In the Name of God

Signals & Systems

Computer Assignment #۱

---

۱. First construct matrix **A** described in the following:

$$\mathbf{A}=\begin{bmatrix} ۱ & ۲ & ۳ & \cdots & N \\ ۲ & ۳ & ٤ & \cdots & N+۱ \\ ۳ & ٤ & ٥ & & N+۲ \\ \vdots & \vdots & \vdots & \cdots & \vdots \\ & & & \ddots & \\ M-N+۱ & M-N+۲ & M-N+۳ & \cdots & M \end{bmatrix}$$

Then, generate a Nx۱ vector **r**, whose elements are random integers from the set $\{۱,۲,۳,\ldots,M\}$ where $M = qN$ and q is integer greater than ۳ .

Now construct matrix **D**:

$$\mathbf{D}(i,j)=\begin{cases} ۱ & \text{if } \mathbf{A}(i,j)\in \mathbf{r} \\ -۱ & O.W \end{cases}$$

Generate and print **A**, **r**, and **D** for N= ٥, M = ۲۰, q= ٤.

Your MATLAB code should work for any N and M with above condition.

Hint: you should do it with some vector/matrix operations. You can use “rand”, “floor”, “ones”, “zeros”, “reshape” functions. Do not use iterative functions such as ‘’if’’, ‘’for’’, ‘’while’’, … or any other specific functions

۲. Consider two discrete-time systems with impulse responses $h_۱[n]$ and $h_۲[n]$ defined as below. To avoid further conflicts and collisions, consider both systems and the input have values in the interval $[-۸, ۸]$.

$$h_۱[n]=\delta[n-۱]-\delta[n]-\delta[n+۱]+\delta[n+۲]$$

$$h_۲[n]=\left(\frac{۱}{۳}\right)^{n}(u[n]+u[n-۲])$$

a. Implement the convolution operation in a Matlab function and calculate $h[n] = h_۱[n] * h_۲[n]$ using built-in *conv* function.

b. Consider the discrete-time signal:

$$x[n] = \left(\frac{١}{٢}\right)^{n} (u[n] - u[n - ٣])$$

i. Imagine $h_١[n]$ and $h_٢[n]$ connected in series. That is the input $x[n]$ is first fed into $h_١[n]$ and its output is then fed into $h_٢[n]$. Calculate and plot the final output using *conv* function.

j. Change the order of the systems and repeat the previous part. Plot the result of this part below the previous part. (Use *subplot* function)

k. Now, find $x[n] * h[n]$ and plot it below the result of the previous parts. Are the results in the way you expected them to be?

٣. a. Discretize the following signals with $T = ٠.١$, and plot these signals in the interval $-٢ < t < ٢$ one time using "$plot$" and another time using "$stem$" in a same figure.

a) $x_١(t) = \sin(٢\pi t)$

b) $x_٢(t) = u(t) - u(t - ١)$

c) $x_٣(t) = ٢r(t) - r(t - ١) + u(t + ١)$

b. Find Energy and Power of each signal and compare the results with the expected analytical values. Determine which one is an energy signal or a power signal. (**Note:** Use "sum" function.)

NOTES

١. Reports must be submitted in PDF format. Use the template available on the course page for your report. Name the report file as below :

CA١_Surname_Student ID

٢. Put your MATLAB codes at the end of each problem solution.