SEMESTER LEARNING ACTIVITY PLANS (SLAP)
SEMESTER ODD 2022/2023

Nanophysics

MFF5617 / 2 Credits

Lecturer Coordinator:

Dr.Sc. Ari Dwi Nugraheni, S.Si., M.Si.

UNIVERSITAS GADJAH MADA
FACULTY OF MATHEMATICS AND NATURAL SCIENCE

2022

	Universitas Gadjah Mada Faculty of Mathematics and Natural Science Physics Department / Study Program Master Physics Semester Odd 2022/2023

SEMESTER LEARNING ACTIVITY PLANS (SLAP)

Code	Course Name	Credits (credits)	Semester	Status	Prerequisite
MFF5617	*Nanophysics*	*2*	*Odd*	*Elective*	*None*

Short Description

Nanophysics course is Elective course 2 credits (Theory) in the 2022 Curriculum Master Physics Study Program, Faculty of Mathematics and Natural Science UGM.

The syllabus of this course is as follows:
Introduction to the concept of nanoscience and nanotechnology, the concept of size-dependent (Bulk Material and Film), Summary of the concept of the physics of compressed substances in nanosystems (Meeting states, electronic structures, phonons, Joint Density of States), physical studies of nanostructures such as quantum dots, quantum wells (quantum wells), quantum wires, nanoparticles, nanocrystals (nanocrystals) and Heterojunction systems. Load transport of nanosystems: Landauer-Buttiker formalism, Tunneling current, Electron Localization, Weak localization, anti-weak localization, Quantum Hall Effect. Nano physical System Applications: nanoelectronic semiconductors (MOSFETs, CMOS), nanoparticle semiconductors, two-dimensional Electron Gas (2DEG) heterojunctions, Carbon Nanoribbons Systems, Carbon Nanotubes, Self Assembly Molecules (SAM), Bionanotechnology, molecular motors.

The courses are held in class for 14 weeks, each week's session last for 2 x 50 minutes. Four weeks of course period is used for Midterm Exam and Final Exam, each held for two weeks as scheduled.

Student evaluation for course assessments is performed summative and formative. The summative evaluation is implemented as written exams, both Midterm and Final Exam, which take a maximum of 120 minutes. The formative evaluation is implemented as individual assignments for each student in the form of completing an assignment individually. Monitoring is carried out by observing student activities during the course, such as attendance, Q&A and discussion about the material presented, and student performance in completing individual assignments.

Program Learning Outcomes (PLO) Imposed on the Course

PLO 3	Mastering further knowledge of classical and modern physics theory, and its relationship with other disciplines, and has mastered an advanced field of physics specialization that allows him to keep up with the latest international research developments.
PLO 4	Mastering various mathematical disciplines related to an advanced field of physics, and able to develop physical models using various mathematical and computational tools with an inter or multidisciplinary approach to solving problems related to an advanced field of physics.
PLO 6	Able to apply knowledge to analyze, synthesize, formulate problems and solve problems comprehensively in one of advanced field of physics, through experimental or theoretical research, then be able to classify and draw conclusions about their findings for the development of science and technology.

Course Outcomes (CO)	**Upon completion of this course, students should be able to:**			
	CO1	Understand the aspects of physical science that support nanotechnology and understand its application in various fields.		
	CO2	Understand the basics of nanophysics and the properties of materials in nanosystems.		
	CO3	Understand the application of nanophysics, how to fabricate nanomaterials and how to characterize nanomaterials.		
	CO4	Understand scientific articles related to nanomaterials.		
	CO5			
	CO6			
	CO7			
	CO8			
The Correlation of CO to Learning Materials and Methods, and Time Allocation		**Learning Materials**	**Learning Methods**	**Time Allocation**
	CO1	Lecture explanations and agreements. Brief review of nanoscience and nanotechnology. Reviewing the influence of physics on nanoscience and nanotechnology. Brief review of nanomaterial fabrication techniques and their characterization techniques.	Lecture, discussion	2 x 50 minutes
	CO1	2.1 Free Electrons. 2.2 Nearly free-electrons. 2.3. Band-Theory concept in a nutshell 2.4. Joint Density of States, Absorption	Lecture, discussion	2 x 50 minutes
	CO1	5.1 Lattice Dynamics (phonons) 5.2 Quasiparticles 5.3 Bulk Materials (Metals, Insulators, Semiconductors, Correlated materials, Molecular materials	Lecture, discussion	2 x 50 minutes
	CO2	6.1 Electronic structure and state of affairs (DOS) of 3D materials 6.2 Electronic structure and conventions (DOS) of Quantum Dot 6.3 Electronic structure and conventions (DOS) of Quantum Wires 6.4 Electronic structure and	Lecture, discussion	2 x 50 minutes

		conventions (DOS) of Quantum Well 6.5. Applications on nanomaterials		
	CO2	7.1 Transport properties and length scale 7.2 Formalism of the Landauer-Buttiker equation 7.3. Tunneling Flow 7.4 Electron localization 7.5 Weak localization and antilocalization 7.6 Quantum Hall Effect	Lecture, discussion	2 x 50 minutes
	CO2	8.1 Preparation and characterization 8.2 Charge transfer in semiconductor systems 8.3 Photocatalytic applications 8.4 Surface modification	Lecture, discussion	2 x 50 minutes
	CO2	9.1 Transistor structures for nanoelectronics 9.2 Nanolayer-base . metal transistors 9.3 FET nanowire ZnO 9.4 FET C60 9.5 Copper-pair Transistors	Lecture, discussion	2 x 50 minutes
	CO3	2D gas electron system and its application technique.	Lecture, discussion	2 x 50 minutes
	CO3	12.1 The electronic structure of Graphene and its Applications 12.2 The electronic structure of Carbon Nanotubes and their applications	Lecture, discussion	2 x 50 minutes
	CO3	13.1 Introduction Self assembly 13.2 Self-assembly monolayer 13.3 Self-assembly of organic transistors 13.4 Surface modification with self-assembly monolayers (SAMs)	Lecture, discussion	2 x 50 minutes
	CO4	14.1 Introduction to Bionanotechnology 14.2 Molecular motor	Lecture, discussion	2 x 50 minutes
	CO4		Lecture, discussion	2 x 50 minutes
	CO4		Lecture, discussion	2 x 50 minutes
	CO4		Lecture, discussion	2 x 50 minutes
	Final Exam/ Project Task Results/ Case Analysis Results			
Learning Methods	Lecture, discussion			

<table>
<tr><td>Student Learning Experience</td><td>Learn to analyze and review: Lecture explanations and agreements. Brief review of nanoscience and nanotechnology. Reviewing the influence of physics on nanoscience and nanotechnology. Brief review of nanomaterial fabrication techniques and their characterization techniques., 2.1 Free Electrons.
2.2 Nearly free-electrons.
2.3. Band-Theory concept in a nutshell
2.4. Joint Density of States, Absorption, 5.1 Lattice Dynamics (phonons)
5.2 Quasiparticles
5.3 Bulk Materials (Metals, Insulators, Semiconductors, Correlated materials, Molecular materials, 6.1 Electronic structure and state of affairs (DOS) of 3D materials
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6.5. Applications on nanomaterials, 7.1 Transport properties and length scale
7.2 Formalism of the Landauer-Buttiker equation
7.3. Tunneling Flow
7.4 Electron localization
7.5 Weak localization and antilocalization
7.6 Quantum Hall Effect, 8.1 Preparation and characterization
8.2 Charge transfer in semiconductor systems
8.3 Photocatalytic applications
8.4 Surface modification, 9.1 Transistor structures for nanoelectronics
9.2 Nanolayer-base . metal transistors
9.3 FET nanowire ZnO
9.4 FET C60
9.5 Copper-pair Transistors, 2D gas electron system and its application technique., 12.1 The electronic structure of Graphene and its Applications
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13.4 Surface modification with self-assembly monolayers (SAMs), 14.1 Introduction to Bionanotechnology
14.2 Molecular motor, , , .</td></tr>
<tr><td>Access to Learning Media/ LMS and Offline and Online Percentage</td><td>Hand-out of powerpoint slides</td></tr>
<tr><td>Assessment Methods and Synchronization with CO</td><td>
<table>
<tr><th>Assessment Methods</th><th>Assessment Percentage</th><th>Criteria/Indicators</th><th>CO1</th><th>CO2</th><th>CO3</th><th>CO4</th></tr>
<tr><td>Participatory Activity*</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Project Results/ Case Study Results/ PBL Results*</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="7">Cognitive</td></tr>
<tr><td>Assignment</td><td>30%</td><td></td><td>7,5%</td><td>7,5%</td><td>7,5%</td><td>7,5%</td></tr>
<tr><td>Quiz</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Midterm Exam</td><td>35%</td><td></td><td>17,5%</td><td>17,5%</td><td></td><td></td></tr>
<tr><td>Final Exam</td><td>35%</td><td></td><td></td><td></td><td>17,5%</td><td>17,5%</td></tr>
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<tr><td></td><td colspan="4">*) can also be obtained from the Midterm or Final Exam as the result of participatory activities or project/ case study results. According to IKU 7, the percentage of project results/ case study/ PBL results is at least 50%.</td></tr>
<tr><td>References</td><td colspan="4">Main references:
1. Douglas Natelson, Nanostructures and Nanotechnology, Cambridge University Press, 2015. (e-book is available).
2. Vladimir V. Mitin, Dimitry I. Sementsov, Nizami D. Vagidov, Quantum Mechanics of Nanostructures, Cambridge University Press, Cambridge UK, 2010 (e-book is available).
3. Supriyo Datta, Electronic Transport in Mesoscopic System, CambridgeUniversity Press, Cambridge UK, 1995 (e-book is available).
4. Hari Singh Nalwa, Nanostructured Materials and Nanotechnology, Academic Press, California USA, 2002 (e-book is available).</td></tr>
<tr><td>Lecturers (Team Teaching)</td><td colspan="4">1. Dr.Sc. Ari Dwi Nugraheni, S.Si., M.Si.
2.
3.
4.</td></tr>
<tr><td rowspan="2">Authorization</td><td>Date of Drafting</td><td>Lecturer Coordinator</td><td>Head of Curriculum Committee</td><td>Head of Study Program</td></tr>
<tr><td></td><td>Dr.Sc. Ari Dwi Nugraheni, S.Si., M.Si.</td><td>Dr.Ing. Ari Setiawan</td><td>Mirza Satriawan, M.Si., Ph.D</td></tr>
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