 0 \le n \le 5 \\ 0 & otherwise \end{cases}$$

Procedure:

- Define the signal *x* as a vector of values [1 1 1 1 1 1], using the (**ones**) command.
- Use the (**conv**) function to evaluate the convolution of x with itself, and name it as *y*.
- Define the index vector n to range from 0 to 10.
- Using the function (**stem**), plot *y* versus *n.*
- Label the vertical and horizontal axes as (Amplitude) and (Time), respectively.
- Title the figure as (*y[n]*).

***Q**: Comment on the relationship between the length of y[n] and x[n]*

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Exercise 2

I. Consider the discrete-time signals:

$$x[n] = \begin{cases} n & 0 \le n \le 5 \\ 0 & otherwise \end{cases}$$

$$u[n] = \begin{cases} 1 & 0 \le n \le 5 \\ 0 & otherwise \end{cases}$$

- Define the signal x as a vector of values [0 1 2 3 4 5].
- Define the signal u as a vector of values [1 1 1 1 1 1], using the (**ones**) command.

- Use the function (**conv**) function to evaluate the convolution of *x* with *u*, and name it as *y*.
- Define the index vector n to range from 0 to 10.
- Using the function (**stem**), plot *y* versus *n*.
- Label the vertical and horizontal axes as (Amplitude) and (Time), respectively.
- Title the figure as (*y[n]*).

II. **Repeat** part I using *u[n+5]* instead of *u[n]*.

***Q**: Comment on the relationship between y[n] in part I, and y[n] of part II.*

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Exercise 3

In this part, continuous-time convolution will be simulated in the discrete case. Consider the continuous-time signals *x(t)* and *h(t)*. Generate these functions using a time step of 0.1.

$$x(t) = \begin{cases} 1 & 0 \le t \le 5 \\ 0 & otherwise \end{cases}$$

$$h(t) = \begin{cases} 1 & 2 \le t \le 7 \\ 0 & otherwise \end{cases}$$

Procedure:

- Define the domain of *x* as a vector ranging from 1 to 5, with a time step of 0.1. Name it as t_x.
- Define the domain of *h* as a vector ranging from 2 to 7, with a time step of 0.1. Name it as t_h.
- Define the signal *x* as a vector of ones over the index vector t_x, using the (**ones**),(**length**) command,

- Define the signal *h* as a vector of ones of the index vector t_h, using the (**ones**)),(**length**) command
- Declare the total time length of the convolution to range from 3 to 12, with a 0.1 step. Name it as t_y.
- Use the function (**conv**) function to evaluate the convolution of *x(t)* with *h(t)*, and name it as *y*.
- ***Hint***: *Do not forget to multiply the conv. by Ts=0.1 (Ts step time)*
- Using the function (**stem**), plot *y* versus n_y.
- Label the vertical and horizontal axes as (Amplitude) and (Time), respectively.
- Title the figure as (*y(t)*).

***Q**: Comment on the relationship between the time length of y(t)and that of x(t) and h(t)*

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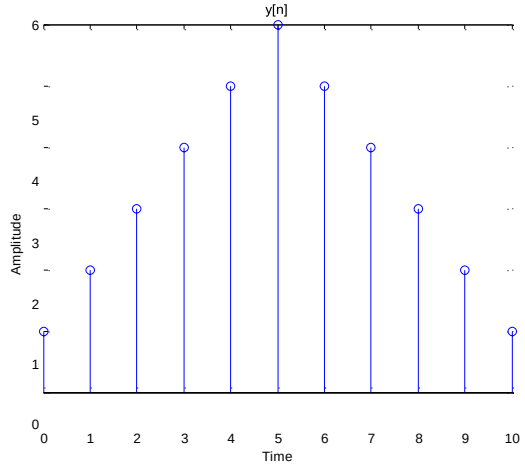
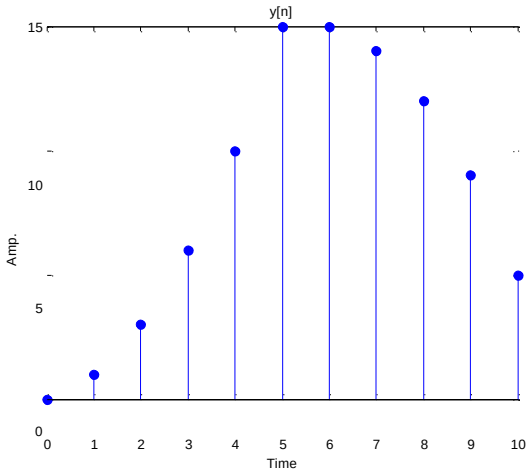
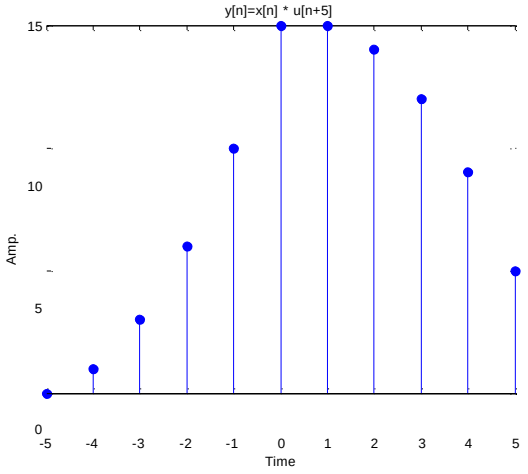
The RESULTS:

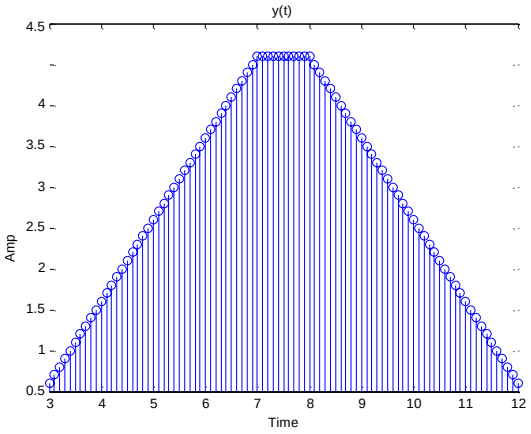


Exercise 1



Exercise 2
Part -1





Exercise 3

Assignment:

Use Matlab to generate the following two functions and find the convolution of them:

a) $x(t)=\cos(\pi t/2)[u(t)-u(t-10)]$, $h(t)=\sin(\pi t)[u(t-3)-u(t-12)]$.

b)$x[n]=3n$ for $-1<n<6$, $h[n]=1$ for $4<n<13$