

# Artificial Intelligence and Engineering Systems – Signals, systems and control

## Artificial Intelligence and Engineering Systems – Signals, systems and control

<b>Offered by</b>	Department of Electrical Engineering
<b>Language</b>	English
<b>Primarily interesting for</b>	Coherent package that is most relevant for students with a background in Computer Science, Data Science, Psychology and Technology, or Industrial Engineering who aim to enter the MSc program Artificial Intelligence and Engineering Systems.
<b>Prerequisites</b>	5ESFO: assumed pre-knowledge 2WBBO 5XSLO: assumed pre-knowledge 2DE20/ 5EMA0 /2MBA20 /8BA080/ 2IP90/ 5EWC0/ 31PAP 5ESDO: assumed pre-knowledge 5ESE0 and 5ESB0 4DB00: assumed pre-knowledge 4DA00 and 4CB00
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### Content and composition

This coherent package is focusing on signals, signal processing techniques, mathematical models for the description of linear and time-invariant dynamical systems and provides a number of elementary techniques for their control. The package offers tools for the representation of signals, for the different representations and for the analysis of dynamical systems and presents a number of techniques for the synthesis of controllers that effect stability, behavior and performance of systems.

The package connects to the entrance level on signals, systems and control of the MSc program *Artificial Intelligence and Engineering Systems* (AI&ES) and is recommended for bachelors students that consider doing a masters in AI&ES and lack relevant background on signals, systems and control. There are two (2) coherent packages preparing for the MSc program AI&ES. Only one of these packages can be selected as coherent package in your Bachelor's degree program.

Table 1. Coherent package 2022-2023

Course code	Course name	Level classification
<b>5ESE0</b>	Signal processing basics (Signals I)	1. Introductory
<b>5ESB0</b>	Systems	1. Introductory
<b>5ESDO</b>	Control systems	3. Advanced
<b>or</b>	<b>or</b>	
<b>4DB00</b>	Dynamics and control of mechanical systems	2. Deepening

Due to the Bachelor Redesign, as indicated in the PER (OER) BSc EE 2023-2024 (pg. 88), the 5ESE0 and 5ESB0 courses will not be offered in the 2023-2024 academic year.

The new elective packages is as follows in the table below.

Table 2. Coherent package 2023-2024

Course code	Course name	Level classification
<b>5ESFO</b>	Signal and Systems	1. Introductory
<b>5XSLO</b>	Fundamentals of machine learning	3. Advanced
<b>5ESDO</b>	Control systems	3. Advanced
<b>or</b>	<b>or</b>	
<b>4DB00</b>	Dynamics and control of mechanical systems	2. Deepening

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Courses in the above table that are included in the major program for which you are registered cannot be taken as courses in this coherent package. If such a course is mandatory in this coherent package, this means that the package cannot be chosen. There is a preference to take the introductory courses *before* the deepening or advanced courses.

## Course description

### 5ESFO Signal and Systems

This course is new to the BSc curriculum as of the academic year 2023-2024 and was developed by adapting and merging two related previous courses: Signal Processing Basics (5ESE0) and Systems (5ESB0). This course will offer a foundation on Signals and Systems theory, which is the basis of understanding, modeling and controlling engineering systems. Several topics will be covered:

- Complex exponentials and phasor notation, Spectrum and Fourier Series, Sampling and aliasing
- Linear-time invariant systems, Discrete convolution, Finite impulse response filters
- Modelling and analysis of dynamical systems, Convolution and impulse response, Laplace transform
- Feedback control analysis and objectives, Poles and stability, PID control

### 5XSLO Fundamentals of machine learning

We live in the age of data. The amount of data has been increasing at an exponential rate over the last decades and is expected to continue. Not only is the volume of the data larger than ever before, also the variety in types of data is consistently growing. Due to the enormous progress in sensor technology, we can measure more than ever before. The vast amounts of heterogeneous data harbor useful information that can help in e.g. disease detection, natural language processing and accident prevention. However, due to its growing volume and complexity, it becomes increasingly harder for humans to extract this information by manually analyzing the patterns in the data. Machine learning is a subfield of Artificial Intelligence (AI) that focusses on building mathematical models that can extract information from data by learning from examples.

### 5ESD0 Control systems

Control systems are omnipresent in everyday use of technology. The basic principles of control of linear dynamic systems are explored, and design methods are treated for designing control systems to handle design specifications in terms of speed (bandwidth), stability and robustness under presence of disturbances and sensor noises. Achievements and limitations are being addressed and the theory is complemented with design assignments on laboratory setups.

### 4DB00 Dynamics and control of mechanical systems

This course is the first step into understanding how to model and control the dynamic response of mechanical systems like high-tech precision systems and automotive systems. To this end, the derivation of the equations of motion of Multi-Degree-Of-Freedom (MDOF) mechanical systems is presented; and their vibrating behavior is characterized. Classic control techniques to “shape” the response of mechanical systems to reference signals and disturbances are introduced.