



### Regulations:

- **Grouping:** You are allowed to work in pairs.
- **Drawing Plots:** Clearly label the coordinate axes and make sure that your plots are not open to different interpretations.
- **Submission:** We provide a latex template for your solutions. Use that template and create a `hw1.tar.gz` file that includes `hw1.tex` and all other related files. Tar.gz file should not contain any directories and should create a `hw1.pdf` file with the following commands, otherwise you will get zero;  
`tar xvzf hw1.tar.gz`  
`pdflatex hw1.tex`  
Submit `hw1.tar.gz` to the odtuclass page of the course.
- **Deadline:** 23:55, 11 April, 2021 (Sunday).
- **Late Submission:** Not allowed.

1. (10 points) Prove the following equality, showing your steps in detail.

$$\frac{de^t}{dt} = e^t$$

2. (16 pts) Solve the following, showing your solution in detail.

- (4 pts) Given a complex number in Cartesian coordinate system,  $z = x + jy$  and  $z - 3 = j - 2\bar{z}$ ,
  - find  $|z|^2$  and
  - find and plot  $z$  on the complex plane.
- (4 pts) Given  $z = re^{j\theta}$  and  $z^4 = -81$ , find  $z$  in polar form.
- (4 pts) Find the magnitude and angle of  $z = \frac{(\frac{1}{2} + \frac{1}{2}j)(1-j)}{1 - \sqrt{3}j}$ .
- (4 pts) Write  $z$  in polar form where  $z = -\frac{3}{j}e^{j\pi/2}$ .

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

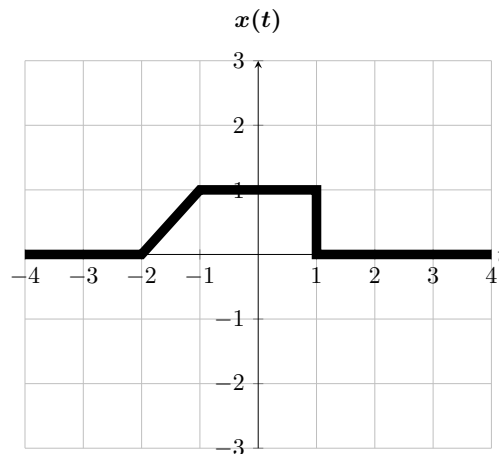


Figure 1:  $t$  vs.  $x(t)$ .

4. (10 pts) Given the  $x[n]$  signal in Figure 2,

- (6 pts) Draw  $x[-n] + x[2n + 1]$ .
- (4 pts) Express  $x[-n] + x[2n + 1]$  in terms of the unit impulse function.

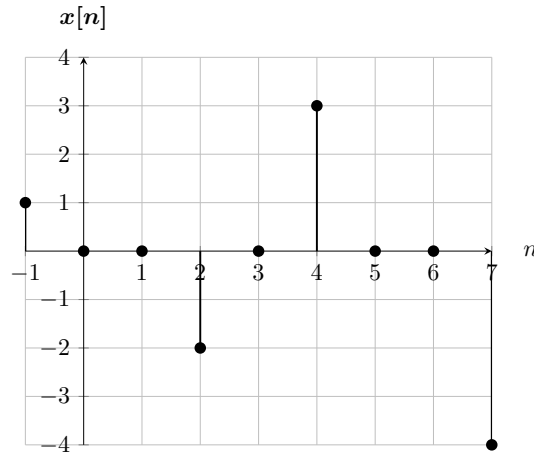


Figure 2:  $n$  vs.  $x[n]$ .

5. (9 pts) Determine whether the following signals are periodic and if periodic find the fundamental period.

- (a) (3 pts)  $x(t) = 3 \cos(7\pi t - \frac{4\pi}{5})$
- (b) (3 pts)  $x[n] = \sin[4n - \frac{\pi}{2}]$
- (c) (3 pts)  $x[n] = 2 \cos[\frac{7\pi}{5}n] + 7 \sin[\frac{5\pi}{2}n - \frac{\pi}{3}]$

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  $\frac{dx(t)}{dt}$ .

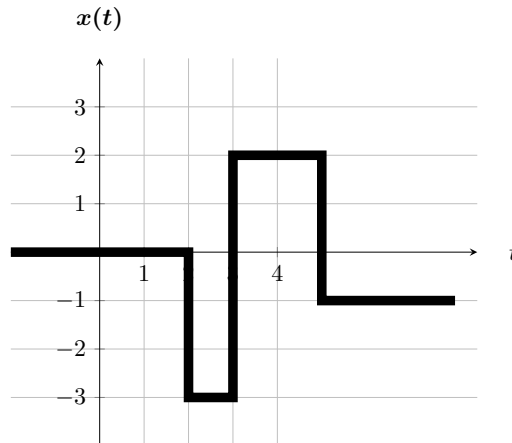


Figure 3:  $t$  vs.  $x(t)$ .

8. (18 pts) Analyze whether the following systems have these properties: *memory*, *stability*, *causality*, *linearity*, *invertibility*, *time-invariance*. Provide your answer in detail.

- (a) (3 pts)  $y[n] = x[3n - 5]$
- (b) (3 pts)  $y(t) = x(3t - 5)$
- (c) (6 pts)  $y(t) = tx(t - 1)$
- (d) (6 pts)  $y[n] = \sum_{k=1}^{\infty} x[n - k]$