EC3093D Digital Signal Processing Lab
Winter Semester 2023-24

Experiment-1: Discrete time signal generation and convolution

General instructions

- The experiment is presented as five problems below. Use Matlab for all problems
- **Report and lab output evaluation** will be **based only on** the problems or parts of problems which are marked as **'Do in lab'**
  - **Report** needs to be submitted (as one pdf file per group) via Eduserver (before deadline) and will be evaluated out of a *maximum* of 100 marks, and split-up is given alongside the problems.
    - For each problem (marked **'Do in lab'**), report should cover
      1. the problem (copy from this document)
      2. the result depicted using necessary figure(s) with proper title, legends, axis labels etc with readable font sizes.
      3. a **brief** discussion of the results, highlighting only the salient/interesting points.
  - **Lab output** will be evaluated out of a *maximum* of 100 marks, and split-up is given alongside the problems.
    - the result depicted using figure(s) with proper title, legends, axis labels etc with readable font sizes.
- You need to be familiar with all the problems. **Experiment test will cover all problems**.
- For queries regarding this experiment, contact vjoseph@nitc.ac.in, sanjayviswanath@nitc.ac.in

Problems

1. **Basic signals**: Generate the following discrete time signals for n=-10 to +10 and display the following in separate figures using "stem" Matlab function:
   a. Unit impulse $\delta[n]$
   b. Unit step u[n]
   c. u[n-1]
   d. **Do in lab (15 marks):** Generate unit impulse $\delta[n]$ using u[n] and u[n-1]
   e. **Do in lab (15 marks):**: Unit ramp r[n], and also x[n]=r[2n] in one figure (using Matlab's hold) with appropriate legend and title for n=-20 to +20.
   f. Generate unit step $u[n]$ using r[n] and r[n-1].

2. Perform the following using the stem function.
   a. Let $x[n] = 20(0.9)^n u[n]$.
      i. Choose c and generate $y[n] = 10(c)^n u[n]$, which reaches zero slower than x[.]

ii. Display x[n] and y[n] for n=-10 to +100 on the same plot with appropriate legend (using hold).

b. **Do in lab (10 marks):** Let $x[n] = 0.2(1.2)^n u[n]$

i. Choose c and generate $y[n] = 2(c)^n u[n]$, which reaches infinity slower than x[.].

ii. Display x[n] and y[n] for n=-10 to +100 on the same plot with appropriate legend (using hold).

c. Generate and display following discrete time signals for n=-10 to +40 on the same plot using hold with appropriate legend:

i. $x[n] = (-0.8)^n u[n]$

ii. $x[n] = -(0.8)^n u[n]$

d. **Do in lab (10 marks):** Generate complex exponential signal $x[n] = e^{(-1/12 + j\pi/6)n}$.

i. Display the real part and imaginary parts of x[n] for n=0 to 20 in one subplot of one figure with appropriate legend.

ii. Display the absolute value of x[n] for n=0 to 20 in another subplot of the same figure.

3. Perform the following.

a. Generate $x1[n]) = \cos(0.2\pi n)$, $x2[n] = \cos(1.8.\pi n)$, $x3[n] = \cos(2.2\pi n)$. Compare the plots generated for the three cases for n=-10 to +10, and comment on your result. Plot all the signals in the same figure using hold.

b. **Do in lab (15 marks):** $x4[n]=\cos(4\pi n/17)$, $x5[n]=3\cos(1.3\pi n)-4\sin(0.5\pi n+0.5\pi)$, $x6[n]=5\cos(1.5\pi n+0.75\pi)+ 4\cos(0.6\pi n)-\sin(0.5\pi n)$. In each case, determine the period of the signal theoretically and verify the result by displaying the signal in a plot.

4. Random signal generation

a. **Do in lab (15 marks):** Display all of the following in one plot using hold function and rand(.,.) function for N=100 including appropriate legend

i. A random signal of length N with samples uniformly distributed in the interval [0,1]

ii. *Another* random signal of length N with samples uniformly distributed in the interval [0,1]

iii. A random signal of length N with samples uniformly distributed in the interval [-5.-3]

b. Display all of the following in one plot using hold function and randn(.,.) function for N=100 including appropriate legend

i. A random signal x[n] of length N with samples normally distributed with zero mean and unity variance;

ii. Another random signal x[n] of length N with samples normally distributed with zero mean and unity variance;

iii. A random signal x[n] of length N with samples normally distributed with zero mean and variance of 100;

5. **Do in lab (40 marks): Convolution**: Write a program to perform convolution of two signals given by

$$y[n] = \sum_k h[k]\,x[n-k]$$

   a. Create any two arbitrary signals x(n) and h(n) of short lengths and compute the result using your program. Use the "conv" function in MATLAB to verify your result.
   b. Set h(n) as the impulse signal $\delta[n]$ and compute the result. Comment on the result.
   c. Create any two arbitrary signals x(n), h(n) and g(n) of short lengths and verify distributive property of convolution.