FISA DISCIPLINEI
Syllabus

1. Information about the 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	PHYSICS OF ADVANCED MATERIALS / according to COR: Analyst - 251201; Research assistant in physics - 211103; Physicist - 211101; Teacher - 233002;

2. Subject matter information

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. Assessment type	**E**	2.7. Subject type	**OB**

3. Study time distribution

3.1. Nr. of hours/week	4	In which: 3.2 course	2	3.3. seminar/laboratory	2
3.4. Total hours in educational plan	56	In which: 3.5 course	28	3.6. seminar/laboratory	28

Time distribution:	**hours**
Study after lecture notes, bibliography or notes	28
Additional documentation in the library, electronic specialty platforms/ field	14
Seminar / laboratory preparations, homework, portfolio and essays	28
Tutoring	
Exams	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. Preconditions (where appropriate)

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 appropriate)

5.3 for course	• Computer connected to the internet, google meet, a WritePad as a surrogate for whiteboard
5.4 for seminar/lab	• Computer connected to the internet, whiteboard (for online seminars: google meet, Computer connected to the internet)

6. Specific skills gained

Professional competences	- The ability of modelling some physical properties of solids with a focus on semiconductors and nanocrystals. - Understanding the physical mechanisms that differentiate the properties of the crystalline materials from the properties of the crystalline nanostructures. - The ability of solving problems in solid state physics by using mathematical, analytical and numerical tools.

7. Course Objectives

7.1 Main Objective	• Acquiring competencies in two chapters of solid state physics: semiconductor physics and crystalline nanostructures physics
7.2 Specific objectives	• Developing the student's skill in understanding and operating with 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 • Developing the student's confidence in using numerical methods for solving problems in solid state physics (Gummel method, transfer matrix method); - Developing the student's ability in using quantum mechanics for studying the nanostructured systems

8. Table of content

8.1 Course	Teaching methods	Observations
1. Semiconductors: crystals, alloys, heterostructures and nanostructures	Interactive lectures using a tablet as a whiteboard.	Curs support available anytime online: http://www.physics.uvt.ro/~marius/ . Lecture face-to-face.
2. Energy band theory. An elementary introduction to the energy band modeling	Interactive lectures using a tablet as a whiteboard.	Curs support available anytime online: http://www.physics.uvt.ro/~marius/ . Lecture face-to-face
3. Electrons and holes. Effective mass	Interactive lectures using a tablet as a whiteboard.	Curs support available anytime online: http://www.physics.uvt.ro/~marius/ . Lecture face-to-face
4. Position-dependent effective mass Schrodinger equation	Interactive lectures using a tablet as a whiteboard.	Curs support available anytime online: http://www.physics.uvt.ro/~marius/ . Lecture face-to-face
5. Numerically solving the Schrodinger equation. The	Interactive lectures using a tablet as a whiteboard.	Curs support available anytime online: http://www.physics.uvt.ro/~marius/ . Lecture face-

transfer matrix method		to-face
6. Superlattices	Interactive lectures using a tablet as a whiteboard.	Curs support available anytime online: http://www.physics.uvt.ro/~marius/ . Lecture face-to-face
7. Quantum wires	Interactive lectures using a tablet as a whiteboard.	Curs support available anytime online: http://www.physics.uvt.ro/~marius/ . Lecture face-to-face
8. Quantum dots. Artificial semiconductors	Interactive lectures using a tablet as a whiteboard.	Curs support available anytime online: http://www.physics.uvt.ro/~marius/ . Lecture face-to-face
9. Impurities in semiconductors	Interactive lectures using a tablet as a whiteboard.	Curs support available anytime online: http://www.physics.uvt.ro/~marius/ . Lecture face-to-face
10. Density of states in semiconductors and nanostructures	Interactive lectures using a tablet as a whiteboard.	Curs support available anytime online: http://www.physics.uvt.ro/~marius/ . Lecture face-to-face.
11. Carrier concentration in semiconductors and nanostructures	Interactive lectures using a tablet as a whiteboard.	Curs support available anytime online: http://www.physics.uvt.ro/~marius/ . Lecture face-to-face.
12. Semiconductor continuity equation. An introduction to numerical modeling of semiconductor devices	Interactive lectures using a tablet as a whiteboard.	Curs support available anytime online: http://www.physics.uvt.ro/~marius/ Lecture face-to-face
13. Conductance quantization. The Landauer formula	Interactive lectures using a tablet as a whiteboard.	Curs support available anytime online: http://www.physics.uvt.ro/~marius/ . Lecture face-to-face
14. Quantum conductance. Ohm's law	Interactive lectures using a tablet as a whiteboard.	Curs support available anytime online: http://www.physics.uvt.ro/~marius/ . Lecture face-to-face
Seminar		
1. Problem solving	Assisted problem solving and simulation. Guidance. Questioning	Seminar support available anytime online: http://www.physics.uvt.ro/~marius/ Seminar face-to-face /online (if necessary)
2. Calculating the energy band structure. Simplified models.	Assisted problem solving and simulation. Guidance. Questioning	Seminar support available anytime online: http://www.physics.uvt.ro/~marius/ Seminar face-to-face /online (if necessary)
3. Calculating the effective mass of electrons and holes.	Assisted problem solving and simulation. Guidance. Questioning	Seminar support available anytime online: http://www.physics.uvt.ro/~marius/ Seminar face-to-face /online (if necessary)
4. Problem solving: The BenDaniel and Duke boundary conditions. Calculation of the energy states.	Assisted problem solving and simulation. Guidance. Questioning	Seminar support available anytime online: http://www.physics.uvt.ro/~marius/ Seminar face-to-face /online (if necessary)
5. Multiple quantum wells.	Assisted problem solving	Seminar support available anytime online:

Calculation of the energy states	and simulation. Guidance. Questioning	http://www.physics.uvt.ro/~marius/ Seminar face-to-face
6. Problem solving: Superlattice. The Kramers approach for computing the energy states	Assisted problem solving and simulation. Guidance. Questioning	Seminar support available anytime online: http://www.physics.uvt.ro/~marius/ Seminar face-to-face
7. Problem solving: Quantum wires	Assisted problem solving and simulation. Guidance. Questioning	Seminar support available anytime online: http://www.physics.uvt.ro/~marius/ Seminar face-to-face
8. Problem solving: Quantum dots	Assisted problem solving and simulation. Guidance. Questioning	Seminar support available anytime online: http://www.physics.uvt.ro/~marius/ Seminar face-to-face
9. Calculating the binding energy. 2D trial wave function.	Assisted problem solving and simulation. Guidance. Questioning	Seminar support available anytime online: http://www.physics.uvt.ro/~marius/ Seminar face-to-face
10. Calculating the density of states	Assisted problem solving and simulation. Guidance. Questioning	Seminar support available anytime online: http://www.physics.uvt.ro/~marius/ Seminar face-to-face
11. Problem solving: Carrier concentration in semiconductors and nanostructures	Assisted problem solving and simulation. Guidance. Questioning	Seminar support available anytime online: http://www.physics.uvt.ro/~marius/ Seminar face-to-face
12. Numerical modeling of optoelectronic sensor. Part 1 – Writing the equations	Assisted problem solving and simulation. Guidance. Questioning	Seminar support available anytime online: http://www.physics.uvt.ro/~marius/ Seminar face-to-face
13. Numerical modeling of optoelectronic sensor. Part 2 – Solving the equations	Assisted problem solving and simulation. Guidance. Questioning	Seminar support available anytime online: http://www.physics.uvt.ro/~marius/ Seminar face-to-face
14. Problem solving: Quantum conductance	Assisted problem solving and simulation. Guidance. Questioning	Seminar support available anytime online: http://www.physics.uvt.ro/~marius/ Seminar face-to-face

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.

10. Assessment

Activity type	10.1 Assessment criteria	10.2 Assessment method	10.3 Percent 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%
10.5. Seminar	The student solves the problems from the seminar and homework. The student proves abilities for solving numerically some problems in semiconductor physics (energy bands, effective mass, nanostructured heterostructures (superlattice, quantum wires and dots), the binding energy of impurity states, density of states and conductance)	Ongoing test	40%
10.6 Minimum performance standards			
General knowledge in the energy band theory and nanostructures (quantum wells, wires and dots). The student proves the ability of solving problems like the ones studied at seminar. The student solves the problems from the seminar and the homework.			

Completion date: 15.09.2022

Subject teacher's signature:

Department Director' Signature: