# Example Examination
# Pattern Recognition

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First Name: Matrikel No.:

Last Name: Signature:

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### Important remarks

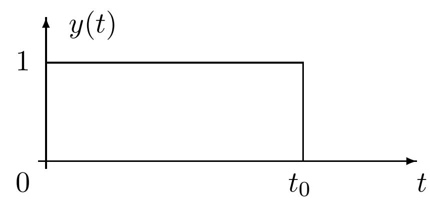
- This examination contains 4 pages. Please check now if you have all pages.
- Check if your name and your matrikel number on this title-page is correct. If not, correct it.
- This is an open book exam. You can use all kinds of material; including books, the lecture manuscript, and the tutorials. You may also use a pocket calculator. However, programmable calculators, notebook-computers and all kinds of mobile devices are not allowed.
- Sub-tasks that can be solved without any previous results are marked with an asterisk (*).
- Each task provides space for your solution. If the provided space is not sufficient for your solution you may use the back of each page. If you use the back of the pages, mark clearly to which subtask the solution belongs.
- If you need more space, additional sheets with an institute-stamp can be provided. Do not use your own sheets.
- Do not use red color.
- Do not separate the pages of this exam.
- At the end of the exam you have to return all pages of this examination.

### Important remarks for the example examination

- This is only a short collection of tasks.
- The real examination has 5-7 tasks.
- The real examination has a duration of 75 minutes and a total of 75 points.
- This is only a collection of possible tasks to show you the style of the examination. The real examination covers the discussed sections of the lecture script and all tutorials!
- Don’t forget to bring a pocket calculator to the real examination.

## **Task 1: Features** (7 Points)

*a) (3 Pt.) Determine the Fourier-transform $Y_f(\omega)$ of the the rectangular function $y(t) = h(t) - h(t - t_0)$, where $h(t)$ is the unit step function. The rectangular function is shown in the plot below.




*Solution:*

b) (4 Pt.) Use $\omega = 2\pi f$ and split $Y_f(f)$ in magnitude and phase.

*Solution:*

## Task 2: Pattern classification (11 Points)

*a) (4 Pt.) Consider a two class problem in a 3-dimensional feature-space. The class $\Omega_1$ is represented by its reference vector $\vec{w}_1$ and the class $\Omega_2$ is represented by its reference vector $\vec{w}_2$.

Classify the patterns $\vec{y}_1$ and $\vec{y}_2$ with the Nearest Neighbor Rule classifier and the Euclidean distance!

$$\vec{w}_1 = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} \quad \vec{w}_2 = \begin{bmatrix} 3 \\ 4 \\ 5 \end{bmatrix} \quad \vec{y}_1 = \begin{bmatrix} 0 \\ 1 \\ 2 \end{bmatrix} \quad \vec{y}_2 = \begin{bmatrix} -1 \\ 6 \\ 8 \end{bmatrix}$$

*Solution:*

Consider a polynomial classifier that devides the two classes $\Omega_1$ and $\Omega_2$

$$\begin{bmatrix} d_1 \\ d_2 \end{bmatrix} = \begin{bmatrix} 2 & 4 & 2 & 1 & 1 \\ 1 & 1 & 1 & 1 & 2 \end{bmatrix} \cdot \begin{bmatrix} y_1^2 & y_2^2 & y_1 & y_2 & 1 \end{bmatrix}^T$$

*b) (2 Pt.) Classify the pattern $\vec{e} = \begin{bmatrix} 2 \\ 5 \end{bmatrix}$.

*Solution:*

*c) (4 Pt.) Determine a formula $f(y_1, y_2) = \frac{5}{4}$ for the decision border of the polynomial classifier

$$\begin{bmatrix} d_1 \\ d_2 \end{bmatrix} = \begin{bmatrix} 2 & 4 & 2 & 1 & 1 \\ 1 & 1 & 1 & 1 & 2 \end{bmatrix} \cdot \begin{bmatrix} y_1^2 & y_2^2 & y_1 & y_2 & 1 \end{bmatrix}^T$$

*Solution:*