Βασικές Αρχές Ημιαγώγιμων Υλικών

1. GENERAL			
SCHOOL	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
DEPARTMENT	Materials Science and Engineering		
LEVEL OF STUDIES	ISCED level 7 (5-year Integrated Master’s programme) ISCED level 6 (4-year BSc programme)		
COURSE CODE	MSEN 723	SEMESTER	7th Semester
COURSE TITLE	**Fundamentals of Semiconductor Materials**		
TEACHING ACTIVITIES Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.		TEACHING HOURS PER WEEK	ECTS CREDITS
		4	6
COURSE TYPE	The course covers the structure, electronic properties, and defects of semiconductors, including doping, charge carriers, band theory, and transport phenomena. Students learn characterization techniques and explore practical applications in devices such as diodes, transistors, LEDs, and solar cells, linking atomic- and micro-scale phenomena to device performance.		
PREREQUISITES	Students are expected to have a foundation in: ● **Physics:** Basic solid-state physics, electricity, and magnetism. ● **Materials Science:** Crystal structures, bonding, and basic material properties. ● **Mathematics:** Calculus and linear algebra for analyzing electronic and thermal behavior. **Chemistry:** Atomic structure, chemical bonding, and periodic table concepts.		
TEACHING AND EXAMINATION METHODS	Lectures, Homework assignments, Quizzes, Midterm examination, Final exam		
COURSE OFFERED TO ERASMUS STUDENTS	Yes.		
COURSE URL	https://elearning.auth.gr/course/view.php?id=xxxxx		

2. LEARNING OUTCOMES	
Learning Outcomes	Upon completing the course, students will be able to: 1. Explain the structure, electronic properties, and behavior of semiconductor materials. 2. Analyze the effects of defects, doping, and impurities on material properties. 3. Relate atomic- and micro-scale phenomena to the performance of semiconductor devices. 4. Apply characterization techniques to assess semiconductor material properties. 5. Connect semiconductor material fundamentals to practical engineering applications.
General Skills	Upon completing this course, students will develop the following skills:

	1. Analytical Thinking: Ability to relate semiconductor structure and composition to electronic and optical properties. 2. Problem-Solving: Analyze the effects of doping, defects, and impurities on semiconductor behavior. 3. Experimental and Data Analysis Skills: Conduct and interpret characterization techniques for semiconductor materials. 4. Technical Proficiency: Use computational and laboratory tools to model, simulate, and analyze semiconductors. 5. Engineering Application: Translate material understanding into practical device design and performance evaluation. 6. Communication Skills: Present scientific findings clearly in written, graphical, and oral formats.

3. COURSE CONTENT

This course covers the structure, electronic properties, defects, and doping of semiconductor materials. Students will learn about charge carriers, band theory, transport phenomena, and characterization techniques, and explore applications in electronic and optoelectronic devices such as diodes, transistors, LEDs, and solar cells. Emphasis is placed on linking atomic- and micro-scale material behavior to device performance.

Course Content

1. **Introduction to Semiconductors: O**verview of semiconductors and their role in materials engineering | Classification: intrinsic and extrinsic semiconductors
2. **Crystal Structure:** Diamond and zinc blende structures | Unit cells, lattice parameters, and symmetry | defects, impurities and their effects
3. **Electronic Structure and Band Theory:** Energy bands and band gaps | Fermi level and carrier concentration | Direct and indirect bandgap materials
4. **Charge Carriers and Doping:** Electrons, holes, and carrier mobility | n-type and p-type doping | Carrier generation, recombination, and transport
5. **Electrical and Optical Properties:** Electrical conductivity and resistivity | Optical absorption, emission, and photoconductivity |Semiconductor heterostructures
6. **Characterization Techniques:** Hall effect measurements | Electrical and optical characterization methods | Surface and interface analysis
7. **Applications:** Devices: diodes, transistors, and LEDs | Solar cells and optoelectronic devices | Microelectronics and nanostructured semiconductors

4. LEARNING & TEACHING METHODS - EVALUATION

Teaching method	Face-to-face.
Use of ICT	ICT plays a significant role in enhancing teaching, learning, experimentation, visualization, and assessment in this course as follows: **Computational Tools for Problem Solving:** Spreadsheet calculations (Excel, Google Sheets), Coding solutions in Python, MATLAB, or Mathematica **Online Learning Platforms:** Learning management systems (LMS) like Moodle, Online lectures, video tutorials, and animations, **Communication and Collaboration:** Online discussion forums, Collaborative documents, Sharing of data and reports **Presentation and Reporting Tools:** Lab reports (word processors), Data plots and charts (graphing tools), Presentations (PowerPoint, Google Slides).
Teaching organization	The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).

	<table><tr><th>Activity</th><th>Workload/semester (hours)</th></tr><tr><td>Lectures</td><td>52</td></tr><tr><td>self-study, quizzes, on-line tests</td><td>46</td></tr><tr><td>Independent study</td><td>50</td></tr><tr><td>Final written exam</td><td>2</td></tr><tr><td>**Total**</td><td>**150**</td></tr></table>
Student evaluation	Assessment Language: English • Assessment Methods: Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Written Exams

5. SUGGESTED BIBLIOGRAPHY
Course Bibliography
Fundamentals of Semiconductor Materials and Devices | ISBN 978-1-119-89142-0 | Wiley 2024
Additional bibliography for study
Fundamentals of Semiconductors | ISBN 978-3-642-00709-5 | Springer 2010