COURSE OUTLINE

(1) GENERAL

SCHOOL	School of Science		
ACADEMIC UNIT	Physics		
LEVEL OF STUDIES	Undergraduate		
COURSE CODE	**10EK101**	**SEMESTER**	**7**
COURSE TITLE	**High Energy Astrophysics**		

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 (theory and exercises)	4	6

COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Specialised Knowledge
PREREQUISITE COURSES:	No (recommended Special Theory of Relativity and Electromagnetism)
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes, in the English language for Erasmus students
COURSE WEBSITE (URL)	https://eclass.uoa.gr/courses/PHYS209/

(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 course aims to introduce the student to High Energy Astrophysics, a field of Astrophysics that studies the most energetic phenomena of the Universe, which are often associated with compact astrophysical objects, and the relevant physical processes. As these phenomena cannot be reproduced in the laboratory, multi-messenger observations with space or ground-based telescopes offer a unique opportunity to study Nature in extreme conditions. At the same time, the student is given the opportunity to go beyond a qualitative presentation and move to the quantitative use of basic theoretical tools for the further modeling of the relevant physical phenomena.

At the end of the course, each student will be able to:
1. Know the various high-energy sources that have been observed and what is the modern view of the scientific community on their characteristics and formation mechanisms.
2. Understand the various mechanisms producing non-thermal radiation as well as the interaction of matter with radiation.
3. Combine the knowledge gained in basic courses (such as Mechanics I and Electromagnetism I) to explain acceleration mechanisms of charged particles to very high energies, as well as the bulk acceleration of magnetized relativistic outflows.
4. Have the necessary tools to understand new mechanisms that may be proposed in the near future in this rapidly evolving research field of Astrophysics.

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…*
	…….

The course aims at the following general competences

Search for, analysis and synthesis of data and information, with the use of the necessary technology
Decision-making
Working independently
Analytical and synthetic thinking
Critical thinking
Time management
Creativity
Meeting Deadlines and Keeping Schedules
Problem solving
Use of numerical tools in problem solving

(3) SYLLABUS

- Introductory concepts: High energy sources, non-thermal radiation spectra, X-ray and gamma-ray astronomy.
- Cosmic radiation: Observations, hadronic interactions.
- Photon-photon absorption: Threshold, active cross-section, optical depth, applications.
- Radiation field: Larmor relation, Thomson scattering.
- Compton scattering: Kinematics, energy losses, radiation spectrum, astrophysical applications.
- Synchrotron radiation: General principles, energy losses, spectrum radiation, astrophysical applications.
- Acceleration of particles at high energies: Fermi mechanisms and acceleration at potential differences with application to neutron star magnetospheres.
- Relativistic magnetohydrodynamics.
- Plasma effect on high energy emission processes: Radiation Cherenkov, Razin effect

(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*	Yes Electronic communication with the students using ICT (Information and Communications Technology)

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
Lectures/ exercises	52
Individual Study/ Study and Analysis of bibliography / Preparation	73
Exercises	*25*
Course Total	**150**

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.

1. Final written exams in Greek (80% of final grade)
2. Exercises during the semester (20% of final grade)

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography (given through the EYDOXUS platform):

- Μαστιχιάδης, Α., Βλαχάκης, Ν., 2015. Αστροφυσική υψηλών ενεργειών. [ηλεκτρ. βιβλ.] Αθήνα:Σύνδεσμος Ελληνικών Ακαδημαϊκών Βιβλιοθηκών. Διαθέσιμο στο: http://hdl.handle.net/11419/3100

- Other:

- Rybicki & Lightman, Radiative Processes in Astrophysics, John Wiley & Sons
- Longair, High Energy Astrophysics, Cambridge University Press