COURSE OUTLINE

(1) GENERAL

SCHOOL	ENGINEERING		
ACADEMIC UNIT	ELECTRICAL AND COMPUTER ENGINEERING DEPT.		
LEVEL OF STUDIES	Undergraduate		
COURSE CODE	**ECE_K250**	**SEMESTER**	**2**
COURSE TITLE	ELECTROTECHNIC 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**
Lectures	3	5
Seminars / Practice exercises	1	
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*	SPECIALIZED
PREREQUISITE COURSES:	
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK
IS THE COURSE OFFERED TO ERASMUS STUDENTS	No.
COURSE WEBSITE (URL)	https://www.ece.uop.gr/

(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 main goal of the course is the introduction in the field of science and technology of materials in terms of their electronic behavior. The course aims to give students basic knowledge of the most widely and constantly evolving field of technical materials used in electrical applications and their properties. By understanding the relationship between the structure of the materials, the processes in which they can be subjected, their production technology and their properties, they will be able to choose during their professional careers, each time studying a set of parameters, the most suitable material for each application through a wide variety of materials available, as well as to participate in the research and design of new materials with improved properties. Reference is also made to other scientific fields such as solid state physics, chemistry and materials science in general. The course examines electrical and electronic materials, their properties and technological applications and gives special emphasis to the education of students in basic relevant concepts, so that

they can be used for their subsequent study in the science of electrical engineering and computer technology. The course aims to present to students some of the main materials used in electrical applications. Interpretation and comprehension of physical and chemical properties of solid-state materials employed by the modern Electrical Engineer (conductors, insulators, semiconductors, superconductors, magnetic materials etc). Interpretation and comprehension of principal effects with technological interest, which are based on the electronic properties of the matter (e.g. photoelectric, field electron emission, Meissner, Schottky etc), and corresponding structures and devices (e.g. p-n junction, LED, laser, electron microscope, motors etc). Familiarization with measuring units and evaluation of the order of magnitude for the parameters involved in the above effects. Development of critical thinking for solving problems related to the above materials and design of elementary structures for exploitation of the above effects. Brief information on the methods and industrial environments for producing modern electrotechnic materials.

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…*
	…….

Upon successful completion of the theoretical course, students will be able to know the electrical materials and their properties and will be able to choose the most suitable material for each application through a number of available materials. Some of the general skills that are promoted through the course are: Autonomous work but also Group work, Promotion of free, creative and inductive thinking.

(3) SYLLABUS

- ✓ **Bonds between atoms:** Bohr's model of the atom, Pauli's exclusion principle and the shell model of the atom, atoms in solids, ionic bonding, the repulsive force, metallic bond, the covalent bond, bonds between molecules, the relationship between the type of bond and the physical properties of a solid.
- ✓ **Crystals and crystalline solids**: close-packed structures, non-close-packed structures, the crystal lattice, labelling crystal planes, X-ray diffraction, electron microscopes, allotropic phase transitions (changing the crystal structure).
- ✓ **Electrical and thermal properties of metals**: Drude's classical theory of electrical conduction, failures of the classical model, Bloch's quantum theory of electrical conduction, Hall Effect. Thermal Conductivity
- ✓ **Modern physics:** Compton Scattering Stimulated Emission and Laser Principles Stimulated Emission and Optical Amplifiers Time-Dependent Schrödinger Equation, Photoelectric Experiment
- ✓ **Band theory of solids**, distribution of the electrons between the energy states (the Fermi-Dirac distribution), the density of states, the free electron model, the density of occupied states, band theory of electrical conduction.
- ✓ **Semiconductors**: band theory of solids, the difference between insulators and semiconductors, holes, optical properties of semiconductors, the effective mass, n-type semiconductors, p-type semiconductors, majority and minority carriers, the Hall effect, the free electron model applied to semiconductors.

- ✓ **Semiconductor devices**: junctions between two metals (the contact potential), the p-n junction (a qualitative description), the p-n junction (a quantitative analysis), the p-n junction with an applied voltage (qualitatively), the p-n junction with an applied voltage (quantitatively), transistors (an introduction), bipolar transistors, the field-effect transistor, the integrated circuit, heterojunctions, optoelectronic devices.
- ✓ **Magnetic properties**: macroscopic magnetic quantities, atomic magnets, materials with magnetic moment, Pauli paramagnetism, Curie paramagnetism, ordered magnetic materials, temperature dependence of permanent magnets, band theory of ferromagnetism, ferromagnetic domains, soft and hard magnets, applications of magnetic materials for information storage.
- ✓ **Superconductivity**: the discovery of superconductivity, the resistivity of a superconductor, the Meissner effect, type II superconductors, superconductivity of superconductors, type I and type II, high-temperature superconductors, superconducting magnets, SQUID magnetometers.
- ✓ **Dielectrics**: induced polarization, other polarization mechanisms, the frequency dependence of the dielectric constant, resonant absorption and dipole relaxation, impurities in dielectrics, piezoelectricity, ferroelectrics, dielectric breakdown.
- ✓ **Crystallization and amorphous solids**: the melting point, crystallization, amorphous solids, optical properties of amorphous solids, amorphous semiconductors, amorphous magnets.
- ✓ **Polymers**: elastic properties of rubber, the rubbery and glassy states, amorphous and crystalline polymers, oriented crystalline polymers, conducting polymers.
- ✓ **Optical Materials**: Real and Imaginary Dielectric Constant Optical Dispersion and Absorption Fresnel's Equations Complex Refractive Index and Light Absorption Dispersion: Refractive Index versus Wavelength Behavior

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face to face in class
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	View slides. View computer animations to describe the time evolution of physics phenomena. Demonstration of laboratory experiments at the time of teaching. Informational material to the eclass.
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.	39
Problem solving.	13
Project	13
Literature studying and material on eclass	60
Course Total	**125 hours (5 ECTS)**

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.*	Student evaluation is carried out with a three-hour written examination in Greek language. This examination counts for the 100% of the final grade, while an optional 10% refers to the examination of the project assigned. The latter is examined orally during a common presentation in presence of all Groups.

(5) ATTACHED BIBLIOGRAPHY

- *Suggested bibliography:*

1. Principles of Electronic Materials and Devices, O. S. Kasap, McGraw-Hill 2002.
2. Materials Science and engineering. An Introduction William D. Callister John willey and Sons Inc. 2000.
3. Principles of solid State Physics Robert A. Levy Academic Press New York
4. Epitome of Solid State Physics (in Greek), E. N. Economou, University Press, Crete.