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

Spintronics

MFF5855 / 3 Credits

Lecturer Coordinator:

Moh. Adhib Ulil Absor, S.Si., M.Sc., Ph.D.

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
MFF5855	*Spintronics*	*3*	*Odd*	*Elective*	*None*

Short Description

Spintronics course is Elective course 3 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:
Quantum Theory on Spin, Spin-Orbit Interaction, Spin Relaxation, Review of Spin-Orbit Interaction on Crystal Systems, Spin-Orbitronics Systems, Magnetic Skyrmion on 2D Materials, Special Topics on Orbitronic Systems, Spin Polarization Phenomena, Effects of Spin Transfer Torque and Spin Injection, Soft and Hard Magnetic, Magnetic Anisotropy, Magnetic Domains, and Domain Walls, GMR and Spin-Dependent Scattering Transport, TMR and Spin-Dependent Tunneling Transport, Spin Transistor, MRAM and Magnetic Storage, spin thermoelectricity.

The courses are held in class for 14 weeks, each week's session last for 3 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.

Upon completion of this course, students should be able to:

Course Outcomes (CO)	***CO1***	Formulate and describe the physical phenomena being studied and reveal vital information in the physics problem through various tricks or specific mathematical procedures and utilizing different approximations.		
	CO2	Pay attention to physics problems in detail, analyze issues, and build arguments logically and carefully.		
	CO3	Research physics problems from various sources and references to understand important information.		
	CO4	Solve issues with structured solutions (well-defined solutions), formulate a problem carefully, and try other approaches to improve the solution of a challenging problem.		
	CO5			
	CO6			
	CO7			
	CO8			
The Correlation of CO to Learning Materials and Methods, and Time Allocation		**Learning Materials**	**Learning Methods**	**Time Allocation**
	CO1	Introduction to spin quantum mechanics, spin-orbit interactions, Overview of spin-orbit interactions in crystal systems, spin-orbitronic systems, Spinorbitronic materials, special topics on orbitronic systems (part I).	Lecture	3 x 50 minutes
	CO1	Introduction to spin quantum mechanics, spin-orbit interactions, Overview of spin-orbit interactions in crystal systems, spin-orbitronic systems, Spinorbitronic materials, special topics on orbitronic systems (Part II).	Lecture	3 x 50 minutes
	CO1	Introduction and classification of magnetic, diamagnetic, ferromagnetic, paramagnetic, antiferromagnetic materials (Part I).	Lecture	3 x 50 minutes
	CO2	Introduction and classification of magnetic, diamagnetic, ferromagnetic, paramagnetic, antiferromagnetic materials (section II).	Lecture	3 x 50 minutes
	CO2	Magnetic domains, magnetic moments and magnetic anisotropy.	Lecture	3 x 50 minutes
	CO2	Spintronic materials based on magnetic and non-magnetic materials, and their applications (part I).	Lecture	3 x 50 minutes
	CO2	Spintronic materials based on magnetic and non-magnetic materials, and their applications (part II).	Lecture	3 x 50 minutes

	CO3	Methods for measuring and characterizing magnetic properties, such as Vibrating Sample Magnetometer (VSM), Torque Magnetometer, Magnetic Force Microscopy (MFM) (part I).	Lecture	3 x 50 minutes
	CO3	Methods for measuring and characterizing magnetic properties, such as Vibrating Sample Magnetometer (VSM), Torque Magnetometer, Magnetic Force Microscopy (MFM) (part II).	Lecture	3 x 50 minutes
	CO3	Symptoms of Giant Magneto-Resistance (GMR) and spintronic phenomena (spin-dependent electron transport). (part I).	Lecture	3 x 50 minutes
	CO4	Symptoms of Giant Magneto-Resistance (GMR) and spintronic phenomena (spin-dependent electron transport). (part II).	Lecture	3 x 50 minutes
	CO4	Spin polarization phenomena, spin Hall effect, Spin Transfer Torque effect, and spin injection, and their applications (part I).	Lecture	3 x 50 minutes
	CO4	Spin polarization phenomena, spin Hall effect, Spin Transfer Torque effect, and spin injection, and their applications (part II).	Lecture	3 x 50 minutes
	CO4	Spintronic devices such as MRAM (Magnetoresistive Random Access Memory.	Lecture	3 x 50 minutes
	Final Exam/ Project Task Results/ Case Analysis Results			
Learning Methods	Lecture			
Student Learning Experience	Learn to analyze and review: Introduction to spin quantum mechanics, spin-orbit interactions, Overview of spin-orbit interactions in crystal systems, spin-orbitronic systems, Spinorbitronic materials, special topics on orbitronic systems (part I)., Introduction to spin quantum mechanics, spin-orbit interactions, Overview of spin-orbit interactions in crystal systems, spin-orbitronic systems, Spinorbitronic materials, special topics on orbitronic systems (Part II)., Introduction and classification of magnetic, diamagnetic, ferromagnetic, paramagnetic, antiferromagnetic materials (Part I)., Introduction and classification of magnetic, diamagnetic, ferromagnetic, paramagnetic, antiferromagnetic materials (section II)., Magnetic domains, magnetic moments and magnetic anisotropy., Spintronic materials based on magnetic and non-magnetic materials, and their applications (part I)., Spintronic materials based on magnetic and non-magnetic materials, and their applications (part II)., Methods for measuring and characterizing magnetic properties, such as Vibrating Sample Magnetometer (VSM), Torque Magnetometer, Magnetic Force Microscopy (MFM) (part I)., Methods for measuring and characterizing magnetic properties, such as Vibrating Sample Magnetometer (VSM), Torque Magnetometer, Magnetic Force Microscopy (MFM) (part II)., Symptoms of Giant Magneto-Resistance (GMR) and spintronic phenomena (spin-dependent electron transport). (part I)., Symptoms of Giant Magneto-Resistance (GMR) and spintronic phenomena (spin-dependent electron transport). (part II)., Spin polarization phenomena, spin Hall effect, Spin Transfer Torque effect, and spin injection, and their applications (part I)., Spin polarization phenomena, spin Hall effect, Spin Transfer Torque effect, and spin injection, and their applications (part II)., Spintronic devices such as MRAM (Magnetoresistive Random Access Memory..			

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<tr><td>Access to Learning Media/ LMS and Offline and Online Percentage</td><td>Sync (google meet), Asynchronous (google classroom, video)</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>
<tr><td colspan="7">*) 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>
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<tr><td>References</td><td>Main references:
1. Coey, J.M.D., 2010, Magnetism and Magnetic Material, Cambridge Univ.Press.
2. Heck, C., 1974, Magnetic Material and Their Application, Newnes-Butterworth.
3. Lombardi, G.C. dan Bianchi, G.E., 2009, Spintronics: Materials, Applications and Devices, Nova Science Pub Inc.</td></tr>
<tr><td>Lecturers (Team Teaching)</td><td>1. Moh. Adhib Ulil Absor, S.Si., M.Sc., Ph.D.
2. Dr. Eng. Edi Suharyadi, S.Si., M.Eng.
3.
4.</td></tr>
<tr><td>Authorization</td><td>
<table>
<tr><th>Date of Drafting</th><th>Lecturer Coordinator</th><th>Head of Curriculum Committee</th><th>Head of Study Program</th></tr>
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