TEACHING INSTRUCTIONAL DESIGN (BRP)

COURSE

Mathematical Methods in Physics 1

by

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UNIVERSITAS INDONESIA
FACULTY OF MATHEMATICS AND NATURAL SCIENCES
PHYSICS UNDERGRADUATE STUDY PROGRAM

TEACHING INSTRUCTIONAL DESIGN

Course Name	Mathematical Methods in Physics 1	**Credit(s)**	**Prerequisite course(s)**	**Requisite for course(s)**	**Integration Between Other Courses**
Course Code	SCPH601213	3	Calculus 1 & 2	Mathematical Methods in Physics 2 & 3	
Relation to Curriculum	Compulsory Course				
Semester	3rd				
Lecturer(s)	Arief Syarifudin Fitrianto				
Course Description	*After completing this lecture, when students are faced with physics problems they are able to apply the concepts of vector algebra, vector calculus, tensor analysis, Laplace transform and various methods of solving Differential Equations to solve and finish these problems with analytically. The language of instruction used in this course is Indonesian*				

Program Learning Outcome (PLO)	
PLO-1	Able to apply classical and modern physics concepts in solving general physics problems.
PLO-2	Able to apply mathematical methods to solve physics problems analytically and computationally
PLO-3	Able to apply knowledge of Physics in society and daily life, as well as identify and adapt to new things.
Course Learning Outcome (CLO)	

CLO-1	After completing this lecture, Physics students are expected to be able to apply the concepts of algebra and vector calculus, tensor analysis, Laplace transforms and various methods of solving differential equations in solving various problems in the world of physics and related.
Sub-CLO(s)	
Sub-CLO 1	Able to apply algebraic concepts such as vector addition, scalar and vector multiplication in various physical problems (C3).
Sub-CLO 2	Able to apply vector calculus concepts such as differential, divergence, curl, vector integral in various physics problems (C3).
Sub-CLO 3	Able to use tensor analysis to solve advanced physics problems (C3).
Sub-CLO 4	Able to analyze various physics problems that involve differential equations in order to get the right method in the solving process (C4)
Sub-CLO 5	Able to analyze various physical problems that contain differential equations using the Laplace transform in the solution process (C4).
Study Materials	- Vector Algebra - Vector Calculus : Vector Differential - Vector Calculus : Differential Operational - Vector Calculus : Vector Integral 1 - Vector Calculus : Vector Integral 2 - Tensor Algebra - Delta Kronecker and Pseudo Tensor - Tensor Calculus - First Order Differential Equation - Second Order Differential Equation - Series Method - Laplace Transform 1 - Laplace Transform 2

Reading List	• M.L. Boas, Mathematical Methods in the Physical Sciences, 3rd Ed, John Wiley and Sons,2006. [DP1] • G.B. Arfken and H.J. Weber, Mathematical Methods for Physicists, 5th Ed, Hartcourt Academic Press, 2001. [DP2] • K.F. Riley, M.P. Hobson, S.J.Bence, Mathematical Methods for Physics and Engineer, 3rd Ed, Cambridge, 2006 [DP3]

I. Teaching Plan

Week	Sub-CLO	Study Materials [with reference]	Teaching Method [with est. time]	Learning Experiences (*O-E-F)	Sub-CLO Achievement Indicator		Sub-CLO Weight on Course (%)
					General	Specific	
1	**Sub – CLO 1** Able to apply algebraic concepts such as vector addition, scalar and vector multiplication in various physical problems (C3)	- Vector Algebra Addition and subtraction operations, scalar multiplication, vector multiplication [Reference DP 1 – 3]	Interactive Lecture and Independent Learning (100 minutes)	**O (30%)** : Before class, hoped students will read reference books and pdf material on EMAS **E (30%)** Students do independent exercises **F (10%)** Lecturer provides question and answer	After taking online and independent training, students can apply the concept of vector algebra to physics problems	Students able to : - Operate vector addition and multiplication - Find the resultant of a vector. Example of the resultant of two Forces.	100 %

				time regarding the exercise material			
2	**Sub – CLO 2** Able to apply vector calculus concepts such as differential, divergence, curl, vector integral in various physics problems (C3)	- Vector Calculus : Vector Differential [Reference DP 1 – 3]	Interactive Lecture and Independent Learning (100 minutes)	**O (30%)** : Students read reference material books on EMAS **E (30%)** Students practice solving physics problems with the vector differential method Students are given several physics cases and related fields that can be solved using the vector differential operator **F (10%)** Lecturers provide advice and direction through online question and answer via EMAS / cellphone chat	Students are able to apply various differential operators to solve physics cases	Students are able to apply vector differentials in cases such as motion of objects, Newton's law, electricity-magnetism	25 %
		- Vector Calculus : Operator	Interactive Lecture and Independent	**O (30%)** :	Students are able to apply	Students can use grad, div,	25 %

		Differential [Reference DP 1 – 3]	Learning (100 minutes)	Students read reference material books on EMAS and reference **E (30%)** Students practice solving physics problems with the vector differential method **F (10%)** Lecturer provides a question and answer session if students experience difficulties during practice	various differential operators to solve physics cases	and curl operators to solve physics problems in mechanics, magnetic electricity	
		- Vector Calculus : Integral Vector [Reference DP 1 – 3]	Interactive Lecture and Independent Learning (100 minutes)	**O (30%)** : Students read reference material books on EMAS and reference **E (30%)** Students practice solving physics problems with the	Students are able to recognize physics problems that can be solved by the vector integral method	Students are able to reconstruct physics problems related to mechanics, heat, magnetic electricity and optics into	

				vector differential method Students work on assignments in form of solving physics problems that can be solved by the vector integral method **F (10%)** Lecturer provides a question and answer session if students experience difficulties during practice		problems that can be solved with vector integrals	
		- Vector Calculus : Integral Vector 2 [Reference DP 1 – 3]	Interactive Lecture and Independent Learning (100 minutes)	**O (30%)** : Students read reference material books on EMAS and reference **E (30%)** Students practice solving physics problems with the vector differential method	Students are able to recognize physics problems that can be solved by the vector integral method	Students are able to reconstruct physics problems related to mechanics, heat, magnetic electricity and optics into problems that can be solved	25 %

				Students work on assignments in form of solving physics problems that can be solved by the vector integral method **F (10%)** Lecturer provides a question and answer session if students experience difficulties during practice		with vector integrals	
3	**Sub – CLO 3** Able to use tensor analysis to solve advanced physics problems (C3).	- Tensor Algebra [Reference DP 1 – 3]	Interactive Lecture and Independent Learning (100 minutes)	**O (30%)** : Students read reference material books on EMAS and reference **E (30%)** Students practice working on physics problems related to tensors. Students work on the cases given in groups	Students are able to solve cases given in groups	Students successfully complete cases and present their work via video conferencing	25 %

				F (10%) Lecturer provides a question and answer session if students experience difficulties during practice			
		- Delta Kronecker and Pseudo – Tensor [Reference DP 1 – 3]	Interactive Lecture and Independent Learning (100 minutes)	**O (30%)** : Students read reference material books on EMAS and reference **E (30%)** Students do assignments related to the use of the delta kronecker and the pseudo tensor. Students are given the task to apply the concept of the kronecker delta and the pseudo tensor in physics cases **F (10%)** Lecturers provide advice and direction	Students understand and are able to apply the concept of kronecker delta and pseudo tensor in physics	Students are able to reconstruct a Physics problem so that it can be solved with a kronecker delta and a pseudo tensor	25 %

				through online and offline discussions			
4	**Sub – CLO 1 - 3**	**Mid Term - Exam**					
5	**Sub – CLO 3** Able to use tensor analysis to solve advanced physics problems (C3)	- Tensor Calculus [Reference DP 1 – 3]	Interactive Lecture and Independent Learning (100 minutes)	**O (30%)** : Students read reference material books on EMAS and reference **E (30%)** Students doing assignments related to calculus operations on tensors. Students do assignments related to tensor calculus to solve several problems in physics and related fields **F (10%)** Lecturers provide advice and direction through online and offline discussions	Students are able to explain and apply various calculus operations on tensors	Students are able to solve cases in advanced physics with tensor calculus	25 %
6	**Sub – CLO 3** Able to use tensor analysis to	- Tensor Covariant [Reference DP 1 – 3]	Interactive Lecture and Independent	**O (30%)** : Students read reference material	Students are able to explain and apply	Students are able to solve cases in	25 %

	solve advanced physics problems (C3)		Learning (100 minutes)	books on EMAS and reference **E (30%)** Students doing assignments related to covariance tensors in Physics Students do assignments related to covariance tensors and their application to solve several problems in physics and related fields **F (10%)** Lecturers provide advice and direction through online and offline discussions	various calculus operations on tensors	Advanced Physics with tensor calculus	
7	**Sub – CLO 4**	- First Order Differential Equation [Reference DP 1 – 3]	Interactive Lecture and Independent Learning (100 minutes)	**O (30%)** : Students read reference material books on EMAS and reference **E (30%)**	Students are able to explain and apply various methods of solving first-order	Students are able to reconstruct physics problems into the form of 1st order differential	

				Students doing assignments related to 1st order differential equations in physics. Students work on assignments related to the method of solving 1st order differential equations to solve several problems in physics and related fields. **F (10%)** Lecturers provide advice and direction through online and offline discussions	differential equations	equations that can be solved with the method of solving that has been studied	
8	**Sub – CLO 4**	- Second Order Differential Equation	Interactive Lecture and Independent Learning (100 minutes)	**O (30%)** : Students read reference material books on EMAS and reference **E (30%)** Students doing assignments related to 2nd order	Students are able to explain and apply various methods of solving 2nd order differential equations	Students are able to reconstruct physics problems into the form of 2nd order differential equations that can be solved	40 %

				differential equations in physics. Students work on assignments related to the method of solving 2nd order differential equations to solve several problems in physics and related fields. **F (10%)** Lecturers provide advice and direction through online and offline discussions		by the method of solving that has been studied	
9	**Sub – CLO 4**	- Series Method	Interactive Lecture and Independent Learning (100 minutes)	**O (30%)** : Students read reference material books on EMAS and reference **E (30%)** Students do exercises on the use of the series method in solving differential equations.	Student sable to explain and apply the series method in solving 1st order and 2nd order differential equations.	Students can analyze physics cases into differential equations that can be found a solution using the series method.	20 %

				Students performs tasks related to using the series method to solve differential equations in cases of physics **F (10%)** Lecturers provide advice and direction through online and offline discussions			
10	**Sub – CLO 5**	- Laplace Transform 1	Interactive Lecture and Independent Learning (100 minutes)	**O (30%)** : Students read reference material books on EMAS and reference **E (30%)** Students do exercises on the use of the Laplace transform method in solving differential equations. Students work on assignments related to the use of the Laplace transform method to solve	Students are able to explain and apply the Laplace transform method in solving 1st and 2nd order differential equations	Students can analyze physics cases into differential equations that can be found a solution with the Laplacde transformation method	50 %

				differential equations in physics cases. **F (10%)** Lecturers provide advice and direction through online and offline discussions			
		- Laplace Transform 2	Interactive Lecture and Independent Learning (100 minutes)	**O (30%)** : Students read reference material books on EMAS and reference **E (30%)** Students do exercises on the use of the inverse Laplace transform method in solving differential equations. Students work on assignments related to using the inverse Laplace transform method to solve differential equations in physics cases	Students are able to explain and apply the Laplace transform method in solving 1st and 2nd order differential equations	Students can analyze physics cases into differential equations that can be found a solution with the Laplacde transformation method	50 %

				F (10%) Lecturers provide advice and direction through online and offline discussions			
11	**Sub – CLO 3 – 5**	**Final Exam**					

****) Synchronous: learning interactions between lecturers and students are carried out at the same time, using video or chat tapplication**

Asynchronous: learning interactions are carried out flexibly and don't have to be at the same time, for example using discussion forums or independent study / student assignments.

II. Assignment Design

Week	Assignment Name	Sub-CLOs	Assignment	Scope	Working Procedure	Deadline	Outcome
2	T1	1 – 2	Students do exercises related to algebra and vector calculus and their applications in Physics	Vector Algebra	Individual Assignment and uploaded on EMAS	1 week	Answer sheet in PDF
4	T2	2	Students solve physics problems with vector differential operators	Differential Vector Operation	Individual Assignment and uploaded on EMAS	1 week	Answer sheet in PDF
5	Quiz 1	1 – 2	Quiz via EMAS	Algebra and Vector Calculus	Written on EMAS	1 hour	Answer sheet in PDF
6	T3	2 – 3	Students solve physics problems with vector integrals and tensor calculus	Integral Vector and Tensor Calculus	Individual Assignment and uploaded on EMAS	1 week	Answer sheet in PDF
10	T4	3 – 4	Students solve problems related to covariance tensors and 1^{st} order differential equations	Covarian Tensor and 1^{st} Differential Order Equation	Individual Assignment and uploaded on EMAS	1 week	Answer sheet in PDF
12	T5	4	Students solve physics problems related to 2nd order differential equations and series methods	2^{nd} Differential Order Equation and Series Method	Individual Assignment and uploaded on EMAS	1 week	Answer sheet in PDF

13	Quiz 2	3 – 4	Quiz via EMAS	1st and 2nd Differential Order Equation	Online Written Exam on EMAS	1 hour	Answer sheet in PDF
14	T6	5	Students solve physics problems with the Laplace transform	Laplace Transform	Individual Assignment and uploaded on EMAS	1 week	Writtens answer uploaded on EMAS in PDF/JPEG

III. Assessment Criteria (Learning Outcome Evaluation)

Evaluation Type	Sub-CLO	Assessment Type	Frequency	Evaluation Weight (%)
Mid – Term Exam	1, 2, 3	Written Test via EMAS	1x	30
Final Exam	3, 4, 5	Written Test via EMAS	1x	30
Weekly Assignment	1, 2, 3, 4, 5	Weekly assignment form	6x	20
Quiz	1, 2, 3, 4, 5	Written Test via EMAS	2x	20
Total				100

IV. Rubric(s)

This rubric is used as a guideline for assessing or giving levels of student performance results. a rubric usually consists of assessment criteria that include the dimensions / aspects that are assessed based on indicators of learning achievement. This assessment rubric is useful for clarifying the basics and aspects of the assessment so that students and lecturers can be guided by the same thing regarding the expected performance demands. Lecturers can choose the type of rubric according to the assessment given.

A. Conversion of the student's final score

Score	Grade	Equivalent
85 - 100	A	4.00
80 - < 85	A-	3.70
75 - < 80	B+	3.30
70 - < 75	B	3.00
65 - < 70	B-	2.70
60 - < 65	C+	2.30
55 - < 60	C	2.00
40 - < 50	D	1.00
< 40	E	0.00

Table 1. Assessment Rubrics Written Exam

Score	Quality Answer
100	The answer is very precise, all the definitions and main components are complete
76 – 99	The answer is quite precise, the meaning and the main components are almost complete
51 – 75	Inaccurate answers, incomplete understanding and main components
26 – 50	The answer is very inaccurate, the meaning and the main components are very incomplete
<25	Wrong answer

Table 2. Assessment Rubrics Weekly Assignment

Score	Quality Answer
100	The answer is very precise, all the definitions and main components are complete
76 – 99	The answer is quite precise, the meaning and the main components are almost complete
51 – 75	Inaccurate answers, incomplete understanding and main components
26 – 50	The answer is very inaccurate, the meaning and the main components are very incomplete
<25	Wrong answer