Program	Level of studies		**Second cycle**	
	Program name		**Physics**	
Course name	**NANOMATERIAL PHYSICS**			
Course ID	Semester	Course status	ECTS credits	L+E
PCM9691	**I**	**ELECTIVE**	**6**	**2+1**
Lecturer				
Aims and intended learning outcomes	The aim of the course is to introduce students with nanomaterials, open questions and research opportunities in this field. Expected learning outcomes: Understanding the qualitative and quantitative properties of nanomaterials; self-use of literature and scientific papers in problem solving through seminar; Improving communication skills by presenting seminar.			

Course content

- Introduction: a historical introduction to nanomaterials and technology development, unusual phenomena in nanomaterials.
- Nanostructure: fundamentals of crystal structure, the definition of nanomaterials, nanoparticles and clusters of atoms, different forms of nanomaterials, carbon nanostructures.
- Irregularities and diffusion: description of defects in a crystal, changing structural features from polycrystalline over microcrystalline to nanocrystalline materials, peculiarities in amorphous state, diffusion processes, differences in atomic diffusion from bulk materials to nanomaterials and amorphous materials.
- Metastable materials, from solid solution to nanostructures: phase diagrams, solid solutions and their structure, long-range and short-range order, superstructure, metastable structures and their preparation, relaxation of structures, occurrence of different nanostructures.
- Physical properties of materials: mechanical and similar: influence of defects on the mechanical properties, designing suitable mechanical properties (hardening and strengthening) of materials through their nanostructuring, special forms of applicable materials.
- Structural properties of special new materials: development of structural characteristics from bulk materials to nanomaterials, some special new materials: fullerene, graphene, nanotubes and nanowires, nanoporous materials.
- Transport phenomena in nanomaterials: electrical conductivity in nanomaterials, thermal conductivity of nanomaterials, thermoelectric effects, semiconductors.
- Magnetism of nanomaterials: occurrence and features of nanomagnets, magnetic behaviour of nanoparticles and their magnetic structures, single molecule nanomagnets, magnetism in metallic glasses, magnetic nanowires and thin films, nanocrystalline magnetic materials.
- Electronic structure and special properties of nanomaterials: density of states and low-dimensional conductivity, atomic microscopes, quantum dots and optical properties, electrical conductivity through the quantum dot.

Student workload (hours)		Grading	
Lectures and Exercises	45	Assessment method	Points
Exam preparation	60	Final exam	50
Seminar	45	Seminar	50
Total	150		
		Total	100

Literature

1. Lecture notes
2. Skripta prof. Dr. Antun Tonejc: Fizika nanomaterijala, http://www.phy.pmf.unizg.hr/~atonejc/FMS%20PDS%20Studij.html
3. Charles Kittel, Introduction to solid state physics, poglavlje Nanostructures
4. Nicola Spladin, Magnetic Materials

Remarks