COURSE SYLLABUS

University	**Alexandru Ioan Cuza University of Iaşi**	**Course title**	
Faculty	**Physics**	**FUNDAMENTAL AND FUNCTIONAL PROPERTIES OF LOW-DIMENSIONAL MATERIALS**	
Department	**Physics**		
Domain	**Simulation Methods**	**Course category** (FC/SC/CC[1]):FC	**Term** (1-4): 2
Level	**Postgraduate (MA)**	**Course type** (Co/El/F[2]):Co	

I. Course structure

Number of hours/week				Credits	Total class hours/ semester	Total hours of individual activity	Examination type (C/Ex/CE[3])	Teaching language
Course	Seminar	Lab.	Project	**5**	**28**	**28**	**Ex**	**English**
2		**2**						

II. Instructors

	Academic degree[4]	Scientific degree	Name and surname	Faculty position (tenure/ associate - organization)
Course	Professor	PhD	Iacomi Felicia	tenure
Seminar				
Laboratory	Professor	PhD	Iacomi Felicia	tenure

III. Prerequisites

Quantum mechanics, Physical statistics, Solid state Physics

IV. Course objectives

This course concerns artificial materials with substructure on the nanometer scale such that the electronic motion is restricted to two, one or zero dimensions. The emphasis is on semiconductor systems but also other low-dimensional systems will be discussed. The concepts and the underlying theory are introduced based on quantum mechanics and extended by the application to heterostructures.

V. Course content

Course	**I. Introduction in the physics of low-dimensional systems.** Properties of materials & nanomaterials, role of size in nanomaterials. **II. Synthesis and characterization methods** Chemical and physical synthesis methods. OD, 1D and 2D systems, 3D nanocompozites. High resolution diffraction, electronmicroscopic and spectroscopic methods used in low-dimensional systems characterization **III. Fundamental properties of low-dimensional systems** Electronic Properties. Band structures. Excitons in semiconductors. Excitons in low-dimensional systems. EMA, ETBM, EBOM, EPM methods. Substrate effects. Effect of surrounding medium. Experimental constraints for theoretical models. Influence of cluster form on quantum size effect. Effect of deffects Metal-insulator transitionisn semimetals quantum size effects Optical Properties.Quantum confinement. Photoluminescence. Bleachind effects. Biexcitons. Non-linear optical properties Transport properties of 2D and 1D systems. Quantized conductance with Landauer-formalism. Scattering phenomena in 1D. **IV Applications of low-dimensional systems.** Quantum devices with controlled band gap Devices based on quantum phenomena and Coulomb blockade. Photonics.Transparent electronics. Spintronics. Nanoelectronics

[1] FC – fundamental course, SC – specialty course, CC – complementary course
[2] Co – compulsory, El – elective, F – facultative
[3] C – colloquium, Ex – exam, CE – colloquium AND exam
[4] Professor / Associate professor / Lecturer / Assistant professor / Teaching assistant

	Biological applications
Seminar	
Laboratory	1. **Use of CaRine software for the study of:** surfaces, interfaces, grain boundaries, multi-layers, stereographic projection, reciprocal lattices in 2D, X-Ray diffraction patterns (XRD) 2. GAXRD method 3**. Use of BandLab software to perform electronic structure calculations of crystalline solids and nanomaterials** **4. Study of quantum size effect on optical absorption** **5. Application of Raman methods in structural studies** **6. Use of ESR method in the study of transitional metals in low-dimensional systems** 7**. Utilization of XPSPEAK software to investigate the size effect on binding energy**

VI. Minimal required references

[1] Martin T. Dove, Structure and dynamics, Oxford University press, 2002.
[2] John Singleton, Band Theory and Electronic Properties of Solids, Oxford University press, 2001.
[3] Stephen Blundell, Magnetism in condensed matter, Oxford University press, 2001.
[4] F.Iacomi, Spectroscopia vibraţională a materialelor zeolitice, Ed. Stef, Iasi, 2007
[5] L.David, C.Craciun, O.Cozar, V.Chis, Rezonanta Electronica de Spin. Principii. Metode. Aplicatii. Presa Universitara Clujeana, Cluj-Napoca, 2001
[6] S. E. Lyshevski, Nano and Molecular Electronics, CRC Press Taylor &Francis Group 2007

VII. Didactic methods

Explaining, Demonstrating, Power Point Presentation

VIII. Assessment

Pre-conditions	Attendance, active participation to lab activities, resolve homework	
Exam dates	**1st Assessment**	April
	2nd Assessment	June

	Assessment means and methods	**Percentage of the final grade**
Exam/Colloquium	written	60%
Seminar		
Laboratory	Practical work, homework.	40%