COURSE SYLLABUS

1. Data about the program

1.1 Higher education institution	Babeș-Bolyai University
1.2 Faculty	Faculty of Physics
1.3 Doctoral school	Physics
1.4 Field of study	Physics
1.5 Study cycle	Doctorate
1.6 Study program / Qualification	Doctoral training / PhD in Physics

2. Course data

2.1 Name of discipline	**Nanostructures and macromolecular systems**						
2.2 Teacher responsible for lectures	Prof. dr. Simion Astilean, Prof. dr. Mihai Todica, Prof. dr. habil. Lucian Baia, CS I dr habil. Ioan Botiz, CSI dr. habil. Monica Focsan						
2.3 Teacher responsible for seminars	Prof. dr. Simion Astilean, Prof. dr. Mihai Todica, Prof. dr. habil. Lucian Baia, CS I dr habil. Ioan Botiz, CSI dr. habil. Monica Focsan						
2.4 Year of study	I	2.5 Semester	I	2.6. Type of evaluation	Continuous evaluation/ Exam	2.7 Course framework	DO

3. Estimated total time of teaching activities (hours per semester)

3.1 Hours per week	3	Out of which: 3.2 Lectures	2	3.3 Seminars / Laboratory classes	1
3.4 Total hours in the curriculum	36	Out of which: 3.5 Lectures	24	3.6 Seminars / Laboratory classes	12
Allocation of study time:					
Study supported by textbooks, other course materials, recommended bibliography and personal student notes					42
Additional learning activities in the library, on specialized online platforms and in the field					14
Preparation of seminars / laboratory classes, topics, papers, portfolios and essays					22
Tutoring					20
Examinations					10
Other activities: -					

3.7 Individual study (total hours)	108
3.8 Total hours per semester	150
3.9 Number of credits	10

4. Preconditions (where applicable)

4.1 Curriculum	•
4.2 Competences	•

5. Conditions (where applicable)

5.1 Conducting lectures	(For face-to-face teaching – Course hall with blackboard, projector, computer and software). *For online teaching - specific platforms: MsTeams, Zoom, Skype will be used.*
5.2 Conducting seminars / laboratory classes	(For face-to-face teaching - Course hall with blackboard, projector, computer and software. Access to the laboratory's equipment and computer network). *For online teaching - specific platforms: MsTeams, Zoom, Skype will be used.*

6. Specific competences acquired

Professional competences	- Competences to advance hypotheses and interpretations based on scientific arguments, measurements and experimental data specific to the field of nanoscience and nanotechnology; - Competences regarding the capacity to acquire concepts, models, theories and advancements in hte filed of nanostructures. - The capacity to independently perform and analyze the obtained information and data. - The capacity to correlate the structural and morphological information resulted from experiments with the physical and chemical properties of nanomaterials. - Practical competences to utilize high-tech equipment. - The capacity to communicate scientific ideas and to write scientific papers. - To develop a critical, yet multi- and interdisciplinary way of thinking.
Transversal competences	- Fulfil the professional tasks effectively and responsibly with respect for law and ethics under qualified assistance. - Fulfil, according to law, the intellectual property rights (inclusively technology transfer), the products certification methodology, the principles, standards and ethical values necessary to develop a rigorous, efficient and responsible strategy of work. - Capability for effective work in multidisciplinary team on different hierarchical levels. Capability to identify the roles and responsibilities within a team, to promote dialogue and efficient cooperation within the team. - Effective use of information sources and communication resources and training assistance, both in Romanian and in a foreign language. - To participate in scientific activities, including design and writing of scientific papers and other studies. - To participate in scientific projects compatible with the highest standards of European education and research.

7. Course objectives (based on the acquired competencies grid)

7.1 The general objective of the course	1. Acquiring advanced theoretical knowledge in the field of solid-state physics, materials science and macromolecular systems. 2. Acquiring advanced methodologies of experimental and theoretical research utilized in the characterization of nanostructured materials and macromolecular structures. 3. Creating the base of physical methods and instruments used in specific research, expertise and monitoring activities in the nanomaterials field.
7.2 Specific objectives	1. To increase the capacity of a PhD student to identify new procedures and complementary solutions related to nanoscale research 2. To get familiar with advanced research methods and techniques that exist within the doctoral school in order to help the PhD student to identify and develop his/her own research topic. 3. To be able to utilize the laboratory equipment in order to perform research experiments in the field of nanomaterials. 4. To be able to utilize the laboratory equipment in order to perform research experiments in the field of plasmonic nanomaterials and their applications. 5. To be able to utilize the theoretical models in order to characterize some local properties of polymers (segmental dynamics, viscoelasticity, thermal and

	electric behavior). 6. To become knowledgeable in characterization of advanced (flexible) organic energy devices such as modern OLEDs, OPVs, sensors, etc. 7. To get competences in scientific communication related to nanostructures and macromolecules.

8. Content

8.1 Lectures	Teaching methods	Comments (no hours)
Correlating the structural and morphological information derived from measurements performed by means of complementary investigation techniques (Raman, IR, UV-vis, DRS, XRD, SEM, TEM, BET) for the characterization of nanostructures and macromolecular systems.	Presentations, Discussions, Problematization, Case studies.	3 h
Structural and morphological investigations of highly porous nanostructures based on TiO_2. Nano-size effects probed by complementary investigation techniques.		3 h
Plasmonic nanoparticules and nanostructures: methods of fabrication, characterization and funcționalization.		3 h
Coupling plasmonic nanoparticules with (bio)(macro)molecules. Applications in biomedical field and nanomedicine		2 h
Nanostructured material-based nano(bio)sensors: recent progress		3 h
Lab-on-a-chip sensing devices for smart healthcare.		2 h
Presentation and discussion of physical properties and structural models of polymers		3 h
Dynamic behavior of polymeric chains at microscopic scale. Electric properties of polymers		2 h
Conjugated macromolecular systems		3 h
Organic-based energetic devices: photovoltaic cells, field effect transistors and LED		2 h
Total		**24 h**
8.2 Seminars / laboratory classes	Teaching methods	Comments (no. hours)
Morphological and structural investigations (experimental and theoretic) of phosphate based glasses containing silver oxide	Projection, (experimental demonstration), Debate Case studies prepared by doctoral students, based on their individual doctoral research topics	3 h
New magnetic behaviors at the nanometer scale		2 h
Chemical synthesis of gold (silver) nanoparticles. Controlling their size and shape. Characterization by surface plasmon resonance		3 h
XRD Analysis of some nanostructured polymeric materials		2 h
Real-time study of perovskite crystallization		2 h
Total		**12 h**
Bibliography:		

1. T. Pradeep, Nano: The Essentials. Understanding Nanoscience and Nanotechnology, McGraw-Hill Publishing Company Ltd, New Delhi, 2007.

2. F. J. Himpsel; J. E. Ortega; G. J. Mankey; R. F. Willis, *Magnetic nanostructures*, Advances in Physics , Vol . 47, No . 4, 511± 597, 1998.

3. Stefan A. Maier, *Plasmonics: Fundamentals and Applications*, Springer, 2007.

4. M. Todica, *Proprietati fizice ale polimerilor*, Presa Universitară Clujeană, 2005.

5. I. Botiz, N. Stingelin: *Influence of Molecular Conformations and Microstructure on the Optoelectronic Properties of Conjugated Polymers*, Materials 7, 2273-2300 (2014).

6. Smart materials for smart healthcare- moving from sensors to actuators to self-sustained nanoenergy nanosystems, Smart Materials in Medicine, 1 (2020) 920124

7. A. Rasooly and K. E. Herold Eds, Biosensors and Biodetection, Methods and Protocols, Volume 1, Optical-Based Detectors, 2009, Springer Protocols.

8. A. I. Kirkland, J. L. Hutchison, Nanocharacterisation, RSC Publishing, Cambridge, 2007.

9. Renat R. Letfullin and Thomas F. George. *Plasmonic Nanomaterials for Nanomedicine,* Springer, 2013.

10. Christine Luscombe Ed., *Semiconducting Polymers: Controlled Synthesis and Microstructure*, Royal Society of Chemistry, 2016.

9. Aligning the contents of the discipline with the expectations of the epistemic community representatives, professional associations and standard employers operating in the program field

The content of the discipline is in accordance with the research directions that are studied in the same field in Romanian and foreign universities. For the adaptation of doctors in physics to the market, the content of the discipline meets the requirements imposed by their employment in national or international universities or research institutes.

10. Examination

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Weight in the final grade
10.4 Lectures	Assessment of knowledge	Exam	50%
10.5 Seminars / labs.	Activity	Oral presentations	50%
10.6 Minimum performance standard			
Correct identification of experimental methods for structural and morphological analyses of nanomaterials Correct identification of the physical properties of a material that are dependent on its dimensionality.			

Date of issue	Signature of the teacher responsible for lectures	Signature of the teacher responsible for seminars
21/09/2021	Prof. dr. Simion Aştilean Prof. dr. Mihai Todica Prof. dr. Lucian Baia CS I dr. habil. Ioan Botiz CS I dr. habil. Monica Focsan	Prof.dr. Simion Aştilean Prof. dr. Mihai Todica Prof. dr. Lucian Baia CS I dr. habil. Ioan Botiz CS I dr. habil. Monica Focsan

Date of approval by the doctoral school council
08 /10/2021

Signature of the doctoral school director