COURSE OUTLINE

(1) GENERAL

SCHOOL	School of Science		
ACADEMIC UNIT	Physics		
LEVEL OF STUDIES	Undergraduate		
COURSE CODE	**10YK103**	**SEMESTER**	**7**
COURSE TITLE	**Astrophysics Laboratory**		

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 practice	4	6

COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Specialised Knowledge
PREREQUISITE COURSES:	No
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes, in English for Erasmus students
COURSE WEBSITE (URL)	https://eclass.uoa.gr/courses/PHYS242/

(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*

This laboratory course is compulsory for students who choose specialization in Astrophysics. The exercises cover topics of Observational Astrophysics and Space Physics

With the completion of the course the student should be able to:

- Manage, process and visualize measurements of scientific instruments and apply basic signal analysis techniques using MATLAB and PYTHON programming languages.
- Evaluate the quality of observational data and explain the effect of errors on the final result.
- Understand the principles of astronomical photometry and spectroscopy with applications in the visible light spectrum.
- Understand the principles of particle and electromagnetic field measurements in space and become acquainted with some basic analysis tools.
- Identify characteristic field and charged particle flux variations and combine them to draw conclusions about the physical processes in planetary magnetospheres driven by various solar and interplanetary disturbances.
- Combine astrometric observations from ground-based and space telescopes with the orbits of stars around the centre of the Galaxy, determine the mass of the central body (black hole) at the centre of the Galaxy, and evaluate the impact of the General Theory of Relativity on the problem of orbits.
- Create the rotation curve of a galaxy from its gas kinematics, to compute its dynamical mass (including that of the dark matter), as well as the gas mass from the line flux of molecular clouds in it. To understand what mass fraction corresponds to gas/stars and dark matter, and realise the consequences of the existence of dark matter.
- Compare energy spectra of charged particles, draw conclusions on the dynamic evolution of charged particle flux and energy, distinguish and evaluate various acceleration and plasma loss processes.
- Recognize the specific characteristics of astronomical observations in high energies (X-rays). Understand the physical processes that are involved in the production of X-ray radiation in astronomical objects. Analyze data from modern X-ray telescopes to derive the magnetic field of a neutron star of an ultra-luminous X-ray pulsar.
- Implement, in collaboration with fellow students, a small-scale research project and present the results in writing and orally.

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

The course aims at the following general competences:
Analysis and synthesis of data and information
Decision-making / Working independently /Team work
Analytical and synthetic thinking/Critical thinking
New Technology skills/Communication skills
Information management /Meeting Deadlines and Keeping Schedules
Flexibility / Adaptability / Problem solving

(3) SYLLABUS

- Introduction to MATLAB
- Optical Astronomy – Photometry (combined with an educational visit to the Gerostathopoulion Observatory of the University)
- Spectroscopy
- Detection of particles and processing of energetic electron measurements
- Detection of magnetic fields and processing of electromagnetic pulsation measurements
- Determination of the mass of the black hole in the center of the Galaxy
- Radio astronomy and interferometry - Spiral galaxy rotation curve
- X-ray/gamma-ray astronomy
- Research project by teams of two to three students

(4) TEACHING and LEARNING METHODS - EVALUATION

<table>
<tr><td>DELIVERY
Face-to-face, Distance learning, etc.</td><td>Face-to-face</td></tr>
<tr><td>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY
Use of ICT in teaching, laboratory education, communication with students</td><td>Yes
Use of email, e-class platform, kahoot and Slack.
Use of MATLAB and PYTHON</td></tr>
<tr><td>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</td><td>
<table>
<tr><th>Activity</th><th>Semester workload</th></tr>
<tr><td>Laboratory practice / Exercises</td><td>52</td></tr>
<tr><td>Study and analysis of bibliography / Preparation</td><td>45</td></tr>
<tr><td>Writing homework reports and team project report</td><td>53</td></tr>
<tr><td>Course Total</td><td>150</td></tr>
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<tr><td>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.</td><td>Open-ended questions, Problem solving.
Homework on laboratory exercise
Research project
Public presentation

Yes.</td></tr>
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(5) RECOMMENDED BIBLIOGRAPHY

- Suggested bibliography

- Space Physics (in Greek) – Ioannis A. Daglis, Christos Katsavrias, Nikolaos Sergis, Georgia Marinou, Kallipos, 2023, https://www.kallipos.gr/el/
- Waves, Particles, and Storms in Geospace - A Complex Interplay – Georgios Balasis, Ioannis A. Daglis, Ian R. Mann, Oxford University Press, ISBN: 9780198705246, 2016
- Galactic Dynamics – Binney & Tremaine, Princeton University Press, 1987

- Related academic journals:

- Annales Geophysicae
- Journal of Geophysical Research: Space Physics
- Space Weather
- Space Science Reviews
- Frontiers in Astronomy and Space Science
- Scientific Reports
- Monthly Notices of the Royal Astronomical Society
- Astrophysical Journal
- Astronomical Journal
- Astronomy & Astrophysics
- Nature Astronomy
- Annual Reviews of Astronomy and Astrophysics