COURSE OUTLINE

(1) GENERAL

SCHOOL	SCIENCE		
ACADEMIC UNIT	INFORMATICS & TELECOMMUNICATIONS		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	ΕΠ23	**SEMESTER**	7
COURSE TITLE	IMAGE ANALYSIS AND COMPUTER VISION		

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**
	4	6
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (4).		

COURSE TYPE *general background, special background, specialised general, knowledge, skills development*	Special background
PREREQUISITE COURSES:	NO
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK
IS THE COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE WEBSITE (URL)	https://eclass.uoa.gr/courses/DI666/

(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 aim of the course is to familiarize students with modern methods in image analysis and computer vision, enabling them to implement these methods. Upon successful completion, the student will be able to:

- (**Knowledge**) Explain and contrast the core concepts and stages of computer vision, situating individual methods within a coherent processing pipeline; and explain the central ideas of image acquisition and image formation via perspective projection.
- (**Skill**) Apply linear and nonlinear filters, formally define convolution and correlation, and implement the corresponding operators on real images using the Python programming language.
- (**Knowledge/Skill**) Detect structures of interest (edges, corners, blobs) across multiple scales, construct image pyramids, and use SIFT/HOG/ORB descriptors for image matching or recognition problems with the OpenCV library; also describe in detail the operation, rationale, and underlying principles of these algorithms.
- (**Competence**) Develop optical flow algorithms for motion estimation and video analysis.
- (**Competence**) Design image classification systems using Bag-of-Visual-Words (BoVW) vector representations and classical classifiers.
- (**Skill**) Apply, train, tune, and evaluate modern neural-network architectures (e.g., CNNs, ViT) on computer-vision tasks using the PyTorch library.
- (**Knowledge/Skill**) Describe modern self-supervised representation-learning methods (e.g., SimCLR, BYOL, DINO, MAE), vision-language representations (e.g., CLIP), and generative architectures for image synthesis (e.g., GANs, diffusion models), distinguishing the advantages and potential pitfalls or subtle application issues of each method on new image datasets.

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	*Others…*
Production of new research ideas	

- Search for, analysis and synthesis of data and information, with the use of the necessary technology.

- Decision-making.

- Working independently.

(3) SYLLABUS

- Mathematical foundations of computer vision.
- Projective geometry, image formation, and stereoscopy.

- Basic concepts of digital images and neighborhood (local) operations.
- Feature extraction and edge detection.
- Corner detection and multi-scale pyramids.
- Scale space, blob detectors, and local feature descriptors.
- Advanced local features and vector representations of images.
- Basic concepts of machine learning.
- Introduction to traditional image recognition.
- Optical flow.
- Introduction to neural networks and the PyTorch library.
- Convolutional Neural Networks.
- The attention mechanism and the Transformer architecture.
- Object detection.
- Semantic image segmentation.
- Self-supervised representation learning and vision-language representations.
- Image synthesis with generative modeling.

(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*	Support of the learning process through *e-class* Contact through e-mail Use of Python programming language
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*	(see table below)
STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure*	The course will be assessed in two complementary ways: A) An individual final exam, held during the semester's examination period.

Activity	*Semester workload*
Lectures	52
Intermediate programming project	35
Final programming project	35
Preparation for final exam	30
Course total	***152***

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.*	B) Two individual programming problem sets, to be submitted at mid-semester and at the end of the semester. They will be graded via a brief, in-person oral examination of each student on their deliverable, which will include code and a written report. The examination will be accompanied by a discussion of the issues encountered and the implementation approach. The final grade for each student will be the sum of the A and B components.

(5) ATTACHED BIBLIOGRAPHY

- *Computer Vision,* 2nd Edition, R. Szeliski, Ed. Fountas, 2022 (Greek).

- *Machine Learning,* K. Diamantaras and D. Botsis, Ed. Kleidarithmos, 2019.

- *Image Processing and Analysis*, G. Tziritas and N. Komodakis, Kallipos, 2023.