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

Classical Mechanics

MFF5401 / 3 Credits

Lecturer Coordinator:

Drs. Yosef Robertus Utomo, S.U.

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
MFF5401	*Classical Mechanics*	*3*	*Odd/Even*	*Compulsory*	*None*

Short Description	Classical Mechanics 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: Fundamental Principles of Newtonian Mechanics, Lagrange, and Hamilton. A system with constraints, symmetry, and the law of conservation. Two-body systems, Kepler motion, kinetics, and rigid-body dynamics. Canonical variables and transformations, Poisson equations of motion, Hamilton-Jacobi theory, relativistic dynamics, swings, and their normal variances. 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***	Describes and discusses: Fundamentals of Mechanics, Newtonian Mechanics for single-particle and plural-particle systems, and calculus of variations to solve mechanical problems in Lagrangian formalism.
	CO2	Describe and discuss: The concept of symmetry and symmetry breaking and their relation to the preservation of a physical quantity through the Noether theorem. Lagrange's equation for a system having a central potential, i.e., planetary orbits and particle scattering.
	CO3	Describe and discuss: Hamiltonian formulation in solving mechanical system problems. The use of Euler-Lagrange formalism for kinematic motion of rigid bodies, Euler angles, rotation of rigid bodies (moment of inertia tensor), Euler equations, and apparent force effects (Coriolis).
	CO4	Explain and discuss: The use of Euler-Lagrange formalism for small oscillatory motions (sign damping, with damping, and external force). Canonical transformation and its relation to Euler Lagrange formalism and Hamiltonian formalism.
	CO5	Explain and discuss: Hamiltonian-Jacobi formalism in discussing the motion of objects. Special relativity theory and its relation to Lagrangian formalism and Hamiltonian formalism.
	CO6	
	CO7	
	CO8	

The Correlation of CO to Learning Materials and Methods, and Time Allocation		**Learning Materials**	**Learning Methods**	**Time Allocation**
	CO1	INTRODUCTION: Summary of the history of classical mechanics and its comparison with quantum and relativistic mechanics. Fundamentals of Newtonian mechanics on single-particle and multiple-particle systems. Application of D'alembert's apparent force principle and its relation to Newtonian mechanics and Lagrangian mechanics.	Lecture	3 x 50 minutes
	CO1	Lagrange method: degrees of freedom, configuration space, general coordinates, conjugate momentum, calculus of variations, Lagrange multiplier, and press. Lagrange motion with constraint and without constraint, Lagrange method for system with velocity dependent potential.	Lecture	3 x 50 minutes
	CO1	Lagrange method: degrees of freedom, configuration space, general coordinates, conjugate momentum, calculus of variations, Lagrange multiplier, and press. Lagrange motion with constraint and without constraint, Lagrange method for system with velocity dependent potential.	Lecture	3 x 50 minutes

	CO2	Noether's theorem, the relation of the Lagrange equation to symmetry and the law of sustainability.	Lecture	3 x 50 minutes
	CO2	Formulasi Hamiltonian, ruang fase, transformasi Legendre, relasi mekanika Hamiltonian dengan simetri dan hukum kelestarian.	Lecture	3 x 50 minutes
	CO2	Lagrange's equations for the Central Potential System, planetary orbit problems and Rutherford scattering.	Lecture	3 x 50 minutes
	CO2	Lagrange's equations for the Central Potential System, planetary orbit problems and Rutherford scattering.	Lecture	3 x 50 minutes
	CO3	Rigid body kinematics, Euler angles, rotation of rigid bodies, moment of inertia tensor, Eq. Euler-Langrage and its relation to kinematics and rotation of rigid bodies, apparent forces (Coriolis effect).	Lecture	3 x 50 minutes
	CO3	Rigid body kinematics, Euler angles, rotation of rigid bodies, moment of inertia tensor, Eq. Euler-Langrage and its relation to kinematics and rotation of rigid bodies, apparent forces (Coriolis effect).	Lecture	3 x 50 minutes
	CO3	Minor oscillations (sign of damping, with damping, and external force) and their relation to Eq. Euler-Langrage.	Lecture	3 x 50 minutes
	CO4	Minor oscillations (sign of damping, with damping, and external force) and their relation to Eq. Euler-Langrage	Lecture	3 x 50 minutes
	CO4	Canonical Transformations and their relation to Lagrangian and Hamiltonian formulations.	Lecture	3 x 50 minutes
	CO4	Canonical Transformations and their relation to Lagrangian and Hamiltonian formulations.	Lecture	3 x 50 minutes
	CO4	Pers. Hamilton-Jacobi in describing the motion of objects.	Lecture	3 x 50 minutes
	Final Exam/ Project Task Results/ Case Analysis Results			
Learning Methods	Lecture			

<table>
<tr><td>Student Learning Experience</td><td>Learn to analyze and review: INTRODUCTION: Summary of the history of classical mechanics and its comparison with quantum and relativistic mechanics. Fundamentals of Newtonian mechanics on single-particle and multiple-particle systems. Application of D'alembert's apparent force principle and its relation to Newtonian mechanics and Lagrangian mechanics., Lagrange method: degrees of freedom, configuration space, general coordinates, conjugate momentum, calculus of variations, Lagrange multiplier, and press. Lagrange motion with constraint and without constraint, Lagrange method for system with velocity dependent potential., Lagrange method: degrees of freedom, configuration space, general coordinates, conjugate momentum, calculus of variations, Lagrange multiplier, and press. Lagrange motion with constraint and without constraint, Lagrange method for system with velocity dependent potential., Noether's theorem, the relation of the Lagrange equation to symmetry and the law of sustainability., Formulasi Hamiltonian, ruang fase, transformasi Legendre, relasi mekanika Hamiltonian dengan simetri dan hukum kelestarian., Lagrange's equations for the Central Potential System, planetary orbit problems and Rutherford scattering., Lagrange's equations for the Central Potential System, planetary orbit problems and Rutherford scattering., Rigid body kinematics, Euler angles, rotation of rigid bodies, moment of inertia tensor, Eq. Euler-Langrage and its relation to kinematics and rotation of rigid bodies, apparent forces (Coriolis effect)., Rigid body kinematics, Euler angles, rotation of rigid bodies, moment of inertia tensor, Eq. Euler-Langrage and its relation to kinematics and rotation of rigid bodies, apparent forces (Coriolis effect)., Minor oscillations (sign of damping, with damping, and external force) and their relation to Eq. Euler-Langrage., Minor oscillations (sign of damping, with damping, and external force) and their relation to Eq. Euler-Langrage, Canonical Transformations and their relation to Lagrangian and Hamiltonian formulations., Canonical Transformations and their relation to Lagrangian and Hamiltonian formulations., Pers. Hamilton-Jacobi in describing the motion of objects..</td></tr>
<tr><td>Access to Learning Media/ LMS and Offline and Online Percentage</td><td></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 colspan="4">Main references:
1. Symon, K.R., 1971, Mechanics, edisi 3, Addison-Wesley.
2. Goldstein, H., 1980, Classical Mechanics, edisi 2, Addison-Wesley.</td></tr>
<tr><td>Lecturers (Team Teaching)</td><td colspan="4">1. Drs. Yosef Robertus Utomo, S.U.
2. Dr. Iman Santoso, S.Si., M.Sc.
3. Romy Hanang Setya Budhi, S.Si., M,Sc., Ph.D.
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>Drs. Yosef Robertus Utomo, S.U.</td><td>Dr.Ing. Ari Setiawan</td><td>Mirza Satriawan, M.Si., Ph.D</td></tr>
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