# COURSE OUTLINE

## (1) GENERAL

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| **SCHOOL** | School of Sciences | | |
| **ACADEMIC UNIT** | Department of Physics | | |
| **LEVEL OF STUDIES** | Undergraduate | | |
| **COURSE CODE** | **508** | **SEMESTER** | **8** |
| **COURSE TITLE** | MAGNETISM AND MAGNETIC MATERIALS | | |

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

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| **COURSE TYPE** *general background, special background, specialised general knowledge, skills development* | Specialised general knowledge |
| **PREREQUISITE COURSES:** | 7.2 SOLID STATE PHYSICS I |
| **LANGUAGE OF INSTRUCTION and EXAMINATIONS:** | Greek |
| **IS THE COURSE OFFERED TO ERASMUS STUDENTS** | Yes |
| **COURSE WEBSITE (URL)** | http://ecourse.uoi.gr/course/view.php?id=2041 |

## (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 course on Magnetism and Magnetic Materials provides the undergraduate students an introduction to the fields of magnetism, magnetic and superconducting materials, as well as to their applications.

In particular, after the successful completion of the course the students will be in position to:

- understand the basic concepts of magnetism and the sources of magnetic moments in materials and the interactions between them, as well as with magnetic fields,
- be able to combine knowledge on quantum physics, statistical physics, solid state physics and molecular and atomic physics for the description and interpretation of the magnetic state and magnetic properties of materials,
- have knowledge of the basic exemplary theoretical models for the

interpretation of the magnetic properties of materials,

- have knowledge of the contemporary technological applications of magnetic materials and the basic principles of their implementation,
- have gained experience on studying and comprehending the modern literature on subjects relate to magnetism and magnetic materials and their applications,
- have knowledge of the characteristics and properties of superconducting materials, as well as the basic theories for their interpretation.

**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?*

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|---|---|
| *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…* |
| | *…….* |

Search for, analysis and synthesis of data and information, with the use of the necessary technology.
Decision-making.
Working independently.
Working in an interdisciplinary environment.
Production of free, creative and inductive thinking.

**(3) SYLLABUS**

Magnetism of electrons. Atomic-ionic magnetic moments and magnetization of solid state substances. Hund's rules. Diamagnetism and paramagnetism of localized/delocalized electrons and conduction electrons. Paramagnetism and Brillouin/Langevin theories. Crystal field and magnetism of 3d and 4f electrons. Pauli paramagnetism and Landau diamagnetism. Mean field theory, band magnetism, Stoner criterion. Direct exchange, superexchange, double exchange and RKKY interactions. Exchange interaction and magnetic ordering: ferromagnetism, antiferromagnetism, ferrimagnetism and special magnetic ordering. Strong and week ferromagnetic metallic materials. Magnetic anisotropy. Hard and soft magnetic materials. Magnetic domains, single domain particles, Bloch and Néel walls, hysteresis and magnetization inversion mechanisms, Stoner-Wohlfarth model. Magnetization relaxation and superparamagnetism. Magnetic nanomaterials and nanoscale magnetism (thin films, thin film heterostructures, nanoparticles). Magnetoresistance and spintronics, half-metallic magnetic materials. Modern magnetic materials and their applications (magnetic sensors, magnetic memory, magnetic recording, magnetic nanoparticles, magnetocaloric and magnetostrictive materials, hybrid magnetic materials). Characteristics and properties of superconducting materials and basic theories for their interpretation.

## (4) TEACHING and LEARNING METHODS - EVALUATION

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|---|---|
| **DELIVERY**<br>*Face-to-face, Distance learning, etc.* | Face-to-face learning. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY**<br>*Use of ICT in teaching, laboratory education, communication with students* | Use of ICT in teaching, use of electronic projectors in lectures. Direct communication with students on lectures and in laboratories. Additional usage of the Moodle asynchronous e-learning system. |
| **TEACHING METHODS**<br>*The manner and methods of teaching are described in detail.*<br>*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.*<br><br>*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 | 47 |
| Practice/tutorials | 5 |
| Educational visits | 6 |
| Study and analysis of bibliography | 19 |
| Essay writing | 8 |
| Project compilation | 12 |
| Exams | 3 |
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| Course total | ***100*** |

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| **STUDENT PERFORMANCE EVALUATION**<br>*Description of the evaluation procedure*<br><br>*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*<br><br>*Specifically-defined evaluation criteria are given, and if and where they are accessible to students.* | Essay development and exercise solving and presentation (30%).<br>Evaluation with project compilation and presentation on a general or special subject (70%). |

## (5) ATTACHED BIBLIOGRAPHY

-Suggested bibliography:


- «Μαγνητικά Υλικά», Ι. Παναγιωτόπουλος, Εκδόσεις Α.Γ. Πνευματικός, Αθήνα, 2010, Κωδικός στον Εύδοξο:21495.
- «Μαγνητισμός και Μαγνητικά Υλικά», J.M.D. Coey, Μετάφραση-Επιμέλεια: Μ. Αγγελακέρης, Κ.Γ. Ευθυμιάδης, Ο.Καλογήρου, Εκδόσεις C. CITY Publish, 2014, Κωδικός στον Εύδοξο: 33074645.


International Scientific Journals:


- Journal of Magnetism and Magnetic Materials (Elsevier)
- Physical Review B (APS)