

# COM-202 - Signal Processing

## Homework 1

due Feb 27, 2025

### Exercise 1. Digital signals

Say which of the following signals are analog and which are digital:

- (a) Music recorded on a CD.
  - (b) Music listened by the audience at a live concert.
  - (c) Music recorded on a LP record (vinyl).
  - (d) Photo recorded using a photographic film.
  - (e) Photo recorded using a CCD sensor.
  - (f) A page on a book.
  - (g) The image of a book page on a Kindle.
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### Exercise 2. Sampling music

A music song recorded in a studio is stored as a digital sequence on a CD. The analog signal representing the music is 2 minutes long and is sampled at a frequency  $f_s = 44100 \text{ s}^{-1}$ . How many samples should be stored on the CD?

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### Exercise 3. Basic signal operations

Consider the discrete-time signal:

$$x[n] = \begin{cases} 1, & 0 \leq n \leq 2, \\ 0, & \text{otherwise.} \end{cases} \quad (1)$$

Sketch  $y[n] = x[n-1] + x[2n] + x[-1-n]$  and carefully label both axes in the plot.

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#### Exercise 4. Periodicity

For each of the following signals, determine if the signal is periodic and, if so, find its period.

(a)  $x_1[n] = \cos\left(\frac{6\pi}{7}n + 1\right)$

(b)  $x_2[n] = \sin\left(\frac{\pi}{2}n\right)\cos\left(\frac{\pi}{4}n\right)$

(c)  $x_3[n] = \cos\left(\frac{n}{8} - \pi\right)$

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#### Exercise 5. Energy and power

For each of the following signals, determine if the signal is an energy signal or a power signal and, accordingly, compute its energy or its power:

(a)  $x_1[n] = \begin{cases} n & 0 \leq n \leq 6 \\ 2 & 6 < n \leq 8 \\ 0 & \text{otherwise} \end{cases}$

(b)  $x_2[n] = (1 + |n|)^{-1}$

(c)  $x_3[n] = e^{jn}$

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#### Exercise 6. Moving average

Consider the following signal,

$$x[n] = \delta[n] + 2\delta[n-1] + 3\delta[n-2].$$

Compute its moving average  $y[n] = \frac{x[n] + x[n-1]}{2}$ , where we call  $x[n]$  the input and  $y[n]$  the output.

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