Signals and Systems 2025
Programming Assignment 1

Deadline: 3/31 1:19 pm

The Convolution Sum

In this section, you will learn how to compute the convolution sum of two signals using Python.

1. Background

Given two finite-duration signals, $x_1[n]$ and $x_2[n]$, with specific intervals outside of which the signals are zero. The convolution sum of these two signals, denoted by $y[n]$, is given by:

$$y[n] = \sum_{k=-\infty}^{\infty} x_1[k] \cdot x_2[n-k]$$

To obtain the value using Python, you can use the `**numpy.convolve**` function:

```
y = np.convolve(x1, x2, 'full')
```

where `x1` and `x2` are arrays representing the signals.

2. Assignment Tasks

Given two signals defined as follows:

$$x_1[n] = \begin{cases} n, & 1 \le n \le 20 \\ 40 - n, & 21 \le n \le 39 \\ 0, & \text{otherwise} \end{cases}$$

$$x_2[n] = u[n-1] - u[n-11]$$

Where $u[n]$ denotes the unit step function.

Please write a Python script (saved as `**myconv.py**`) to implement the following problems:

(a) (15%) Use the `**matplotlib.pyplot.stem**` function to plot $x_1[n]$ vs n and $x_2[n]$ vs n.

(b) (15%) Use the `**numpy.convolve**` function directly to compute the convolution sum and use `**matplotlib.pyplot.stem**` to plot the output $y[n]$ vs n.

(c) (20%) Create a Python function to compute the convolution sum using the matrix

form as described. Use `**matplotlib.pyplot.stem**` to plot the output $y[n]$ vs n. Verify whether the answer matches the result from Problem (b).

(d) (50%) Repeat Problems (a) to (c) again but with $x_1[n]$ and $x_2[n]$ defined as follows:

$$x_1[n] = \begin{cases} 3^n u[n], & 1 \le n \le 3 \\ 0, & \text{otherwise} \end{cases}$$

$$x_2[n] = \begin{cases} 2^n u[n], & 1 \le n \le 5 \\ 0, & \text{otherwise} \end{cases}$$

Note: Your `**myconv.py**` script should output 8 figures in total, corresponding to each part of the tasks. (2 figures for Problem (a), 1 figure for Problem (b), 1 figure for Problem (c), and 4 figures for Problem (d))

3. E3 Submission Instructions

- Please upload a **Python script** (saved as `**myconv.py**`) and a **report** (saved as `**report.pdf**`). Include the figures mentioned above in the report and provide explanations as needed. **Do not zip them into a compressed file!**