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

Mathematical Physics

MFF5009 / 3 Credits

Lecturer Coordinator:

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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/Even 2022/2023

SEMESTER LEARNING ACTIVITY PLANS (SLAP)

Code	Course Name	Credits (credits)	Semester	Status	Prerequisite
MFF5009	*Mathematical Physics*	*3*	*Odd/Even*	*Compulsory*	*None*

Short Description

Mathematical Physics course is Compulsory 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:
Overview of basic vector concepts: vector algebra, unit vector, scalar multiplication, cross product, position vector, unit vector in Cartesian coordinates, vector components, vectors relative to the coordinate axis, rotation vectors, and rotation matrix.
Advanced vector constraints: true vectors and pseudovectors, examples of true vectors and pseudovectors.
Vector calculus: parameterized vectors, field definition, vector fields, scalar fields, isoscalar surfaces, vector derivatives, gradients and their meanings, divergences and their meanings, rotations and their meanings, essential identities, path integrals, surface integrals, space integrals, Gauss's theorem for vector fields, Gauss's theorem for scalar fields, Stokes' theorem for vector fields, Stokes' theorem for scalar fields, Green's theorem, continuous vector fields and potential concepts, solenoid vector fields, applied Gauss's theorem and Stokes' theorem.
Curved coordinate system: curvilinear coordinate system, coordinate domain, orthogonal coordinate system, coordinate transformation, examples, curvilinear coordinates, surface coordinates, covariance basis, contravariance basis, scale factor, line elements in curvilinear coordinates, area elements in curvilinear coordinates, volume element coordinates curved, vector calculus in curved coordinates.
Linear Algebra: vector spaces, real vector spaces, complex vector spaces, vector subspaces, characterization of vector subspaces, linear combinations, finite linear combinations, linear expanse, linear independent sets and linear dependent sets, finite and infinite bases, vector space dimensions, basic properties, linear mapping, linear mapping kernels, linear mapping matrix, basis transformation, linear equation system, eigenvalue problem.
Partial differential equations: characterization of partial differential equations, methods of solving partial differential equations, boundary conditions and initial conditions, solving boundary condition problems, wave equations, heat propagation and diffusion equations, Green functions, self-value problems, hermitian differential operators, boundary condition problem-solving.

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.

Course Outcomes (CO)	**Upon completion of this course, students should be able to:**			
	CO1	Calculating vector addition and subtraction calculations, vector multiplication, look for vectors that are perpendicular to each other, express vectors in component form, create vector rotations and rotation matrices. Distinguish between true vectors and pseudo vectors. Calculates the derivative of a vector in a given direction, looking for a vector that is perpendicular to the isoscalar plane.		
	CO2	Calculating line integrals, area integrals and volume integrals, converting area integrals to line integrals and vice versa, converting volume integrals to area integrals and vice versa. Looking for the application of line integral, area integral and volume integral in Physics.		
	CO3	Perform transformations between curvilinear coordinates and provide examples of curvilinear coordinates and their covariance and contra-variant bases. Calculates derivatives and integrals of vectors on curved coordinates.		
	CO4	Understand the concept of vector space and be able to construct vector space structures, both real and complex vector spaces. Mastering the concept of vector subspace and able to characterize vector subspace. Mastering the concepts of linear combinations, finite linear combinations, and linear stretches. Determine that a set of vectors is a linearly independent set or a linearly dependent set. Mastering the concept and able to determine the finite basis and infinite basis, the dimensions of the vector space, and the properties of the basis. Understand concepts and be able to define linear mapping, linear mapping kernel, linear mapping matrix expression, and basis transformation. Mastering and able to find solutions to systems of linear equations and self-assessment problems.		
	CO5	Performing the characterization of partial differential equations, boundary conditions, and initial conditions. Calculating the solution of boundary conditions problems related to wave equations, heat propagation equations, and diffusion through various methods: Green function method, and self-function method.		
	CO6			
	CO7			
	CO8			
The Correlation of CO to Learning Materials and Methods, and		**Learning Materials**	**Learning Methods**	**Time Allocation**
	CO1	Overview of elementary vector concepts.	Lecture, discussion	3 x 50 minutes
	CO1	Advanced vector limit	Lecture, discussion	3 x 50 minutes

Time Allocation	***CO1***	Vector Calculus	Lecture, discussion	3 x 50 minutes
	CO2	Vector Calculus	Lecture, discussion	3 x 50 minutes
	CO2	Vector Calculus	Lecture, discussion	3 x 50 minutes
	CO2	Curved coordinates	Lecture, discussion	3 x 50 minutes
	CO2	Curved coordinates	Lecture, discussion	3 x 50 minutes
	CO3	Linear algebra	Lecture, discussion	3 x 50 minutes
	CO3	Linear algebra	Lecture, discussion	3 x 50 minutes
	CO3	Linear algebra	Lecture, discussion	3 x 50 minutes
	CO4	Partial differential equation	Lecture, discussion	3 x 50 minutes
	CO4	Partial differential equation	Lecture, discussion	3 x 50 minutes
	CO4		Lecture, discussion	3 x 50 minutes
	CO4		Lecture, discussion	3 x 50 minutes
	Final Exam/ Project Task Results/ Case Analysis Results			
Learning Methods	Lecture, discussion			
Student Learning Experience	Learn to analyze and review: Overview of elementary vector concepts., Advanced vector limit, Vector Calculus, Vector Calculus, Vector Calculus, Curved coordinates, Curved coordinates, Linear algebra, Linear algebra, Linear algebra, Partial differential equation, Partial differential equation, , .			
Access to Learning Media/ LMS and Offline and Online Percentage	Whiteboard			

Assessment Methods and Synchronization with CO

Assessment Methods	**Assessment Percentage**	**Criteria/Indicators**	**CO1**	**CO2**	**CO3**	**CO4**
Participatory Activity*						
Project Results/ Case Study Results/ PBL Results*						
Cognitive						
Assignment	30%		7,5%	7,5%	7,5%	7,5%
Quiz						

	Midterm Exam	35%		17,5%	17,5%		
	Final Exam	35%				17,5%	17,5%
	*) 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%.						

References	**Main references:** K. F. Riley, M. P. Hobson, and S. J. Bence, 2006, Mathematical methods for physics and engineering, Cambridge University Press, Cambridge.
Lecturers (*Team Teaching*)	1. Dr. Dwi Satya Palupi, S.Si., M.Si. 2. 3. 4.

Authorization	**Date of Drafting**	**Lecturer Coordinator**	**Head of Curriculum Committee**	**Head of Study Program**
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