

# Statistical Signal Processing I

## MATLAB Homework

### Instructions (**Please read carefully**)

Return your solution to Moodle before 01.11.2023 16:15. Late returning will lead to deduction of points.

Upload your solutions to Moodle as ZIPPED file containing all files needed to run your codes. Your codes must be ready to run without any additional user configuration.

Use filename `MATLAB_Group.zip`. In addition to the well-commented program, make sure the report includes the following:

- The full name and the student number for each group member.
- Clear answers to the problems posted (including for example figures obtained by running the simulation program).
- Plagiarism is strictly forbidden and will lead to immediate rejection!
- You will get separate grade for each MATLAB exercise and you must need passing grade in order to pass the whole course.

### Task

The data

$$x[n] = \theta n + w[n]$$

for  $n = 0, 1, 2, \dots, N-1$  are observed, where  $w[n]$  is zero-mean WGN with variance  $\sigma^2$ . The objective is to estimate  $\theta$ .

It is known that the Cramer-Rao lower bound is  $\text{CRLB} = \frac{\sigma^2}{\sum_{n=0}^{N-1} n^2}$

1. Show that the estimator  $\hat{\theta} = \frac{\sum_{n=0}^{N-1} x[n]n}{\sum_{n=0}^{N-1} n^2}$  is **efficient** by Monte Carlo (MC) simulation.
2. Generate figure that shows that simulated and theoretical probability density functions agree for the estimator in (a). Make sure that your figures includes labels and legends.
3. What happens when  $N = 1$ , and  $N \rightarrow \infty$  ? Explain why.

Use the following parameter for the simulations:

$MC = 10000$ , % Number of Monte Carlo loops

$N = 10$ ,

$\sigma^2 = 2$

$\theta = 10$ .