**FIM720  Neural Networks, 7.5 credits**
Artificiella neurala nätverk, 7,5 högskolepoäng  
*Second Cycle*

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**Confirmation**
This course syllabus was confirmed by Department of Physics on 2016-11-10 and was last revised on 2018-08-16 to be valid from 2018-08-16, autumn semester of 2018.

*Field of education:* Science 100%  
*Department:* Department of Physics

**Position in the educational system**
The course is part of the program in Complex Adaptive systems.
The course can be part of the following programmes: 1) Physics and learning, Master's Programme (N2FOL), 2) Applied Data Science Master's Programme (N2ADS), 3) Complex Adaptive Systems, Master's Programme (N2CAS), 4) Physics of Materials and Biological Systems, Master's Programme (N2PMB) and 5) Physics, Master's Programme (N2PHY)

*Main field of studies*  
Physics

*Specialization*  
A1N, Second cycle, has only first-cycle course/s as entry requirements

**Entry requirements**
A bachelors degree in physics, mathematics, or similar.

**Learning outcomes**
Neural networks are distributed computational models inspired by the structure of the human brain, consisting of many simple processing elements which are connected in a network. Neural networks are increasingly used in the engineering sciences for tasks such as pattern recognition, prediction and control. The theory of neural networks is an inter-disciplinary field (neurobiology, computer science and statistical physics).
The course gives an overview and a basic understanding of neural-network algorithms.

*Knowledge and understanding*
understand and explain strengths and weaknesses of the neural-network algorithms discussed in class
determine under which circumstances neural networks are useful in real applications
distinguish between supervised and unsupervised learning and explain the key principles of the corresponding algorithms
efficiently and reliably implement the algorithms introduced in class on a computer,
interpret the results of computer simulations
describe principles of more general optimisation algorithms
write well-structured technical reports in English presenting and explaining analytical calculations and numerical results
communicate results and conclusions in a clear and logical fashion

*Course content*
Introduction to neural networks (McCulloch Pitts neurons, associative memory problem, Hopfield model and Hebb's rule, storage capacity, energy function)
Stochastic neural networks (noise, order parameter, mean-field theory for the storage capacity)
Optimisation
Supervised learning: perceptrons and layered networks (feed-forward networks, multilayer perceptrons, gradient descent, backpropagation, conjugate-gradient methods, performance of multilayer networks)
Unsupervised learning (Hebbian learning, Oja's rule, competitive learning, topographic maps)
Recurrent networks and time-series analysis (recurrent backpropagation, backpropagation in time
Reinforcement learning

*Form of teaching*
Lectures, set homework problems, examples classes.

*Language of instruction:* English

*Assessment*
The final grade is based on homework assignments as well as on a written examination.
If a student, who has failed the same examined component twice, wishes to change examiner before the next examination, a written application shall be sent to the department responsible for the course and shall be granted unless there are special reasons to the contrary (Chapter 6, Section 22 of Higher Education Ordinance).

In cases where a course has been discontinued or has undergone major changes, the student shall normally be guaranteed at least three examination occasions (including the ordinary examination) during a period of at least one year from the last time the course was given.

**Grades**
The grading scale comprises: Pass with Distinction (VG), Pass (G) and Fail (U).

**Course evaluation**
Web-based course evaluation.

The results of and possible changes to the course will be shared with students who participated in the evaluation and students who are starting the course.

**Additional information**
This syllabus was originally established 2006-10-25, but this is the first version to be registered in Gubas.