MIDDLE EAST TECHNICAL UNIVERSITY
DEPARTMENT OF COMPUTER ENGINEERING

CENG 384

Spring 2022
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, 03 April, 2022 (Sunday).
- **Late Submission:** Not allowed.

1. (16 pts) Solve the following, showing your solution in detail.
   (a) (4 pts) Given a complex number in Cartesian coordinate system, $z = x + jy$ and $2z - 9 = 4j - \bar{z}$,
      i. find $|z|^2$ and
      ii. find and plot z on the complex plane.
   (b) (4 pts) Given $z^3 = -27j$, find z in polar form ($z = re^{j\theta}$).
   (c) (4 pts) Find the magnitude and angle of $z = \frac{(1+j)(\sqrt{3}-j)}{(\sqrt{3}+j)}$
   (d) (4 pts) Write z in polar form where $z = -(1+j)^8 e^{j\pi/2}$.

2. (12 pts) Calculate power P and energy E of the given signals and determine whether they are Power signals, Energy signals or neither of them.
   (a) (6 pts) $x[n] = nu[n]$
   (b) (6 pts) $x(t) = e^{-2t}u(t)$

3. (10 pts) Given the $x(t)$ signal in Figure 1, draw the signal $y(t) = \frac{1}{2}x(-\frac{1}{3}t + 2)$.

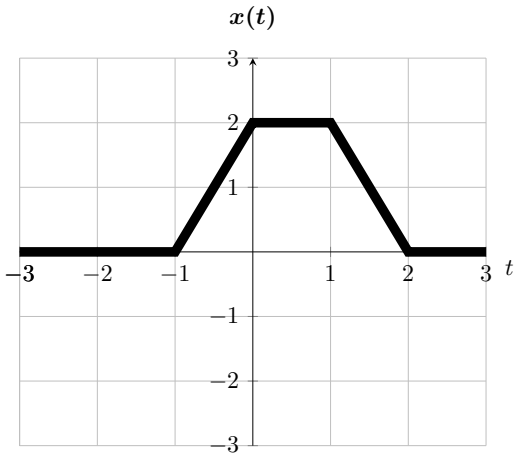

Figure 1: t vs. $x(t)$.

4. (15 pts) Given the $x[n]$ signal in Figure 2,
   (a) (10 pts) Draw $x[-2n] + x[n-2]$.
   (b) (5 pts) Express $x[-2n] + x[n-2]$ in terms of the unit impulse function.

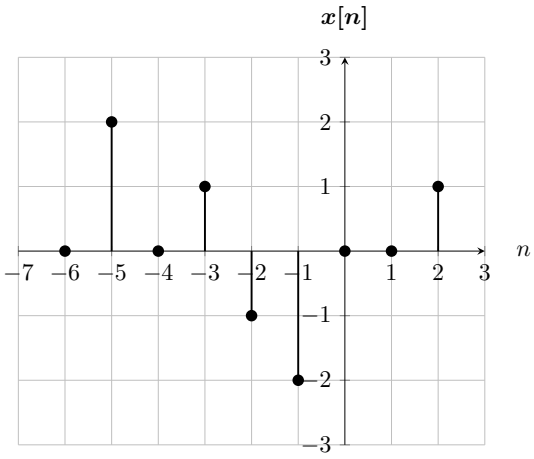

Figure 2: n vs. $x[n]$.

5. (8 pts) Determine whether the following signals are periodic and if periodic find the fundamental period.
   (a) (4 pts) $x(t) = \frac{e^{j3t}}{-j}$
   (b) (4 pts) $x[n] = \frac{1}{2}\sin[\frac{7\pi}{8}n] + 4\cos[\frac{3\pi}{4}n - \frac{\pi}{2}]$

6. (15 pts) Consider the signal in Figure 1.
   (a) (5 pts) Show that the signal is neither even nor odd.
   (b) (10 pts) Find the even and odd decompositions of the signal and draw these parts.

7. (12 pts) Given the $x(t)$ signal in Figure 3,
   (a) (5 pts) Express $x(t)$ in terms of the unit step function.
   (b) (7 pts) Find and draw $\frac{dx(t)}{dt}$.

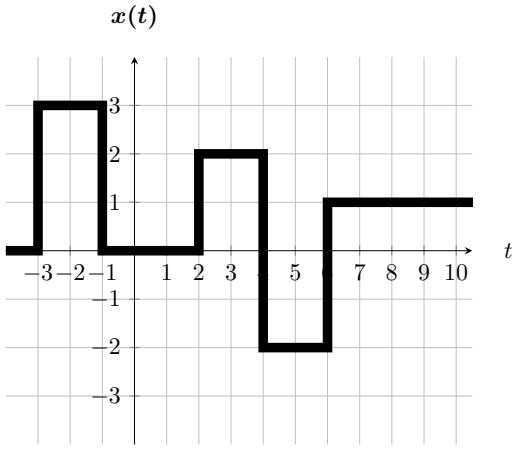

Figure 3: t vs. $x(t)$.

8. (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) $y[n] = x[2n - 2]$
   (b) (6 pts) $y(t) = tx(\frac{t}{2} - 1)$