Syllabus

Kursbeschreibung

Titel der Lehrveranstaltung	Elektronische Materialien und Bauelemente
Code der Lehrveranstaltung	42436
Zusätzlicher Titel der Lehrveranstaltung	
Wissenschaftlich-disziplinärer Bereich	NN
Sprache	Englisch
Studiengang	Bachelor in Elektro- und Informationstechnik
Andere Studiengänge (gem. Lehrveranstaltung)	
Dozenten/Dozentinnen	Prof. Dr. Niko Stephan Münzenrieder, Niko.Muenzenrieder@unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/42095 Prof. Franco Cacialli, Franco.Cacialli@unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/47601
Wissensch. Mitarbeiter/Mitarbeiterin	
Semester	Alle Semester
Studienjahr/e	2
KP	14
Vorlesungsstunden	84
Laboratoriumsstunden	56
Stunden für individuelles Studium	210
Vorgesehene Sprechzeiten	42
Inhaltsangabe	1. Module 1: Introduction to Quantum Electronics (II year, I semester, 5 CFU) · Failure of classical mechanics: Black Body Radiation,

	Photoelectric and Compton effects. · Early quantum theory: Wave nature of matter, Bohr atom, De Broglie hypothesis, early models of the atom. · Quantum Mechanics: wavefunction, Heisenberg Uncertainty Principle, 1D Schroedinger equation (particle in a box and tunnelling). Quantization of the angular momentum. · Quantum mechanics of the atom. Pauli Exclusion Principle. · Bloch Theorem. Model of Kronig and Penney. 2. Module 2: Electronic Devices (II year, II semester, 9 CFU) · Semiconducting materials. · Electronic properties of solids. · Semiconductor fabrication and characterization techniques. · PN junctions and diodes. · Transistors (Bipolar, FET) · Memories (DRAM; SRAM; Flash; resistive). · Photonic devices (LEDs; lasers; photodiodes; solar cells). · Other electronic devices. · Practical exercises and laboratory work.
Themen der Lehrveranstaltung	1. Module 1: Introduction to Quantum Electronics (II year, I semester, 5 CFU) · Failure of classical mechanics: Black Body Radiation, Photoelectric and Compton effects. · Early quantum theory: Wave nature of matter, Bohr atom, De Broglie hypothesis, early models of the atom. · Quantum Mechanics: wavefunction, Heisenberg Uncertainty Principle, 1D Schroedinger equation (particle in a box and tunnelling). Quantization of the angular momentum. · Quantum mechanics of the atom. Pauli Exclusion Principle. · Bloch Theorem. Model of Kronig and Penney. 2. Module 2: Electronic Devices (II year, II semester, 9 CFU) The topics covered include: • Physics of semiconductor materials (e.g., crystal structure, energy bands, density of states, dopants, electronic transport) • Nanotechnology • pn junctions and diodes • MOSFETs • JFETs • Bipolar junction transistors • Sensors • Other electronic devices

	• Practical exercises and laboratory work.
Stichwörter	Semiconductors Electronic properties of matter Electronic devices
Empfohlene Voraussetzungen	
Propädeutische Lehrveranstaltungen	
Unterrichtsform	Frontal lectures, exercises, and laboratories.
Anwesenheitspflicht	suggested
Spezifische Bildungsziele und erwartete Lernergebnisse	to be inserted by the two lecturers
Spezifisches Bildungsziel und erwartete Lernergebnisse (zusätzliche Informationen)	
Art der Prüfung	M1: Summative assessment Form: Written and oral (at the discretion of the examiner(s), based on the results of the written component). See also below. Details: Closed book exam The exam includes a written and an oral component. The written exam (1.5 hours) consists of two parts: a first part (problem 1) with a series of (mostly) qualitative or semi-quantitative questions based on the understanding of the topics covered in the lectures, as well as a second part (problems 2-3) consisting of several numerical or symbolic problems to be solved related to the various topics covered in the lectures. Oral component: The oral component is mandatory, but depending on the quality of the written exam, and the explanations given in the solution, the commission (at their discretion) may decide it is not necessary. The oral exam may include questions on the programme covered in the lectures (including those of the written part of the exam) and may lead to an increase or a reduction of the grade of the written component. Importantly, if a student is requested by the commission to attend and sit the oral exam, and the student fails to do so, the exam will

	be considered as "not presented". Grading for all components will be based upon: - The correctness of the approach and the mathematical steps of the solution, the calculation of numerical results and the correct use of physical quantities and units. - The correctness of the provided answers and of the explanation presented, as well as the terminology used. To pass the exam the final grade must be greater or equal to 18. If the final score is greater than 30, a "cum laude" grade is awarded. The student can have access to the exam with pen, pencil and a portable calculator. A short list of constants is provided to the students along with the text of the exam. Students should also be able provide proof of identity (e.g. Campus card, ID card, passport) before the start of the exam. M2: The exam will be in in written form. Students will have the choice to take an oral midterm exam to earn a bonus of up to 5 points out of 30 for the final mark. The students might also have the possibility to substitute a part of the final exam with a group project to be carried out during the semester and concluded by an oral presentation.
Bewertungskriterien	M1: The exam includes a practical, a written and an oral component. The written exam (1.5 hours) consists of two parts: a first part (problem 1) with a series of (mostly) qualitative or semi-quantitative questions based on the understanding of the topics covered in the lectures, as well as a second part (problems 2-3) consisting of numerical or symbolic problems to be solved related to the various topics covered in the lectures. Oral component: The oral component is mandatory, but depending on the quality of the written exam, and the explanations given in the solution, the commission (at their discretion) may decide it is not necessary. The oral exam may include questions on the programme covered in the lectures (including those of the written part of the exam) and may lead to an increase or a reduction of the grade of the written component. Importantly, if a student is requested by the commission to attend and sit the oral exam, and the student fails to do so, the exam will be considered as "not presented".

	Grading for all components will be based upon: - The correctness of the approach and the mathematical steps of the solution, the calculation of numerical results and the correct use of physical quantities and units. - The correctness of the provided answers and of the explanation presented, as well as the terminology used. To pass the exam the final grade must be greater or equal to 18. If the final score is greater than 30, a "cum laude" grade is awarded. The student can have access to the exam with pen, pencil and a portable calculator. A short list of constants is provided to the students along with the text of the exam. Students should also be able provide proof of identity (e.g. Campus card, ID card, passport) before the start of the exam. M2: The assessment criteria will be the accuracy of the answers given in the written examination, with particular attention to the resolution procedure adopted and the formal correctness of the same.
Pflichtliteratur	Various textbooks can be used as a reference for the electronic devices module, for example: · „Semiconductor Physics and Devices", Donald A. Neamen · „Physics of Semiconductor Devices", S. M. Sze and Kwok K. Ng · „Microelectronics", Jacob Millman and Arvin Grabel · „The Art of Electronics", Paul Horowitz and Winfield Hill
Weiterführende Literatur	
Weitere Informationen	
Ziele für nachhaltige Entwicklung (SDGs)	Hochwertige Bildung

Kursmodul

Titel des Bestandteils der Lehrveranstaltung	M1 Einführung in die Quantenelektronik
Code der Lehrveranstaltung	42436A
Wissenschaftlich-disziplinärer Bereich	FIS/03

Sprache	Englisch
Dozenten/Dozentinnen	Prof. Franco Cacialli, Franco.Cacialli@unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/47601
Wissensch. Mitarbeiter/Mitarbeiterin	
Semester	Erstes Semester
KP	5
Verantwortliche/r Dozent/in	
Vorlesungsstunden	30
Laboratoriumsstunden	20
Stunden für individuelles Studium	75
Vorgesehene Sprechzeiten	15
Inhaltsangabe	1. Module 1: Introduction to Quantum Electronics (II year, I semester, 5 CFU) · Failure of classical mechanics: Black Body Radiation, Photoelectric and Compton effects. · Early quantum theory: Wave nature of matter, Bohr atom, De Broglie hypothesis, early models of the atom. · Quantum Mechanics: wavefunction, Heisenberg Uncertainty Principle, 1D Schroedinger equation (particle in a box and tunnelling). Quantization of the angular momentum. · Quantum mechanics of the atom. Pauli Exclusion Principle. · Bloch Theorem. Model of Kronig and Penney.
Themen der Lehrveranstaltung	Module 1: Introduction to Quantum Electronics (II year, I semester, 5 CFU) • Failure of classical mechanics: Black Body Radiation, Photoelectric and Compton effects. • Early quantum theory: Wave nature of matter, Bohr atom, De Broglie hypothesis, early models of the atom. • Quantum Mechanics: wavefunction, Heisenberg Uncertainty Principle, 1D Schroedinger equation (particle in a box and tunnelling). Quantization of the angular momentum. • Quantum mechanics of the atom. The hydrogen atom. Schroedinger equation and the 4 quantum numbers. Pauli

	Exclusion Principle. • Quantum mechanics of molecules, formation of chemical bonds, covalent and ionic bonds. • Quantum mechanics of solids: metallic bonds, statistical methods, density of states, Fermi level, electron gas at 0K and higher temperatures. • Model of Kronig and Penney. Energy bands, Brillouin zones and reduced representation of energy bands.
Unterrichtsform	Lectures with in class exercises and demonstrations.
Pflichtliteratur	Blackboard / lecture slides *Physics for Scientists and Engineers with Modern Physics*, Douglas C. Giancoli, Pearson, 4th edition, 2008. Also available in electronic format (pdf) from UNIBZ library. · *Physics for Scientists and Engineers*, Paul A. Tippler, Macmillan, 6th edition, 2007 Subject Librarian: David Gebhardi, David.Gebhardi@unibz.it and Ilaria Miceli, Ilaria.Miceli@unibz.it
Weiterführende Literatur	· C. Kittel, *Introduction to Solid State Physics*, 8th ed., John Wiley & Sons, 2005. · N. W. Ashcroft and N. D. Mermin, *Solid State Physics*, Holt, Rinehart and Winston, 1976.

Kursmodul

Titel des Bestandteils der Lehrveranstaltung	M2 Elektronische Bauelemente
Code der Lehrveranstaltung	42436B
Wissenschaftlich-disziplinärer Bereich	IINF-01/A
Sprache	Englisch
Dozenten/Dozentinnen	Prof. Dr. Niko Stephan Münzenrieder, Niko.Muenzenrieder@unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/42095

Wissensch. Mitarbeiter/Mitarbeiterin	
Semester	Zweites Semester
KP	9
Verantwortliche/r Dozent/in	
Vorlesungsstunden	54
Laboratoriumsstunden	36
Stunden für individuelles Studium	135
Vorgesehene Sprechzeiten	27
Inhaltsangabe	2. Module 2: Electronic Devices (II year, II semester, 9 CFU) · Semiconducting materials. · Electronic properties of solids. · Semiconductor fabrication and characterization techniques. · PN junctions and diodes. · Transistors (Bipolar, FET) · Memories (DRAM; SRAM; Flash; resistive). · Photonic devices (LEDs; lasers; photodiodes; solar cells). · Other electronic devices. · Practical exercises and laboratory work.
Themen der Lehrveranstaltung	2. Module 2: Electronic Devices (II year, II semester, 9 CFU) The topics covered include: • Physics of semiconductor materials (e.g., crystal structure, energy bands, density of states, dopants, electronic transport) • Nanotechnology • pn junctions and diodes • MOSFETs • JFETs • Bipolar junction transistors • Sensors • Other electronic devices • Practical exercises and laboratory work.
Unterrichtsform	Lectures with in class exercises and demonstrations. Practical sessions.
Pflichtliteratur	Various textbooks can be used as a reference, for example: • „Semiconductor Physics and Devices", Donald A. Neamen

	• „Physics of Semiconductor Devices“, S. M. Sze and Kwok K. Ng • „Microelectronics”, Jacob Millman and Arvin Grabel • „The Art of Electronics”, Paul Horowitz and Winfield Hill
Weiterführende Literatur	