COURSE OUTLINE

(1) GENERAL

SCHOOL	ENGINEERING		
ACADEMIC UNIT	Informatics and Computer Engineering		
LEVEL OF STUDIES	Undergraduate		
COURSE CODE	ICE-7103	**SEMESTER**	9th
COURSE TITLE	Pattern Recognition and Machine Learning		
INDEPENDENT TEACHING ACTIVITIES if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits		**WEEKLY TEACHING HOURS**	**CREDITS**
Lectures		3	
Computer Laboratory		1	
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).		**4**	**5**
COURSE TYPE general background, special background, specialised general knowledge, skills development	Specialised general knowledge, skills development		
PREREQUISITE COURSES:			
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes (in English)		
COURSE WEBSITE (URL)	https://eclass.uniwa.gr/courses/ICE299/		

(2) LEARNING OUTCOMES

Learning outcomes

The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.
Consult Appendix A

- Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area
- Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B
- Guidelines for writing Learning Outcomes

Upon successful completion of the course, the student must be able to:

- understand the difference between the algorithmic way of solving the problems of classical artificial intelligence and the inductive learning process of artificial neural networks
- design and implement pattern recognition and machine learning systems for a range of applications, such as visual object recognition, voice recognition, classification of sensory, multimodal and other data
- estimate conditional parametric probability distributions of data features based on labeled data, using techniques such as maximum likelihood or maximum a posteriori probability, as well as the expected - maximization (EM) algorithm
- extract and select appropriate features of reduced dimensions
- implement and train different machine learning models such as neural networks, Gaussian mixtures, hidden Markov models
- perform data clustering using various algorithms
- design and implement deep machine learning models (e.g. convolutional neural networks, LSTM, stacked autoencoders, etc.) for pattern recognition in different types of data and applications
- appreciate the special features, capabilities and limitations of different machine learning techniques and choose the most suitable ones for solving complex problems.

General Competences

Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the course aim?

Search for, analysis and synthesis of data and information, with the use of the necessary technology	Project planning and management
Adapting to new situations	Respect for difference and multiculturalism
Decision-making	Respect for the natural environment
Working independently	Showing social, professional and ethical responsibility and sensitivity to gender issues
Team work	Criticism and self-criticism
Working in an international environment	Production of free, creative and inductive thinking
Working in an interdisciplinary environment	……
Production of new research ideas	Others…
	…….

- Search for, analysis and synthesis of data and information, with the use of the necessary technology
- Decision-making
- Working independently
- Team work
- Production of new research ideas
- Production of free, creative and inductive thinking

(3) SYLLABUS

Introduction to Pattern Recognition and Machine Learning. Pattern recognition methods. Supervised and unsupervised learning methods. Bayesian classifiers and minimum cost Bayesian classifiers. Distance functions. Classification by shortest distance and K-nearest neighbors. Clustering. The K-means algorithm. Linear and non-linear discriminant functions. Estimation of the probability density of patterns. Parzen windows. Supervised classification methods. Cost functions. Feature extraction and selection, dimensionality problems and dimensionality reduction. Principal component analysis (PCA), linear discriminant analysis (LDA), independent component analysis (ICA). Gaussian Mixture Models. The EM (Expectation – Maximization) algorithm. Markov chains and Hidden Markov models. Support Vector Machines. Advanced pattern recognition and machine learning topics. Bagging, boosting, ensemble classifiers. Deep learning. Convolutional Neural Networks. Deep Recurrent Neural Networks (RNN), Long Short-Term Memory (LSTM) networks. Deep Belief Networks. Stacked Autoencoders. Generative Adversarial Networks. Applications in clustering, classification and recognition of events in different types of data (visual, audio, spatio-temporal, etc.) and in various fields (e.g. computer vision, remote sensing, energy, telecommunications, biomedicine).

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY Face-to-face, Distance learning, etc.	Face-to-face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY Use of ICT in teaching, laboratory education, communication with students	Use of web-based asynchronous elearning systems to support the educational material (notes, powerpoint presentations, self assignments, past exams etc.) and examinations. Use of email and announcements in elearning system to communicate and inform students.
TEACHING METHODS The manner and methods of teaching are described in detail. Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching,	

Activity	Semester workload
Lectures	39
Computer Laboratory	13
Written assignments	30
Self study	43
Course total	**125**

educational visits, project, essay writing, artistic creativity, etc. The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS	
STUDENT PERFORMANCE EVALUATION Description of the evaluation procedure Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other Specifically-defined evaluation criteria are given, and if and where they are accessible to students.	I. Final written exam (70%) which may contain : - Short-answer questions - Multiple choice questionnaires - Problem solving II. Computer laboratory assignments and projects (programming/computationsl/analytic) (30%) The exam material and the assessment process are made known to students in the lecture hall, the laboratory and the e-learning platform of the course.

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

1. Αναγνώριση Προτύπων, Θεοδωρίδης Σέργιος, Κουτρούμπας Κωνσταντίνος, Ιατρικές εκδόσεις Π.Χ. Πασχαλίδης, 2011.
2. Εισαγωγή στην αναγνώριση προτύπων με Matlab, Θεοδωρίδης Σέργιος, Ιατρικές εκδόσεις Π.Χ. Πασχαλίδης, 2011.

- Additional bibliography:

1. Pattern Classification, Richard O. Duda, Peter E. Hart, David G. Stork, 2nd Edition, Wiley, 2000
2. Pattern Recognition and Machine Learning, C. M. Bishop, Springer, 2006.
3. Deep Learning, I. Goodfellow, Y. Bengio and A. Courville, MIT Press, 2016, http://www.deeplearningbook.org.
4. Introduction to Statistical Pattern Recognition, K. Fukunaga, Academic Press.

- Relevant journals:

- IEEE Transactions on Pattern Analysis and Machine Intelligence
- Pattern Recognition, Elsevier
- Pattern Recognition Letters, Elsevier
- Journal of Machine Learning Research
- IEEE Transactions on Neural Networks and Learning Systems