COURSE OUTLINE

(1) GENERAL

SCHOOL	School of Science		
ACADEMIC UNIT	Physics		
LEVEL OF STUDIES	Undergraduate		
COURSE CODE	10YKO32	**SEMESTER**	**5**
COURSE TITLE	**Electromagnetism I**		

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)	5 (3 theory & 2 exercises)	7

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	Yes, in the English language for Erasmus students
COURSE WEBSITE (URL)	https://eclass.uoa.gr/courses/PHYS125/

(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*

By successfully attending and completing the course of 'Electromagnetism I' the student is expected to obtain the necessary background and to develop skills that at the end of the semester should mature into specific abilities so that the student should be able to:

- Recognize and describe mathematically electrostatic and magnetostatic phenomena in vacuum and inside matter, i.e. dielectric and magnetic materials.
- Analyze and resolve basic and advanced problems so that their solution can be clearly anticipated. Clarify/evaluate the obtained results.
- Identify all the parameters involved in a problem, and most important to prioritize these parameters in terms of significance, recognizing those who have the most important contribution.
- Adopt assumptions and approximations, when necessary, to resolve a physical problem, while adequately documenting the correctness of the mathematical approach.

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 general skills that the student should acquire at the end of the semester mainly refer to:

- Analysis of clearly/self-consistently defined electrostatic and magnetostatic problems both in vacuum and under the presence of relevant materials.
- Development of 'critical thinking' to evaluate the clarity/self-consistency of a problem in both physical and mathematical terms.
- Handling existing knowledge through both 'inductive' and 'deductive' reasoning in problem analysis.
- Cultivation of self-consciousness and autonomy with the aim of efficiency in individual work.
- Promotion of 'free thinking' with the ultimate goal to introduce creative 'new proposals' that are in-line with existing knowledge.

(3) SYLLABUS

- Mathematical background: Delta function. Helmholtz theorem. Gauss theorem. Stokes theorem. Theorem of uniqueness. Laplace equation in Cartesian, cylindrical and spherical coordinates. General properties of solutions of Laplace's/Poisson's equation solutions/Relation with symmetries of the physical problem.

- Methods of solution: Boundary value problems in cartesian, cylindrical and spherical coordinates. Multipole expansion. Methods of Images. Method of Inversion.

- Electrostatics in vacuum. Scalar potential. Electric field. Generalized Coulomb's law for point, surface and volume/spatial charge densities. Gauss's law in integral and differential form/Symmetries of the physical problem. Parity under space inversion. Force on point, surface and volume/spatial charge densities. Work of the electric-force field. Conservation of energy in the electric-force field. Boundary conditions for the scalar potential and electric field.

- Electrostatics in matter. Electric polarization. Electric dipole/Force and torque. Multipole expansion of the scalar potential. Polarization mechanisms. Dielectrics. Bound charges of electric polarization. Electrical neutrality of dielectrics. Electrical displacement. Boundary conditions for the electrical displacement. Induced polarization: linear/nonlinear, homogeneous/heterogeneous, isotropic/anisotropic dielectrics. Permanent electrical polarization. Capacitors-Capacity. Poisson's/Laplace's equation for the scalar potential in dielectrics. Energy stored in dielectric materials. Force acting on dielectric materials.

- Magnetostatics in vacuum. Vector potential. Magnetic field. Generalized Biot-Savart Law for linear, surface and volume/spatial current densities. Ampere's law in integral and differential form/Symmetries of the physical problem. Parity under space inversion. Force on linear, surface and volume/spatial current densities. Work of the magnetic-force field. Conservation of energy in the magnetic-force field. Magnetic scalar pseudo-potential. Boundary conditions for the vector potential and magnetic field.

- Magnetostatics in matter. Magnetic polarization. Magnetic dipole/Force and torque. Multipole expansion of the vector potential. Polarization mechanisms. Magnetic materials. Bound currents of magnetic polarization. Magnetic induction. Boundary conditions for the magnetic induction. Induced magnetic polarization: linear/nonlinear, homogeneous/heterogeneous, isotropic/anisotropic diamagnetic, paramagnetic and ferromagnetic materials. Permanent magnetic polarization. Magnetic scalar pseudo-potential. Magnetic pseudo-charges. Multipole expansion of the magnetic scalar pseudo-potential. Poisson's/Laplace's equation of the magnetic pseudo-potential for the case of permanent magnets. Energy stored in magnetic materials. Force acting on magnetic materials.

- Law of induction. Maxwell's equations.

(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) Computer-aided lectures, use of Overhead Projectors, e-class platform
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

Activity	Semester workload
Lectures	39
Exercises	26
Individual Study/ Study and Analysis of bibliography / Preparation	107
Final written exams	3
Course Total	**175**

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.*	Final written exams in Greek. Oral examination, if needed.

(5) ATTACHED BIBLIOGRAPHY

- ‘Introduction to Electrodynamics’, D. Griffiths, Cambridge University Press (2017)
- Classical Electrodynamics, I. Bergados, ARIS SYMEON
- ‘Electrodynamics’, G. L. Pollack, D. R. Stump, Pearson (2005)