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

Computational Physics

MFF5027 / 3 Credits

Lecturer Coordinator:

Drs. Pekik Nurwantoro, M.S., 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
MFF5027	*Computational Physics*	*3*	*Odd*	*Elective*	*None*

Short Description	Computational Physics 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: Summary of numerical methods: Computational error analysis, numerical interpolation and integration methods, iteration methods to find the zero point (root), numerical derivation and integration, a system of linear equations, function approximation, matrix inversion, and eigenvalue problems. Numerical methods for solving differential and integral equations. Fast Fourier Transform. Basic understanding of Computational Physics: Finite difference presentation of differential and integral operators, solving nonlinear equations, initial condition problems, boundary condition problems, numerical solutions for n-dimensional systems, application of various methods to various physics cases. 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	Formulate and provide (to describe) the physical phenomena that are being studied and reveal important information contained in the physics problem through various tricks or certain mathematical procedures and utilize various approaches (approximations).		
	CO2	Solve a problem with structured solutions (well-defined solutions), formulate a problem carefully and try other approaches (approaches) in an effort to improve the solution of a challenging problem.		
	CO3	Conduct a search for physics problems from various sources and references to get an understanding of important information.		
	CO4	Apply various forms of visualization, graphics or simulations through computer assistance and the use of appropriate software, programming languages and packages or numerical tools.		
	CO5			
	CO6			
	CO7			
	CO8			
The Correlation of CO to Learning Materials and Methods, and Time Allocation		**Learning Materials**	**Learning Methods**	**Time Allocation**
	CO1	Understanding and basics of Computational Physics, including an understanding of the principles of processing information by computers using binary operations and their consequences for computer performance.	Lecture, discussion	3 x 50 minutes
	CO1	The basics of understanding Computational Physics that need to be a concern for students, such as the concept of approximation, rounding, numerical stability and others	Lecture, discussion	3 x 50 minutes
	CO1	Basic aspects of Computational Physics, explanation and understanding of the basic aspects of Computational Physics concerning the use of universal or normalized units, representation of discrete forms for mathematical operators or physical quantities and others.	Lecture, discussion	3 x 50 minutes
	CO2	The initial conditions problem, an explanation of the emergence of the initial conditions problem in a particular differential equation and the introduction of several algorithms for solving the initial conditions problem.	Lecture, discussion	3 x 50 minutes
	CO2	Physics problems related to initial conditions problems, explanations	Lecture, discussion	3 x 50 minutes

		of the emergence of physics problems related to initial conditions problems and the introduction of algorithms for solving these physics problems.		
	CO2	Boundary condition problems, an explanation of the emergence of boundary conditions problems in a particular differential equation and the introduction of several boundary condition problem solving algorithms.	Lecture, discussion	3 x 50 minutes
	CO2	Physics problems related to boundary conditions problems, explanations of the emergence of physics problems related to boundary conditions problems and the introduction of algorithms for solving these physics problems.	Lecture, discussion	3 x 50 minutes
	CO3	The Matrix Method, an explanation of the concept of matrices and their numerical solution methods as well as the introduction of several algorithms that require matrix handling.	Lecture, discussion	3 x 50 minutes
	CO3	Physics problems related to the handling of the matrix method, an explanation of the emergence of physics problems related to the matrix method and the introduction of algorithms for solving these physics problems.	Lecture, discussion	3 x 50 minutes
	CO3	Eigen value problems, an explanation of the emergence of eigenvalue problems and numerical solution techniques to obtain eigenvalues and their eigenfunctions as well as the introduction of several algorithms for solving eigenvalue problems, both of which involve searching for eigenvalues only. as well as those includes functions the eigens.	Lecture, discussion	3 x 50 minutes
	CO4	Physics problems related to eigenvalue problems, explanations about the emergence of physics problems related to eigenvalue problems and the introduction of	Lecture, discussion	3 x 50 minutes

		algorithms for solving these physics problems.		
	CO4	Numerical integration and quadrature problems, explanation of numerical integration methods and introduction to some algorithm for solution integration and quadrature numeric.	Lecture, discussion	3 x 50 minutes
	CO4	Physics problems related to numerical integration problems, explanations of the emergence of physics problems related to numerical integration problems and the introduction of algorithms for solving these physics problems.	Lecture, discussion	3 x 50 minutes
	CO4	The explanation of the method of solving the zero point problem is finding the roots of a nonlinear function and the introduction of several numerical algorithms for the zero point problem as well as some physical problems that can be formulated in the zero point problem.	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: Understanding and basics of Computational Physics, including an understanding of the principles of processing information by computers using binary operations and their consequences for computer performance., The basics of understanding Computational Physics that need to be a concern for students, such as the concept of approximation, rounding, numerical stability and others, Basic aspects of Computational Physics, explanation and understanding of the basic aspects of Computational Physics concerning the use of universal or normalized units, representation of discrete forms for mathematical operators or physical quantities and others., The initial conditions problem, an explanation of the emergence of the initial conditions problem in a particular differential equation and the introduction of several algorithms for solving the initial conditions problem., Physics problems related to initial conditions problems, explanations of the emergence of physics problems related to initial conditions problems and the introduction of algorithms for solving these physics problems., Boundary condition problems, an explanation of the emergence of boundary conditions problems in a particular differential equation and the introduction of several boundary condition problem solving algorithms., Physics problems related to boundary conditions problems, explanations of the emergence of physics problems related to boundary conditions problems and the introduction of algorithms for solving these physics problems., The Matrix Method, an explanation of the concept of matrices and their numerical solution methods as well as the introduction of several algorithms that require matrix handling., Physics problems related to the handling of the matrix method, an explanation of the emergence of physics problems related to the matrix method and the introduction of algorithms for solving these physics problems., Eigen value problems, an explanation of the emergence of eigenvalue problems and numerical solution techniques to obtain eigenvalues and their eigenfunctions as well as the introduction of several algorithms for solving eigenvalue problems, both of which involve searching for eigenvalues only. as well as those			

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the eigens., Physics problems related to eigenvalue problems, explanations about the emergence of physics problems related to eigenvalue problems and the introduction of algorithms for solving these physics problems., Numerical integration and quadrature problems, explanation of numerical integration methods and introduction to some
algorithm for
solution
integration and
quadrature
numeric., Physics problems related to numerical integration problems, explanations of the emergence of physics problems related to numerical integration problems and the introduction of algorithms for solving these physics problems., The explanation of the method of solving the zero point problem is finding the roots of a nonlinear function and the introduction of several numerical algorithms for the zero point problem as well as some physical problems that can be formulated in the zero point problem..</td></tr>
<tr><td>Access to Learning Media/ LMS and Offline and Online Percentage</td><td>Powerpoint, whiteboard</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>
</table>
</td></tr>
<tr><td>References</td><td>Main references:
1. Conte, S.D., and de Boor, C., 1980, Elementary Numerical Analysis, An Algorithm Approach, 3rd ed., McGraw-Hill Press.
2. W.H. et al., 1987, NUMERICAL RECIPES, The Art of Scientific Computing, dan Vet-telling.
3. W.T. et al., Numerical Recipes Examples Book (FORTRAN), Cambridge University Press.
4. Veseley, F.J., 1994, Computational Physics, Plenum Press.
5. Koonin, S.E., 1986, Computational Physics, Addison-Wesley Co.</td></tr>
<tr><td>Lecturers (Team Teaching)</td><td>1. Drs. Pekik Nurwantoro, M.S., Ph.D.
2.
3.
4.</td></tr>
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Authorization	Date of Drafting	Lecturer Coordinator	Head of Curriculum Committee	Head of Study Program
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