ECE250: Signals and Systems
Assignment 1

Issued on: September 12, 2022

Max-Marks : 45

Due by: September 19, 2022 (6:00 pm)

Guidelines for submission

Theory Problems:

- Submit a hard copy of your solutions in the wooden box kept on the 3rd Floor of Old Academic Block (right side of the lift).
- Write your Name, Roll No. and Group No. (as assigned for your tutorials) on the hard copy of your solutions.

Programming Problems:

- Use Matlab to solve the programming problems.
- For your solutions, you need to submit a zipped file on Google classroom with the following:
  - program files (.m) with all dependencies.
  - a report (.pdf) with your coding outputs and generated plots. The report should be self-complete with all your assumptions and inferences clearly specified.
- Before submission, please name your zipped file as: "A1_GroupNo_RollNo_Name.zip".
- Codes/reports submitted without a zipped file or without following the naming convention will NOT be checked.

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1) [CO1] (9 points) A discrete signal $x[n]$ is given as shown in Fig. 1. Using $x[n]$, two more signals $y[n]$ and $z[n]$ are generated, as per the following definitions:
   - Even$\{y[n]\} = x[n]$ for $n \geq 0$ and Odd$\{y[n]\} = x[n]$ for $n < 0$
   - Even$\{z[n]\} = x[n]$ for $-\infty < n < \infty$. Assume that $z[n] = 0$ for $n < 0$

   i) (6 pts) Find and sketch $y[n]$ and $z[n]$.

   ii) (3 pts) For the three signals i.e. $x[n]$, $y[n]$, and $z[n]$, check and justify whether any of these are odd/even functions.

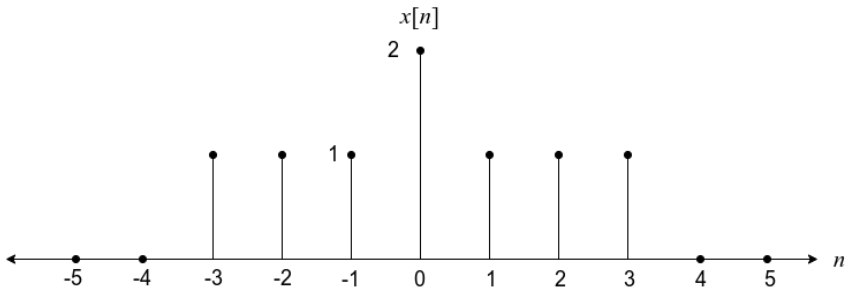

Figure 1: Signal $x[n]$

2) [CO1] (9 points) For the signal $g(t) = (\sqrt{2} + \sqrt{2}j)e^{j\pi/4}e^{(-1+j2\pi)t}$, sketch the following:

i) (3 pts) Real$\{g(t)\}$

ii) (3 pts) Imag$\{g(t)\}$

iii) (3 pts) $g(t+2) + \bar{g}(t+2)$, where $\bar{g}(t)$ denotes the complex conjugate of $g(t)$.

3) [CO1] (11 points) Two students of the Signal and Systems course are instructed to generate periodic signals of period T seconds using triangular pulses. Student-A generated a signal of the form $s_1(t) = at/T$ for $0 \leq t < T$ as depicted in Fig. 2 (left), where a is a positive quantity that denotes the amplitude of the signal. In comparison, student-B generated a signal $s_2(t)$ as shown in Fig. 2 (right).

i) (2 pts) Write the mathematical expression of signal $s_2(t)$ for $0 \leq t < T$.

ii) For both the signals, compute the following signal parameters:

a) (1 pt) Peak or maximum value

b) (1 pt) Energy

c) (1 pt) Power

d) (2 pts) Root-mean-square (RMS) value

$$RMS\{s(t)\} = \left(\frac{1}{T}\int_0^T s(t)^2 dt\right)^{1/2} \tag{1}$$

e) (1 pt) Mean or average value

$$\text{Avg}\{s(t)\} = \left(\frac{1}{T}\int_0^T s(t) dt\right) \tag{2}$$

f) (1 pts) Mean absolute value

$$\text{MAV}\{s(t)\} = \left(\frac{1}{T}\int_0^T |s(t)| dt\right) \tag{3}$$

g) (2 pts) Sketch the derivate of the signal $s_1(t)$.

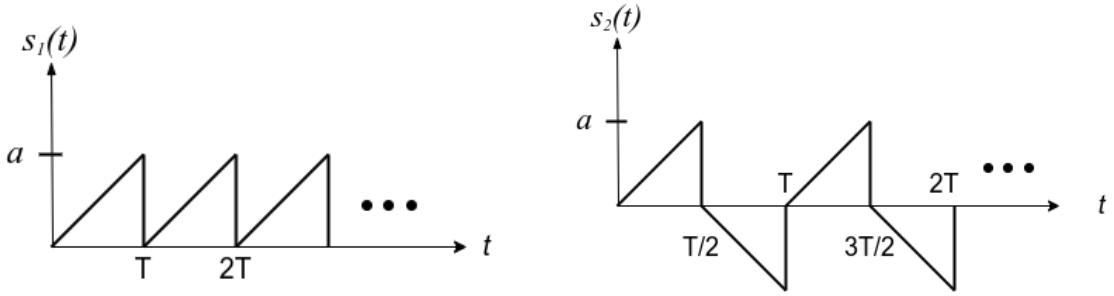

Figure 2: Signals $s_1[t]$ and $s_2[t]$

4) [CO2] (6 points) A system S is described by the relation $y(t) = x(at + b)$, where $x(t)$ is the input signal and $y(t)$ is the output signal.

i) (1 pt) Determine the values of b for which the system remains memoryless. Take $a = 100$.

ii) (1 pt) Will the system be memoryless if $b = -t^2$ yielding the system of form $y(t) = x(at - t^2)$? Take a = 97.

iii) (2 pts) If the input $x(t) = cos(t)$, will the system be causal? Justify.

iv) (2 pts) Another system S_2 is described by the relation $y(t) = e^{x(at+b)}$. Is it stable? Justify.

Note: Each part of this problem is to be solved individually.

Programming Problems:

5) [CO1] (6 points) Generate and plot each of the following sequences over the indicated intervals.

   i) (3 pts) $x[n] = n[u[n] - u[n-10]] + 10e^{-0.3(n-10)}[u[n-10] - u[n-20]]$, $0 \leq n \leq 20$

   ii) (3 pts) $y[n] = cos[0.03\pi n] + u[n]$, $0 \leq n \leq 50$

6) [CO1] (4 points) Let $z[n] = u[n] - u[n-10]$. Decompose $z[n]$ into its even and odd components and plot these in three individual subplots for the interval $-20 \leq n \leq 20$.