RTU Course "Elements of Solid State Electronics"

33000 Faculty of Computer Science, Information Technology and Energy

General data

Code	REA604
Course title	Elements of Solid State Electronics
Course status in the programme	Compulsory/Courses of Limited Choice
Responsible instructor	Arnis Gulbis
Academic staff	Dmitrijs Pikuļins
Volume of the course: parts and credits points	1 part, 7.5 credits
Language of instruction	LV, EN
Annotation	In the study course, students are introduced to atomic-crystalline and micro-structures of solids. Elements of physical statistics, solid zone structures and kinetic phenomena, as well as solid state contact effects, are considered. Development trends of integrated solid-state electronics, micro-and nano-electronics are explained. The knowledge gained during the course is especially useful when participating in the development of modern integrated circuits or when conducting research on the characteristics and peculiarities of integrated circuits.
Goals and objectives of the course in terms of competences and skills	The aim of the study course is to provide in-depth knowledge of solid-state electronics processes. Tasks of the study course: 1. To provide an understanding of the crystalline state of a substance and the resulting parameters; 2. To acquaint students with the structures of area diagrams and their analysis methods, 3. To promote understanding of solid-state internal contacts and electronic processes, 4. To develop skills to orientate in the technological base and applications of solid-state electronics.
Structure and tasks of independent studies	1. Preparing for tests independently. Task: to promote systematic acquisition of material, to identify less learned concepts. 2. Independent research of scientific publications. Task: to promote the skills of searching, selecting and analyzing information on a given topic.
Recommended literature	Obligātā/Obligatory 1.Shur M. Physics of Semiconductor Devices. Prentice - Hall, 1990. 680 p. 2.L.Solymer, D.Walsh. Electrical properties of materials. Oxford Sc. Publ., 8th ed. 2009. 464 p. 3.Ben G. Streetman. Solid State Electronic Devices 7th Edition, Pearson, 2014. ISBN 9780133356038 4.Stephen A. Campbell. Fabrication Engineering at the Micro- and Nanoscale, Oxford University Press, 2012., 688 p. ISBN 9780199861224. 5.John H. Lau. Semiconductor Advanced Packaging, Springer, 2021, 744.p. ISBN 9789811613760. Papildu/Additional 1.Sharon Ann Holgate. Understanding Solid State Physics, CRC Press, 2021. ISBN 9780367249854 2.Mochizuki, Kazuhiro. Vertical GaN and SiC Power Devices, Artech House, 2018, 386.p. 3.Щука А.А. Электроника. С.-Пб.: БХВ-Петербург, 2005. 800 с. 4.6. G.W.Hanson. Fundamentals of Nanoelectronics. Peason Educat. Intern., 2008. 385 p.
Course prerequisites	Basics of semiconductor electronics

Course contents

Content	Full- and part-time intramural studies		Part time extramural studies	
	Contact Hours	Indep. work	Contact Hours	Indep. work
1. Interactions of atomic particles; Lennard-Jones potential; solid models.	2	3	0	0
2. Hard bullet model; crystal structure coordination number, structure stability limits	2	3	0	0
3. Groups of ideal crystals; crystalline structures of the densest arrangement of atomic particles, Miller indices.	2	3	0	0
4. Peculiarities of the solid state structure of a substance; solids formation processes.	2	3	0	0
5. Single crystals, polycrystals, nanocrystals, amorphous substances, fullerenes, graphenes, nanotubes.	2	3	0	0
6. Microparticle collectives; the essence of microparticle identity.	2	3	0	0
7. The principle of Paul's prohibition; microparticles - bosons and fermions.	2	3	0	0
8. Degenerate and non-degenerate collectives; number of states in systems.	2	3	0	0
9. The essence of chemical potential; Fermi energy.	2	3	0	0
10. Classical and bosonic statistics; their applications.	2	3	0	0
11. Electron (fermion) statistics. Comparisons between statistics.	2	3	0	0
12. Quantum mechanical characteristics of free and limited electron; quantum: pits, wires and point	2	3	0	0
13. Electrons in crystals: a weak and strong bond model.	2	3	0	0
14. Kronig-Penni model.	2	3	0	0

15. Typical zone structures.	2	3	0	0
16. Effective mass of electrons; charge carriers - electrons and holes.	2	3	0	0
17. High Electron Mobility (HEMT) devices.	2	3	0	0
18. Hall effect and devices.	2	3	0	0
19. Magnetoresistive phenomena. Spintronic elements.	2	3	0	0
20. Magnetic and magneto-optical recording media.	2	3	0	0
21. Metal-semiconductor contacts.	2	3	0	0
22. Current rectifying and ohmic contacts.	2	3	0	0
23. Schottky barriers and diodes.	2	3	0	0
24. Steep and smooth transitions; their characteristics and properties.	2	3	0	0
25. Charge accumulation and switching processes.	2	3	0	0
26. Transition penetration processes.	2	3	0	0
27. Transition equivalent schemes; capacity.	2	3	0	0
28. "pn" junction semiconductor devices.	2	3	0	0
29. Light emitting diodes.	2	3	0	0
30. Heteroplanes. Devices based on heterosexuals.	2	3	0	0
31. Solidarity information accumulators.	2	3	0	0
32. Optical recording media.	2	3	0	0
33. Magnetic recording media.	2	3	0	0
34. The essence and possibilities of planar technology of microelectronics.	2	3	0	0
35. Integrated passive elements.	2	3	0	0
36. Si and SiGe technologies, their possibilities.	2	3	0	0
37. GaAs (A3B5) technologies, their possibilities.	2	3	0	0
38. High Frequency Microelectronics - Monolithic Microwave Integrated Circuits (MMICs).	2	3	0	0
39. The essence of the latest products in microelectronics (tunnel resonance, single electron, micromechanics, etc.).	2	3	0	0
40. Forecasts of solid state electronics (microelectronics) development: Masonry laws, product life cycles.	2	3	0	0
Total:	80	120	0	0

Learning outcomes and assessment

Learning outcomes	Assessment methods
Able to read the indicated original publications related to solid-state electronics.	Tests. Exam.
Able to draw conclusions about the possibilities and disadvantages of a specific solid device on the basis of the acquired material.	Tests. Exam.
Able to extrapolate the acquired knowledge regarding the latest products, their technologies.	Tests. Exam.
Orients and is able to understand and delve into the construction of solid state electronics.	Tests. Exam.

Evaluation criteria of study results

Criterion	%
Tests	50
Exam	50
Total:	100

Study subject structure

Part	CP	Hours			Tests		
		Lectures	Practical	Lab.	Test	Exam	Work
1.	7.5	5.0	0.0	0.0		*	