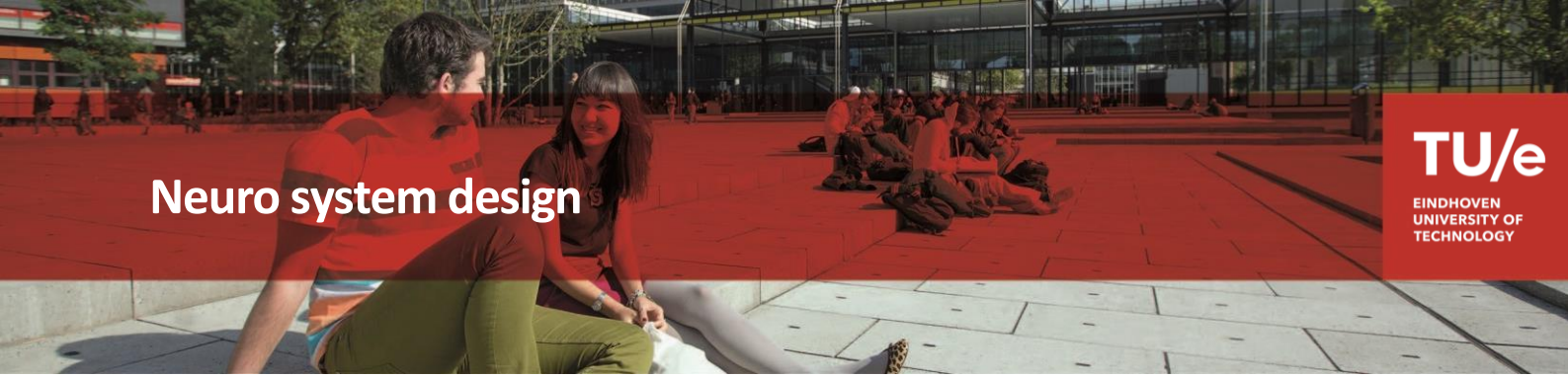


Neuro system design

Neuro system design	
Offered by	Department of Electrical Engineering
Language	English
Primarily interesting for	Electrical Engineering, Biomedical Engineering, Computer Science and Engineering, Applied Physics
Assumed previous knowledge	Electronics (5ECB0, 5ECC0 or 5XCA0), Computation (5EIA0 or 2IP90 & 2IC30), Linear algebra (2DE20 or a similar course)
Contact person	dr. R. Jordans, r.jordans@tue.nl

Content and composition

This elective package focuses on analysis and interpretation of neurological data as well as circuit design for analysis of neural signals and stimulation of the neural system. We start the courses with introducing the fundamental structures and algorithms of neurological and neuromorphic data processing, and show how this relates to current trends in AI. With this basis we take a closer look at health electronics and cover the low-power circuit design techniques used for data collection and early processing. Finally, we also look at the implementation of the data processing algorithms on modern digital architectures such as CPU, GPU, and hardware accelerators. Overall, this elective package should give you a good overview of the current techniques involved in neurological data acquisition and processing, as well as, teaching you the skills to start working on your own projects in the topic.

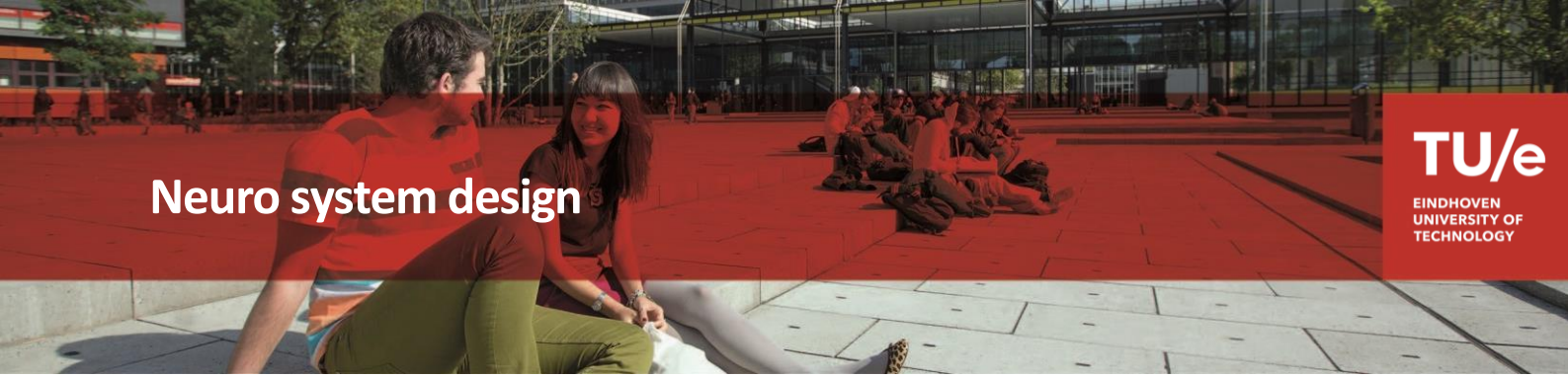
Course code	Course name	Level classification
5XSL0	Fundamentals of machine learning	2, deepening
5XCC0	Biopotential and neural interface circuits	3, advanced
5XIF0	Neuro computation	3, advanced

The preferred order for students to follow the courses is as stated above: 1st 5XSL0, 2nd 5XCC0, and 3rd 5XIF0.

Course description

5XSL0 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 focuses on building mathematical models that can extract information from data by learning from examples. This course aims to offer a solid theoretical basis for modern machine learning methods. It will teach students the mathematical foundations of machine learning, introduce a number of elementary techniques and discuss methods for evaluation of model performance. These concepts are the fundamental building blocks of modern AI approaches, such as deep learning, and offer insight and understanding in the workings of such models.



Neuro system design

5XCC0 Biopotential and neural interface circuits
This course gives an overview of low-power IC design techniques in the healthcare domain, with special focus to interfaces for the acquisition of neural signals and stimulation of the neural system. It also gives you the opportunity to practice these concepts in several circuit design assignments. Contents: Health applications, electronics fundamentals, low power design principles, low power analog and digital design, amplifiers, filters, ADCs, layout techniques, biomedical circuits, bio-inspired circuits, neural interfaces, Cadence software tutorials (schematic and layout), design assignments.

5XIF0 Neuro computation
This course gives an overview of signal processing algorithms used for data processing and modelling of neurological processes. It also gives an introduction in how these algorithms can be implemented efficiently on current computational hardware platforms. Contents: Electrophysiology, neurological processes, modeling techniques, signal processing algorithms, dense algebra, sparse algebra, list sorting, computational architectures, CPU, GPU, accelerators, system level design.