MIDDLE EAST TECHNICAL UNIVERSITY
DEPARTMENT OF COMPUTER ENGINEERING

CENG 384

Spring 2023
Homework 1

Regulations:

- **Grouping:** You are strongly encouraged to work in pairs.
- **Drawing Plots:** Clearly label the coordinate axes and make sure that your plots are not open to different interpretations.
- **Submission:** You need to submit a pdf file named 'hw1.pdf' to the odtuclass page of the course. You need to use the given template 'hw1.tex' to generate your pdf files. Otherwise you will receive zero.
- **Deadline:** 23:55, 02 April, 2023 (Sunday).
- **Late Submission:** Not allowed.

1. (20 pts) Solve the following, showing your solution in detail.
   (a) (5 pts) $z = x + yj$ and $2z + 5 = j - \bar{z}$, find $|z|^2$ and plot z on the complex plane.
   (b) (5 pts) $z = re^{j\theta}$ and $z^5 = 32j$, find z in polar form.
   (c) (5 pts) Find the magnitude and angle of $z = \frac{(1+j)(\frac{1}{2}+\frac{\sqrt{3}}{2}j)}{j-1}$.
   (d) (5 pts) Write z in polar form where $z = je^{-j\pi/2}$.

2. (10 pts) Given the signal $x(t)$ in Figure 1, draw the signal $y(t) = x(\frac{1}{2}t + 1)$.

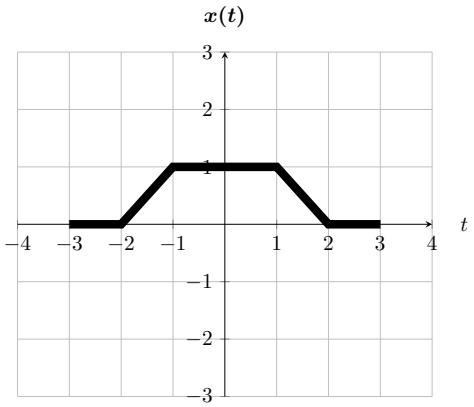

Figure 1: t vs. $x(t)$.

3. (15 pts) Given the $x[n]$ signal in Figure 2,
   (a) (10 pts) Draw $x[-n] + x[2n-1]$.
   (b) (5 pts) Express $x[-n] + x[2n-1]$ in terms of the unit impulse function.

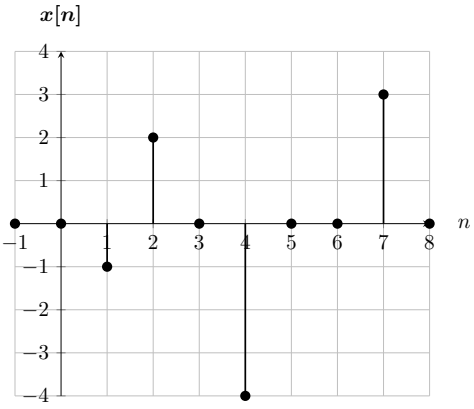

Figure 2: n vs. $x[n]$.

4. (15 pts) Determine whether the following signals are periodic and if periodic, find the fundamental period.
   (a) (5 pts) $x(t) = 5\sin(3t - \frac{\pi}{4})$
   (b) (5 pts) $x[n] = \cos[\frac{13\pi}{10}n] + \sin[\frac{7\pi}{10}n]$
   (c) (5 pts) $x[n] = \frac{1}{2}\cos[7n - 5]$

5. (10 pts) Given the $x(t)$ signal in Figure 3,
   (a) (5 pts) Express $x(t)$ in terms of the unit step function.
   (b) (5 pts) Find and draw $\frac{dx(t)}{dt}$.

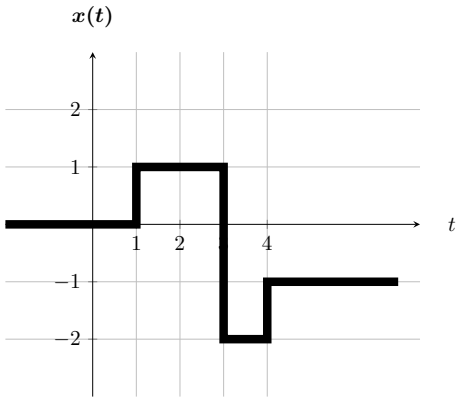

Figure 3: t vs. $x(t)$.

6. (12 pts) Analyze whether the following systems have these properties: *memory, stability, causality, linearity, invertibility, time-invariance*. Provide your answer in detail.
   (a) (6 pts) $y(t) = tx(2t + 3)$
   (b) (6 pts) $y[n] = \sum_{k=1}^{\infty} x[n - k]$

7. (18 pts) Programming.
   (a) (9 pts) Write a computer program to plot the **even and odd parts** of a discrete time signal $x[n]$. Your program takes the signal and the starting index(s_i) of the signal as input. For example, let's say $x[n] = [1, 6, 8, 9]$ and $s_i = 3$, then $x[3] = 1$, $x[4] = 6$, $x[5] = 8$, $x[6] = 9$ and $x[n] = 0$ for other n values.
   You should add your codes and the outputs for the given 3 input files (sine_part_a.csv, shifted_sawtooth_part_a.csv, chirp_part_a.csv) to your solution. The first element in the files is the starting index and remaining ones are the elements of the signal.
   (b) (9 pts) Write a computer program to plot the shifted and scaled version $x[an + b]$ of a discrete time signal $x[n]$. Your program takes the signal and the starting index(s_i) of the signal as input. Differently from part a, you should also take a and b values as input.
   You should add your codes and the outputs for the given 3 input files (sine_part_b.csv, shifted_sawtooth_part_b.csv, chirp_part_b.csv) to your solution. The first element in the files is the starting index, the second element is the value of a, the third element is the value of b and remaining ones are the elements of the signal.

   You should write your code in `Python` and no library is allowed other than `matplotlib.pyplot`.