Syllabus

Descrizione corso

Titolo insegnamento	Materiali e dispositivi elettronici
Codice insegnamento	42436
Titolo aggiuntivo	
Settore Scientifico-Disciplinare	NN
Lingua	Inglese
Corso di Studio	Corso di laurea in Ingegneria elettronica e dell'Informazione
Altri Corsi di Studio (mutuati)	
Docenti	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
Assistente	
Semestre	Tutti i semestri
Anno/i di corso	2
CFU	14
Ore didattica frontale	84
Ore di laboratorio	56
Ore di studio individuale	210
Ore di ricevimento previste	42
Sintesi contenuti	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.
Argomenti dell'insegnamento	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.
Parole chiave	Semiconductors

	Electronic properties of matter Electronic devices
Prerequisiti	
Insegnamenti propedeutici	
Modalità di insegnamento	Frontal lectures, exercises, and laboratories.
Obbligo di frequenza	suggested
Obiettivi formativi specifici e risultati di apprendimento attesi	to be inserted by the two lecturers
Obiettivi formativi specifici e risultati di apprendimento attesi (ulteriori info.)	
Modalità di esame	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.
Criteri di valutazione	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.
Bibliografia obbligatoria	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
Bibliografia facoltativa	
Altre informazioni	
Obiettivi di Sviluppo Sostenibile (SDGs)	Istruzione di qualità

Modulo del corso

Titolo della parte costituente del corso	M1 Introduzione all´elettronica quantistica
Codice insegnamento	42436A
Settore Scientifico-Disciplinare	FIS/03
Lingua	Inglese
Docenti	prof. Franco Cacialli, Franco.Cacialli@unibz.it https://www.unibz.it/en/faculties/engineering/academic-

	staff/person/47601
Assistente	
Semestre	Primo semestre
CFU	5
Docente responsabile	
Ore didattica frontale	30
Ore di laboratorio	20
Ore di studio individuale	75
Ore di ricevimento previste	15
Sintesi contenuti	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.
Argomenti dell'insegnamento	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.
Modalità di insegnamento	Lectures with in class exercises and demonstrations.
Bibliografia obbligatoria	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
Bibliografia facoltativa	· 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.

Modulo del corso

Titolo della parte costituente del corso	M2 Dispositivi Elettronici
Codice insegnamento	42436B
Settore Scientifico-Disciplinare	IINF-01/A
Lingua	Inglese
Docenti	prof. dr. Niko Stephan Münzenrieder, Niko.Muenzenrieder@unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/42095
Assistente	
Semestre	Secondo semestre
CFU	9
Docente responsabile	
Ore didattica frontale	54

Ore di laboratorio	36
Ore di studio individuale	135
Ore di ricevimento previste	27
Sintesi contenuti	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.
Argomenti dell'insegnamento	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.
Modalità di insegnamento	Lectures with in class exercises and demonstrations. Practical sessions.
Bibliografia obbligatoria	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
Bibliografia facoltativa	