COURSE OUTLINE

(1) GENERAL

SCHOOL	Sciences and Engineering		
ACADEMIC UNIT	Computer Science		
LEVEL OF STUDIES	1st Cycle		
COURSE CODE	COMP-447	**SEMESTER**	Fall
COURSE TITLE	Neural Networks and Deep 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**
		2.5	6
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).			
COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Special background		
PREREQUISITE COURSES:	MATH-280, COMP-270		
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	English		
IS THE COURSE OFFERED TO ERASMUS STUDENTS			
COURSE WEBSITE (URL)			

(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*

After completion of the course students are expected to be able to:

- Describe the relation between biological and artificial neural networks and discuss current applications of artificial neural networks
- Explain the structure of single-layer perceptrons, learning algorithms, and their limitations
- Explain and contrast back-propagation networks (multi-layer perceptrons) to single-layer perceptrons

- Explain how we handle temporality with neural networks, recurrent neural networks and back-propagation through time
- Explain the architecture of Radial Basis Function Networks, Hopfield models and Kohonen self-organizing maps, their learning algorithms and applications.
- Compare and contrast the various Artificial Neural Network architectures and learning algorithms presented throughout the course
- Explain the fundamentals of deep learning and convolutional neural networks
- Explain how we handle deep sequence models and the importance of long-short term memory (LSTM) networks
- Explain why we need deep generative models and the application of auto-encoders
- Design and develop neural network-based solutions to solve complex and unpredictable problems in pattern recognition, computer vision, and sequence modeling.
- Critically evaluate the performance and limitations of neural network models based on empirical results, considering factors such as generalization, convergence, and model interpretability.
- Manage and execute small-scale AI projects, taking responsibility for the selection of appropriate methods and communicating outcomes through technical reports or presentations.
- Integrate theoretical understanding with practical experimentation to demonstrate innovation and autonomy in developing intelligent systems based on neural computation.

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
Adapting to new situations
Decision-making
Working independently
Production of new research ideas
Criticism and self-criticism
Production of free, creative and inductive thinking

(3) SYLLABUS

1. What is a neural network? Biological neural networks and artificial neural networks, their similarities and differences. History of neural networks and current applications.
2. Fundamentals of learning and training samples, supervised and unsupervised learning.
3. Single Layer Perceptrons: architecture, activation function, learning rule, convergence theorem, limitations.
4. Multi-layer Perceptrons: hidden units, Back-propagation (generalized delta) learning rule, applications.

5. Temporality and recurrent neural networks, learning algorithms and applications.
6. Radial Basis Function Networks: architecture, learning, differences with multi-layer perceptrons.
7. The Hopfield model: architecture, learning algorithm, applications to character recognition.
8. Self-Organizing Maps (SOMs): structure of the Kohonen self-organizing map, learning algorithm, applications.
9. Deep Learning and Convolutional Neural Networks, learning algorithm, applications.
10. Deep Sequence modelling and LSTM networks, learning algorithm, applications.
11. Deep generative models and Auto-encoders, learning algorithm, applications.

(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 ICT in teaching / Χρήση ΤΠΕ* *Communication with students / Επικοινωνία με Φοιτητές*
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, 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.*	Mid-term, Projects, Homework, Final Examination

Activity	***Semester workload***
Lectures	35
Preparation, homework	50
Projects	42
Exam preparation	21
Final Exam	2
Course total	***150***

(5) ATTACHED BIBLIOGRAPHY

Required Textbooks / Readings:

Title	Authors	Publisher	Year	ISBN

Neural Networks and Learning Machines (3rd ed.)	Simon O. Haykin	Prentice Hall	2008	0131471392
Deep Learning	Aaron Courville, Ian Goodfellow and Yoshua Bengio	MIT Press	2015	9780262035613

Recommended Textbooks/Reading:

Title	**Authors**	**Publisher**	**Year**	**ISBN**
An Introduction to Neural Networks	Kevin Gurney	CRC press	1997	1857285034
Neural Networks for Pattern Recognition	Christopher M. Bishop	Oxford University Press	1995	9780125264204
Fundamentals of Neural Networks: Architectures, Algorithms And Applications	Laurene V. Fausett	Prentice Hall	1994	0133341860