COURSE DESCRIPTION

1. Program identification information

1.1 Higher education institution	POLITEHNICA University of Bucharest
1.2 Faculty	Electronics, Telecommunications and Information Technology
1.3 Department	Electronic Technology and Reliability
1.4 Domain of studies	Electronic Engineering, Telecommunications and Informational Technologies
1.5 Cycle of studies	License
1.6 Program of studies/Qualification	Technologies and Systems of Telecommunications (TSTeng)

2. Course identification information

2.1 Name of the course				Materials for Electronics			
2.2 Lecturer				Lecturer eng. Drăgulinescu Andrei, PhD			
2.3 Instructor for practical activities							
2.4 Year of studies	II	2.5 Semester	3	2.6 Evaluation type	Exam	2.7 Course choice type	Compulsory

3. Total estimated time (hours per semester for academic activities)

3.1 Number of hours per week, out of which	3	3.2 course	3	3.3 practical activities	0
3.4 Total hours in the curricula, out of which	42	3.5 course	42	3.6 practical activities	0

Distribution of time	Hours
Study according to the manual, course support, bibliography and hand notes	30
Supplemental documentation (library, electronic access resources, in the field, etc)	6
Preparation for practical activities, homeworks, essays, portfolios, etc.	0
Tutoring	0
Examinations	3
Other activities	0

3.7 Total hours of individual study	36
3.9 Total hours per semester	78
3. 10 Number of ECTS credit points	3

4. Prerequisites (if applicable)

4.1 curricular	Physics 1, Physics 2, Chemistry, Fundamentals of Electronic Engineering 1, Fundamentals of Electrotechnical Engineering 2
4.2 competence-based	Knowledge of Physics, Chemistry and fundamentals of Electrotechnical Engineering

5. Requisites (if applicable)

5.1 for running the course	Not applicable, according to current PUB regulations.
5.2 for running of the	-

applications	

6. Specific competences

Professional competences	C1. Using of fundamental elements that refer to the electronic devices, circuits and instrumentation C2. Application, in typical situations, of basic methods of signal acquisition and processing
Transversal competences	It is not the case

7. Course objectives (as implied by the grid of specific competences)

7.1 General objective of the course	Presentation of the structure and of the fundamental characteristics and properties of the materials used in electronics. Characterization of conductor, semiconductor, dielectric, magnetic, superconductor and organic materials and devices. Presentation of the main domains of applications for materials.
4.2 Specific objectives	Developing the abilities to optimally use various materials in applications and projects; gaining the general knowledge regarding the influence of the structure of the material on its properties. The possibility of evaluating, from the catalogue data, the characteristics of a device fabricated from a certain material. Knowledge of the limitations imposed on various materials for their use in advanced electronic devices fabrication. Knowledge of the properties of newly discovered materials for their application in new devices.

8. Content

8.1 Lectures	Teaching techniques	Remarks
STRUCTURE OF SOLID MATERIALS 1.1 Introduction 1.2 Order in Materials 1.3 Metallic Crystalline Structures 1.4 Fundamental Types of Lattices 1.5 Crystallographic Planes 1.6 Crystallographic Directions 1.7 Interplanar Spacings 1.8 Crystalline Structures for Elemental and Compound Materials and for Alloys 1.9 Reciprocal Lattice 1.10 Problems and Applications	Verbal communication methods that are used involve the expositive method and the problematization method, used frontally. The lectures are held by using classical teaching methods or multimedia facilities. The course is available in printed form (as a book).	6 hours
DISTRIBUTION OF ELECTRONS IN A CRYSTAL 2.1 Fermi Energy and Fermi Surface 2.2 Density of States Function 2.3 Fermi-Dirac Distribution Function 2.4 Occupancy of Electronic States (Population Density of Electrons) and Calculus of the Fermi Energy 2.5 Effective Mass of an Electron in a Solid 2.6 Position and a More Rigorous Calculus for the Fermi Energy		6 hours

2.7 Problems and Applications		
CONDUCTIVE PROPERTIES OF MATERIALS 3.1 Conductivity and Ohm's Law 3.2 Conductivity in Metals, Dielectrics and Semiconductors 3.3 Conductivity in Metals – Classical Theory of Free Electrons 3.4 Conductivity in Metals and Nonmetals – Quantum Theory 3.5 Electrical Resistivity of Metals and Alloys 3.6 Electron Mobility and Carrier Density in Metals and Nonmetals 3.7 Problems and Applications		6 hours
DIELECTRIC MATERIALS 4.1 Dielectric Properties 4.2 Theory of Polarization in Dielectrics 4.3 Types of Polarization 4.4 Dielectric Constant and Its Dependence on Frequency and Temperature 4.5 Types of Dielectric Materials 4.6 Ferroelectricity 4.7 Piezoelectricity 4.8 Electrostriction. Pyroelectricity 4.9 Problems and Applications		6 hours
SEMICONDUCTOR MATERIALS 5.1 Intrinsic Semiconductors 5.2 Extrinsic Semiconductors 5.3 Temperature Variation of Conductivity and Carrier Concentration in Semiconductor Materials 5.4 Effective Masses in Semiconductors 5.5 Fabrication Techniques of Semiconductor Devices 5.6 Problems and Applications		6 hours
MAGNETIC MATERIALS 6.1 Introduction 6.2 Basic Concepts 6.3 Diamagnetism 6.4 Paramagnetism 6.5 Ferromagnetism 6.6 Antiferromagnetism and Ferrimagnetism 6.7 Influence of Temperature on the Magnetic Behaviour of Materials 6.8 Magnetic Domains and Hysteresis 6.9 Soft and Hard Magnetic Materials 6.10 Energetic Losses in Magnetic Materials		6 hours

6.11 Problems and Applications		
SUPERCONDUCTOR MATERIALS 7.1 Introduction 7.2 General Properties of Superconductor Materials 7.3 BCS Theory of Superconductors 7.4 Type II Superconductors 7.5 Josephson Superconducting Tunneling 7.6 High-Temperature Superconductors 7.7 Problems and Applications		6 hours

Bibliography

Callister, William D. Jr., *Fundamentals of Materials Science and Engineering*, Fifth Edition, John Wiley & Sons, New York, 2001.

Drăgulinescu, Andrei, *Materials for Electronics and Optoelectronics*, Matrix ROM, București, 2015.

Gao, Wei and Nigel A. Sammes, *An Introduction to Electronic and Ionic Materials*, World Scientific Publishing, Singapore, 1999.

Hummel, Rolf E., *Electronic Properties of Materials*, Third Edition, Springer, New York, 2001.

Irene, Eugene A., *Electronic Materials Science*, John Wiley & Sons, 2005.

Kittel, Charles, *Introduction to Solid State Physics*, Seventh Edition, John Wiley & Sons, New York, 1996.

Lee, Jiun-Haw, David N. Liu and Shin-Tson Wu, *Introduction to Flat Panel Displays*, John Wiley & Sons Ltd., Chicester, 2008.

Martin, John W., *Materials for Engineering*, Third Edition, Woodhead Publishing Limited, Abington Hall, Abington, Cambridge, England, 2006.

Mihály, László and Michael C. Martin, *Solid State Physics. Problems and Solutions*, John Wiley & Sons, New York, 1996.

Mitchell, Brian S., *An Introduction to Materials Engineering and Science for Chemical and Materials Engineers*, John Wiley & Sons, New York, 2004.

Șchiopu, Paul and Carmen Liliana Șchiopu, *Materials Science*, UPB, București, 2002.

Yung-kuo, Lim (ed.), *Problems and Solutions on Solid State Physics, Relativity and Miscellaneous Topics*, Third Edition, World Scientific Publishing, Singapore, 2003.

8.2 Practical applications	Teaching techniques	Remarks
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Bibliography:

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9. Bridging the course content with the expectations of the epistemic community representatives, professional associations and employers representatives for the domain of the program

Materials have nowadays a contribution in practically all aspects of our everyday lives. Historically, humans knew at first only a limited number of materials, comprising those occuring naturally, like stone, clay, wood, a.s.o. With the discovery of techniques for producing new materials, their applications widened. Further progress was achieved when it was discovered that, by addition of other substances to a certain material or by heat treatments applied to that material, its properties change, making it suitable for different new applications, in accordance with its new properties. In spite of these advances, only relatively recently in history (i.e. in the last about 70 years) did scientists understand the relationships between the structural elements of materials and their properties. This lead to an explosion of new applications, with tens of

thousands of different new materials, with conveniently chosen characteristics specialized for a very wide area of domains of applications.

The relationships between the structures and properties of materials which, as mentioned before, were understood only in the last 70 years, lead to developing this discipline of **materials science**. On the basis of these relationships, **materials engineering** was created, concerning the design or engineering of the structure of a material, in order to produce a desired set of properties for a specific application. These properties can be classified into six different categories: mechanical, electrical, thermal, magnetic, optical and deteriorative.

Materials science and engineering has as a goal achieving the best possible performance. This performance is a function of the material's properties, which in turn are determined by the structure, and the structure depends on how the material is processed.

This provides graduates with the appropriate skills and training requirements according to current qualifications, and a modern, high quality and competitive scientific and technical training, enabling them acquiring a working place after the graduation. The course fits therefore perfectly to the Bucharest Polytechnic University policy, considering both its content and structure, and the skills and international openness it offers to students.

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Weight in the final mark
10.4 Lectures	- knowledge of fundamental theoretical notions - developing the ability for applying the theoretical notions for problem solving	One test taken in the course of the semester Mid-Term Examination Final Examination	10% 30% 60%
10.5 Practical applications	-	-	-
10.6 Minimal performance standard			
- demonstrating the abilities of solving problems that involve treating crystalline lattices or the functions that characterize the electrons distributions in a crystal; - comparison and characterization of different crystalline systems / highlighting the fundamental properties of conductive, insulating, semiconductor, magnetic and superconducting materials.			

Date
25.09.2017

Lecturer
Ș.l. Dr. Ing. Andrei Drăgulinescu

Date of department approval
26.09.2017

Director of Department,
Conf. Dr. Ing. Marian Vlădescu