COURSE OUTLINE

(1) GENERAL

SCHOOL			
ACADEMIC UNIT	**Interdisciplinary Graduate Programme in the BRAIN and MIND sciences**		
LEVEL OF STUDIES	7		
COURSE CODE	**B&M-R-137**	SEMESTER	**depending on availability**
COURSE TITLE	Deep Machine Learning for 3D Computer Vision and Image Synthesis		

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
laboratory exercises	6	9-27
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, skills development
PREREQUISITE COURSES:	B&M-103 Introduction to Computational Neuroscience Also recommended: CS-472 Computational Vision CS-577 Machine Learning
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	English
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	https://elearn.uoc.gr/course/view.php?id=5543

(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*

The research goal of the Computational Vision and Robotics Laboratory of the Institute of Computer Science at the Foundation for Research and Technology – Hellas (FORTH) is to contribute to the understanding of the computational foundations of perception, intelligence, and motor skills in living organisms, through the creation of computational models based on different hypotheses. The laboratory applies theories and computational models to create innovative artificial systems with applications in fields such as industrial automation, human–machine interaction, assistive technologies, security, home automation, entertainment, and virtual and augmented reality.

One area of the laboratory's activities, led by Dr. Anastasios Roussos, supervisor of this internship, focuses on developing new methodologies that combine geometry and physics with the most advanced deep learning methods, in order to extract detailed and reliable three-dimensional (3D) information from two-dimensional images and videos, as well as to create synthetic images and videos with high levels of realism.

Upon completion of the laboratory internship, the student will be able to:

- Integrate and apply the knowledge acquired from compulsory and elective courses of the program in the research context of their internship topic
- Reproduce current knowledge and fundamental theories in the field of deep learning for 3D computer vision and realistic image and video synthesis
- Acquire skills for programming and successfully conducting experiments
- Use knowledge as a basis for original ideas and research
- Think conceptually, develop, and elaborate arguments
- Analyze and carry out complex scientific work
- Collaborate effectively with colleagues and supervisors
- Take responsibility for the outcomes of their work
- Communicate conclusions and knowledge—arising from original research, self-study, or experience—clearly and accurately to both specialist and non-specialist audiences

If the laboratory internship develops into a Master's thesis, the student's further engagement with the research topic will enable them to:

- Independently complete fundamental research based on methodological knowledge
- Contribute originally to the development and application of ideas in the research field
- Recognize the limitations of existing knowledge in their scientific domain and at the interface between neighboring scientific fields, adapting their actions accordingly
- Identify and analyze complex problems and solve them strategically and creatively
- Take responsibility for managing complex processes
- Defend, before a specialized audience, their research results and their implications

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

- Project planning and management
- Showing social, professional and ethical responsibility and sensitivity to gender issues
- Criticism and self-criticism
- Production of free, creative and inductive thinking

(3) SYLLABUS

Training in research methods and topics related to deep learning methodologies for 3D computer vision and image synthesis. Specifically, the student will be trained in one or more of the following areas:

- 3D morphable models
- 3D reconstruction and modeling of the human face/hands/skull
- 3D analysis of human facial expressions
- Visual recognition and photorealistic synthesis of sign language
- Generative adversarial networks (GANs) for image and video synthesis
- Denoising diffusion models for image synthesis from text descriptions

(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 a scientific programming language, such as Python or MATLAB • Use of software for image and video analysis, creation and editing of 3D object models, and generation of synthetic images • Use of online platforms for sharing analysis code • Use of publishers' databases / electronic repositories of scientific articles
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*	

Activity	*Semester workload*
Study and analysis of bibliography	50-150
project	100-300
essay writing	25-75
non-directed study	50-150
Course total	***225-675***

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.*	Evaluation Language: English Evaluation Criteria: The student's dedication to conducting the study, autonomy and independence, critical review and analysis of the literature, progress over time, and the quality of the report are evaluated. Evaluation criteria are outlined in the study guide and communicated to students at the beginning of the course.

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

Scientific articles published in reputable scientific journals and conferences related to deep learning methodologies for 3D computer vision and image/video synthesis.