FISA DISCIPLINEI
Syllabus

1. Information about the study program

1.1. University	West University of Timisoara
1.2. Faculty	PHYSICS
1.3. Department	PHYSICS
1.4. Study direction	PHYSICS
1.5. Study cycle	MASTER
1.6. Study program / qualification	ADVANCED RESEARCH METHOD IN PHYSICS / according to COR: Analyst - 251201; Research assistant in physics - 211103; Physicist - 211101; Teacher - 233002;

2. 2. Information about the subject/discipline

2.1. Subject matter			Complements of solid-state physics				
2.2. Subject teacher			Prof. dr. Marius Paulescu				
2.3. Subject applications teacher (seminar / laboratory)			Prof. dr. Marius Paulescu				
2.4. Study year	1	2.5. Semester	1	2.6. Type of assessment	**E**	2.7. Subject type	**OB**

3. 3. Total estimated time (hours of teaching per semester)

3.1. Number of hours per week	4	3.2 course	2	3.3. seminar/laboratory	2
3.4. Total hours in the curriculum	56	3.5 course	28	3.6. seminar/laboratory	28

Time distribution:	**hours**
Study based on instructions, course materials, bibliography and notes	28
Additional documentation library, electronic platforms/ field	14
Training seminars / laboratory, homework, portfolio and essays	28
Tutoring	
Examination	6
Other activities...	-

3.7. **Total number of personal study hour**	**76**
3.8. **Total number of hours in semester**	**132**
3.9. **Number of credits**	**7**

4. 4. Prerequisites (where applicable)

4.1. Curriculum	• Solid state physics; Quantum mechanics; Mathematical analysis
4.2. Competences	• Basic knowledge in solid state physics • Basic knowledge about the numerical methods applied in physics

5. Conditions (where applicable)

5.3 for course	• Computer connected to the internet
5.4 for seminar/lab	• Computer connected to the internet, whiteboard

1. Discipline objectives – learning outcomes

Knowledge	Acquiring knowledge in two chapters of solid state physics: semiconductor physics and crystalline nanostructures physics. Understanding the physical mechanisms that differentiate the properties of the crystalline materials from the properties of the crystalline nanostructures Knowledge about specific models for: energy bands, effective mass, nanostructured heterostructures (superlattice, quantum wires and dots), the binding energy of impurity states, density of states and conductance. Knowledge in using quantum mechanics for studying the nanostructured systemsKnowledge in using numerical methods for solving problems in solid state physics.
Skills	Modelling some physical properties of solids with a focus on semiconductors and nanocrystals. Acquiring skills in solving problems in solid state physics by using mathematical, analytical and numerical tools
Responsibility and autonomy	Carrying out professional tasks efficiently and responsibly under qualified assistance. Teamwork techniques Effective use of information sources, both in Romanian and in an international language. Acquiring a positive and responsible attitude towards one's own professional development

7. Contents

7.1 Course	Teaching methods	Comments
1. Semiconductors: crystals, alloys, heterostructures and nanostructures	Interactive lectures using a whiteboard.	Lecture notes available online on E-learning Platform
2. Energy band theory. An elementary introduction to the energy band modeling	Interactive lectures using a whiteboard.	Lecture notes available online on E-learning Platform
3. Electrons and holes. Effective mass	Interactive lectures using a whiteboard.	Lecture notes available online on E-learning Platform
4. Position-dependent effective mass Schrodinger equation	Interactive lectures using a whiteboard.	Lecture notes available online on E-learning Platform
5. Numerically solving the Schrodinger equation. The transfer matrix method	Interactive lectures using a whiteboard.	Lecture notes available online on E-learning Platform
6. Superlattices	Interactive lectures using a whiteboard.	Lecture notes available online on E-learning Platform
7. Quantum wires	Interactive lectures using a whiteboard.	Lecture notes available online on E-learning Platform

8. Quantum dots. Artificial semiconductors	Interactive lectures using a whiteboard.	Lecture notes available online on E-learning Platform
9. Impurities in semiconductors	Interactive lectures using a whiteboard.	Lecture notes available online on E-learning Platform
10. Density of states in semiconductors and nanostructures	Interactive lectures using a whiteboard.	Lecture notes available online on E-learning Platform
11. Carrier concentration in semiconductors and nanostructures	Interactive lectures using a whiteboard.	Lecture notes available online on E-learning Platform.
12. Semiconductor continuity equation. An introduction to numerical modeling of semiconductor devices	Interactive lectures using a whiteboard.	Lecture notes available online on E-learning Platform
13. Conductance quantization. The Landauer formula	Interactive lectures using a whiteboard.	Lecture notes available online on E-learning Platform
14. Quantum conductance. Ohm's law	Interactive lectures using a whiteboard.	Lecture notes available online on E-learning Platform
Seminar		
1. Solving problems	Solving problems and simulations. Guidance.	Seminar support and solved problems are available online on E-learning Platform
2. Calculating the energy band structure. Simplified models.	Solving problems and simulations. Guidance.	Seminar support and solved problems are available online on E-learning Platform
3. Calculating the effective mass of electrons and holes.	Solving problems and simulations. Guidance.	Seminar support and solved problems are available online on E-learning Platform
4. Problem solving: The BenDaniel and Duke boundary conditions. Calculation of the energy states.	Solving problems and simulations. Guidance. Questioning	Seminar support and solved problems are available online on E-learning Platform
5. Multiple quantum wells. Calculation of the energy states	Solving problems and simulations. Guidance.	Seminar support and solved problems are available online on E-learning Platform
6. Problem solving: Superlattice. The Kramers approach for computing the energy states	Solving problems and simulations. Guidance.	Seminar support and solved problems are available online on E-learning Platform
7. Problem solving: Quantum wires	Solving problems and simulations. Guidance.	Seminar support and solved problems are available online on E-learning Platform
8. Problem solving: Quantum dots	Solving problems and simulations. Guidance	Seminar support and solved problems are available online on E-learning Platform
9. Calculating the binding energy. 2D trial wave function.	Solving problems and simulations. Guidance	Seminar support and solved problems are available online on E-learning Platform
10. Calculating the density of states	Solving problems and simulations. Guidance	Seminar support and solved problems are available online on E-learning Platform
11. Problem solving: Carrier concentration in semiconductors	Solving problems and simulations. Guidance	Seminar support and solved problems are

and nanostructures		available online on E-learning Platform
12. Numerical modeling of optoelectronic sensor. Part 1 – Writing the equations	Solving problems and simulations. Guidance	Seminar support and solved problems are available online on E-learning Platform
13. Numerical modeling of optoelectronic sensor. Part 2 – Solving the equations	Solving problems and simulations. Guidance	Seminar support and solved problems are available online on E-learning Platform
14. Problem solving: Quantum conductance	Solving problems and simulations. Guidance	Seminar support and solved problems are available online on E-learning Platform

Bibliography

1. Paulescu M. Complements of solid-state physics. Lectures and seminars http://www.physics.uvt.ro/~marius/
2. Harrison P. Quantum wells, wires and dots. Wiley-Interscience, 2006.
3. Datta S. Quantum transport - Atom to transistor. Cmbridge University Press, 2007.
4. Kittel C. Introducere în fizica corpului solid. Ed. Tehnică, București, 1972.
5. Tsu R. Superlattice to Nanoelectronics. Elsevier, Amsterdam, 2006
6. Durkam C. Current at the nanoscale: An introduction to nanoelectronics, Imperial College Press, 2007.
7. Ibach H, Luth H. Solid-State Physics: An Introduction to Principles of Materials Science. Springer, 2009.
8. O'Reilly EP. Introduction to quantum theory of solids. Taylor & Francis, 2003.
9. G. Bastard, Wave mechanics applied to semiconductor heterostructures, EDP Sciences, Paris, 1992.

8. Corroboration of the course contents with the epistemic expectations of the community representative, professional associations and representative employers of the programme itself

The course Complements of Solid State Physics Complement is a general physics course of which content has the role of standardizing and consolidating students' knowledge in the field of solid state physics. The focus on the physics of nanostructures is of interest for employers both from research and industry.

9. Examination

Activity type	9.1 Evaluation criteria	9.2 Evaluation method	9.3 Percentage in final mark
Course	The basic theoretical knowledge and the ability to solve problems will be evaluated	Final exam. Written test consisting of questions and problems.	60%
Seminar	The student solves the problems from the seminar and homework. The student proves knowledge and skills for solving numerically some problems in semiconductor physics (energy bands, effective mass, nanostructured heterostructures (superlattice, quantum wires and	Ongoing test	40%

	dots), the binding energy of impurity states, density of states and conductance)		

10.6 Minimum performance standards
General knowledge in energy band theory and nanostructures (quantum wells, wires and dots). The student proves the ability to solve problems like the ones studied at seminar. The student solves the problems from the seminar and the homework.

Date of submission:

Titular of the course:

Prof. Dr. Marius Paulescu [redacted]

Date of approval in department:

HEAD OF THE DEPARTMENT

Prof. Dr. Marin Catalin

[redacted]