	Universitas Negeri Surabaya Faculty of Mathematics and Natural Sciences Undergraduate Physics Study Program	Document Code

SEMESTER LEARNING PLAN

Courses	CODE	Course Family	Credit Weight			SEMESTER	Compilation Date
Mathematical Physics II	4520104071	Compulsory Study Program Subjects	**T=4**	**P=0**	**ECTS=6.36**	2	January 6, 2024

AUTHORIZATION	SP Developer	Course Cluster Coordinator	Study Program Coordinator
	Nugrahani Primary Putri, M.Si.	....	Prof. Dr. Munasir, S.Si., M.Si.

Learning model: Case Studies

Program Learning Outcomes (PLO)

PLO study program that is charged to the course

PLO-5	Able to demonstrate as a good scientist, critical thinking skills and innovation in research and professional fields.
PLO-10	Analyze physical systems by applying mathematics and computing/ICT tools.

Program Objectives (PO)

PO - 1	Students are able to formulate simple physical systems related to mechanics and thermodynamics into mathematical models using relevant symbolic/numeric language.
PO - 2	Students are able to solve problems in simple physical systems related to mechanics and thermodynamics using mathematical physics and computational approaches.
PO - 3	Students are able to analyze a simple physical system related to mechanics and thermodynamics using mathematical physics and computational approaches.

PLO-PO Matrix

P.O	PLO-5	PLO-10
PO-1		
PO-2		
PO-3		

PO Matrix at the end of each learning stage (Sub-PO)

P.O	Week															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
PO-1																
PO-2																
PO-3																

Short Course Description

This course examines infinite series, complex numbers, partial differentials, ordinary differential equations, and vector analysis through active learning by combining the methods of discussion, questions and answers, also assignments using IT.

References

Main :

1. Mary L. Boas. 2006. Mathematical Methods in the Physical Science . 3th edition. New York: John Wiley & Sons.

Supporters:

1. Arfken, G. 1995. Mathematical Methods for Physicists. Academic Press.
2. Riley, K.F., Hobson, M.P., Bence, S.J. 2006. Mathematical Methods for Physics and Engineering, 3rd ed. Cambridge Univ. Press.
3. Hassani, Sadri. 2009. Mathematical Methods for Students of Physics and Related Fields, 2nd ed. Illinois: Springer.

Supporting lecturer	Dr. Zainul Arifin Imam Supardi, M.Si. SUPARDIYONO Prof. Dr. Munasir, S.Si., M.Si. Dzulkiflih, S.Si., M.T. Nugrahani Primary Putri, S.Si., M.Si. Dr. Eng. Evi Suaebah, M.Si., M.Sc. Dr. Fitriana, S.Si.

Week-	Final abilities of each learning stage (Sub-PO)	Evaluation		Help Learning, Learning methods, Student Assignments, [Estimated time]		Learning materials [References]	Assessment Weight (%)
		Indicator	Criteria & Form	Offline (*offline*)	Online (*online*)		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	1. Students are able to formulate simple physical systems related to mechanics and thermodynamics into mathematical models using infinite series 2. Students are able to solve problems of simple physical systems related to mechanics and thermodynamics into mathematical models using infinite series and computational tools 3. Students are able to analyze problems of simple physical systems related to mechanics and thermodynamics into mathematical models using infinite series and computational tools.	1.1. Students are able to undertake convergence test of a series. 2.2. Students are able to analyze a function into power series. 3.3. Students are able to solve mechanics and thermodynamics problems using series concept.	**Criteria:** Students will get full marks if they meet the assessment indicators **Form of Assessment** : Participatory Activities, Portfolio Assessment	Lecture and discussion 4 x 50 minutes	Lectures and discussions 4 x 50	**Material:** 1. Definition and notation 2. Convergence test of infinite series 3. Alternating series 4. Power series 5. Convergence interval of power series 6. Taylor Analysis of a function **Bibliography:** *Mary L. Boas. 2006. Mathematical Methods in the Physical Science. 3rd edition. New York: John Wiley & Sons.*	2%

2	1. Students are able to formulate simple physical systems related to mechanics and thermodynamics into mathematical models using infinite series 2. Students are able to solve problems of simple physical systems related to mechanics and thermodynamics into mathematical models using infinite series and computational tools 3. Students are able to analyze problems of simple physical systems related to mechanics and thermodynamics into mathematical models using infinite series and computational tools.	1. 1. Students are able to undertake convergence test of a series. 2. 2. Students are able to analyze a function into power series. 3. 3. Students are able to solve mechanics and thermodynamics problems using series concept.	**Criteria:** Students will get full marks if they meet the assessment indicators **Form of Assessment** : Participatory Activities, Portfolio Assessment	Lecture and discussion 4 x 50 minutes	Lectures and discussions 4 x 50	**Material:** 1. Definition and notation 2. Convergence test of infinite series 3. Alternating series 4. Power series 5. Convergence interval of power series 6. Taylor Analysis of a function **Bibliography:** *Mary L. Boas. 2006. Mathematical Methods in the Physical Science. 3rd edition. New York: John Wiley & Sons.*	2%
3	1. Students are able to formulate simple physical systems related to mechanics and thermodynamics into mathematical models using infinite series 2. Students are able to solve problems of simple physical systems related to mechanics and thermodynamics into mathematical models using infinite series and computational tools 3. Students are able to analyze problems of simple physical systems related to mechanics and thermodynamics into mathematical models using infinite series and computational tools.	1. 1. Students are able to undertake convergence test of a series. 2. 2. Students are able to analyze a function into power series. 3. 3. Students are able to solve mechanics and thermodynamics problems using series concept.	**Criteria:** Students will get full marks if they meet the assessment indicators **Form of Assessment** : Participatory Activities, Portfolio Assessment	Lecture and discussion 4 x 50 minutes	Lectures and discussions 4 x 50	**Material:** 1. Definition and notation 2. Convergence test of infinite series 3. Alternating series 4. Power series 5. Convergence interval of power series 6. Taylor Analysis of a function **Bibliography:** *Mary L. Boas. 2006. Mathematical Methods in the Physical Science. 3rd edition. New York: John Wiley & Sons.*	5%

4	1. Students are able to formulate simple physical systems related to mechanics and thermodynamics into mathematical models using complex numbers 2. Students are able to solve problems of simple physical systems related to mechanics and thermodynamics into mathematical models using complex numbers and computational tools 3. Students are able to analyze problems of simple physical systems related to mechanics and thermodynamics into mathematical models using complex numbers and computational tools.	1. 1. Students are able to perform complex algebraic operations 2. 2. Students are able to solve problems related to complex series, exponential functions, logarithms, trigonometry, and hyperbolic complexes. 3. 3. Students are able to apply complex numbers to solve physics problems	**Criteria:** Students will get full marks if they meet the assessment indicators **Form of Assessment** : Participatory Activities, Portfolio Assessment	Lectures and discussions. 4 x 50 minutes	Lectures and discussions 4 x 50	**Material:** 1. Real and imaginary parts of complex numbers 2. Complex number algebra 3. Complex fields 4. Complex equations 5. Complex series 6. Complex power series 7. Exponential functions and Euler's formula 8. Complex logarithmic functions 9. Complex powers and roots 10. Trigonometric and hyperbolic functions 11. Application of complex numbers in physics **Reference:** *Mary L. Boas. 2006. Mathematical Methods in the Physical Science. 3rd edition. New York: John Wiley & Sons.*	2%
5	1. Students are able to formulate simple physical systems related to mechanics and thermodynamics into mathematical models using complex numbers 2. Students are able to solve problems of simple physical systems related to mechanics and thermodynamics into mathematical models using complex numbers and computational tools 3. Students are able to analyze problems of simple physical systems related to mechanics and thermodynamics into mathematical models using complex numbers and computational tools.	1. 1. Students are able to perform complex algebraic operations 2. 2. Students are able to solve problems related to complex series, exponential functions, logarithms, trigonometry, and hyperbolic complexes. 3. 3. Students are able to apply complex numbers to solve physics problems	**Form of Assessment** : Participatory Activities, Portfolio Assessment	Lectures and discussions. 4 x 50 minutes	Lectures and discussions 4 x 50	**Material:** 1. Real and imaginary parts of complex numbers 2. Complex number algebra 3. Complex fields 4. Complex equations 5. Complex series 6. Complex power series 7. Exponential functions and Euler's formula 8. Complex logarithmic functions 9. Complex powers and roots 10. Trigonometric and hyperbolic functions 11. Application of complex numbers in physics **Reference:** *Mary L. Boas. 2006. Mathematical Methods in the Physical Science. 3rd edition. New York: John Wiley & Sons.*	5%

6	1. Students are able to formulate simple physical systems related to mechanics and thermodynamics into mathematical models using complex numbers 2. Students are able to solve problems of simple physical systems related to mechanics and thermodynamics into mathematical models using complex numbers and computational tools 3. Students are able to analyze problems of simple physical systems related to mechanics and thermodynamics into mathematical models using complex numbers and computational tools.	1. 1. Students are able to perform complex algebraic operations 2. 2. Students are able to solve problems related to complex series, exponential functions, logarithms, trigonometry, and hyperbolic complexes. 3. 3. Students are able to apply complex numbers to solve physics problems	**Criteria:** Students will get full marks if they meet the assessment indicators **Form of Assessment** : Participatory Activities, Portfolio Assessment	Lectures and discussions. 4 x 50 minutes	Lectures and discussions 4 x 50	**Material:** 1. Real and imaginary parts of complex numbers 2. Complex number algebra 3. Complex fields 4. Complex equations 5. Complex series 6. Complex power series 7. Exponential functions and Euler's formula 8. Complex logarithmic functions 9. Complex powers and roots 10. Trigonometric and hyperbolic functions 11. Application of complex numbers in physics **Reference:** *Mary L. Boas. 2006. Mathematical Methods in the Physical Science. 3rd edition. New York: John Wiley & Sons.*	5%
7	1. Students are able to formulate simple physical systems related to mechanics and thermodynamics into mathematical models using complex numbers 2. Students are able to solve problems of simple physical systems related to mechanics and thermodynamics into mathematical models using complex numbers and computational tools 3. Students are able to analyze problems of simple physical systems related to mechanics and thermodynamics into mathematical models using complex numbers and computational tools.	1. 1. Students are able to perform complex algebraic operations 2. 2. Students are able to solve problems related to complex series, exponential functions, logarithms, trigonometry, and hyperbolic complexes. 3. 3. Students are able to apply complex numbers to solve physics problems	**Criteria:** Students will get full marks if they meet the assessment indicators **Form of Assessment** : Participatory Activities, Portfolio Assessment	Lectures and discussions. 4 x 50 minutes	Lectures and discussions 4 x 50	**Material:** 1. Real and imaginary parts of complex numbers 2. Complex number algebra 3. Complex fields 4. Complex equations 5. Complex series 6. Complex power series 7. Exponential functions and Euler's formula 8. Complex logarithmic functions 9. Complex powers and roots 10. Trigonometric and hyperbolic functions 11. Application of complex numbers in physics **Reference:** *Mary L. Boas. 2006. Mathematical Methods in the Physical Science. 3rd edition. New York: John Wiley & Sons.*	5%

8	Students are able to solve physics and mathematics problems using the concepts of infinite series and complex numbers		**Criteria:** Students will get full marks if they meet the assessment indicators **Form of Assessment** : Test	Mid-term examination 2 x 50	UTS 2 x 50	**Material:** Ch 1 and 2 **Bibliography:** *Mary L. Boas. 2006. Mathematical Methods in the Physical Science. 3rd edition. New York: John Wiley & Sons.*	20%
9	1. Students are able to formulate simple physical systems related to mechanics and thermodynamics into mathematical models using partial differentiation 2. Students are able to solve problems of simple physical systems related to mechanics and thermodynamics into mathematical models using partial differentiation and computational tools. 3. Students are able to analyze problems of simple physical systems related to mechanics and thermodynamics into mathematical models using partial differentiation and computational tools.	1. 1. Students are able to execute partial differential using chain rules. 2. 2. Students are able to execute implicit differentiation, change variables and limit requirements 3. 3. Students are able to look for minimum and maximum value of a function 4. 4. Students are able to solve mechanics and thermodynamics problems using partial differential concepts	**Criteria:** Students will get full marks if they meet the assessment indicators **Form of Assessment** : Participatory Activities, Portfolio Assessment	Lectures and discussions 4 x 50	Lectures and discussions 4 x 50	**Material:** Ch 4 **Bibliography:** *Mary L. Boas. 2006. Mathematical Methods in the Physical Science. 3rd edition. New York: John Wiley & Sons.*	5%

10	1. Students are able to formulate simple physical systems related to mechanics and thermodynamics into mathematical models using partial differentiation 2. Students are able to solve problems of simple physical systems related to mechanics and thermodynamics into mathematical models using partial differentiation and computational tools. 3. Students are able to analyze problems of simple physical systems related to mechanics and thermodynamics into mathematical models using partial differentiation and computational tools.	1. 1. Students are able to execute partial differential using chain rules. 2. 2. Students are able to execute implicit differentiation, change variables and limit requirements 3. 3. Students are able to look for minimum and maximum value of a function 4. 4. Students are able to solve mechanics and thermodynamics problems using partial differential concepts	**Criteria:** Students will get full marks if they meet the assessment indicators **Form of Assessment** : Participatory Activities	Lectures and discussions 4 x 50	Lectures and discussions 4 x 50	**Material:** Ch 4 **Bibliography:** *Mary L. Boas. 2006. Mathematical Methods in the Physical Science. 3rd edition. New York: John Wiley & Sons.*	5%

11	1. Students are able to formulate simple physical systems related to mechanics and thermodynamics into mathematical models using ordinary differential equations 2. Students are able to solve problems of simple physical systems related to mechanics and thermodynamics into mathematical models using ordinary differential equations and computational tools. 3. Students are able to analyze problems of simple physical systems related to mechanics and thermodynamics into mathematical models using ordinary differential equations and computational tools.	1. 1. Students are able to identify first and second order differential equations related to physics concepts particularly mechanics and thermodynamics. 2. 2. Students are able to solve first order differential equations. 3. 3. Students are able to find solutions for first order differential equations in physics problems.	**Criteria:** Students will get full marks if they meet the assessment indicators **Form of Assessment** : Participatory Activities, Portfolio Assessment	Lectures and discussions 4 x 50	Lectures and discussions 4 x 50	**Material:** Ch 8 **Bibliography:** *Mary L. Boas. 2006. Mathematical Methods in the Physical Science. 3rd edition. New York: John Wiley & Sons.*	2%

12	1. Students are able to formulate simple physical systems related to mechanics and thermodynamics into mathematical models using ordinary differential equations 2. Students are able to solve problems of simple physical systems related to mechanics and thermodynamics into mathematical models using ordinary differential equations and computational tools. 3. Students are able to analyze problems of simple physical systems related to mechanics and thermodynamics into mathematical models using ordinary differential equations and computational tools.	1. 1. Students are able to solve second order differential equations. 2. 2. Students are able to find solutions for second order differential equations in physics problems. 3. 3. Students are able to apply ordinary differential equations to solve physics problems in accordance with the concepts of mechanics and thermodynamics.	**Criteria:** Students will get full marks if they meet the assessment indicators **Form of Assessment** : Participatory Activities, Portfolio Assessment	Lectures and discussions 4 x 50	Lectures and discussions 4 x 50	**Material:** Ch 8 **Bibliography:** *Mary L. Boas. 2006. Mathematical Methods in the Physical Science. 3rd edition. New York: John Wiley & Sons.*	3%

13	1. Students are able to formulate simple physical systems related to mechanics and thermodynamics into mathematical models using ordinary differential equations 2. Students are able to solve problems of simple physical systems related to mechanics and thermodynamics into mathematical models using ordinary differential equations and computational tools. 3. Students are able to analyze problems of simple physical systems related to mechanics and thermodynamics into mathematical models using ordinary differential equations and computational tools.	1. 1. Students are able to solve second order differential equations. 2. 2. Students are able to find solutions for second order differential equations in physics problems. 3. 3. Students are able to apply ordinary differential equations to solve physics problems in accordance with the concepts of mechanics and thermodynamics.	**Criteria:** Students will get full marks if they meet the assessment indicators **Form of Assessment** : Participatory Activities, Portfolio Assessment	Lectures and discussions 4 x 50	Lectures and discussions 4 x 50	**Material:** Ch 8 **Bibliography:** *Mary L. Boas. 2006. Mathematical Methods in the Physical Science. 3rd edition. New York: John Wiley & Sons.*	3%

14	1. Students are able to formulate simple physical systems related to mechanics and thermodynamics into mathematical models using vector analysis 2. Students are able to solve problems of physical systems related to mechanics and thermodynamics into mathematical models using vector analysis and computational tools. 3. Students are able to analyze problems of simple physical systems related to mechanics and thermodynamics into mathematical models using vector analysis and computational tools.	1. 1. Students are able to hold vector multiplication and vector differentiation, also formulate a simple physical system using vector multiplication and vector 2. 2. Students are able to use vector operators in cartesian coordinates, gradient, divergence and curl in simple physical models. 3. 3. Students are able to understand Green Theorem, divergence theorem and Stokes theorem.	**Form of Assessment** : Participatory Activities	Lectures and discussions 4 x 50	Lectures and discussions 4 x 50	**Material:** Ch 6 **Bibliography:** *Mary L. Boas. 2006. Mathematical Methods in the Physical Science. 3rd edition. New York: John Wiley & Sons.*	1%
15	1. Students are able to formulate simple physical systems related to mechanics and thermodynamics into mathematical models using vector analysis 2. Students are able to solve problems of physical systems related to mechanics and thermodynamics into mathematical models using vector analysis and computational tools. 3. Students are able to analyze problems of simple physical systems related to mechanics and thermodynamics into mathematical models using vector analysis and computational tools.	1. 1. Students are able to hold vector multiplication and vector differentiation, also formulate a simple physical system using vector multiplication and vector 2. 2. Students are able to use vector operators in cartesian coordinates, gradient, divergence and curl in simple physical models. 3. 3. Students are able to understand Green Theorem, divergence theorem and Stokes theorem.	**Form of Assessment** : Participatory Activities	Lectures and discussions 4 x 50	Lectures and discussions 4 x 50	**Material:** Ch 6 **Bibliography:** *Mary L. Boas. 2006. Mathematical Methods in the Physical Science. 3rd edition. New York: John Wiley & Sons.*	5%

16	Students are able to solve physics and mathematics problems using partial differential concepts, ordinary differential equations and vector analysis	Students are able to solve physics and mathematics problems using partial differential concepts, ordinary differential equations and vector analysis.	**Criteria:** Students will get full marks if they meet the assessment indicators **Form of Assessment** : Test	final exam 2 x 50	UAS 2 x 50	**Material:** Ch 4, 8 and 6 **Bibliography:** *Mary L. Boas. 2006. Mathematical Methods in the Physical Science. 3rd edition. New York: John Wiley & Sons.*	30%

Evaluation Percentage Recap: Case Study

No	Evaluation	Percentage
1.	Participatory Activities	30.5%
2.	Portfolio Assessment	19.5%
3.	Test	50%
		100%

Notes

1. **Learning Outcomes of Study Program Graduates (PLO - Study Program)** are the abilities possessed by each Study Program graduate which are the internalization of attitudes, mastery of knowledge and skills according to the level of their study program obtained through the learning process.
2. **The PLO imposed on courses** are several learning outcomes of study program graduates (CPL-Study Program) which are used for the formation/development of a course consisting of aspects of attitude, general skills, special skills and knowledge.
3. **Program Objectives (PO)** are abilities that are specifically described from the PLO assigned to a course, and are specific to the study material or learning materials for that course.
4. **Subject Sub-PO (Sub-PO)** is a capability that is specifically described from the PO that can be measured or observed and is the final ability that is planned at each learning stage, and is specific to the learning material of the course.
5. **Indicators for assessing** ability in the process and student learning outcomes are specific and measurable statements that identify the ability or performance of student learning outcomes accompanied by evidence.
6. **Assessment Criteria** are benchmarks used as a measure or measure of learning achievement in assessments based on predetermined indicators. Assessment criteria are guidelines for assessors so that assessments are consistent and unbiased. Criteria can be quantitative or qualitative.
7. **Forms of assessment:** test and non-test.
8. **Forms of learning:** Lecture, Response, Tutorial, Seminar or equivalent, Practicum, Studio Practice, Workshop Practice, Field Practice, Research, Community Service and/or other equivalent forms of learning.
9. **Learning Methods:** Small Group Discussion, Role-Play & Simulation, Discovery Learning, Self-Directed Learning, Cooperative Learning, Collaborative Learning, Contextual Learning, Project Based Learning, and other equivalent methods.
10. **Learning materials** are details or descriptions of study materials which can be presented in the form of several main points and sub-topics.
11. **The assessment weight** is the percentage of assessment of each sub-PO achievement whose size is proportional to the level of difficulty of achieving that sub-PO, and the total is 100%.
12. TM=Face to face, PT=Structured assignments, BM=Independent study.