



SYLLABUS & RPS (SEMESTER LEARNING PLAN)
CURRICULUM 2023-2028
STUDY PROGRAM : BACHELOR (S1)
DEPARTMENT : PHYSICS

FACULTY OF SCIENCE AND DATA ANALYTICS
INSTITUT TEKNOLOGI SEPULUH NOPEMBER
2023

DOCUMENT

SYLLABUS & RPS (SEMESTER LEARNING PLAN)
CURRICULUM 2023-2028
STUDY PROGRAM : BACHELOR (S1)
DEPARTMENT : PHYSICS

Surabaya, October 2023

Curriculum for Bachelor Physics Study Program, Department of Physics, FSAD-ITS 2023-2028			
No	**Code**	**Courses**	**sks**
Semester 1			
1	SF234101	Physics I	5
2	SM234101	Calculus I	3
3	SF234111	Mathematical Physics I	2
4	SK234101	Chemistry I	4
5	SB234101	Biology	2
6	SF234112	*The wonder of physics*	2
		Total Semester1	18
Semester 2			
1	SF234201	Physics II	5
2	SM234201	Calculus II	3
3	SF234211	Mathematical Physics II	4
4	SF234210	Chemistry II	2
5	SF234212	Introduction to Computational Physics	2
6	SF234213	Science and Ethics	2
		Total Semester 2	18
Semester 3			
1	SF234301	Thermodynamics	4
2	SF234302	Mathematical Physics III	4
3	SF234303	Measurement Analysis Method	2
4	SF234304	Methods of Scientifical Writing	2
5	SF234305	Electronics	4
6	SF234306	Laboratory Physics I	2
7	SF234307	Energy Science and Technology	2
		Total Semester 3	20
Semester 4			
1	SF234401	Mechanics	4
2	SF234402	Modern Physics	4
3	SF234403	Computational Physics	4
4	SF234404	Laboratory Management	2
5	SF234405	Laboratory Physics II	2
6	SF234406	Waves	4
		Total Semester 4	20

Semester 5			
1	SF234501	Quantum Physics	4
2	SF234502	Electromagnetic Fields	4
3	SF2345X1	Limited Elective Course	6
4	SF2345XX	Free Choice Elective Course	6
		Total Semester 5	20
Elective Course (limited)			
1	SF234541	Group Theory	2
2	SF234551	Material Structure	2
3	SF234561	Optoelectronics	2
4	SF234571	Instrumentation Physics	2
5	SF234581	Geology	2
6	SF234591	Radiological Physics and Dosimetry	2
Elective Course (Free Choice)			
1	SF234542	Advanced Mathematical Physics	3
2	SF234543	Relativistic Quantum Theory	2
3	SF234552	Ceramic Physics	2
4	SF234553	Metal Physics	2
	SF234554	Polymer Physics	2
5	SF234562	Fiber Optic Sensors	3
6	SF234563	Photonics	3
7	SF234572	Sensors and Transducers	2
8	SF234573	Renewable Energy	2
	SF234574	Building Physics	2
9	SF234582	Geoelectric Exploration	2
10	SF234583	Seismology	2
	SF234584	Gravity and Magnetic Exploration	2
11	SF234592	Anatomy and Physiology	2
	SF234593	Radiobiologi	2
12	SF234594	Nuclear Medicine Physics	2

Semester 6			
1	SF234601	Statistical Physics	4
2	SF234602	Laboratory Physics III	2
3	UG234914	English	2
4	UG234911	Pancasila	2
5	UG234912	Indonesian	2
6	UG234913	Civics	2
7	SF2346X1	Limited Elective Course	6
		Total Semester 6	20
Elective Course (limited)			
1	SF234641	Introduction to Particle Physics	2
2	SF234651	Synthesis and Processing	2
3	SF234661	Antenna and Propagation	2
4	SF234671	Acoustic Physics	2
5	SF234681	Inversion Method	2
6	SF234691	Diagnostic and Intervesional Radiology Physics	2
Semester 7			
1	SF234701	Solid State Physics	4
2	SF234702	Nuclear Physics	4
3	SF2347XX	Free Choice Elective Course	5
4	UG23490X	Religion	2
5	UG234916	Applied Technology and Digital Transformation	3
6	UG234915	Technopreneurship	2
		Total Semester 7	20
Elective Course (Free Choice)			
1	SF234741	Introduction to Cosmology	3
2	SF234742	Special Topics on Quantum Physics	3
3	SF234751	Materials Characterization	3
4	SF234752	Advanced Materials	2
5	SF234761	Optical and Antenna Modeling	3
6	SF234762	Image processing	2
7	SF234771	Control System and Data Analysis	3
8	SF234772	Electro Acoustic	2
9	SF234781	Seismic Exploration	3
10	SF234782	Electromagnetic Exploration	2
11	SF234791	Radiotherapy Physics	2
12	SF234792	Health Physics and Radiation Protection	2
Semester 8			
1	FD234SNN	Enrichment Course	2
2	SF234801	Final Project	6
		Total Semester 8	8
		TOTAL	144

COMPULSORY COURSES OF UNDERGRADUATE PHYSICS STUDY PROGRAM
DEPARTMENT OF PHYSICS
FSAD – ITS

CURRICULUM 2023 COURSE SYLLABUS

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER **DEPARTMENT OF PHYSICS** **STUDY PROGRAM BACHELOR (S1)**

SYLLABUS

COURSES	Name	Physical Mathematics I
	Code	SF234103
	Credit	2 credits
	Semester	1

DESCRIPTION

The Mathematical Physics I course is a compulsory course for first-year students in the ITS Physics Department. In this course, students will be introduced to mathematical concepts and techniques that are the basis for analyzing physical problems both analytically and computationally.

The topics of discussion that will be introduced in this course include:

- vectors (definition, operations on vectors, and applications of vectors in equations of lines and planes and how to calculate the distance between two objects using vectors),
- matrix (definition, matrix operations, solution of systems of linear equations using matrices, matrix properties, matrix transformations, types of matrices, and finding values and eigenvectors of matrices), and
- partial differentials (partial differentials, total differentials, and chain rules).

LEARNING OUTCOMES

No	PLO DESCRIPTION
PLO-4	Able to communicate **and be responsible in applying information technology to document, store, and secure data** compiled for problem solving in the field of physics expertise. [KU]
PLO-6	Able to apply **the principles and applications of mathematical physics, computational physics, and instrumentation** both in how to operate physical instruments in general and analyze data and information from these instruments. [P]
PLO-7	Able to apply **relevant and cutting-edge principles, characteristics, functions, and technological** applications in the field of physics and **software applications**. [P]
PLO-8	Able to **formulate physical phenomena and problems** and able to make**mathematical or physical models / simulations** in accordance with hypotheses based on **the results of observations and experiments** conducted. [KK]

SUB LEARNING OUTCOMES OF COURSES	
No	LO Description
LO-1	able to define vectors and perform operations on vectors
LO-2	Able to use vectors in defining lines and planes and finding the distance between two objects
LO-3	able to understand the concept of vector spaces, linear combinations and linear operators
LO-4	Able to define matrices and perform operations on matrices
LO-5	Able to apply matrix methods in finding solutions to systems of linear equations
LO-6	Able to understand the characteristics of matrices, types of matrices, and transformations on matrices
LO-7	Able to understand concepts and use methods to find eigenvalues and vectors using matrices
LO-8	able to understand the concept and use partial differential methods and chain rules

SUBJECT

1) Vectors: vectors and scalars, algebraic operations on vectors, base vectors, linear dependencies and independences, equations of lines and planes, finding distances using vectors, vector spaces, linear copombination, linear operators
2) Matrices: definition of matrices, algebraic operations on matrices, systems of linear equations using matrices, row reduction, determinants of matrices and Cramer's rule, fundamental properties and definitions of determinants, inverse matrices, rank and trace matrices, linear transformations and orthogonal transformations, special types of matrices
3) Eigenvalues and vectors: definition of eigenvalues and vectors, matrix diagonalization, *singular value decomposition* (SVD)

REFERENCE

No	**MAIN REFERENCE**
1	Boas, M.L., 2005. Mathematical Methods in the Physical Sciences, 3rd edition. ed. Wiley, Hoboken, NJ.
2	Riley, K.F., and Hobson, M.P. 2011. Foundation Mathematics for Physical Sciences., Cambridge University Press. Edinburgh.
	SUPPORTINGReference
3	Hassani, S. 2013. Mathematical Methods for Students of Physics and Related Fields., Springer, NY.

PREREQUISITES (If applicable)

None

Semester Learning Plan (RPS)

Physical Mathematics I

Week to -	Meeting to-	Learning materials
1	1	Review of vectors and mathematical operations on vectors
2	2	Base vectors and linear dependencies
3	3	Line and plane equations; Find a distance using a vector
4	4	Quiz 1
5	5	Vector spaces, linear combinations and linear operators
6	6	Review of matrices, matrix operations
7	7	Finding solutions to linear equations using matrices
8	8	ETS
9	9	Determinants, inverses and ranks of matrices
10	10	Linear transformations and orthogonal transformations on matrices
11	11	Types of special matrices and their application
12	12	Hermitian matrix and its properties
13	13	Quiz 2
14	14	Linear vector space
15	15	Find the eigenvalues and vectors of a matrix
16	16	EAS

CURRICULUM 2023 COURSE SYLLABUS

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER **DEPARTMENT OF PHYSICS** **STUDY PROGRAM BACHELOR (S1)**

SYLLABUS		
COURSES	Name	Physical Mathematics II
	Code	SF234209
	Credit	4 sks
	Semester	2

DESCRIPTION

The general material in the Mathematical Physics course is a combination of (1) describing physical phenomena with mathematical expressions and (2) methods of solving mathematical problems in accordance with the phenomena discussed.
In particular, in the Mathematical Physics II course, the learning objective is for students to have competence in solving series problems, Fourier series, complex numbers, partial differentiation, vector analysis, and ordinary differential equations.

COURSE LEARNING OUTCOMES

No	PLO DESCRIPTION
PLO-4	Able to communicate **and be responsible in applying information technology to document, store, and secure data** compiled for problem solving in the field of physics expertise. [KU]
PLO-6	Able to apply **the principles and applications of mathematical physics, computational physics, and instrumentation** both in how to operate physical instruments in general and analyze data and information from these instruments. [P]
PLO-7	Able to apply **relevant and cutting-edge principles, characteristics, functions, and technological** applications in the field of physics and **software applications**. [P]
PLO-8	Able to **formulate physical phenomena and problems** and able to make**mathematical or physical models / simulations** in accordance with hypotheses based on **the results of observations and experiments** conducted. [KK]

SUB LEARNING OUTCOMES OF COURSES

No	LO Description
LO-1	Have competence in solving complex series and number problems and their implementation (including the Fourier series).
LO-2	Have competence in solving advanced calculus problems (consisting of partial differential and folding integral)
LO-3	Have competence in vector analysis (on basic physics problems)
LO-4	Have the ability to compile basic physics problems into ordinary differential equations and solve them
LO-5	Have the ability to solve integral calculations with special functions

SUBJECT	
1) Series: infinite series, power series, convergence tests and regions of convergence of series, expansion of functions to power series (Taylor and Maclaurin), examples of physical phenomena solved by series; 2) Complex numbers: notation and various expressions of complex numbers, complex conjugates, algebra of complex numbers, geometric meanings of complex equations and inequalities, and simple complex functions. 3) Fourier series: periodic series, expansion of functions into Fourier series, Dirichlet conditions and Parseval's Theorem, application examples. 4) Partial differential: approaches to derivatives, chain rules, implicit differentiation, problems of minimum and maximum values of functions with and without constraints (constraints). 5) Vector analysis: introduction, vector operations (point multiplication, cross multiplication), 3 vector multiplication, vector derivative, field, del operator, *directional derivative* (gradient recognition), divergence, curl, laplacian, line integral, Green's theorem, divergence theorem, and Stokes' theorem. 6) Ordinary differential equations (GDP): introduction and methods of solution of differential equations , 1st order GDP, 2nd order GDP and its physical applications, Laplace transform, completion of GDP by Laplace transform. 7) Special functions: factorial function, gamma function, beta function, elliptic function.	
REFERENCE	
No	**MAIN REFERENCE**
1	Boas, M.L., 2005. Mathematical Methods in the Physical Sciences, 3rd edition. ed. Wiley, Hoboken, NJ.
	SUPPORTINGREFERENCE
2	Schramm, A.J., 2022. Mathematical Methods and Physical Insights: An Integrated Approach, New edition. ed. Cambridge University Press, Cambridge ; New York, NY.
3	Arfken, G.B., Weber, H.J., Harris, F.E., 2012. Mathematical Methods for Physicists, 7th edition. ed. Elsevier..
PREREQUISITES (If applicable)	
Calculus 1 – minimum value of D Mathematical Physics I – minimum grade D	

Semester Learning Plan (RPS)

Physical Mathematics II

Week to -	Meeting to-	Learning materials
1	1	Introduction; Infinity series &; power series
	2	Power series algebra; Array applications
2	3	Complex numbers: notation and diagrams. Complex conjugates. Simple complex algebra (addition, multiplication/division, root/power).
	4	The geometric meaning of complex equations and inequalities. 2-dimensional series. Simple complex functions (trigonometric, hyperbolic, exponential, etc.). Exercises in algebra, geometry, and complex functions.
3	5	Periodic function. Fourier series sinus-cosine. Correlation of periods with arguments and coefficients of series components.
	6	Parity function. Fourier expansion exercise periodic function.
4	7	The Fourier expansion is complex.
	8	Infinity Series and Complex Numbers Quiz.
5	9	Partial differentiation: definition and notation, total differential, chain rules.
	10	Partial differentiation of parametric functions. Implicit differentiation.
6	11	Problem maximum/minimum, multiplier Lagrange 1 parameter.
	12	Fourier Series and Partial Differentiation Quiz.
7	13	STD Mass
	14	STD Mass
8	15	Introduction, vector multiplication, multiplication of 3 vectors (*triple products*) and their applications
	16	Turunan vektor, medan, operator del, gradient, *directional derivative*
9	17	Use of del operators (divergence, curl, laplacian)
	18	Line integral, conservative field, potential field
10	19	Green's theorem on the field of
	20	Teorema divergensi dan teorema Stokes
11	21	Vector analysis problem practice
	22	Vector analysis quiz
12	23	Introduction and methods of solution of differential equations, ordinary differential equations (GDP) of order 1
	24	Homogeneous 2nd-order GDP of zero right terms and their physical applications
13	25	GDP of the 2nd order homogeneous right term nonzero and its physics applications
	26	Introduction to Laplace transformation and GDP solutions with basic Laplace transformation; preview of other GDP settlement methods
14	27	GDP exercises
	28	GDP Quiz

15	29	Special Functions: Factorial function, gamma function, beta function, error function.
	30	Elliptic function, Special Function Exercise.
16	31	EAS
	32	EAS

CURRICULUM 2023 COURSE SYLLABUS

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER **DEPARTMENT OF PHYSICS** **STUDY PROGRAM BACHELOR (S1)**

SYLLABUS

COURSES	Name	Introduction to Computational Physics
	Code	SF234211
	Credit	2 sks
	Semester	2

DESCRIPTION

In this course, students will learn programming algorithms and numerical methods to analyze and solve simple physics problems by implementing numerical methods programmatically on a computer.
In particular, through the various methods provided in this course, students are expected to master algorithms, numerical methods, programming to find the roots of simple polynomial and non-linear equations, solving simple linear algebra equations, and matching the curves of physical symptom model functions to experimental data.

COURSE LEARNING OUTCOMES

No	PLO DESCRIPTION
PLO-2	Able to study and utilize science and technology in order to apply it to the field of Physics expertise, and able to make appropriate decisions from the results of their own work or group work in the form of final project reports or other forms of learning activities whose output is equivalent to the final project through logical, critical, systematic and innovative thinking.
PLO-4	Able to communicate and be responsible in applying information technology to document, store, and secure data compiled for problem solving in the field of physics expertise.
PLO-6	Able to apply the principles and applications of mathematical physics, computational physics, and instrumentation both in how to operate physical instruments in general and analyze data and information from these instruments.
PLO-7	Able to apply relevant and cutting-edge principles, characteristics, functions, and technological applications in the field of physics and software applications.
PLO-8	Able to formulate physical phenomena and problems and able to make mathematical or physical modeling / simulations in accordance with hypotheses based on the results of observations and experiments conducted.

SUB LEARNING OUTCOMES OF COURSES

No	LO Description
LO-1	Understand about the basics of algorithms, computer programming and numerical methods
LO-2	Have competence in finding the roots of simple polynomial and non-linear equations numerically using computational physics methods
LO-3	Have competence in finding solutions of linear equations with numerical methods using computational physics methods
LO-4	Have competence in matching the curves of physical symptom model functions to experimental data using numerical methods using computational physics methods

SUBJECT	
1. Computer programming algorithms: matlab introduction, algorithms, iteration, conditioning 2. Method numeric 3. Polynomial roots and simple non-linear equations: bisection, regulation-falsi, Newton-Raphson, *secant methods* 4. Solution of linear equations: matrix triangulation, Gaussian elimination, Gauss–Jordan elimination, Gauss–Seidel elimination 5. Curve matching: regression (linear, quadratic, linearization) and interpolation (linear, Newton, Lagrange, splines)	
REFERENCE	
No	**MAIN REFERENCE**
1	Chapra SC & Canale RP, 2015. Numerical Methods for Engineers, 7th Edition, McGraw Hill, USA.
2	Chapra S. Applied Numerical Methods with MATLAB for Engineers and Scientists, 2nd Edition, McGraw Hill, 2006.
3	Hoffman J & Frankel S, 2018. Numerical Methods for Engineers & Scientists, 2nd edition extended. CRC Press, USA.
	SUPPORTINGREFERENCE
1	Boas, M.L., 2005. Mathematical Methods in the Physical Sciences, 3rd edition. ed. Wiley, Hoboken, NJ.
PREREQUISITES (If applicable)	
Math 1 – minimum grade D Mathematical Physics I – minimum grade D	

Semester Learning Plan (RPS)

Introduction to Computational Physics

Week to -	Meeting to-	Learning materials
1	1	Introduction; Programming algorithm; Introduction to Matlab
2	2	Numerical methods and computational foundations of physics
3	3	Numerical method and finding the roots of equations with the method of Bisection
4	4	The roots of the equation by the Regula-falsi method
5	5	Roots of equations with Newton-Rhapson &; Secant method
6	6	Solution of linear equations: Matrix Triangulation &; Gaussian Elimination
7	7	Solution of linear equations: Gauss-Jordan &; Gauss-Seidel elimination
8	8	ETS
9	9	Curve matching: Linear Regression
10	10	Curve matching: Quadratic Regression
11	11	Curve matching: Linearization
12	12	Curve matching: Linear &; Newtonian Interpolation
13	13	Curve matching: Lagrange Interpolation
14	14	Curve matching: Linear and Quadratic Spline Interpolation
15	15	Curve matching: Cubic Spline Interpolation
16	16	EAS

CURRICULUM 2023 COURSE SYLLABUS

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER **DEPARTMENT OF PHYSICS** **STUDY PROGRAM BACHELOR (S1)**

SYLLABUS

COURSES	Name	Physical Mathematics III
	Code	SF234314
	Credit	4 credits
	Semester	3

DESCRIPTION

The general material in the Mathematical Physics course is a combination of (1) describing physical phenomena with mathematical expressions and (2) methods of solving mathematical problems in accordance with the phenomena discussed.
In particular, in the Mathematical Physics III course, the learning objective is for students to have competence in solving problems (A) folding integrals, in cartesian and curvilinear coordinates; (B) Integral transformations: Laplace transform, Fourier transform, convolution, Green function, PD solution with transformation; (C) Complex variable functions, in particular for integral calculations and GDP solutions, and (D) Probability and statistics, in particular for uncertainty calculations (standard deviation) and particle statistics. In addition, (E) special functions, which include Bessel's equations and functions, Legendre equations and functions, recursion relations, Legendre series, Hermitte functions, Laguerre functions; (F) partial differential equation (PDP): wave equation, Laplace and Poisson equations, heat propagation and diffusion equations, solutions using variable separation methods, in cartesian, polar, spherical, and cylindrical coordinates;

COURSE LEARNING OUTCOMES

No	PLO DESCRIPTION
PLO-4	Able to communicate **and be responsible in applying information technology to document, store, and secure data** compiled for problem solving in the field of physics expertise. [KU]
PLO-6	Able to apply **the principles and applications of mathematical physics, computational physics, and instrumentation** both in how to operate physical instruments in general and analyze data and information from these instruments. [P]
PLO-7	Able to apply **relevant and cutting-edge principles, characteristics, functions, and technological** applications in the field of physics and **software applications**. [P]
PLO-8	Able to **formulate physical phenomena and problems** and able to make**mathematical or physical models / simulations** in accordance with hypotheses based on **the results of observations and experiments** conducted. [KK]

SUB LEARNING OUTCOMES OF COURSES	
No	LO Description
LO-1	Able to understand and use folding integrals in cartesian, polar, cylindrical, and spherical coordinates, as well as being able to understand and use integral transformations which include Laplace transforms, Fourier transforms, convolutions, Green functions, PD solutions with transformations.
LO-2	Able to understand and use complex functions for the solution of Laplace integrals and inversions and probability theory and statistics for solving particle distribution problems and uncertainty theory in physical measurements.
LO-3	Have the competence to solve problems in physics related to the equations and functions of Legendre and Bessel
LO-4	Have the ability to compile basic physics problems into partial differential equations and solve them

SUBJECT

1) 2-dimensional folding integrals: cartesian and polar; 3 dimensions: Cartesian, cylindrical, and spherical. Know the Jacobians.
2) Advanced integral transformations: Laplace transform, Fourier transform, Dirac delta function, convolution, Green function.
3) Probability and statistics: applications to particle distribution and physical measurements.
4) Legendre equation: Legendre equation and its solution (Legendre function), Rodriguez formula, Legendre polynomial generating function, Legendre polynomial recursion relationship, Legendre series, associated Legendre function
5) Bessel equation: Frobenius method, Bessel equation and its solution (Bessel function), recursion relationship of Bessel function, general differential equations in the form of Bessel functions, other types of Bessel functions, orthogonality of Bessel functions
6) Partial differential equation (PDP): Laplace-cartesian equation, heat-cartesian diffusion/flow equation, Schrodinger-cartesian equation, wave-cartesian equation, Laplace-cylindrical equation, heat-cylindrical diffusion/flow equation, Laplace-spherical equation, Schrodinger-spherical equation.

REFERENCE

No	MAIN REFERENCE
1	Boas, M.L., 2005. Mathematical Methods in the Physical Sciences, 3rd edition. ed. Wiley, Hoboken, NJ.
	SUPPORTINGREFERENCE
2	Schramm, A.J., 2022. Mathematical Methods and Physical Insights: An Integrated Approach, New edition. ed. Cambridge University Press, Cambridge; New York, NY.
3	Arfken, G.B., Weber, H.J., Harris, F.E., 2012. Mathematical Methods for Physicists, 7th edition. ed. Elsevier.

PREREQUISITES (If applicable)

Calculus 2 – minimum D value
Mathematical Physics II – minimum D

Semester Learning Plan (RPS)

Physical Mathematics III

Week to -	Meeting to-	Learning materials
1	1	The concept of folding integration. Cartesian 2D folding integral, polar folding integral.
	2	Integral lipat 3D kartesian.
2	3	Cylindrical and spherical folding integral.
	4	Folding integral exercise.
3	5	Advanced integral transformations Laplace transform: Dirac delta function, convolution. Applications to problems of ordinary differential equations.
	6	Fourier transform, Parseval theorem, Fourier transform for calculating integrals, convolutions. Green function.
4	7	Advanced integral transformation exercises.
	8	Quiz: folding integrals and integral transformations.
5	9	Complex variable functions.
	10	Residue theorem for calculating integrals and solving Laplace inverse transformations.
6	11	Probability Theorem: methods of calculating ways, permutations and combinations – particle statistics
	12	Continuous distribution: binomial, normal and Gaussian – physical measurements
7	13	Exercises Complex Variable Functions and Probabilities.
	14	Quiz: Complex Variable Functions and Probability.
8	15	STD Mass
	16	STD Mass
9	17	Legendre equation and its solution (Legendre function), Rodriguez's formula
	18	Legendre polynomial generator function, Legendre polynomial recursion relationship, Legendre series.
10	19	Associated Legendre functions, Legendre equation problem exercises.
	20	Frobenius method, Bessel equation and its solution (Bessel function).
11	21	Recursion relationships of Bessel functions, general differential equations in the form of Bessel functions, other types of Bessel functions, orthogonality of Bessel functions.
	22	Bessel equation problem practice
12	23	Legendre and Bessel equations and functions quiz
	24	Introduction to partial differential equations (PDP). Laplace-cartesian equation; Variable separation
13	25	Heat-cartesian diffusion/flow equation, Schrodinger-cartesian equation
	26	Wave-cartesian equation
14	27	Laplace-cylindrical equation, heat-cylindrical diffusion/flow equation
	28	Laplace-ball equation, Schrodinger-spherical equation

15	29	PDP practice
	30	Kuis PDP
16	31	EAS Weight
	32	EAS Weight

CURRICULUM 2023 COURSE SYLLABUS

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER **DEPARTMENT OF PHYSICS** **STUDY PROGRAM BACHELOR (S1)**

SYLLABUS

COURSES	Name	Measurement Analysis Methods
	Code	SF234315
	Credit	2 credits
	Semester	3

DESCRIPTION

In this course, students will learn to understand the correct measurement methods, methods in using errors either or not, understanding the use of important numbers, making and analyzing graphs and their gausian functions.

COURSE LEARNING OUTCOMES

No	PLO DESCRIPTION
PLO-2	Able to study and utilize science and technology in order to apply it to the field of Physics expertise, and able to **make appropriate decisions from the results of their own work or group work** in the form of final project reports or other forms of learning activities whose output is equivalent to the final project through **logical, critical, systematic and innovative thinking**. [KU]
PLO-4	Able to communicate **and be responsible in applying information technology to document, store, and secure data** compiled for problem solving in the field of physics expertise. [KU]
PLO-10	Able to disseminate the results of problem studies (case studies) and physical behavior based on standard scientific principles **in oral and written communication in the form of reports or scientific papers in** accordance with the rules of correct writing by **understanding the mechanism of plagiarism and publishing it at the national or international level.** [KK]

SUB LEARNING OUTCOMES OF COURSES

No	LO Description
LO-1	Able to explain and use quantities and units, and know the measurement method
LO-2	Able to explain and apply how to determine measurement errors
LO-3	Able to explain the method of propagation of errors and distinguish between erroneous and non-errant errors
LO-4	Students are able to apply and present the final results in the use of important / meaningful numbers
LO-5	Understand how to create observation charts and analyze the graphs created.
LO-6	Students understand how to use linear regression in data analysis
LO-7	Students know how to normally distribute and function gaussian
LO-8	Students understand the method of rejection of the measurement data obtained

SUBJECT

Quantities and units and know the method of measurement; how to determine the measurement error; method of propagation of erroneous, erroneous and erroneous err; the use of important / meaningful numbers; create observation charts and analyze graphs; the use of linear regression in data analysis; normal distribution and gaussian function; method of rejection of the measurement data obtained.

REFERENCE	
No	**MAIN REFERENCE**
1	Alan s. Moris " Measurement and instrumentation principles"Butterworth-heinemann, oxford 2001
2	Sunarta, "Bahan Ajar MPF – S1 https://id.scribd.com/document/361931266/Bahan-Ajar-MPF
	SUPPORTINGREFERENCE
1	Imron, A., "Diktat Analysis of Physical Measurements", Physics, MIPA-ITS
2	Faradiba " Metpde learning material book for Physics measurement, Indonesian Christian University, Jakarta 2020 http://repository.uki.ac.id/2753/1/modulMPF.pdf
PREREQUISITES (If applicable)	
Physics I Fisika II	

Semester Learning Plan (RPS)

Measurement Analysis Methods

Week to -	Meeting to-	Learning materials
1	1	Introduction (Lecture contract) measurement methods. Knowing the measuring method, Knowing some errors in measurements (2 x 50 minutes)
2	2	Method of Determination of measurement errors knowing the various errors, accuracy in choosing formulas (2 x 50 minutes)
3	3	Error propagation method Accuracy explains the method of propagation and Can choose which error is gayut and not gayut (2 x 50 minutes)
4	4	Final presentation of important figures Accuracy in calculating by paying attention to important numbers (2 x 50 minutes)
5,6	5,6	Observation and analysis charts Can make charts correctly (sb y and sb x) and analyze the formed charts (2 x 50 minutes)
7	7	Quis 1 (Analisa error grafik) (2 x 50 minutes)
8	8	**Project 1 (presentation) (2 x 50 minutes)**
9,10	9,10	Linear Regression Method Accurately explain the propagation method and choose which errors are related and unrelated, create graphs with other software (2 x 50 minutes)
11,12	11,12	Normal Distribution and Gausian function create a normal distribution graph using excel, impedance parameter Z (2 x 50 minutes)
13	13	Data rejection methods Know what data can be used and discarded due to noise (2 x 50 minutes)
14	14	Weighting theory Know how to use weighting theory (2 x 50 minutes)
15	15	Quis 2 (research/experiment reporting (2 x 50 minutes)
16	16	**Project 2 (presentation) (2 x 50 minutes)**

CURRICULUM 2023 COURSE SYLLABUS

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER **DEPARTMENT OF PHYSICS** **STUDY PROGRAM BACHELOR (S1)**

SYLLABUS

COURSES	Name	Elektronika
	Code	SF234317
	Credit	4
	Semester	3

DESCRIPTION

In this MK, students learn to identify and apply electronic components, electronic circuit analysis, electronics measurement concepts and applications of semiconductor materials in electronics

COURSE LEARNING OUTCOMES

No	PLO DESCRIPTION
PLO-2	Able to study and utilize science and technology in order to apply it to the field of Physics expertise, and able to make appropriate decisions from the results of their own work or group work in the form of final project reports or other forms of learning activities whose output is equivalent to the final project through logical, critical, systematic and innovative thinking. [KU]
PLO-6	Able to apply the principles and applications of mathematical physics, computational physics, and instrumentation both in how to operate physical instruments in general and analyze data and information from these instruments. [P]
PLO-11	Able to adapt, collaborate, create, contribute and innovate in applying science in social life and have a global perspective in its role as a global citizen, and able to use international languages. [KK]

SUB LEARNING OUTCOMES OF COURSES

No	LO Description
LO- 1	Students are able to identify and apply electronic components
LO- 2	Students are able to analyze electronic circuits
LO- 3	Students are able to understand the concept of electronic measurement
LO- 4	Students are able to understand the applications of semiconductor materials

SUBJECT

1. Material Review Basic concepts of DC circuits: system of units, charge and current, voltage, power and energy,
2. Electronic components and Electronic measurement concepts (R, C, L, voltage)
3. Basic laws: ohm's law (point, branch and loop), kirchoff's law, series-parallel resistors, voltage dividers and current dividers, wye-delta transformations
4. DC circuit analysis methods: point analysis, point analysis with voltage source, mesh analysis, mesh analysis with current source
5. Circuit theorem: linearity, superposition, Thevenin's Theorem, Norton's theorem and maximum power transfer

6. Sinusoids, Phasors, phasor relationships for circuit elements, impedance, Instantaneous power and average power, maximum power transfer, effective value and rms, power factor
7. Analog electrical measurement I,V,R
8. First order series: series and parallel, RC circuit with free source, RL circuit with free source, singularity function, step response for RC and RL circuits,
9. Transient state, RLC circuit, low pass filter, high pass filter, transfer function, amplitude response, phase response, Bode plot approach.
10. Introduction to Laplace transformations and their application to solving electrical circuits
11. Diode:Semiconductor material, p-type semiconductor, n-type semiconductor, pn junction, diode, diode characteristics, diode type and type
12. Use of diodes as rectifiers, Zener diodes, unregulated dc power supplies, diode application circuit
13. Transistors:Bipolar transistors: pnp and npn transistors, transistor characteristics, transistor equivalent circuit, grounded base amplifier (CB), grounded emitter amplifier (CE), grounded collector amplifier (CC), voltage amplifier, transistor as small current amplifier, ac and dc load line.
14. Application of transistors as amplifiers and switches
15. Introduction to Op Amp: characteristics, Inverting, Noninverting, summing and comparators.

REFERENCE

No	**MAIN REFERENCE**
1	Charles K. Alexander, Matthew N. O. Sadiku, Fundamentals of ElectricCircuits, Fifth Edition, 2012.
2	J. W. Nilssson dan S. A, Riedel, 2008, Electronic Circuit, PearsonPrentice Hall.
3	Boylestad, 2002, Introductory Circuit Analysis, 10th edition, PrenticeHall.
4	Instrumentation lecturers, Basic electronics practicum module 1
	SUPPORTINGREFERENCE
1	Millman and Halkias,2001, Integrated Electronics, Tata McGraw-Hill.
2	Robert L Boylestad and Louis Nashelsky, 2009, Electronics Devices and Theory, 10 edition, Pearson Education.

PREREQUISITES (If applicable)

Fisika 2

Semester Learning Plan (RPS)

Elektronika

Week to -	Meeting to-	Learning materials
1	1	Introduction: the concept of electric current, DC and AC current
	2	Electronic components and electronic measurement
2	3	Basic laws of electronics : Ohm's law, series circuit, parallel circuit
	4	Hukum Kirchoff
3	5	DC circuit analysis methods
	6	Circuit Theorem : linear, superposition
4	7	Circuit theorem: Thevenin, Northon, Power transfer
	8	**Rating 1**
5	9	Alternating Current Circuit: AC current component
	10	Impedance, Impedance diagram, effective value and Power factor
6	11	Electrical Measurement
	12	Rangkaian orde 1
7	13	**Evaluation 2 (ETS)**
	14	
8	15	Transient State
	16	Filter circuit
9	17	Step response circuit on RC and RL circuits
	18	Introduction to the Laplace transformation
10	19	Laplace transformation for Electric design
	20	Transformasi laplace inverse
11	21	**Rating 3**
	22	Semiconductor materials, Diodes, diode characteristics
12	23	Use of diodes, rectifier circuits
	24	Transistor: type of transistor, catrateristic transistor, transistor equivalent circuit
13	25	Penggunaan transistor common base, Common Emitor, Common Colector
	26	Transistor as a switch
14	27	Introduction to op-amps
	28	Op-Amp characteristics and types
15	29	Transient State
	30	Filter circuit
16	31	**Evaluation 3 (EAS)**
	32	

CURRICULUM 2023 COURSE SYLLABUS

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER **DEPARTMENT OF PHYSICS** **STUDY PROGRAM BACHELOR (S1)**

SYLLABUS		
COURSES	Name	Laboratory Physics 1
	Code	SF234318
	Credit	2 sks
	Semester	2

DESCRIPTION

In this course students will learn to understand the basic concepts of DC circuits, basic laws, circuit analysis methods, transient states, RLC circuits, transfer functions, amplitude responses, phase responses, bode plot approaches, diodes, transistors, Bipolar Junction Transitor (BJT), DC-biasing - BJT, BJT Analysis in domain AC in the form of **practicum**.

COURSE LEARNING OUTCOMES

No	PLO DESCRIPTION
PLO-2	Able to study and utilize science and technology in order to apply it to the field of Physics expertise, and able to make appropriate decisions from the results of their own work or group work in the form of final project reports or other forms of learning activities whose output is equivalent to the final project through logical, critical, systematic and innovative thinking. [KU]
PLO-4	Able to communicate and be responsible in applying information technology to document, store, and secure data compiled for problem solving in the field of physics expertise. [KU]
PLO-7	Able to apply relevant and cutting-edge principles, characteristics, functions, and technological applications in the field of physics and software applications. [P]
PLO-10	Able to disseminate the results of problem studies (case studies) and physical behavior based on standard scientific principles in oral and written communication in the form of reports or scientific papers in accordance with the rules of correct writing by understanding the mechanism of plagiarism and publishing it at the national or international level. [KK]

SUB LEARNING OUTCOMES OF COURSES

No	LO Description
LO- 1	Students are able to understand the basic concepts of DC circuits, basic laws
LO- 2	Students are able to understand the circuit analysis method
LO- 3	Students are able to understand transient symptoms, transfer functions, amplitude response, phase response
LO- 4	Students understand diode characteristics and bode plot approaches
LO- 5	Students understand about transistors, Bipolar Junction Transitor (BJT), DC - biasing - BJT, BJT Analysis in domain AC

SUBJECT

Ohm's Law and Kirchoff's Law; Circuit Analysis; Transient symptoms in series RL, RC, RLC series; diode characteristics; BJT

REFERENCE

No	**MAIN REFERENCE**
1	Electronics Lecturer Team. 2022. Laboratory Physics Practicum Module 1

PREREQUISITES (If applicable)
Fisika II

Semester Learning Plan (RPS)

Laboratory Physics 1

Week to -	Meeting to-	Learning materials
1	1	Introduction (lecture contract), introduction to laboratory equipment (2 x 50 minutes)
2	2	How to use practicum equipment (2 x 50 minutes)
3	3	How practicum data is presented (2 x 50 minutes)
4	4	Preparation of practicum reports (2 x 50 minutes)
5	5	Ohm's Law Practicum and Kirchoff's Law (P1) (2 x 170 minutes)
6	6	Ohm's Law Practicum and Kirchoff's Law (P1) (2 x 170 minutes)
7	7	Circuit Analysis Practicum (P2) (2 x 170 minutes)
8	8	ETS (Resume paper) (2 x 170 minutes)
9	9	Circuit Analysis Practicum (P2) (2 x 170 minutes)
10	10	Transient Symptom Practicum on RL, RC, and RLC series (P3) (2 x 170 minutes)
11	11	Transient Symptom Practicum on RL, RC, and RLC series (P3) (2 x 170 minutes)
12	12	Diode Characteristics Practicum (P4) (2 x 170 minutes)
13	13	Diode Characteristics Practicum (P4) (2 x 170 minutes)
14	14	Praktikum Bipolar Junction Transistor (P5) (2 x 170 minutes)
15	15	Praktikum Bipolar Junction Transistor (P5) (2 x 170 minutes)
16	16	EAS (Presentation)

CURRICULUM 2023 COURSE SYLLABUS

INSTITUT TEKNOLOGI SEPULUH NOPEMBER
DEPARTMENT OF PHYSICS
STUDY PROGRAM BACHELOR (S1)

SYLLABUS

COURSES	Name	Energy Science and Technology
	Code	SF234319
	Credit	2 SKS
	Semester	3

DESCRIPTION

This course aims to provide students with an introduction to the overview of knowledge and use of renewable energy, the technological developments that accompany it, and aspects related to storage systems, efficiency efforts and policies to preserve nature in a sustainable manner

COURSE LEARNING OUTCOMES

No	CP-MK
PLO-5	Able to understand and apply the **theoretical concepts of classical physics and modern physics** in depth through the identification of physical properties of a physical system. [P]
PLO-7	Able to apply **relevant and cutting-edge principles, characteristics, functions, and technological** applications in the field of physics and **software applications**. [P]

SUB LEARNING OUTCOMES OF COURSES

No	LO Description
LO- 1	Students understand carbon dioxide emissions, global warming, climate change, and their impacts
LO- 2	Students understand the use of non-renewable energy (fossil), and the importance of renewable and sustainable energy
LO- 3	Students understand the potential and technology of using solar, wind, water, wave and current, bio-energy, and geothermal energy
LO- 4	Students understand radioactivity, reactions and fission reactors, fusion, and nuclear energy potential
LO- 5	Students understand storage systems and energy efficiency
LO- 6	Students understand regulations and public policies related to the use of energy for industry and society

SUBJECT

Energy and environment, fossil and renewable energy, development of renewable energy sources and use and related technologies, energy storage systems and efficiency, social and policy aspects

REFERENCE

No	**MAIN REFERENCE**
1	V. Nelson, "Introduction to Renewable Energy ", CRC Press, New York, 2011.
2	D.C. Giancoli, " Physics: Principles with Applications", 6th edition, Pearson Education, Inc, 2005
3	Kularatna.N, G.Kosala, "Energy storage Devices for Renewable Energy-Based systems", Academic Press, 2021
	SUPPORTINGREFERENCE
1	Halliday and Resnnick, " Fundamentals of Physics", 9th edition, John Wiley & Sons, Inc, 2011

PREREQUISITES (If applicable)

Fisika 1
Fisika 2

Semester Learning Plan (RPS)
Energy Science and Technology

Week to -	Meeting to-	Learning materials
1	1	Energy and Environment : carbon dioxide emissions, global warming, climate change (LO- 1)
2	2	Energy use: fossil and renewable (LO- 2)
3	3	Solar energy: solar position, heat and light, photovoltaic effect, solar power plant (LO- 3)
4	4	**Quiz – 1**
5	5	Wind potential and energy (LO- 3)
6	6	Water energy: large, small and micro scale power plants (LO- 3)
	7	Ocean energy: waves and currents, depth temperature difference (LO- 3)
7	8	**Midterm Evaluation (ETS)**
8	9	Bio-energy: ethanol, diesel, biogas, waste power (LO- 3)
9	10	Geothermal energy (LO- 3)
10	11	Temperature difference, generator and thermo-electric converter (LO- 3)
12	12	**Quiz – 2**
13	13	Nuclear energy, fission and fusion reactors, radioactivity (LO- 4)
14	14	Energy storage systems (batteries, capacitors and supercapacitors) and energy efficiency (LO- 5)
15	15	Energy – industry – economy and public policy and regulation (LO- 6)
16	16	**End of Semester Evaluation (EAS)**

CURRICULUM 2023 COURSE SYLLABUS

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER **DEPARTMENT OF PHYSICS** **STUDY PROGRAM BACHELOR (S1)**

SYLLABUS		
COURSES	Name	Mechanical Engineering
	Code	SF234420
	Credit	4 SKS
	Semester	4

DESCRIPTION

The mechanics course is a course that discusses classical motion mechanics to the intermediate level as an advanced to motion mechanics studied at the preparatory level. Mechanics is the basis of science and applied as a strong provision in the world of work, especially in the fields of science and applied physics. As an advanced course, it begins with an introduction to unit systems and Hk Newton about motion, vector analysis and vector operations as a support for analysis. Next discussed physical phenomena about particle dynamics, conversion laws and collisions in particle systems. The physical phenomena of oscillations, central force, force and gravitational potential will be discussed as advanced matter. In the final part of this mechanics course, particle dynamics will be discussed using Lagrangian and Hamiltonian mathematical approaches and specifically discusses mechanics in fluids (static and dynamic).

LEARNING OUTCOMES OF COURSE GRADUATES

No	PLO DESCRIPTION
PLO-5	Able to understand and apply the theoretical concepts of classical physics and modern physics in depth through the identification of physical properties of a physical system. [P]

SUB LEARNING OUTCOMES OF COURSES

No	LO Description
LO- 1	Students are able to use quantities, physical units and apply Newton's laws in inertial and non-inertial systems
LO- 2	Students understand and are able to operate vectors and differential vectors on mechanical problems
LO- 3	Students are able to understand and understand the dynamics of particles in one, two and dimensions in the framework of cartesian, polar, cylindrical and spherical coordinates.
LO- 4	Students are able to understand particle systems, conservation and collisions.
LO- 5	Students are able to understand harmonic and muffled oscillation systems.
LO- 6	Students are able to understand the central force, force and gravitational potential.
LO- 7	Students are able to use Lagrangian and Hamiltonian equations in dynamics.
LO- 8	Students are able to understand static and dynamic fluid mechanics.

SUBJECT

- Introduction to mechanics; Quantities and units, Newton's Laws in inertial and non-inertial systems.
- Vector analysis and vector operators; Vector properties, vector operations, vector differential opreators (gradient, divergence and curl).

- One-, two- and three-dimensional particle dynamics; Dynamics of motion by force (constant, changing with time, speed, position), conservative force and potential energy. Cartesian, polar, cylindrical and spherical coordinates. Harmonic oscillations in two and three dimensions as well as parabolic motion.
- Particle systems, conservation and collision laws; Conservation of linear and angular momentum, conservation of mechanical energy, elastic and non-elastic collisions.
- Harmonic oscillations; Harmonic and muffled oscillations.
- Central style; Central force and energy potential, the general properties of motion due to the central force.
- Gravitational force and potential; Hk Newton about gravity, gravitational fields and potentials and gravitational equipotentials.
- Lagrangian and Hamiltonian in particle dynamics; Lagrangian equations in single and particle systems, Hamilton's function in dynamics.
- Fluid mechanics; Hydrosomic hydrodynamics.

REFERENCE	
No	**MAIN REFERENCE**
1	Arya, Atam Parkash, “Introduction to Classical Machanics”, 2 nd Ed Allyn and Bacon, Boston, 1998
2	Grant R. Fowles & George L. Cassiday, “Analytical Mechanics”, 7 th Ed,Thomson brooks/cole, Belmort CA USA, 2005
3	Frank M.White, “Fluid Mechanics”, 8 th Ed, Mc Graw Hill, USA, 2016
	SUPPORTINGREFERENCE
1	R. Douglas Gregory, “Classical Mechanics”, Cambridge University Press Uk, 2006

PREREQUISITES (If applicable)
Physics I - minimum D

Semester Learning Plan (RPS)

Mechanical Engineering

Week to -	Meeting to-	Learning materials
1	1	Introduction to mechanics and vector analysis
	2	Vector operators and vector differentials (1)
2	3	Vector operators and vector differentials (2)
	4	One-dimensional particle dynamics
3	5	Two- and three-dimensional particle dynamics (1)
	6	Two- and three-dimensional particle dynamics (2)
4	7	Two- and three-dimensional particle dynamics (3)
	8	**Quiz 1**
5	9	Particle systems, Hk conservation and collisions (1)
	10	Particle systems, Hk conservation and collisions (2)
6	11	Elastic and non-elastic collisions
	12	Osilasi harmonic
7	13	Muffled oscillations
	14	Amplitude, resonant energy
8	15	**Midterm Evaluation**
	16	
9	17	Central force and potential energy
	18	General properties of motion by central force
10	19	Gravitational force and potential
	20	Gravitational Field and Potential
11	21	Gravitational equipotential
	22	Lagrangian equation in dynamics (1)
12	23	Lagrangian equation in dynamics (2)
	24	**Quiz 2**
13	25	Hamiltonian equation in dynamics (1)
	26	Hamiltonian equations in dynamics (2)
14	27	Hydrostatics (1)
	28	Hydrostatics (2)
15	29	Hydrodynamics (1)
	30	Hydrodynamics (2)
16	31	**End of Semester Evaluation**
	32	

CURRICULUM 2023 COURSE SYLLABUS

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER **DEPARTMENT OF PHYSICS** **STUDY PROGRAM BACHELOR (S1)**

SYLLABUS

COURSES	Name	Modern Physics
	Code	SF234421
	Credit	4 SKS
	Semester	4

DESCRIPTION

In this course, students will learn about the concepts of modern physics, including the theory of special relativity, the nature of wave-particle dualism, atomic and molecular theory, introduction to quantum physics, statistical physics, solid physics, core physics and elementary physics, so that students have the basic knowledge to take quantum physics courses and to prepare a framework for understanding core physics and solid matter physics.

COURSE LEARNING OUTCOMES

No	PLO DESCRIPTION
PLO-5	Able to understand and apply the theoretical concepts of classical physics and modern physics in depth through the identification of physical properties of a physical system **[P]**
PLO-7	Able to apply relevant and cutting-edge principles, characteristics, functions, and technology applications in the field of physics and software applications **[P]**

SUB LEARNING OUTCOMES OF COURSES

No	LO Description
LO- 1	Students are able to explain the postulates of special relativity and their implications
LO- 2	Students are able to understand the nature of wave-particle dualism and analyze the appearance of this property in physical phenomena
LO- 3	Students are able to put forward atomic and molecular theories
LO- 4	Students understand the basics of quantum physics, statistical physics, solid state physics, core physics and elementary particles

SUBJECT

The transition from classical physics to modern physics; special theory of relativity; particle properties of waves; wave properties of particles; atomic structure; introduction to quantum physics; quantum theory of the hydrogen atom; multi-electron atoms; molecule; introduction to statistical physics; introduction to solid state physics; atomic nucleus, radioactivity and elementary particles

REFERENCE

No	MAIN REFERENCE
1	Beiser, A., “Concepts of Modern Physics”, McGraw Hill, Sixth Edition, New York, 2003.
2	Weinberg, S., “Foundations of Modern Physics”, Cambridge University Press, Cambridge, 2021
3	Krane, S.K (terj: Hans J. Wospakrik), “Fisika Modern”, UI Press, Jakarta, 1992.

No	SUPPORTINGREFERENCE
1	Serway, R.A, Moses, C.J and Moyer, C.A, "Modern Physics", third edition, 2005. (E-Book)
2	Singh, R.B, "Introduction to Modern Physics, New Age International Publishers, " Volume 1, 2nd ed, 2009 (E-Book)
3	Eisberg, R. & Resnicks, R., "Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles", John Wiley & Sons, New York, 2nd Ed., 1985.
PREREQUISITES (If applicable)	
Physics 1 &; Physics 2 (Minimum D)	

Semester Learning Plan (RPS)

Modern Physics

Week to -	Meeting to-	Learning materials
1	1	Introduction to MK, Introduction: The transition of classical physics to modern physics
	2	**Chapter 1 Special Theory of Relativity (LO- 1)** Special relativity, time dilation, long contraction, Doppler effect, Twin paradox
2	3	**Chapter 1 Special Theory of Relativity (LO- 1)** Examples of special relativity (electrity and magnetism), relativistic momentum, equivalence of mass and energy, Lorentz transform
	4	**Chapter 2 Particle Properties of Waves (LO- 2)** Electromagnetic waves, blackbody radiation, photoelectric effect
3	5	**Chapter 2 Particle Properties of Waves (LO- 2)** X-ray generation & X-ray diffraction, Compton effect, pair production
	6	**Chapter 3 Wave Properties of Particles (LO- 2)** De Broglie wave, wave description, phase velocity &; group velocity
4	7	**Chapter 3 Wave Properties of Particles (LO- 2)** Electron diffraction, uncertainty principle
	8	**Quiz-1 (Chapters 1 – 3)**
5	9	**Bab 4 Structure Atom (LO- 3)** The development of the atomic model, atomic spectrum, Bohr theory, correspondence principle
	10	**Bab 4 Structure Atom (LO- 3)** Spectral series and energy levels, atomic excitation, modification of Bohr's theory
6	11	**Chapter 5 Introduction to Quantum Physics (LO- 4)** Wave equation, press. Schrödinger is time-independent and time-dependent, linearity & superposition
	12	**Chapter 5 Introduction to Quantum Physics (LO- 4)** Expectation value, Operator, particles in box, potential well
7	13	**Chapter 5 Introduction to Quantum Physics (LO- 4)** Breakthrough effect, harmonic oscillator
	14	**Practice questions Chapter 1 - 5**
8	15	**Midterm Evaluation (Chapters 1 - 5)**
	16	
9	17	**Chapter 6 Quantum Theory of the Hydrogen Atom (LO- 4)** Schrodinger equation of hydrogen atom, electron quantum number and spin
	18	**Chapter 6 Quantum Theory of the Hydrogen Atom (LO- 4)** Electron probability density, energy level, and Zeeman effect
10	19	**Chapter 7 Multielectron Atoms (LO- 4)** Prinsip larangan Pauli, tabel periodik, struktur atom
	20	**Chapter 7 Multielectron Atoms (LO- 4)**

		Spin-orbit coupling, total momentum sudut, spektra sinar-X
11	21	**Bab 8 Molecule (LO- 3)** Ikatan kovalen molekul, ikatan ion, ikatan hidrogen
	22	**Bab 8 Molecule (LO- 3)** Rotational energy level, vibrational energy level, and molecular electronic spectra
12	23	**Bab 9 Pengantar Fisika Statistik (LO- 4)** Classical and quantum statistics, Maxwell-Boltzmann statistics, molecular energy in ideal gases
	24	**Bab 9 Pengantar Fisika Statistik (LO- 4)** Bose-Einstein statistics and its applications, Fermi-Dirac statistics and their applications
13	25	**Kuis-2 (Bab 6 – 9)**
	26	**Chapter 10 Introduction to Solid Matter Physics (LO- 4)** Crystal structure, heat capacity of solids, electrons in metals, solid band theory
14	27	**Chapter 10 Introduction to Solid Matter Physics (LO- 4)** Semiconductors, magnetism and superconductivity
	28	**Bab 11 Pengantar Fisika Inti (LO- 4)** The structure of the atomic nucleus, radioactive decay
15	29	**Bab 11 Pengantar Fisika Inti (LO- 4)** Fundamental forces, particle classification, standard models of elementary particles
	30	**Practice questions Chapter 6-11**
16	31	**End of Semester Evaluation (Chapters 6 - 11)**
	32	

CURRICULUM 2023 COURSE SYLLABUS

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER **DEPARTMENT OF PHYSICS** **STUDY PROGRAM BACHELOR (S1)**

SYLLABUS		
COURSES	Name	Computational Physics
	Code	SF234422
	Credit	4 sks
	Semester	4

DESCRIPTION

In this course, students will learn programming algorithms and numerical methods to analyze and solve physics problems by implementing numerical methods programmed on computers. In particular, through various methods given in this lecture, students are expected to master and be able to implement: numerical methods to solve differential and integral problems, ordinary differential equations, and partial differential equations. In addition, students are also expected to be able to implement the Fourier series and Fourier transform numerically, and be able to solve optimization problems with and without constraints through the Gauss-Newton approach or *a simple* Artificial Intelligent (AI) approach.

COURSE LEARNING OUTCOMES

No.	PLO DESCRIPTION
PLO-4	Able to communicate **and be responsible in applying information technology to document, store, and secure data** compiled for problem solving in the field of physics expertise. [KU]
PLO-6	Able to apply **the principles and applications of mathematical physics, computational physics, and instrumentation** both in how to operate physical instruments in general and analyze data and information from these instruments. [P]
PLO-7	Able to apply **relevant and cutting-edge principles, characteristics, functions, and technological** applications in the field of physics and **software applications**. [P]
PLO-8	Able to **formulate physical phenomena and problems** and able to make**mathematical or physical models / simulations** in accordance with hypotheses based on **the results of observations and experiments** conducted. [KK]

SUB LEARNING OUTCOMES OF COURSES

No	LO Description
LO- 1	Understand and implement multiple differential approaches numerically
LO- 2	Can solve integral problems numerically
LO- 3	Solve ordinary differential equation problems numerically
LO- 4	Have competence in solving partial differential equations numerically through Finite Difference, Finite Volume, and *Finite Element* methods
LO- 5	Have competence in solving Fourier series problems and numerical Fourier transformations
LO- 6	Have competence in solving optimization problems with and without constraints through the Gauss-Newton approach or a simple *Artificial Intelligent* (AI) approach

SUBJECT

- Differential Method: first differential (forward, backward and central difference *with 2 and 3 point approximations), second differential (*forward, *backward* and central difference*)*
- Numerically integral: Monte-Carlo, Square (left, right, and center), trapezoid, Simpson 1/3 and 3/8, and Romberg Method
- Ordinary differential equations (GDP): Euler, Taylor, Runge-Kutta, Adam-Bashforth, and Adam-Moulton
- Partial differential equations (PDP): *Finite Difference, Finite Volume*, and *Finite Element* methods for solving parabolic, elliptic, and hyperbolic equations.
- Fourier series and Fourier transform
- Optimization: optimization without constraints (Gauss-Newton), constrained optimization (integration of Langrange and Gauss-Newton multipliers, simple artificial intelligence, for example: *particle swarm optimization*, *Differential evolution*, JAYA)

REFERENCE

No	**MAIN REFERENCE**
1	Esfandiari, R.S., 2017, Numerical methods for Engineers and Scientist using Matlab, Second edition, CRC Press
2	Gilat, A. , Subramaniam, V., 2014, Numerical methods for engineers and scientists: an introduction with applications using Matlab, Third edition, Wiley
3	Ruas, V., 2016, An Introduction to Numerical Methods for Partial Differential Equations, Wiley
4	Mazumder, S., 2016, Numerical Methods for Partial Differential Equations. Finite Difference and Finite Volume Methods, Academic Press
No	**SUPPORTINGREFERENCE**
1	Lindfield, G.R., 2012, Numerical methods using MATLAB, Academic Press
2	Klein, A., Godunov, A., 2010, Introductory computational physics, Cambridge University Press
3	Pang, T., 2006, An Introduction to Computational Physics, Cambridge University Press

PREREQUISITES (If applicable)

Fismat II minimum D
Introduction to Computational Physics at least D

Semester Learning Plan (RPS)
Computational Physics

Week to -	Meeting to-	Learning materials
1	1	Introduction: Lecture contracts, literature, programming languages used (syntax review), etc.
	2	Numerical differential I: First differential (forward, *backward* and *central difference approximations*)
2	3	Numerical differential II: Second differential (forward, *backward* and *central difference approaches*)
	4	Numerically integral I: square approach, trapezoid, Simpson 1/3 and 3/8
3	5	Numerically integral II: Romberg and Monte Carlo approaches
	6	**Ordinary differential equation (GDP) I: *Initial Value Problem* (IVP)** *One Step methods*: Euler dan Taylor
4	7	**PDB II: IVP** using *One Step methods:* Runge-Kutta
	8	**PDB III: IVP** using *Multi Step methods*: Adam-Bashforth and Adam-Moulton
5	9	**Quis I**
	10	**Partial differential equation (PDP) I: *Boundary Value Problem* (BVP)** using method for IVP
6	11	**PDP II: BVP** uses method for IVP
	12	**PDP III: BVP using** Finite Difference *1D* method
7	13	**PDP IV: BVP** using *Finite Difference* 2D method
	14	**PDP V: BVP** using *Finite Difference* 2D method
8	15-16	**ETS**
9	17	**PDP VI: Case Study:** *Finite Difference Time Domain* 1D and 2D (Heat Transfer, EM wave propagation in medium)
	18	**PDP VII: BVP** using Finite *Volume method*
10	19	**PDP VIII: BVP** using *Finite Volume method*
	20	PDP IX: Praktikum *Finite Volume* (1D dan 2D)
11	21	**PDP X: BVP** using *Finite Element method*
	22	**PDP XI: BVP** using *Finite Element method*
12	23	Lab Finite *Element* (1D dan 2D)
	24	Deret Fourier
13	25	Transformasi Fourier
	26	**Quis II**
14	27	Optimization without strains: Gauss method
	28	Optimasi tanpa konstrain berbasis *artificial intelligence* (AI) sederhana (misalkan *Particle Swarm optimization, Differential evolution*, JAYA)
15	29	Constrained Optimization: Mathematical methods (*Langrange multiplier* and Gauss methods) and AI methods
	30	Constrained Optimization: Mathematical methods (*Langrange multiplier* and Gauss methods) and AI methods
16	31-32	**EAS**

CURRICULUM 2023 COURSE SYLLABUS

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER **DEPARTMENT OF PHYSICS** **STUDY PROGRAM BACHELOR (S1)**

SYLLABUS		
COURSES	Name	Laboratory Management
	Code	SF234423
	Credit	2 sks
	Semester	4

DESCRIPTION

This course is a compulsory course for all students at the Faculty of Science and Data Analytics (FSAD). In this course, students will learn laboratory management in general as well as laboratory management organizations and systems in accordance with ISO/IEC 17025:2017 standards

COURSE LEARNING OUTCOMES

No	PLO DESCRIPTION
PLO-1	Able to show attitudes and characters that reflect**: piety to God Almighty,** ethics and integrity**, noble ethics, sensitivity and care for social and environmental problems, respect cultural differences and pluralism, uphold law enforcement, prioritize the interests of the nation and the wider community, through creativity and innovation, excellence, strong leadership**, synergies, and other potentials possessed to achieve maximum results. [S]
PLO-2	Able to study and utilize science and technology in order to apply it to the field of Physics expertise, and able to **make appropriate decisions from the results of their own work or group work** in the form of final project reports or other forms of learning activities whose output is equivalent to the final project through **logical, critical, systematic and innovative thinking**. [KU]
PLO-4	Able to communicate **and be responsible in applying information technology to document, store, and secure data** compiled for problem solving in the field of physics expertise. [KU]

SUB LEARNING OUTCOMES OF COURSES

No	LO Description
LO- 1	Students know the definition of laboratories and types of laboratories and understand management requirements based on SNI ISO / IEC 17025: 20017
LO- 2	Students know the health, safety and welfare of working in the laboratory, as well as prevention of risks that cause disruption to their health due to activities in the laboratory
LO- 3	Students know how to handle toxic and hazardous materials in the laboratory
LO- 4	Students know the scope of the laboratory standardization system
LO- 5	Students know the technical requirements and quality requirements of testing and calibration laboratories
LO- 6	Students know the documentation system and traceability of measurements in the testing laboratory
LO- 7	Students understand the measurement uncertainty system in the measurement process in the laboratory

LO- 8	Students know the inventory system *related to* managing inventory data on goods and tools as well as activities that occur in the laboratory

SUBJECT

- Basic understanding of laboratories
- Work safety in the laboratory
- Handling of toxic and hazardous substances
- Understanding and scope of laboratory standardization system
- Technical requirements and quality requirements of testing and calibration laboratories
- Measurement documentation and traceability systems in testing laboratories
- Measurement uncertainty
- Laboratory inventory system

REFERENCE

No	**MAIN REFERENCE**
1	ISO, ISO/IEC 17025:2017, “General requirements for the competence of testing and calibration laboratories”, 2017
No	**SUPPORTINGREFERENCE**
1	R. J. Alaimo, “Handbook of chemical health and safety”, Oxford University Press, New York, 2001
2	BSN, SNI ISO IEC 17025_2008, "Indonesian National Standard. General requirements of competence of testing laboratories and calibration laboratories", 2008.
3	R. Burke,” Hazardous Materials Chemistry for Emergency Responders”, 2 nd Edition, Lewis Publisher, 2002

PREREQUISITES (If applicable)

Fisika I, Kimia I, Pengantar Biologi/Biologi Umum

Semester Learning Plan (RPS)

Laboratory Management

Week to -	Meeting to-	Learning materials
1	1	Introduction (lecture contract), formation of presentation groups and explaining tasks during laboratory management lectures. (2 x 50 minutes)
2	2	Introduction to ISO/IEC 17025:2017 on management system requirements, general requirements, structural requirements, resource requirements and process requirements. (2 x 50 minutes)
3	3	Explanation of the basic understanding of laboratories and various laboratories (2 x 50 minutes)
4	4	Explanation of work safety in the laboratory. (2 x 50 minutes)
5	5	Explanation of handling toxic and hazardous substances (2 x 50 minutes)
6	6	Explanation of the understanding and scope of the laboratory standardization system (2 x 50 minutes)
	7	Explanation of technical requirements and quality requirements of testing and calibration laboratories (2 x 50 minutes)
7	8	ETS Create a paper with a topic that has been determined according to the material that has been given previously (2 x 50 minutes)
8	9	Explanation of documentation systems and traceability of measurements in testing laboratories (2 x 50 minutes)
9	10	Explanation of measurement uncertainty and laboratory inventory systems (2 x 50 minutes)
10	11	Group presentations (2 x 50 minutes)
12	12	Group presentations (2 x 50 minutes)
13	13	Group presentations (2 x 50 minutes)
14	14	Group presentations (2 x 50 minutes)
15	15	Group presentations (2 x 50 minutes)
16	16	EAS Individual assignments make PPT and video presentations about laboratory management lectures, information / benefits obtained after laboratory management lectures (2 x 50 minutes)

CURRICULUM 2023 COURSE SYLLABUS

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER **DEPARTMENT OF PHYSICS** **STUDY PROGRAM BACHELOR (S1)**

SYLLABUS		
COURSES	Name	Laboratory Physics II
	Code	SF234424
	Credit	2 credits
	Semester	4

DESCRIPTION

In this course, students will learn to understand the properties and characteristics of modern physics and waves in the form of **practicum**.

COURSE LEARNING OUTCOMES

No	PLO DESCRIPTION
PLO-2	Able to study and utilize science and technology in order to apply it to the field of Physics expertise, and able to **make appropriate decisions from the results of their own work or group work** in the form of final project reports or other forms of learning activities whose output is equivalent to the final project through **logical, critical, systematic and innovative thinking**. [KU]
PLO-4	Able to communicate **and be responsible in applying information technology to document, store, and secure data** compiled for problem solving in the field of physics expertise. [KU]
PLO-5	Able to understand and apply the **theoretical concepts of classical physics and modern physics** in depth through the identification of physical properties of a physical system. [P]
PLO-7	Able to apply **relevant and cutting-edge principles, characteristics, functions, and technological** applications in the field of physics and **software applications**. [P]
PLO-10	Able to disseminate the results of problem studies (case studies) and physical behavior based on standard scientific principles **in oral and written communication in the form of reports or scientific papers in** accordance with the rules of correct writing by **understanding the mechanism of plagiarism and publishing it at the national or international level.** [KK]

SUB LEARNING OUTCOMES OF COURSES

No	LO Description
LO- 1	Students are able to understand stationary wavelengths, understand the relationship between wave propagation speed (V) and rope tension force (F), and are able to analyze factors that affect wave speed on ropes
LO- 2	Students are able to understand the type of damping, know the factors that affect damping, and can determine the damping constant of the spring system
LO- 3	Students are able to understand the symptoms of diffraction, can measure laser wavelengths, and know the influence of the lattice distance to the screen on the resulting light dark pattern, interference events in Newton Ring experiments, know the functions of tools on Newton Rings, are able to measure the wavelength of halogen lamps using the Newton ring method

LO- 4	Students understand the principle of polarimeter, can measure the rotation angle of the type of sugar solution as a function of concentration, and are able to determine the concentration of sugar solution with a polarimeter
LO- 5	Students understand the Bohr model of atoms and excitation phenomena, are able to determine atomic excitation voltages and determine the spectrum of possible fluorescent atoms from the energy levels obtained, determine the size of the radius of oil droplets and are able to determine the charge of oil grains
LO- 6	Students are able to understand the photoelectric effect, determine the value of the planck constant and the work function of a material, and to determine the effect of light intensity on current

SUBJECT

- Frank Hertz experiment
- Drops Belong
- Spektrometer
- Konstanta Planck
- Geiger Muller
- Melde's experiment
- Muffled Vibration
- Diffraction Grid
- Cincin Newton
- Polarimeter

REFERENCE

No	**MAIN REFERENCE**
1	Lecturer Team. 2022. Laboratory Physics Practicum Module 2

PREREQUISITES (If applicable)

Gelombang
Modern Physics

Semester Learning Plan (RPS)

Laboratory Physics II

Week to -	Meeting to-	Learning materials
1	1	Introduction (lecture contract), introduction to laboratory equipment (2 x 50 minutes)
2	2	How to use practicum equipment (2 x 50 minutes)
3	3	How practicum data is presented (2 x 50 minutes)
4	4	Preparation of practicum reports (2 x 50 minutes)
5	5	P1: Percobaan Geiger Muller (2 x 170 minutes)
6	6	Q2: Trial Drops Possession (2 x 170 minutes)
7	7	Q3: Frank Hertz Experiment (2 x 170 minutes)
8	8	ETS (Resume Paper) (2 x 50 minutes)
9	9	Q4: Plank constant experiment (2 x 170 minutes)
10	10	Q5: Experimental Spectrometer (2 x 170 minutes)
11	11	P6: Percobaan Cincin Newton (2 x 170 minutes)
12	12	P7: Percobaan Polarimeter (2 x 170 minutes)
13	13	Q8: Melde's Experiment (2 x 170 minutes)
14	14	P9: Muffled Vibration Experiment (2 x 170 minutes)
15	15	Q10: Diffraction Lattice Experiment (2 x 170 minutes)
16	16	EAS (Presentation) (2 x 50 minutes)

CURRICULUM 2023 COURSE SYLLABUS

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER **DEPARTMENT OF PHYSICS** **STUDY PROGRAM BACHELOR (S1)**

SYLLABUS		
COURSES	Name	Gelombang
	Code	SF234425
	Credit	4 SKS
	Semester	4

DESCRIPTION

This subject contains the concept and formulation of simple harmonic mechanical waves, transverse waves, longitudinal waves, electromagnetic waves, two- and three-dimensional waves, light waves, geometric optics, physical optics, and their applications in various fields.

COURSE LEARNING OUTCOMES

No	PLO DESCRIPTION
PLO-5	Able to understand and apply the theoretical concepts of classical physics and modern physics in depth through the identification of physical properties of a physical system. [P]
PLO-9	Able to solve physics problems comprehensively with various alternative solutions and analyze existing physics systems and predict the potential application of physics behavior in information technology in the context of scientific development and further implementation in the field of physics expertise. [KK]

SUB LEARNING OUTCOMES OF COURSES

No	LO Description
LO- 1	Students are able to explain the basic concepts of simple harmonic vibration and use equations related to simple harmonic vibration
LO- 2	Students are able to explain the basic concepts of transverse waves and use equations related to transverse waves
LO- 3	Students are able to explain the basic concepts of longitudinal waves and sound and use equations related to longitudinal waves and sound
LO- 4	Students are able to explain the basic concepts of light propagation and use equations related to light propagation
LO- 5	Students are able to explain the basic concepts of geometric optics and use equations related to geometric optics
LO- 6	Students are able to explain the basic concepts of physical optics and use equations related to physical optics

SUBJECT

simple harmonic vibration; Transverse Waves; Longitudinal Waves and Sound; light propagation; Geometric Optics; Physical Optics

REFERENCE

No	**MAIN REFERENCE**
1	Pain, H. J., and P. Rankin, Introduction to Vibrations and Waves, John Wiley & Sons, Ltd., 2015
2	Hecht, E., Optics, Pearson Education Limited, 5th-edition, 2017

	SUPPORTINGREFERENCE
1	Crawford, F. S., Waves, Berkeley Physics Course, Vol 3, Mc Graw-Hill, 1968
2	Pedrotti, F.L. and L. S. Pedrotti, Introduction to Optics, Prentice-Hall, 1987
PREREQUISITES (If applicable)	
Fisika 2	

Semester Learning Plan (RPS)

Gelombang

Week to -	Meeting to-	Learning materials
1	1 & 2	Application of simple harmonic motion and superposition of two simple harmonic vibrations
2	3 & 4	Wave Group Overview
3	5 & 6	Transverse Wave Motion, Bandwidth Theorem
4	7 & 8	**Quis 1** and its discussion
5	9 & 10	Gerak Gelombang Longitudinal
6	11 & 12	Sound Reflection and Transmission, Sound Intensity
7	13 & 14	Water waves, Doppler effect
8	15 & 16	**Midterm Evaluation**
9	17 & 18	Light propagation
10	19 & 20	Mirror, Lens, Prism
11	21 & 22	Alat-alat Optik, Serat Optik
12	23 & 24	**Quis 2** and its discussion
13	25 & 26	Light Polarization
14	27 & 28	Light Interference
15	29 & 30	Light Diffraction
16	31 & 32	**End of Semester Evaluation**

CURRICULUM 2023 COURSE SYLLABUS

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER **DEPARTMENT OF PHYSICS** **STUDY PROGRAM BACHELOR (S1)**

SYLLABUS

COURSES	Name	Quantum Physics
	Code	SF234526
	Credit	4 SKS
	Semester	5

DESCRIPTION

This course discusses quantum principles, understanding simple quantum systems, formulation methods and solutions to solve atomic problems.

COURSE LEARNING OUTCOMES

No	PLO DESCRIPTION
PLO-5	Able to understand and apply the theoretical concepts of classical physics and modern physics in depth through the identification of physical properties of a physical system **[P]**
PLO-8	Able to formulate physical phenomena and problems and able to make mathematical or physical modeling / simulations in accordance with hypotheses based on the results of observations and experiments conducted **[KK]**

SUB LEARNING OUTCOMES OF COURSES

No	LO Description
LO- 1	Students are able to understand wave mechanics: Schrodinger equation, interpretation of wave functions, normalization of wave functions, eigenvalues, eigenfunctions, degeneration, operators and expectation values
LO- 2	Students are able to derive and obtain solutions to the Schroedinger equation: free particles, ladder potential, well potential, breakthrough effect, simple harmonic oscillator, hydrogen atom, angular momentum
LO- 3	Students are able to explain the theory of time-free disorder: non-degeneration cases, degeneration cases; the Stark effect and the theory of time-dependent disorder

SUBJECT

Wave packets, indeterminate principle, Schroedinger equation, eigenfunctions and values, particle motion in one-dimensional potentials, operator methods, particle motion in three-dimensional space, hydrogen atoms, radial, polar and azimutal equations, angular momentum, matrix methods of operators and spins, summation of angular momentum, time-free theory of disturbances, Stark effect, time-dependent theory of disturbances

REFERENCE

No	**MAIN REFERENCE**
1	S. Gasiorowicz, "Quantum Physics", 3rd Ed., Wiley Internat. Ed., USA, 2003.
	SUPPORTINGREFERENCE
1	A. Purwanto, “Fisika Kuantum”, Gava Media, Yogyakarta, 2006.
2	Libofs, R.L,“Introductory Quantum Mechanics” Wesley Publishing Company, 2nd.th, New York, 1992

PREREQUISITES (If applicable)
Modern Physics (Minimum Value D)

Semester Learning Plan (RPS)

Quantum Physics

Week to -	Meeting to-	Learning materials
1	1	Kontrak Kuliah
	2	History: Classical Physics (Newtonian, Maxwellian), Blackbody Radiation, Photoelectric Effect, Compton Effect, discrete spectrum of hydrogen atoms
2	3	Wave-particle dualism, wave packets, Heisenberg's principle of incertainty and old quantum theory
	4	Free particles and Schroedinger's equation, continuity of wave function, continuity equation, meaning of wave function
3	5	Operator and expectation value, time-free potential and Eigen equation
	6	Infinite one-dimensional square potential, wave and energy functions, properties of quantum systems, average position and momentum
4	7	Ladder potential, reflection and transmission coefficients
	8	Potential Obstructions and tunnel effects
5	9	Resonance state, well potential: bound state, odd function and even function, number of states
	10	**Quiz 1**
6	11	Harmonic oscillators, wave and energy functions
	12	Ladder operator and annihilation-creation operator
7	13	Position and momentum commutators, linear operators, hermitian operators
	14	Three-dimensional Schroedinger equation, continuity equation, observable dynamics, time-free potential, three-dimensional box potential, degeneration state and state density
8	15	**Midterm Evaluation (ETS)**
	16	
9	17	Particles in spherical symmetry potential: azimuth equation, polar equation and radial equation
	18	Angular momentum and quantization
10	19	Radial solution, effective potential and infinitely wall ball potential
	20	Hydrogen atoms, radial solutions
11	21	eigen function and eigen energy spectrum
	22	Commutator and matrix representation of angular, spin momentum operators
12	23	Practice questions
	24	**Quiz 2**
13	25	Partikel identik
	26	Time-free theory of disorder, non-degenerative state, shift in energy levels
14	27	Time-free disorder theory, degenerative state
	28	Stark effect

15	29	Practice questions
	30	Practice questions
16	31	**End of Semester Evaluation (EAS)**
	32	

CURRICULUM 2023 COURSE SYLLABUS

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER **DEPARTMENT OF PHYSICS** **STUDY PROGRAM BACHELOR (S1)**

SYLLABUS		
COURSES	Name	While the European Championships
	Code	SF234527
	Credit	4 SKS
	Semester	5

DESCRIPTION

In this course, students will learn to understand the formulation of the basic laws of electromagnetic fields in a vacuum and in materials and be able to apply them to various fields.

COURSE LEARNING OUTCOMES

No	PLO DESCRIPTION
PLO-5	Able to understand and apply the theoretical concepts of classical physics and modern physics in depth through the identification of physical properties of a physical system. [P]
PLO-9	Able to solve physics problems comprehensively with various alternative solutions and analyze existing physics systems and predict the potential application of physics behavior in information technology in the context of scientific development and further implementation in the field of physics expertise. [KK]

SUB LEARNING OUTCOMES OF COURSES

No	LO Description
LO- 1	Able to apply theoretical physics concepts and solve physics problems related to electromagnetic fields using vector analysis
LO- 2	Able to apply theoretical physics concepts and solve physical problems related to electrostatic field properties in a vacuum
LO- 3	ampu apply theoretical physics concepts and solve related physics problems Properties of magnetostatic fields in a vacuum
LO- 4	Able to apply theoretical physics concepts and solve physics problems related to electromagnetic waves in a vacuum
LO- 5	Able to apply theoretical physics concepts and solve physics problems related to electrostatics in materials
LO- 6	Able to apply theoretical physics concepts and solve physics problems related to magnetostatics in materials
LO- 7	Able to apply theoretical physics concepts and solve physical problems related to microscopic theories of electric fields and magnetic fields in materials
LO- 8	Able to apply theoretical physics concepts and solve physics problems related to electromagnetic waves in electromagnetic wave materials and applications

SUBJECT	
• **Vector Analysis for Electromagnetic Fields: Vector fields**, gradients, divergences, rotations, Gauss and Stokes' theorems • **Properties of Electrostatic Fields**: Electric field rotation, electric potential, electric field divergence, Laplace equation, boundary requirement problems, multipoles, conductor systems, electric field energy • **Magnetostatic Field Properties**: Divergence of magnetic fields, magnetic field rotation, vector potential and magnetic scalar • **Electromagnetic Waves**: Equation of electromanetic waves in vacuum, wave energy and momentum, reflection and habituation • **Electrostatics in Materials**: Polarization, Gauss's law, boundary requirement issues, border states, electric field energy • **Magnetostatics in Materials**: Magnetization, external and internal fields, boundary requirements, ferromagnetism, magnetic circuits, magnetic field energy • **Microscopic theory**: Bahan dielectric microscopic theory, bahan diamagnetic microscopic theory, paramagnetic dan ferromagnetic • **Electromagnetic Waves**: Equation of electromanetic waves in dielectric materials and conductors, potential waves, radiation, Electromagnetic wave applications	
REFERENCE	
No	**MAIN REFERENCE**
1	Reitz, J. R., F. J. Milford, and R. W. Christy, Foundations of Electromagnetic Theory, 2nd, Addison Wesley, 1993
2	Griffith, D. J., Introduction to Electrodynamics, 4th, Prentice Hall, 2013
	SUPPORTINGREFERENCE
1	Nayfeh, M. H. and M. K. Brussel, Electricity and Magnetism, John Wiley & Sons, 1983
2	Wangsness, R. K., Electromagnetic Fields, John Wiley & Sons, 1986
PREREQUISITES (If applicable)	
Physics 2, Physics 3	

Semester Learning Plan (RPS)

While the European Championships

Week to -	Meeting to-	Learning materials
1	1 & 2	Vector analysis for electromagnetic fields
2	3 & 4	Electric field rotation, electric potential, electric field divergence, Laplace's equation, boundary condition problems
3	5 & 6	Multipol, conductor system, electric field energy
4	7 & 8	Divergence of the magnetic field, the rotation of the magnetic field
5	9 & 10	Magnetic vector and scalar potentials, **Quis 1**
6	11 & 12	Electromanetic wave equation in a vacuum
7	13 & 14	Wave energy and momentum, wave reflection and habituation
8	15 & 16	**Midterm Evaluation**
9	17 & 18	Polarization, Gauss's law, the question of boundary requirements
10	19 & 20	Border state, electric field energy
11	21 & 22	Magnetization, external and internal fields, boundary requirements
12	23 & 24	Ferromagnetisme, rangkaian magnetik, energi medan magnetik, **Quis 2**
13	25 & 26	Bahan dielectric microscopic theory, Bahan diamagnetic microscopic theory, pre-magnetic ferromagnetic dan
14	27 & 28	Equation of electromanetic waves in dielectric and conducting materials, potential waves, radiation
15	29 & 30	Electromagnetic wave application
16	31 & 32	**End of Semester Evaluation**

CURRICULUM 2023 COURSE SYLLABUS

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER **DEPARTMENT OF PHYSICS** **STUDY PROGRAM BACHELOR (S1)**

SYLLABUS		
COURSES	Name	Fisika Statistik
	Code	SF234628
	Credit	4
	Semester	6

DESCRIPTION
This course discusses microscopic aspects, namely constituent particles and their behavior and reformulates the quantities of thermodynamic macroscopic phenomena or systems

COURSE LEARNING OUTCOMES	
No	PLO DESCRIPTION
PLO-2	Able to study and utilize science and technology in order to apply it to the field of Physics expertise, and able to make appropriate decisions from the results of their own work or group work in the form of final project reports or other forms of learning activities whose output is equivalent to the final project through logical, critical, systematic and innovative thinking. **[KU]**
PLO-5	Able to understand and apply the theoretical concepts of classical physics and modern physics in depth through the identification of physical properties of a physical system. **[P]**
PLO-8	Able to formulate physical phenomena and problems and able to make mathematical or physical modeling / simulations in accordance with hypotheses based on the results of observations and experiments conducted. **[KK]**

SUB LEARNING OUTCOMES OF COURSES	
No	LO Description
LO- 1	Able to understand statistical reviews such as random walks, binomial distributions, averages, and factorial functions in statistical physics
LO--2	Able to understand statistical formulation in mechanics and characteristics of macroscopic systems: many molecules, fluctuations, irreverses, equilibrium
LO- 3	Able to understand the specification of the state of many particle systems, ensembles, and postulates of statistical physics
LO- 4	Able to understand entropy and temperature, interactive systems, microcanonical ensembles,
LO- 5	Able to understand canonical ensemble, large canonical ensemble, and partition function
LO- 6	Able to understand the classical distribution of Maxwell-Boltzmann and the equipartition theorem and its applications: classical partition functions and ideal gases, Maxwell velocity distribution, paramagnetism and heat Types of solids
LO- 7	Able to understand the Bose-Einstein quantum distribution and its applications: Planck's law of radiation, photon statistics, phonons and heat capacity types
LO- 8	Able to understand the Fermi-Dirac quantum distribution and its applications: Fermi energy and temperature

SUBJECT	
Random walk and binomial distributions, mean and factorial functions, characteristics of microsystems, state specifications of many-particle systems, statistical ensembles and postulates, entropy and temperature, interactive systems, microcanonical ensembles, canonical ensembles and large canonical ensembles, partition functions, Maxwell-Boltzmann classical distribution and equipartition theorem, Bose-Einstein quantum distribution and Planck's law of radiation, and Fermi-Dirac quantum distribution and Fermi energy and temperature	
REFERENCE	
No	**MAIN REFERENCE**
1	Pointon, A.J.,"An Introduction to Statistical Physics", Longman Grup Ltd., London, 1978
2	Yoshioka, D,''Statistical Physics : an introduction", Springer, 2007
	SUPPORTINGREFERENCE
1	Purwanto, A.(2007).' Fisika Statistik', GavaMedia, Yogyakarta.
2	Huang, K.(2001).' Introduction to Statistical Physics', Taylor and Francis: London & New York.
3	Greiner, W., Neise, L. dan Stocker H.. (1997).' Thermodynamics and Statistical Mechanics', Springer, Berlin.
4	Sontagg, R.E. dan van Wylen, G.J.(1991).' Introduction to Thermodynamics, Classical and Statistical', 3rd edition, John Wiley & Sons: New York.
5	Alonso, M. dan Finn, E.J.(1979).' Fundamental University Physics. III, Quantum and Statistical Physics', Addison Wesley: Reading.
PREREQUISITES (If applicable)	
Thermodynamics (ever taken, minimum value D)	

Semester Learning Plan (RPS)

Fisika Statistik

Week to -	Meeting to-	Learning materials
1	1	Introductions and contracts
	2	A brief overview of thermodynamics and what is statistical physics
2	3	Random walk and binomial distribution
	4	Statistical formulation of mechanical problems, characteristics of macroscopic systems: many molecules, fluctuations, irreversible, equilibrium
3	5	System state specifications: microstates, phase spaces, ensemble and statistical postulates
	6	Number and meeting circumstances allowed
4	7	Energy distribution, entropy and temperature and their changes
	8	Kuiz 1
5	9	System interactive dan ensemble mirkokanonik
	10	Ensemble kanonik dan factor Boltzmann
6	11	Average value and energy fluctuations
	12	Equation of state and thermodynamic quantity
7	13	Large canonical ensemble, Gibbs factor, chemical potential
	14	Equation of state and fluctuations in the number of particles
8	15	Pekan ETS
	16	Pekan ETS
9	17	Classic and ideal gas partition functions
	18	The validity of the classical approach and the principle of equipartition
10	19	Maxwell speed distribution
	20	Partikel Identik
11	21	The function of partitions for particles is identical and non-identical
	22	Kuiz 2
12	23	Photon statistics and Planck's law of radiation
	24	Bose-Einstein statistics and distribution functions for bosons
13	25	Phonons and specific heat capacity
	26	Statistics Fermi-Dirac dan Energi Fermi
14	27	Gas eleektron dan temperature Fermi
	28	Distribution functions for fermions
15	29	Statistic Maxwell-Boltzmann
	30	Paramagnetism and Heat Types of Solids
16	31	EAS Week
	32	EAS Week

CURRICULUM 2023 COURSE SYLLABUS

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER **DEPARTMENT OF PHYSICS** **STUDY PROGRAM BACHELOR (S1)**

SYLLABUS		
COURSES	Name	Laboratory Physics III
	Code	SF234629
	Credit	2 SKS
	Semester	6

DESCRIPTION

In this course, students will conduct practicum covering the fields of instrumentation, optics, materials, earth physics, and medical physics as well as design and prepare practicum activities and present the results. So that students are expected to have the ability to conduct experiments by utilizing laboratory equipment that supports the final project course, as well as knowing various methods and approaches to various types of experiments.

COURSE LEARNING OUTCOMES

No	PLO DESCRIPTION
PLO-2	Able to study and utilize science and technology in order to apply it to the field of Physics expertise, and able to **make appropriate decisions from the results of their own work or group work** in the form of final project reports or other forms of learning activities whose output is equivalent to the final project through **logical, critical, systematic and innovative thinking**. [KU]
PLO-4	Able to communicate **and be responsible in applying information technology to document, store, and secure data** compiled for problem solving in the field of physics expertise. [KU]
PLO-7	Able to apply **relevant and cutting-edge principles, characteristics, functions, and technological** applications in the field of physics and **software applications**. [P]
PLO-10	Able to disseminate the results of problem studies (case studies) and physical behavior based on standard scientific principles **in oral and written communication in the form of reports or scientific papers in** accordance with the rules of correct writing by **understanding the mechanism of plagiarism and publishing it at the national or international level.** [KK]

SUB LEARNING OUTCOMES OF COURSES

No	LO Description
LO- 1	Able to carry out practicum activities in the Instrumentation Laboratory, to make RLC circuits by observing transient symptoms at DC sources and observing voltage and current phases at AC sources, to make inverting and non-inverting OP Amp circuits and measure their strengthening, and to measure the spread of sound pressure levels in the room and calculate the absorption coefficient of a material
LO- 2	Able to carry out practicum activities in the Optics Laboratory, to determine the thickness of the thin *film,* analyze the roughness of the plate by observing the speckle pattern, and to determine the antenna radiation pattern
LO- 3	Able to carry out practicum activities in the Advanced Materials Laboratory, to study the mechanical, electrical, physical, optical, and heat transfer properties of materials
LO- 4	Able to carry out practicum activities in the Geophysical Laboratory, to measure resistivity values and determine seismic parameters below the ground surface

LO- 5	Able to carry out practicum activities in the Medical Laboratory, to create a radiotherapy treatment planning system for a cancer case and assess radiotherapy treatment planning according to ICRU 83 and dose limitation limits

SUBJECT

- Conducting practicum activities in the Instrumentation Laboratory, to make RLC circuits by observing transient symptoms at DC sources and observing voltage and current phases at AC sources, to make inverting and non-inverting OP Amp circuits and measure their gain, and to measure the spread of sound pressure levels in the room and calculate the absorption coefficient of a material
- Conducting practicum activities in the Optics Laboratory, to determine the thickness of the thin film, analyze the roughness of the plate by observing the speckle pattern, and to determine the antenna radiation pattern
- Conducting practicum activities in the Advanced Materials Laboratory, to study the density of solids and powders / sand, susceptibility of a material, and electrical conductivity using RCL meters
- Conducting practicum activities in the Geophysical Laboratory, to measure resistivity values and determine seismic parameters below the ground surface
- Conducting practicum activities in the Medical Laboratory, for planning radiotherapy treatment for a cancer case, radiotherapy treatment according to ICRU 83 and dose limitation limits

REFERENCE

No	**MAIN REFERENCE**
1	Laboratory Physics Practicum Module 3
	SUPPORTINGREFERENCE
1	Various resources related to practicum topics

PREREQUISITES (If applicable)

Laboratory physics I

Semester Learning Plan (RPS)

Laboratory Physics III

Week to -	Meeting to-	Learning materials
1	1	Division of Practicum Groups (2 x 50 minutes)
2	2	Briefing Lab (2 x 50 minutes)
3	3	Practicum I (Optics, Geophysics, Instrumentation, Advanced Materials, Medical) (2 x 170 minutes)
4	4	Practicum I (Optics, Geophysics, Instrumentation, Advanced Materials, Medical) (2 x 170 minutes)
5	5	Practicum II (Geophysics, Instrumentation, Advanced Materials, Medical, Optics) (2 x 170 minutes)
6	6	Practicum II (Geophysics, Instrumentation, Advanced Materials, Medical, Optics) (2 x 170 minutes)
7	7	Tugas 1 (Resume paper) (2 x 50 minutes)
8	8	ETS (Presentation) (2 x 50 minutes)
9	9	Practicum III (Instrumentation, Advanced Materials, Medical, Optics, Geophysics) (2 x 170 minutes)
10	10	Practicum III (Instrumentation, Advanced Materials, Medical, Optics, Geophysics) (2 x 170 minutes)
11	11	Practicum IV (Advanced Materials, Medical, Optics, Geophysics, Instrumentation) (2 x 170 minutes)
12	12	Practicum IV (Advanced Materials, Medical, Optics, Geophysics, Instrumentation) (2 x 170 minutes)
13	13	Practicum V (Medical, Optics, Geophysics, Instrumentation, Advanced Materials) (2 x 170 minutes)
14	14	Practicum V (Medical, Optics, Geophysics, Instrumentation, Advanced Materials) (2 x 170 minutes)
15	15	Tugas 2 (Resume paper) (2 x 50 minutes)
16	16	EAS (Presentation) (2 x 50 minutes)

CURRICULUM 2023 COURSE SYLLABUS

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER **DEPARTMENT OF PHYSICS** **STUDY PROGRAM BACHELOR (S1)**

SYLLABUS

COURSES	Name	Fisika Zat Padat
	Code	SF234730
	Credit	4 credits
	Semester	7

DESCRIPTION

In this course, students study the physical properties (heat, electricity, semiconductivity, dielectric, optical, magnetic, superconductivity) of solid materials. In studying the physical properties of solids, it begins with examining the crystal structure and characterization equipment used. The physical properties studied are also reviewed from the current particle size apsek (nanomaterials). At the end of the lecture, students are able to explain and apply the principles of physics in understanding the structure and properties of solids and their application.

COURSE LEARNING OUTCOMES

No	PLO DESCRIPTION
PLO-5	Able to understand and apply the theoretical concepts of classical physics and modern physics in depth through the identification of physical properties of a physical system **[P]**
PLO-8	Able to formulate physical phenomena and problems and able to make mathematical or physical modeling / simulations in accordance with hypotheses based on the results of observations and experiments conducted **[KK]**
PLO-9	Able to solve physical problems comprehensively with various alternative solutions and analyze existing physical systems and predict the potential application of physical behavior in information technology in the context of scientific development and further implementation in the field of physics expertise **[KK]**

SUB LEARNING OUTCOMES OF COURSES

No	LO Description
LO- 1	Students understand crystal structure, diffraction in crystals, crystal lattice vibrations
LO- 2	Students are able to explain the behavior of electrons in metals and the electronic structure of solids
LO- 3	Students can explain thermal conduction, semiconductivity and semiconductor devices
LO- 4	Students understand the optical properties of solids
LO- 5	Students understand the magnetic properties of solids
LO- 6	Students can understand superconductivity and nanomaterials.

SUBJECT	
• Crystal structure (crystalline state, Bravais lattice, crystal direction and plane) and Interatomic forces; X-ray diffraction (Hk bragg, scattering of atoms and crystals, reverse lattice, application of x-rays) diffraction of neutrons and electrons; Vibrational lattice (heat capacity of Einstein and debye models, heat capacity, heat conductivity, scattering of x-rays, neutrons, and light by phonons). • Electrons in metals (conduction electrons, electrical conductivity and resistivity, Fermi surface, heat conductivity in metals); solids electronic structure (solid band structure, Brillouin zone, energy band and its application) • Semiconductivity (semiconductor materials, intrinsic and extrinsic semiconductors, p-type and n-type semiconductors, diffusion symptoms), semiconductor devices (p-n junctions, junction transistors, diode types, integrated circuits) • Dielectrics and optical properties of solids (formulation of dielectrics and dielectric constants, polarization and polarisability, pizoelectrics, ferroelectrics) • Magnetism and Magnetic Resonance (symptoms of magnetism, magnetic susceptibility, classification of magnetic materials, paramagnetic resonance and nuclear magnetic resonance) • Superconductivity (symptoms of superconductivity and super-conductors, ion conduction, amorphous semi-conductors, liquid crystals), nanomaterials.	
REFERENCE	
No	**MAIN REFERENCE**
1	M.A Omar, “Elementary Solid State Physics”, Addison Wesley, New York, 1975
2	Kittel, C. & McEuen, P., "Introduction Solid State Physics" John Willey and Sons, New York, 2019
3	Ibach, H. & Luth, H., “Solid-State Physics: An Introduction to Principles of Materials Science, Springer, Berlin, 2009
No	**SUPPORTINGREFERENCE**
1	Darminto, dan Z Arifin, “Fisika Zat Padat I” Diktat Kuliah Jurusan Fisika FMIPA-ITS, Surabaya, 2010
2	F Blackmore, “Solid State Physics” John Willey and Sons, New York, 1976
3	Eugene Kogan, “Solid State Physics” Bar Ilan University, 2018
PREREQUISITES (If applicable)	
Quantum Physics (minimum C), Statistical Physics (minimum D)	

Semester Learning Plan (RPS)

Fisika Zat Padat

Week to -	Meeting to-	Learning materials
1	1	**BAB 1 Crystallographs (LO- 1)** Atomic Bonding (Ion Bonds, Covalent, Metals, Van der Waals Hydrogen and Mixtures), Symmetry and Lattice (lattice and base symmetry, unit cells, lattice symmetry and crystal systems)
	2	**Advanced CHAPTER 1 Crystallography (LO- 1)** Crystal Structure (Simple Crystal structure, Compressible arrangement, Crystal Field and Direction) , Crystal Diffraction (Radiation Source, X-ray Diffraction, Diffraction and Reverse Lattle), Record Crystal (Point Defect, Line Defect, Field Defect)
2	3	Practice Questions chapter 1
	4	**BAB 2 Dynamics Kisi (LO- 1)** Elastic Waves and Phonons ; Vibration Lattice ;
3	5	**Advanced CHAPTER 2 Lattice Dynamics (LO- 1)** Wave velocity (Classical Theory Model, Einstein Model, Debye Model);
	6	**Advanced CHAPTER 2 Lattice Dynamics (LO- 1)** Energy and Number of Phons; Thermal conduction
4	7	Practice Questions Chapter 2
	8	**QUIZ 1 (CHAPTER 1 and CHAPTER 2)**
5	9	**CHAPTER 3 Electrons in Metals (LO- 2)** Classic Free Electron ; Quantum Free Electrons ;
	10	**Advanced CHAPTER 3 Electrons in Metals (LO- 2)** Electron state density ; Heat Capacity and Conductivity; Solid Substance Energy Band
6	11	Practice Questions Chapter 3
	12	**BAB 4 Semikonduktor dan Piranti Semikonduktor (LO- 3)** semiconductor materials ; Intrinsic Semiconductors ; Extrinsic Semiconductors (P-type and n-type semiconductors) ; Diffusion
7	13	**Advanced Chapter 4 Semiconductors and Semiconductor Devices (LO- 3)** Semiconductor Devices (Diodes, Tunnel Diodes, Varactor Diodes, Laser Diodes, Integrated Circuits
	14	Practice Questions Chapter 4
8	15	**Midterm Evaluation (CHAPTER 1 - 4)**
	16	
9	17	**CHAPTER 5 Dielectrica and Optical Properties (LO- 4)** Basic formulation of Dielectrics ; Dielectric And Local Terrain Constants;
	18	**Advanced CHAPTER 5 Dielectrica and Optical Properties (LO- 4)** Source of polarisability ; Dipolar polarability ; Dipolar Dispersion ;

10	19	**Advanced CHAPTER 5 Dielectrica and Optical Properties (LO- 4)** Dipolar Polarization in Solids; ionic polarizability ;
	20	**Advanced CHAPTER 5 Dielectrica and Optical Properties (LO- 4)** Polarisasi Electronics; Piezoelectric; Ferroelectric :
11	21	Practice Questions Chapter 5
	22	**CHAPTER 6 Magnetic and Magnetic Resonance (LO- 5)** Basic formulation of Magnetic ; magnetic susceptibility; Classification of Magnet materials; Diamagnetic Langevin
12	23	**Advanced CHAPTER 6 Magnetic and Magnetic Resonance (LO- 5)** Paramagnetic (quantum theory, magnetization of pure atoms, rare earth ions, fession ion groups ; Magnetization In Metals (spin paramagnetic, diamagnetic)
	24	**Advanced CHAPTER 6 Magnetic and Magnetic Resonance (LO- 5)** Ferromagnetics in Insulators (Molecular Field Theory) ; Antiferromagnetic and Ferrimagnetic (Ferrimagnetic) ; Ferromagnetism in Metals; Ferromagnetic domain (Magnetization Process) ;
13	25	**Advanced CHAPTER 6 Magnetic and Magnetic Resonance (LO- 5)** Paramagneric Resonancy (Resonance, Relaxation, Maser ; magnetic resonance of the core;
	26	Practice Questions chapter 6
14	27	**QUIZ 2 (Bab 5 dan 6)**
	28	**BAB 7 Superconductor (LO- 6)** Zero resistance, Superconducting Events; Meissner effect ; Critical Field ; Thermodynamics of Supeercomductor Transitions ; Two-Stream Model
15	29	**Advanced CHAPTER 7 Superconductors (LO- 6)** Electrodynamic Superconductors ; Superconducting Theory ; Breakthrough and Josephson Effect ; Mixed topics (intermediate states ; Christian Field in Small Specimens ; Type 2 Superconductor
	30	Practice Questions Chapter 7
16	31	**End of Semester Evaluation (EAS)**
	32	

CURRICULUM 2023 COURSE SYLLABUS

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER **DEPARTMENT OF PHYSICS** **STUDY PROGRAM BACHELOR (S1)**

SYLLABUS		
COURSES	Name	Fisika Nuklir
	Code	SF234731
	Credit	4 SKS
	Semester	7

DESCRIPTION

In this course students will learn and understand the basic properties of the core, core models, radioactive symptoms, radioactive decay theories, radiation detection systems, core reactions, reactor basics, several applications of radioisotopes in everyday life.

COURSE LEARNING OUTCOMES

No	PLO DESCRIPTION
PLO-5	Able to understand and apply the theoretical concepts of classical physics and modern physics in depth through the identification of physical properties of a physical system **[P]**
PLO-8	Able to formulate physical phenomena and problems and able to make mathematical or physical modeling / simulations in accordance with hypotheses based on the results of observations and experiments conducted **[KK]**
PLO-9	Able to solve physical problems comprehensively with various alternative solutions and analyze existing physical systems and predict the potential application of physical behavior in information technology in the context of scientific development and further implementation in the field of physics expertise **[KK]**

SUB LEARNING OUTCOMES OF COURSES

No	LO Description
LO- 1	Students understand the structure and properties of atomic nuclei
LO- 2	Students are able to calculate core binding energy and are able to apply it to problem solving
LO- 3	Students understand the symptoms of radioactivity
LO- 4	Students are able to perform calculations in radioactivity and are able to apply them to problem solving
LO- 5	Students understand the types of nuclear radiation and their application in life
LO- 6	Students master the basics of nuclear reactions and their application in life
LO- 7	Students are able to explain the basis and interaction of elementary particles

SUBJECT

- Structure and properties of the atomic nucleus: arrangement of the nucleus, size and shape of the nucleus, angular momentum and magnetic moment of the nucleus, nuclear force (interaction between nucleons in the nucleus), stability of the atomic nucleus, binding energy of the nucleus, Weiszacker semi-empirical formula
- Core models: Liquid drop model, Fermi model, Skin model (potential well model, harmonic oscillator model), L.S coupling
- Radioactivity: basic quantities of radioactivity, continuous decay, radioactive equilibrium, artificial radioactivity.

• Types of nuclear radiation: alpha decay, beta decay, gamma decay, radiation detector. • Nuclear reactions: classification of nuclear reactions, nuclear reaction mechanisms, kinematics of nuclear reactions, parameters of nuclear reactions. • Radioactive Applications • Elementary particles: interactions of muons, hadrons, laptons, quarks	
REFERENCE	
No	**MAIN REFERENCE**
1	Das, A. & Ferbel, T, "Introduction to Nuclear and Particle Physics", World Scientific, 2nd Ed., 2003.
2	Belyaev, A. & Ross, D., "The Basics of Nuclear and Particle Physics," Springer, Gewerbestrasse, 2021
3	Arya, A.P., "Fundamental Nuclear Physics", John Wiley and Sons, New York, 1983.
No	**SUPPORTINGREFERENCE**
1	Eisberg, R., & R. Resnick, "Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles", John Wiley & Sons, New York, 2nd Ed., 1985.
2	Wong,S.S.M., "Introductory Nuclear Physics", PTR Prentice Hall, Englewood, New Jersey, 1990.
3	Krane, K.S., "Introductory Nuclear Physics", John Wiley & Sons, New York, 1988.
PREREQUISITES (If applicable)	
Quantum Physics (minimum C)	

Semester Learning Plan (RPS)

Fisika Nuklir

Week to -	Meeting to-	Learning materials
1	1	**Introduction MK, Advance** Review struktur atom (Dalton, Thomson, Rutherford, Neils Bohr, Schrödinger, konfigurasi elektron)
	2	**Nuclear particle constituent model (LO- 1)** Proton-Electron and Proton-Neutron, the reasons underlying their emergence and use
2	3	**Structure and properties of the atomic nucleus (LO- 1)** **Atomic mass/nucleus unit, size, density, charge**
	4	**Structure and properties of the atomic nucleus (LO- 2)** **Angular momentum, atomic nucleus dipole moment, binding energy and nuclear/ nuclear force: Yukawa nuclear potential and pion exchange force (meson phi) between nucleons**
3	5	**Model Inti (LO- 2)** **Weiszacker Model of Liquid Drops and Semi-Empirical Formula, its background, advantages and disadvantages**
	6	**Model Inti (LO- 2)** **Fermi Gas Models, their background, advantages and disadvantages**
4	7	**Model Inti (LO- 2)** **Skin model, Motivation and background**, potential well model, harmonic oscillator model, central potential + spin orbit coupling (L.S) model
	8	**Quiz 1**
5	9	**Radioactivity (LO- 3 &; 4)** **Radiation type, radioactive decay law, half-life, radioactive unit, and natural radioactive sequence**
	10	**Radioactivity (LO- 3 &; 4)** **Laws of successive decay, radioactive equilibrium (transient equilibrium, and permanent/secular), determination of half-life (short, long, mixed)**
6	11	**Alpha particle decay (LO- 5)** Decay reactions, decay energy, kinetic energy, and alpha particle tunneling phenomena
	12	**Beta particle decay (LO- 5)** The decay reaction of Beta particles, energy and speed, and various occurrences of Beta particle decay.
7	13	**Gamma Decay (LO- 5)** Gamma decay, Energy and speed of Gamma ray emission, and Gamma Rays from Alpha and Beta decay
	14	**Core Reaction (LO- 6)** Nuclear reaction, nuclear reaction speed, conservation of nuclear reaction energy, decay energy (Q-value) of nuclear reaction, exoergic and endoergic reactions, conditions for the occurrence of nuclear reactions, Q-value measurement

8	15	**Midterm Evaluation (ETS)**
	16	
9	17	**Nuclear Fission (LO- 6)** Fission processes and characteristics, fission energy, nuclear fission and structure, and controlled fission reactions
	18	**Nuclear Fission (LO- 6)** Fission reactors, radioactive fission products, natural fission reactors, and fission explosions
10	19	**Fusi Nuklir (LO- 6)** Processes and characteristics of fusion, solar fusion, and controlled fusion reactors
	20	**Radiation detector (LO- 6)** Radiation & matter interaction, Gas Detector (ionization chamber, proportional counters, Geiger-Mueller tube)
11	21	**Radiation detector (LO- 6)** Sintilation Detectors (Inorganic Synctilators, Organic Sintilators), and Semiconductor Detectors (Silicon, High Purity Germanium)
	22	**Particle elementer (LO- 7)** Particle interaction, symmetry and the law of conservation
12	23	**Particle elementer (LO- 7)** Model quark, dinamika quark, muon, hadron, dan lapton
	24	**Astrofisika Nuklir (LO- 7)** Hot big bang cosmology, particle and nuclear interactions of the universe, nuclear synthesis of stars, and nuclear cosmchronology
13	25	**Quiz 2**
	26	**Applications of Nuclear Physics (LO- 6)** Reactor & Accelerator basics (electrostatic, cyclotron, synchrotron)
14	27	**Applications of Nuclear Physics (LO- 6)** Accelerators (linear accelerators, and colliding beam accelerators)
	28	**Applications of Nuclear Physics (LO- 6)** Electrical energy, and defense (weapons)
15	29	**Applications of Nuclear Physics (LO- 6)** Medical and medical
	30	**Applications of Nuclear Physics (LO- 6)** Agriculture and food
16	31	**End of Semester Evaluation (EAS)**
	32	

ELECTIVE COURSES IN THEORETICAL PHYSICS
PRODI SARJANA FISIKA
DEPARTMENT OF PHYSICS
FSAD - ITS

CURRICULUM 2023 COURSE SYLLABUS

INSTITUT TEKNOLOGI SEPULUH NOPEMBER
DEPARTMENT OF PHYSICS
STUDY PROGRAM BACHELOR (S1)

SYLLABUS

COURSES	Name	Advanced Mathematical Physics
	Code	SF234534
	Credit	3 credits
	Semester	5

DESCRIPTION

This course discusses the topics of mathematical physics including integral equations, green functions, complex analysis, introduction to geometry and topology as methods to solve advanced physics problems.

COURSE LEARNING OUTCOMES

No	PLO DESCRIPTION
PLO-02	Able to study and utilize science and technology in order to apply it to the field of Physics expertise, and able to make appropriate decisions from the results of their own work or group work in the form of final project reports or other forms of learning activities whose output is equivalent to the final project through logical, critical, systematic and innovative thinking.
PLO-06	Able to apply the principles and applications of mathematical physics, computational physics, and instrumentation both in how to operate physical instruments in general and analyze data and information from these instruments
PLO-08	Able to formulate physical phenomena and problems and able to make mathematical or physical modeling / simulations in accordance with hypotheses based on the results of observations and experiments conducted.

SUB LEARNING OUTCOMES OF COURSES

No	LO Description
LO- 1	Able to understand and apply Integral Equations
LO- 2	Able to understand and apply the Green Function
LO- 3	Able to understand and apply Advanced Complex Analysis
LO- 4	Able to understand Regulatory Methods in particle physics
LO- 5	Able to understand the basic concepts of Geometry and Topology

SUBJECT

Integral Equations, Green Functions, Complex Analysis, Regulatory Methods in particle physics, Introduction to Geometry and Topology

REFERENCE

No	**MAIN REFERENCE**
1	Kusse, B., Westwig, E." Mathematical Physics: Applied Mathematics for Scientists and Engineers", John Wiley & Sons, Canada, 1998
	SUPPORTINGREFERENCE
1	Wyld, H.W., “Mathematical Method for Physics”, Benyamin/Cumming, Massachusset, 1976
2	Arfken, G., “Mathematical Method for Physicists”, Academic Press, London, 1985

3	Riley, K.F., Hobson, M.P. dan Bence, S.J.,"Mathematical Methods for Physics and Engineering", Edisi 3, Cambridge University Press, 2006
4	Barton, G. "Elements of Green's Functions and Propagation", Oxford Science publications, 1991
5	Boas, M.L.,"Mathematical Methods in the Physical Science", Edisi 3, John Wiley Sons, New York, 2006.
6	Nash, C. and S. Sen, "Topology and Geometry for Physicist", Academic Press, London, 1983
PREREQUISITES (If applicable)	

Semester Learning Plan (RPS)

Advanced Mathematical Physics

Week to -	Meeting to-	Learning materials
1	1	Introduction, Integral equations (Voltera, Freidholm)
2	2	Examples of integral equation problems
3	3	Dirac delta function, WWII Green function, Green function for classical mechanics
4	4	Green function for electromagnetic fields
5	5	Green's function for quantum mechanical propagators
6	6	Green's function for relativistic quantum mechanical propagators
7	7	Green's function for relativistic quantum mechanical propagators
8	8	**Midterm Evaluation (ETS)**
9	9	Advanced Complex Analasis – Review
10	10	Advanced Complex Analysis
11	11	Advanced Complex Analysis of Quantum Field Theory
12	12	Regulatory methods in particle physics
13	13	Regulatory methods in particle physics
14	14	Geometric and topological concepts
15	15	Geometric and topological concepts
16	16	**End of Semester Evaluation (EAS)**

CURRICULUM 2023 COURSE SYLLABUS

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER **DEPARTMENT OF PHYSICS** **STUDY PROGRAM BACHELOR (S1)**

SYLLABUS		
COURSES	Name	Group theory
	Code	SF234535
	Credit	2 SKS
	Semester	5

DESCRIPTION

This course discusses the principles of symmetry in group theory as a method of simplifying, classifying and solving physics problems. Broadly speaking, the discussion of the material is divided into 2, namely finite groups and continuous groups.

COURSE LEARNING OUTCOMES

No	PLO DESCRIPTION
PLO-02	Able to study and utilize science and technology in order to apply it to the field of Physics expertise, and able to make appropriate decisions from the results of their own work or group work in the form of final project reports or other forms of learning activities whose output is equivalent to the final project through logical, critical, systematic and innovative thinking.
PLO-06	Able to apply the principles and applications of mathematical physics, computational physics, and instrumentation both in how to operate physical instruments in general and analyze data and information from these instruments
PLO-08	Able to formulate physical phenomena and problems and able to make mathematical or physical modeling / simulations in accordance with hypotheses based on the results of observations and experiments conducted.

SUB LEARNING OUTCOMES OF COURSES

No	LO Description
LO- 1	Understand the concept of symmetry in physics and the definition of groups following examples of simple groups (such as numbers, cyclic group Sn, dehydral group Dn)
LO- 2	Understand the concept of Permutation groups and Cayley's Theorem
LO- 3	Understand finite group concepts, properties (conjugation classes, subgroups, homomorphisms, isomorphisms, automorphisms), and finite group examples
LO- 4	Calculate and recognize the properties of multiple finite group instances
LO- 5	Understand the concept of Representation Theory and its properties (equivalence of representation, character, reducibility), along with vector spaces, scalar products, and unitary representations
LO- 6	Understand the concept of irreducible representation (Schur Lemma, fundamental orthogonality theorem, character orthogonality)
LO- 7	Understand and calculate the Character Table, direc product representation, and its decomposition
LO- 8	Understand the concept of continue groups and some examples (SO(2), SO(3), SU(2))

LO- 9	Understand the concept of continue groups and some examples (SO(2), SO(3), SU(2))
LO- 10	Understand the nature of continuing groups (commutation relationships, irreducible representations, characters, Clebsch-Gordan coefficients)
LO- 11	Understand finite group applications to macroscopic properties of H2O crystals and molecules
LO- 12	Understanding finite and continue group applications at atomic energy levels
LO- 13	Understand the concept of SU(N) groups and their application to particle physics
LO- 14	Calculate and apply the concepts of SU(N) and SO(N) groups to the building unified theory model
SUBJECT	
Symmetry and group definition; Finite group; Group representation theory; continuous group; Applications in quantum mechanics, and crystallography	
REFERENCE	
No	**MAIN REFERENCE**
1	Jones, H.F., Groups, Representations and Physics, Institute of Physics, Bristol, 1998
	SUPPORTINGREFERENCE
1	Joshi, A.W.,' Element of Group Theory for Physicists", Wiley Eastern, New Delhi, 1973
2	Tung, W.K., "Group Theory in Physics", World Scientific, Singapore, 1985.
PREREQUISITES (If applicable)	

Semester Learning Plan (RPS)

Group theory

Week to -	Meeting to-	Learning materials
1	1	The concept of symmetry in physics and the definition of groups follows examples of simple groups (such as numbers, cyclic group Sn, dehydral group Dn)
2	2	Permutation group concept and Cayley's Theorem
3	3	Finite group concepts, properties (conjugation classes, subgroups, homomorphisms, isomorphisms, automorphisms), and finite group examples
4	4	The concept of Representation Theory and its properties (equivalence of representation, character, reducibility), along with vector spaces, scalar products, and unitary representations
5	5	The concept of irreducible representation (Schur Lemma, fundamental orthogonality theorem, character orthogonality)
6	6	Character Table, direc product representation, and its decomposition
7	7	The concept of continue groups and some examples(SO(2), SO(3), SU(2))
8	8	**Midterm Evaluation (ETS)**
9	9	Properties of the continuing group (commutation relationship, irreducible representation, character, Clebsch-Gordan coefficient)
10	10	Properties of the continuing group (commutation relationship, irreducible representation, character, Clebsch-Gordan coefficient)
11	11	SU(N) group concept
12	12	Young Tables grup SU(N)
13	13	Application of finite groups and continue groups at molecular energy levels
14	14	The concept of SU(N) and SO(N) groups in the unified theory building model
15	15	The concept of SU(N) and SO(N) groups in the unified theory building model
16	16	**End of Semester Evaluation (EAS)**

CURRICULUM 2023 COURSE SYLLABUS

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER **DEPARTMENT OF PHYSICS** **STUDY PROGRAM BACHELOR (S1)**

SYLLABUS

COURSES	Name	Relativistic Quantum Theory
	Code	SF234536
	Credit	2 SKS
	Semester	5

DESCRIPTION

This course discusses material about quantum mechanics in relativistic cases. The discussion of the material starts from the derivation of the Klein-Gordon equation, Dirac, to the introduction to quantum field theory.

COURSE LEARNING OUTCOMES

No	PLO DESCRIPTION
PLO-02	Able to study and utilize science and technology in order to apply it to the field of Physics expertise, and able to make appropriate decisions from the results of their own work or group work in the form of final project reports or other forms of learning activities whose output is equivalent to the final project through logical, critical, systematic and innovative thinking.
PLO-05	Able to understand and apply the theoretical concepts of classical physics and modern physics in depth through the identification of physical properties of a physical system
PLO-06	Able to apply the principles and applications of mathematical physics, computational physics, and instrumentation both in how to operate physical instruments in general and analyze data and information from these instruments
PLO-08	Able to formulate physical phenomena and problems and able to make mathematical or physical modeling / simulations in accordance with hypotheses based on the results of observations and experiments conducted.

SUB LEARNING OUTCOMES OF COURSES

No	LO Description
LO- 1	Able to understand the formulation of Klein-Gordon equations, Dirac and solutions of Weyl's equations
LO- 2	Understand the formulation of Maxwell's equations in relativistic notation and Yang-Mills theory
LO- 3	Understand the second quantization process of the Klein-Gordon, Dirac, EM fields, and Majorana fields
LO- 4	Understand the mechanisms of disorder theory and their application in simple quantum field systems

SUBJECT

Klein–Gordon equation, Dirac equation, Solution of Weyl equation, Maxwell equation, classical Yang-Mills theory, Klein–Gordon field quantization, Dirac and Majorana mean for simple quantum field systems.

REFERENCE

No	**MAIN REFERENCE**
1	W. Greiner, Relativistic Quantum Mechanics - Wave Equations, Springer (2000)
	SUPPORTINGREFERENCE
1	F. Gross, Relativistic Quantum Mechanics and Field Theory, Wiley (1993)
2	Mandl and G. Shaw, Quantum Field Theory, rev. ed., Wiley (1994)

3	Halzen, F. and Martin, A.D., Quarks and Leptons, an Introductory Course in Modern Particle Physics, John Wiley and Sons, New York, 1984
PREREQUISITES (If applicable)	

Semester Learning Plan (RPS)

Relativistic Quantum Theory

Week to -	Meeting to-	Learning materials
1	1	Formulation of the Klein-Gordon equation,
2	2	Formulation of the Dirac equation
3	3	Formulation of the Dirac equation
4	4	Formulation of the Weyl equation
5	5	Formulation of Maxwell's equations in relativistic notation
6	6	Yang-Mills theories
7	7	Second quantization of the Klein-Gordon field
8	8	**Midterm Evaluation (ETS)**
9	9	Second quantization of the Dirac field
10	10	Second quantization of the Majorana field
11	11	Second quantization of the electromagnetic field
12	12	The mechanisms of disorder theory and their application in simple quantum field systems
13	13	The mechanisms of disorder theory and their application in simple quantum field systems
14	14	The mechanisms of disorder theory and their application in simple quantum field systems
15	15	The mechanisms of disorder theory and their application in simple quantum field systems
16	16	**End of Semester Evaluation (EAS)**

CURRICULUM 2023 COURSE SYLLABUS

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER **DEPARTMENT OF PHYSICS** **STUDY PROGRAM BACHELOR (S1)**

SYLLABUS		
COURSES	Name	Pengantar Fisika Partikel
	Code	SF234637
	Credit	2 SKS
	Semester	6

DESCRIPTION

This course discusses the introductory material of elementary particle physics and its interactions. The discussion includes the characteristics of elementary particles (fermions, bosons) and explanations of eleketromagnetic interactions, weak interactions, and strong interactions. In addition, the process of calculating the scatter cross-section is also discussed by applying Feynman's rule to describe the interaction of a scattering process.

COURSE LEARNING OUTCOMES

No	PLO DESCRIPTION
PLO-02	Able to study and utilize science and technology in order to apply it to the field of Physics expertise, and able to make appropriate decisions from the results of their own work or group work in the form of final project reports or other forms of learning activities whose output is equivalent to the final project through logical, critical, systematic and innovative thinking.
PLO-05	Able to understand and apply the theoretical concepts of classical physics and modern physics in depth through the identification of physical properties of a physical system
PLO-06	Able to apply the principles and applications of mathematical physics, computational physics, and instrumentation both in how to operate physical instruments in general and analyze data and information from these instruments
PLO-08	Able to formulate physical phenomena and problems and able to make mathematical or physical modeling / simulations in accordance with hypotheses based on the results of observations and experiments conducted.

SUB LEARNING OUTCOMES OF COURSES

No	LO Description
LO- 1	Able to understand and explain a brief history of elementary particles, dynamics, and fundamental forces
LO- 2	Able to understand and explain Lepton and Quark: quantum numbers of leptons and quarks (spin, flavor, isospin, color,), positronium, meson, baryon, eight-fold way
LO- 3	Able to understand and explain the concept of symmetry: groups and the law of conservation, CPT theorem
LO- 4	Able to understand and explain Feynman diagrams: Feynman rules, propagators, coupling constants, scatter cross-sections
LO- 5	Able to understand and explain Introduction to quantum electrodynamics: Klein-Gordon and Dirac equations
LO- 6	Able to understand and explain Introduction to quantum chromodynamics: Quark-quark interaction, asymptotic freedom

LO- 7	Able to understand and explain weak interactions and unification
SUBJECT	
A brief history of elementary particles, dynamics and fundamental forces; leptons and quarks; symmetry: groups and the law of conservation, the CPT theorem; Feynman diagrams, introduction to quantum electrodynamics, introduction to quantum chromodynamics, weak interactions and unification	
REFERENCE	
No	**MAIN REFERENCE**
1	Grifftith, D., Introction to Elementary Particle, John Wiley and Sons, New York, 1987
	SUPPORTINGREFERENCE
1	Fayyazuddin and Riazuddin, "A Modern Introduction to Particle Physics", World Scientific, Singapore, 1992
2	Halzen, F. and Martin, A.D., Quarks and Leptons, an Introductory Course in Modern Particle Physics, John Wiley and Sons, New York, 1984
PREREQUISITES (If applicable)	

Semester Learning Plan (RPS)
Pengantar Fisika Partikel

Week to -	Meeting to-	Learning materials
1	1	A brief history of elementary particles, dynamics and fundamental forces
2	2	The concept of symmetry of particles - the relation between symmetry and the law of conservation
3	3	CPT Theorem
4	4	Electrodynamics quantum
5	5	Feynman diagram rules
6	6	Feynman's rule for calculating the scattering cross-section of electron and photon interactions
7	7	Quantum chromodynamics
8	8	**Midterm Evaluation (ETS)**
9	9	Cross-section of the interaction of quarks and quarks with Feynman's rule
10	10	What is asymptotic freedom
11	11	Weak interactions following weak interacting particles
12	12	Weak interactions following weak interacting particles
13	13	Unification of weak interactions and strong interactions
14	14	Advanced unification theory (GUT)
15	15	Supersymmetry theory, and extra dimensions
16	16	**End of Semester Evaluation (EAS)**

CURRICULUM 2023 COURSE SYLLABUS

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER **DEPARTMENT OF PHYSICS** **STUDY PROGRAM BACHELOR (S1)**

SYLLABUS		
COURSES	Name	Introduction to Cosmology
	Code	SF234738
	Credit	3 SKS
	Semester	7

DESCRIPTION

This course equips students to understand the problems of Einstein's theory from special relativity to general relativity. Next will also be discussed the application of both in cosmology based on Einstein's theory of general relativity

COURSE LEARNING OUTCOMES

No	PLO DESCRIPTION
PLO-02	Able to study and utilize science and technology in order to apply it to the field of Physics expertise, and able to make appropriate decisions from the results of their own work or group work in the form of final project reports or other forms of learning activities whose output is equivalent to the final project through logical, critical, systematic and innovative thinking.
PLO-05	Able to understand and apply the theoretical concepts of classical physics and modern physics in depth through the identification of physical properties of a physical system
PLO-06	Able to apply the principles and applications of mathematical physics, computational physics, and instrumentation both in how to operate physical instruments in general and analyze data and information from these instruments
PLO-08	Able to formulate physical phenomena and problems and able to make mathematical or physical modeling / simulations in accordance with hypotheses based on the results of observations and experiments conducted.

SUB LEARNING OUTCOMES OF COURSES

No	LO Description
LO- 1	Able to understand Einstein's theory of special relativity, Einstein's postulates, as well as electromagnetism as a consequence of special relativity
LO- 2	Able to understand Lorentz transformations along with relativistic kinematics, summation of velocities
LO- 3	Able to understand tensors in special and general relativity
LO- 4	Able to understand curved space-time and reformulate Einstein's equations
LO- 5	Able to understand Einstein's field equations
LO- 6	Able to understand Schwarzchild solutions and black holes
LO- 7	Know about gravitational waves
LO- 8	Understand the basic principles of cosmology.

SUBJECT

Postulates of special relativity, electromagnetism, Lorentz transforms, relativistic kinematics, summation of velocities and transformations, relativistic energy and momentum, equivalence principle, general relativity principle, global and local metrics, Einstein's field equations, Schwarzchild solution, gravitational radiation, and Cosmology.

REFERENCE	
No	**MAIN REFERENCE**
1	B. Schutz, "*A First Course in General Relativity*", 2nd Edition, Cambridge University Press, 2009
	SUPPORTINGREFERENCE
1	W. Rindler, "*Relativity: Special, General and Cosmological*", 2. ed., reprinted., Oxford u.a. Oxford Univ. Press, 2009
PREREQUISITES (If applicable)	

Semester Learning Plan (RPS)
Introduction to Cosmology

Week to -	Meeting to-	Learning materials
1	1	Einstein's special theory of relativity postulates Einstein as well as electromagnetism as a consequence of special relativity
2	2	Einstein's special theory of relativity postulates Einstein as well as electromagnetism as a consequence of special relativity
3	3	Einstein's special theory of relativity postulates Einstein as well as electromagnetism as a consequence of special relativity
4	4	Lorentz transformation with relativistic kinematics, summation of velocities
5	5	Lorentz transformation with relativistic kinematics, summation of velocities
6	6	Lorentz transformation with relativistic kinematics, summation of velocities
7	7	Tensors in special and general relativity
8	8	**Midterm Evaluation (ETS)**
9	9	Symbol: Kristofel, Riemann Tensor, Ricci Tensioner, Dan Skalar Ricci
10	10	Symbol: Kristofel, Riemann Tensor, Ricci Tensioner, Dan Skalar Ricci
11	11	Symbol: Kristofel, Riemann Tensor, Ricci Tensioner, Dan Skalar Ricci
12	12	Einstein's field equations
13	13	Einstein's field equations
14	14	The concept of expansion of the Universe
15	15	The concept of expansion of the Universe
16	16	**End of Semester Evaluation (EAS)**

CURRICULUM 2023 COURSE SYLLABUS

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER **DEPARTMENT OF PHYSICS** **STUDY PROGRAM BACHELOR (S1)**

SYLLABUS

COURSES	Name	Special Topics on Quantum Physics
	Code	SF234739
	Credit	3 SKS
	Semester	7

DESCRIPTION

This course discusses the latest popular quantum physics, including quantum teleportation, quantum computing, and quantum thermodynamics.

COURSE LEARNING OUTCOMES

No	PLO DESCRIPTION
PLO-02	Able to study and utilize science and technology in order to apply it to the field of Physics expertise, and able to make appropriate decisions from the results of their own work or group work in the form of final project reports or other forms of learning activities whose output is equivalent to the final project through logical, critical, systematic and innovative thinking.
PLO-05	Able to understand and apply the theoretical concepts of classical physics and modern physics in depth through the identification of physical properties of a physical system
PLO-06	Able to apply the principles and applications of mathematical physics, computational physics, and instrumentation both in how to operate physical instruments in general and analyze data and information from these instruments
PLO-08	Able to formulate physical phenomena and problems and able to make mathematical or physical modeling / simulations in accordance with hypotheses based on the results of observations and experiments conducted.

SUB LEARNING OUTCOMES OF COURSES

No	LO Description
LO- 1	Able to understand about Quantum Computing (Quantum Bits, Quantum Gates, and Quantum Algorithms)
LO- 2	Able to understand Quantum Teleportation
LO- 3	Able to understand the concept of Quantum Thermodynamics

SUBJECT

Quantum Computing (Quantum Bits, Quantum Gates, Quantum Algorithms), Quantum Teleportation, Quantum Thermodynamics

REFERENCE

No	**MAIN REFERENCE**
1	M. Nakahara, Quantum Computing, CRC Press(2008)
	SUPPORTINGREFERENCE
1	M.A. Neilson, I.L. Chuang, Quantum Computation and Quantum Information, Cambridge Press(2000)

PREREQUISITES (If applicable)

Semester Learning Plan (RPS)
Special Topics on Quantum Physics

Week to -	Meeting to-	Learning materials
1	1	Quantum computing concepts (Quantum Bits)
2	2	The concept of quantum computing (Quantum Gates)
3	3	The concept of quantum computing (Quantum Gates)
4	4	The concept of quantum computing (Quantum Algorithm)
5	5	The concept of quantum computing (Quantum Algorithm)
6	6	The concept of quantum computing (Quantum Algorithm)
7	7	The concept of quantum computing (Quantum Algorithm)
8	8	**Midterm Evaluation (ETS)**
9	9	Quantum teleportation
10	10	Quantum teleportation
11	11	Quantum teleportation
12	12	Quantum thermodynamics
13	13	Quantum thermodynamics
14	14	Quantum thermodynamics
15	15	Quantum thermodynamics
16	16	**End of Semester Evaluation (EAS)**

ELECTIVE COURSES IN ADVANCED MATERIALS
PRODI SARJANA FISIKA
DEPARTMENT OF PHYSICS
FSAD - ITS

CURRICULUM 2023 COURSE SYLLABUS

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER **DEPARTMENT OF PHYSICS** **STUDY PROGRAM BACHELOR (S1)**

SYLLABUS		
COURSES	Name	Strukur Material
	Code	SF234540
	Credit	2 SKS
	Semester	5

DESCRIPTION

This course is an introduction for students to explore material knowledge, especially in structural aspects. The lecture begins with a re-examination of atomic structure, bonds between atoms, followed by molecular and crystal structures in solid materials. An overview of characterization and an introduction to structural analysis are also part of this lecture.

COURSE LEARNING OUTCOMES

No	CP-MK
PLO-5	Able to understand and apply the theoretical concepts of classical physics and modern physics in depth through the identification of physical properties of a physical system. [P]
PLO-7	Able to apply relevant and cutting-edge principles, characteristics, functions, and technological applications in the field of physics and software applications. [P]
PLO-8	Able to formulate physical phenomena and problems and able to make mathematical or physical modeling / simulations in accordance with hypotheses based on the results of observations and experiments conducted. [KK]
PLO-9	Able to solve physical problems comprehensively with various alternative solutions and analyze existing physical systems and predict the potential application of physical behavior in information technology in the context of scientific development and further implementation in the field of physics expertise. [KK]

SUB LEARNING OUTCOMES OF COURSES

No	LO Description
LO- 1	Able to explain the arrangement of electrons in atoms of elements in periodic order
LO- 2	Able to explain the types and mechanisms of bonds between atoms in the formation of molecules or atomic groups
LO- 3	Able to explain the arrangement of atoms in crystals, lattice and crystal structure and a number of notions related to crystallity
LO- 4	Able to analyze functional groups, electron transitions between band levels by spectrometry
LO- 5	Able to analyze crystal structure and local structure by diffractometry and spectroscopy
LO- 6	Able to analyze the surface morphology of materials with microscopy

SUBJECT

Atomic structure, bonds between atoms, molecular structure, crystallography, analysis: functional groups, crystal structure, locan structure and surface morphology.

REFERENCE	
No	**MAIN REFERENCE**
1	W.D. Callister Jr. and D. G. Rethwisch, "Materials Science and Engineering : An Introduction", 8th Ed., Jhn Wiley & Sons Inc., New York, 2010.
	SUPPORTINGREFERENCE
1	Sriati Djaprie (Tr: Lawrence H Van Vlack), "Materials Science and Technology" Fifth Edition, Erlangga, Jakarta, 1989
PREREQUISITES (If applicable)	
Modern Physics	

Semester Learning Plan (RPS)
Structure Material

Week to -	Meeting to-	Learning materials
1	1	Arrangement of electrons in atoms, excitation and de-excitation of electrons, ionization
2	2	Bonds between atoms: primary and secondary, molecules and atomic groups
3	3	Crystal structure : lattice, base, crystal system
4	4	**Quiz – 1**
5	5	The plane and direction of the Crystal and its index
6	6	Crystal diffraction
7	7	Interaction of radiation and matter, principle of scattering and spectrometry
8	8	**Midterm Evaluation (ETS)**
9	9	Rotation and vibary of molecules/atomic clusters, infrared spectroscopy
10	10	Electron transition between energy bands, light/ultra-violet spectroscopy
11	11	Spin electrons and atomic nuclei, magnetic resonance
12	12	**Quiz – 2**
13	13	Local structure of atomic bonds in crystals, X-ray absorption spectroscopy
14	14	Surface structure : morphology, topography, distribution of elements
15	15	Optical and electronic microscopy, neutron scattering
16	16	**End of Semester Evaluation (EAS)**

CURRICULUM 2023 COURSE SYLLABUS

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER **DEPARTMENT OF PHYSICS** **STUDY PROGRAM BACHELOR (S1)**

SYLLABUS		
COURSES	Name	**Fisika Keramik**
	Code	SF234541
	Credit	2 SKS
	Semester	5

DESCRIPTION

The Ceramic Physics course is included in the cluster of elective courses of interest in the field of materials physics at the Department of Physics FSAD-ITS. In the introduction, students will learn about the characteristics of ceramic materials in general (traditional ceramics, advanced ceramics) and their use. Arrangement of ions (cations and anions) with CCP (Cubic Close Packed*), HCP (*Hexagonal Close Packed) structures and explanation of Pauling's rule in the formation of ceramic structures. Ceramic structures are divided into several types, namely AX, AX_2, A2X3, and ABX3. Understanding phase diagrams and phase rules in one-component systems, binary and ternary systems. In ceramic synthesis, some things that need to be discussed include thermal analysis, chemical reactions, reactions in solid conditions, and reactions in liquid conditions. Sintering mechanism *and shrinkage analysis, kinetics* of sintering in the solid phase, *sintering* in the liquid phase and study of ceramic microstructure. Determination of grain density and growth. The characteristics of ceramic materials that need to be studied include mechanical *properties, thermal shock*, electrical properties and magnetic properties. This Ceramic Physics course is the basis of knowledge and skills that must be possessed for students who take an interest in the field of material physics, especially in terms of the synthesis of ceramic materials, mechanisms that occur during the process of making ceramic materials, and studying the functional characteristics of ceramic materials in terms of their mechanical properties, electrical properties, and magnetic properties.

COURSE LEARNING OUTCOMES

No	PLO DESCRIPTION
PLO-7	Able to apply relevant and cutting-edge principles, characteristics, functions, and technological applications in the field of physics and software applications. [P]
PLO-8	Able to formulate physical phenomena and problems and able to make mathematical or physical modeling / simulations in accordance with hypotheses based on the results of observations and experiments conducted. [KK]
PLO-9	Able to solve physical problems comprehensively with various alternative solutions and analyze existing physical systems and predict the potential application of physical behavior in information technology in the context of scientific development and further implementation in the field of physics expertise. [KK]

SUB LEARNING OUTCOMES OF COURSES	
No	LO Description
LO- 1	Able to understand and explain the understanding and general properties of ceramic materials, various examples of ceramic materials and their use. Students are able to explain and study the arrangement patterns (arrangement) of atoms and ions, *Cubic Closed Packing*, *Hexagonal Closed Packing* and Pauling's rules in the formation of ceramic material structures.
LO- 2	Able to understand, understand and describe the arrangement of atoms in ceramic crystals in AX structures (CsCl, NaCl), AX2 and A2X (*fluorite,* zirconia*), and able to use basic structures as a foundation to understand some additional structures that are widely used in ceramic applications with A2X3 structures (alumina, ilmenite), ABX3 (*perovskite*), spinel structures, complex structures, and silicate structures.*
LO- 3	Able to understand and explain the concept of defect formation in crystals, types of defects (point defects, line defects/dislocations, Schottky defects, Frenkel defects), Kroger diagrams, oxidation - reduction.
LO- 4	Able to understand and explain the principle of phase equilibrium, the use of phase diagrams, phase composition and quantity for binary systems (double-phase materials) and ternary (more than two phase materials).
LO- 5	Able to explain ceramic synthesis: powder synthesis *under solid state reaction conditions by* mechanical methods, powder synthesis through wet *reaction route* by chemical methods, thermal properties analysis and chemical reactions, as well as ceramic formation processes, sintering mechanisms, *shrinkage analysis,* microstructure control, high density achievement, and *grain growth processes*.
LO- 6	Able to understand and explain the characteristics of mechanical properties in ceramics: *fractures*, Griffith criteria, Weibull distribution functions, thermomechanical symptoms (response of ceramic materials to temperature changes), thermal stress*, and thermal* shock*.*
LO- 7	Able to understand and explain the characteristics of electrical, conductivity, ferroelectric, piezoelectric, magnetic, paramagnetic, spinel, ferrite characteristics.
SUBJECT	

- Introduction, understanding of ceramic materials, virtues and usage.
- *Ion packing*, CCP (Cubic Close Packed), *HCP (*Hexagonal Close Packed*), Pauling's rule in the formation of ceramic structures.*
- Structure ceramic AX (CsCl, *rock salt*), AX2/A2X (*fluorite*, *zirconia*).
- Structure ceramic A_{2X3} (alumina, ilmenite), ABX_3 (*perovskite*), structure spinel dan structure kompleks, structure silicate.
- *Defects,* Kroger diagrams, oxidation reductions.
- Phase balance, phase diagram, binary system and terner.
- Ceramic synthesis: thermal analysis, chemical *reaction, solid state* reaction, *wet reaction route*.
- *Sintering*, shrinkage analysis.
- Microstructure, density, *grain-growth*.
- Characteristics of mechanical properties of ceramics: *fracture,* Griffith criterion, Weibull distribution.

• Termomekanik, thermal stress, thermal *shock* . • Characteristics of electrical, conductivity, ferroelectric properties. • Characteristic magnetic, paramagnetic, spinel, ferry.	
REFERENCE	
No	**MAIN REFERENCE**
1	C.B. Carter and M.G. Norton, "Ceramic Materials: Science and Engineering", Springer, 2007.
	SUPPORTINGREFERENCE
1	W.D. Kingery, "Introduction to Ceramics" 2nd ed Willey.
2	M.W. Barsoum, "Fundamentals of Ceramics", The McGraw-Hill, International Edition, 1997.
3	M.N. Rahaman, "Ceramic Processing and Sintering", Second Edition, Taylor & Francis Group, 2003.
PREREQUISITES (If applicable)	
Modern Physics	

Semester Learning Plan (RPS)
Fisika Keramik

Week to -	Meeting to-	Learning materials
1	1	Introduction, understanding of ceramic materials, virtues and usage.
2	2	*Ion packing*, CCP (Cubic Close Packed), *HCP (*Hexagonal Close Packed*), Pauling's rule in the formation of ceramic structures.*
3	3	Structure ceramic AX (CsCl, *rock salt*), AX2/A2X (*fluorite*, *zirconia*). Structure ceramic A_{2X3} (alumina, ilmenite), ABX_3 (*perovskite*), structure spinel dan structure kompleks, structure silicate.
4	4	*Defects,* Kroger diagrams, oxidation reductions.
5	5	WANTED 1
6	6	Phase balance, phase diagram, binary system and terner.
7	7	Ceramic synthesis: thermal analysis, chemical *reaction, solid state* reaction, *wet reaction route*.
8	8	ETS
9	9	*Sintering*, shrinkage analysis. Microstructure, density, *grain-growth*.
10	10	Characteristics of mechanical properties of ceramics: *fracture,* Griffith criterion, Weibull distribution.
11	11	Termomekanik, thermal stress, thermal *shock* .
12	12	WANTED 2
13	13	Characteristics of electrical, conductivity, ferroelectric, piezoelectric properties.
14	14	Characteristic magnetic, paramagnetic, spinel, ferry.
15	15	Characteristic magnetic, paramagnetic, spinel, ferry.
16	16	EAS

CURRICULUM 2023 COURSE SYLLABUS

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER **DEPARTMENT OF PHYSICS** **STUDY PROGRAM BACHELOR (S1)**

SYLLABUS		
COURSES	Name	Fisika Logam
	Code	SF234542
	Credit	2 SKS
	Semester	5

DESCRIPTION

This metal physics course belongs to the cluster of advanced materials courses in the Department of Physics FSAD-ITS. The metal physics course discusses metal structures and defects, reinforcement methods and identification of metal properties and alloys. In this course, students learn and understand the basic properties and structure of metals, solid cacads, solid solutions and phase diagrams, metal characterization techniques and their alloys, metal solidification, phase transformation, metal reinforcement methods, classification of ferrous and non-ferrous metals, properties of metals and their alloys; mechanical and electrochemical sifak. Through this course, students are able to explain and understand the superior properties of metals and their alloys and are able to explain test methods in identifying the structure and properties of metals and alloys.

COURSE LEARNING OUTCOMES

No	PLO DESCRIPTION
PLO-5	Able to understand and apply the theoretical concepts of classical physics and modern physics in depth through the identification of physical properties of a physical system **[P]**
PLO-7	Able to apply relevant and cutting-edge principles, characteristics, functions, and technology applications in the field of physics and software applications **[P]**
PLO-9	Able to solve physical problems comprehensively with various alternative solutions and analyze existing physical systems and predict the potential application of physical behavior in information technology in the context of scientific development and further implementation in the field of physics expertise **[KK]**
PLO-10	Able to disseminate the results of problem studies (case studies) and physical behavior based on standard scientific principles in oral and written communication in the form of reports or scientific papers in accordance with the correct writing rules by understanding the mechanism of plagiarism and publishing it at the national or international level **[KK]**

SUB LEARNING OUTCOMES OF COURSES

No	LO Description
LO-1	Able to understand crystal structure and amorphous, crystallography in metals.
LO-2	Able to understand and explain the concepts of void defects, interstitial, dislocation, grain boundaries, diffusion and plastic deformation.
LO-3	Able to understand and interpret microstructure data and other physical properties from micrographic data, XRF and XRD, S / TEM and EDX.
LO-4	Able to understand and explain solid dissolution, phase diagrams and compaction methods in ferrous and non-ferrous metal alloy systems
LO-5	Able to explain and analyze phase transformations and reinforcement methods through heat treatment of metals.

LO-6	Able to understand and explain phase transformations that occur in iron-carbon alloy systems.
LO-7	Able to understand and explain the selection of ferrous or nonferrous metal alloy systems related to their use.
LO-8	Able to understand and explain the mechanical and electrochemical properties of ferrous and non-ferrous metals.

SUBJECT

- Introduction, metal structure and alloys,
- Cacat padatan,
- Techniques of characterization of metals and their alloys,
- Solid solution and phase diagrams,
- Pemadatan Logam,
- Phase Transformation,
- Methods of strengthening metals and their alloys,
- Classification of ferrous and non-ferrous metals,
- The properties of the metal and its alloy.

REFERENCE

No	**REFERENCE UTAMA**
1	W.D Callister,Jr "Materials Science and Enggineering An Introduction" John Willey and Sons, Inc. New York, 2007 (Ebook)
2	R. E. Smallman, and R. J. Bishop, "Modern Physical Metallurgy and Materials Engineering" Butterworth-Heinemann Linacre House, Jordan Hill, Oxford, 1999 (Ebook)
	SUPPORTINGREFERENCE
1	Sriati Djaprie (Tr: Lawrence H Van Vlack), "Materials Science and Technology" Fifth Edition, Erlangga, Jakarta, 1989
2	R. Abbaschia, L. Abbaschian, R.R. Reed-Hill, "Physica Metallurgy Principles" 4rd edition, CENCAGE Learning , Stanford USA 2009

PREREQUISITES (If applicable)

Modern Physics

Semester Learning Plan (RPS)
Fisika Logam

Week to -	Meeting to-	Learning materials
1	1	Introduction; metal structure, crystal system and structure, amorphous metal, crystal plane and direction, crystal bonding, atomic compression factor.
2	2	Crystal solids defects, intersthesia defects, stress and strain fields, slip systems, dislocation dense, plastic deformation.
3	3	Grain limit elements, grain limit stress fields, grain limit energy, surface tension, grain limit effect on mechanical properties, grain size effect, grain density.
4	4	Diffusion, intrinsic diffusion, self-diffusion, diffusion coefficient, isomophy diffusion in alloy systems, interstitial diffusion measurement.
5	5	Metals' and alloys' characterization techniques; XRF and XRD, S-TEM + EDX, Topography and Metallography.
6	6	Solid dissolving and phase diagrams.
7	7	Binary and tertner phase diagram systems
8	8	**Midterm Evaluation**
9	9	Metal compaction methods, nucleation and grain growth kinetics.
10	10	Phase transformation, isomorphous alloy system, heating and cooling, eutectic system and its microstructure, peritectic transformation, monotectic, intermediate phase
11	11	Iron-carbon alloy system, TTT diagram, deformation twinning method and martensite reaction
12	12	Metode penguatan logam, annealing, hardening, precipitation hardening, normalizing.
13	13	Classification of ferrous and non-ferrous metals
14	14	Properties – mechanical properties of metals and their choirs
15	15	Properties – electrochemical properties of Metals and their choirs
16	16	**End of Semester Evaluation**

CURRICULUM 2023 COURSE SYLLABUS

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER **DEPARTMENT OF PHYSICS** **STUDY PROGRAM BACHELOR (S1)**

SYLLABUS		
COURSES	Name	Fisika Polimer
	Code	SF234543
	Credit	2 SKS
	Semester	5

DESCRIPTION

In the Polymer Physics course, students learn the basics of polymers, synthesis, characterization of physical properties, introduction to physical properties characterization tools and the current development of polymer physical properties. In studying the synthesis and physical properties of polymers by relating the structure of crystallinity, molecular weight with their external physical properties. Students also study the development and current physical properties (heat, mechanical, electrical, polymer fusion) supported by appropriate characterization equipment as well as various processing methods. At the end of the lecture, students are able to explain, understand, apply physical principles in understanding the structure and properties of polymers as well as the positive-negative impacts of the application of polymers in everyday life including environmental impacts.

COURSE LEARNING OUTCOMES

No	PLO DESCRIPTION
PLO-3	Able to manage self-learning, and develop themselves as lifelong learners to compete at national, and international levels, in order to make a real contribution to solving problems by implementing information and communication technology and paying attention to sustainability principles and understanding technology-based entrepreneurship **[KU]**
PLO-7	Able to apply relevant and cutting-edge principles, characteristics, functions, and technology applications in the field of physics and software applications **[P]**
PLO-9	Able to solve physical problems comprehensively with various alternative solutions and analyze existing physical systems and predict the potential application of physical behavior in information technology in the context of scientific development and further implementation in the field of physics expertise **[KK]**

SUB LEARNING OUTCOMES OF COURSES

No	LO Description
LO- 1	Students know the material of polymer jens.
LO- 2	Students are able to know the types of bonds and polymer chains.
LO- 3	Students are able to get to know the structure and synthesis of polymer materials.
LO- 4	Students are able to understand the physical properties of polymer materials.
LO- 5	Students are able to recognize and understand the tools for characterizing the physical properties of polymers.
LO- 6	Students are able to get to know the methods of processing and application of polymers.
LO- 7	Students are able to know the current polymers.

LO- 8	Students have a concern for positive and negative impacts on the environment
SUBJECT	
• Pengantar fisika polimer. • Molekul hidrokarbon, molekul dan kimiawi polimer. • Bonding in polymers, bonding distance and bonding strength. • Polymer chain structure, polymer molecular shape, polymer molecular weight, polymer configuration.. • Synthesis of polymeric materials, addition polymerization, condensation polymerization. • Kristalinitas polimer, model kristalinitas polimer, struktur semikristal, transisi gelas. • Characteristics of polymeric materials, properties and tools of characterization of polymer properties (mechanical, thermal, optical, electrical). • Polymer processing and application. • Introduction of contemporary polymers (conductive, polyalloy, shape memory polymer). • Polymers and the environment.	
REFERENCE	
No	**MAIN REFERENCE**
1.	Rosen, S. L., "Fundamental Principles of Polymeric Materials", A WileyInterscience Publication, John Wiley & Sons, New York, 1986.
2.	Billmeyer, F.W., "Texbook of Polymer Science", Wiley Interscience, New York, 1990.
	SUPPORTINGREFERENCE
1.	William M Alvino, Plastics For Electronic, Materilas, Properties, and Design Applications, McGraw-Hill, Inc, New York , 1994
2.	Iwao Teraoka, Polymer Solutions, An Introduction to Physicals Properties, John Wiley & Sons, Inc , 2002.
PREREQUISITES (If applicable)	

Semester Learning Plan (RPS)
Fisika Polimer

Week to -	Meeting to-	Learning materials
1	1	Pengenalan jenis bahan polimer.
2	2	Jenis ikatan, molekul hidrokarbon dan rantai polimer.
3	3	Struktur polimer, rerata berat molekul, rerata jumlah molekul polimer.
4	4	**Quiz-1**
5	5	Jenis-jenis polimer; polimer alam dan sintetis
6	6	Synthesis of polymers, polymer additives and processing methods.
7	7	Kristalinitas polimer.
8	8	**Midterm Evaluation**
9	9	Mechanical properties, thermal properties, electrical properties, optical properties of polymers.
10	10	Test equipment of structure, crystallinity, thermal polymers.
11	11	Test equipment of mechanical properties, electrical properties, optical properties of polymers.
12	12	**Quiz-2**
13	13	Polymer processing and application.
14	14	Current polymers (conductive, polyalloy, shape memory polymer, optical).
15	15	Polymers and the environment.
16	16	**End of Semester Evaluation**

CURRICULUM 2023 COURSE SYLLABUS

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER **DEPARTMENT OF PHYSICS** **STUDY PROGRAM BACHELOR (S1)**

SYLLABUS		
COURSES	Name	Synthesis and Processing
	Code	SF234644
	Credit	2 SKS
	Semester	6

DESCRIPTION

This course is a special topic and part of the introduction to materials science for physical scientists and engineers in general, including introduction and understanding of types, characterization, processing and fabrication as well as applications of metal materials and metal alloys, ceramics and glass, polymers, and composites. This course is intended to develop insight and critical thinking to students towards the development of synthesis and processing of a material and the development of advanced material physics and its applications.

COURSE LEARNING OUTCOMES

No	PLO DESCRIPTION
PLO-02	Able to study and utilize science and technology in order to apply it to the field of Physics expertise, and able to make appropriate decisions from the results of their own work or group work in the form of final project reports or other forms of learning activities whose output is equivalent to the final project through logical, critical, systematic and innovative thinking. [KU]
PLO-08	Able to formulate physical phenomena and problems and able to make mathematical or physical modeling / simulations in accordance with hypotheses based on the results of observations and experiments conducted. [KK]
PLO-09	Able to solve physical problems comprehensively with various alternative solutions and analyze existing physical systems and predict the potential application of physical behavior in information technology in the context of scientific development and further implementation in the field of physics expertise. [KK]

SUB LEARNING OUTCOMES OF COURSES

No	LO Description
LO- 1	Students are able to get to know the types of metals and metal alloys.
LO- 2	Students are able to understand and apply fabrication and thermal processes of metals and metal alloys.
LO- 3	Students are able to recognize and understand the types and applications of ceramics and glassware.
LO- 4	Students are able to apply the fabrication and processing of ceramics and glass.
LO- 5	Students are able to understand the types, characterization and applications of polymers
LO- 6	Students are able to analyze the mechanical and thermal properties of polymers
LO- 7	Students are able to apply polymer synthesis and processing.
LO- 8	Students are able to recognize and understand the types and applications of composite materials.

LO- 9	Students are able to apply and analyze composite synthesis and processing.
SUBJECT	
• Introduction of metal types and metal cobels. • Fabrication and thermal process of metals and metal alloys. • Types and applications of ceramics and glassware. • Fabrication and processing of ceramics and glassware. • Types, characterization and application of polymers • Mechanical and thermal properties of polymers • Synthesis and processing of polymers. • Introduction to types and applications of composite materials. • Composite synthesis and processing.	
REFERENCE	
No	**MAIN REFERENCE**
1	Callister Jr,W.D., Rethwisch, D.G.,"Fundamental of Materials Science & Engineering", John Wiley and Son, 10th Edition, New York, 2018.
2	Askeland, D.R., Wright, W.J.," The Science and Engineering of Materials", Cengage Learning, Seventh Edition, Boston, 2016.
3	Askeland, D.R., Fulay, P.P.,"Essentials of Materials Science and Engineering", Cengage Learning, Second Edition, Boston, 2009.
	SUPPORTINGREFERENCE
1	Shackelford, J.F., "Introduction to materials science for engineers", 8th Edition, Pearson, Boston, 2015
2	Smith, W.F., "Principles of Materials Science and Engineering", 3rd Edition, McGraw-Hill, Inc (International Edition), New York, 1996.
PREREQUISITES (If applicable)	

Semester Learning Plan (RPS)

Synthesis and Processing

Week to -	Meeting to-	Learning materials
1	1	
2	2	
3	3	
4	4	
5	5	
6	6	
7	7	
8	8	**Midterm Evaluation (ETS)**
9	9	
10	10	
11	11	
12	12	
13	13	
14	14	
15	15	
16	16	**End of Semester Evaluation (EAS)**

CURRICULUM 2023 COURSE SYLLABUS

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER **DEPARTMENT OF PHYSICS** **STUDY PROGRAM BACHELOR (S1)**

SYLLABUS		
COURSES	Name	Material Characterization
	Code	SF234745
	Credit	3 SKS
	Semester	7

DESCRIPTION

This Material Characterization course belongs to the cluster of advanced material courses in the Department of Physics FSAD-ITS. The Material Characterization course discusses testing tools and how to analyze a material. In this course, students will learn the principles of radiation generation that can be used for characterization and analysis of materials and practice virtually the generation and relate to the type of analysis that is in accordance with the principles of micrography: Optical Microscope (MO), *Scanning Electron Microscope (SEM),* transmission electron microscopy *(TEM), X-Ray Fluorescence (*XRF), *Energy Dispersive X-Ray (EDX)* and its application, then it can choose the type of characterization, evaluate, analyze and interpret data from various characterization techniques, the theory of absorption of infra-red waves by molecules in *Fourier Transform Infrared* (FTIR) spectroscopy, then the principle of data measurement and analysis, the theory of crystal diffraction with x-ray radiation, then evaluate and report the principle of data measurement, processing, analysis and interpretation, and the principles of thermal analysis on materials. This Material Characterization course is the basis of knowledge and skills that must be possessed for physicists who work in an industry when analyzing a material.

COURSE LEARNING OUTCOMES

No	PLO DESCRIPTION
PLO-4	Able to communicate and be responsible in applying information technology to document, store, and secure data compiled for problem solving in the field of physics expertise. **[KU]**
PLO-7	Able to apply relevant and cutting-edge principles, characteristics, functions, and technological applications in the field of physics and software applications. **[P]**
PLO-8	Able to formulate physical phenomena and problems and able to make mathematical or physical modeling / simulations in accordance with hypotheses based on the results of observations and experiments conducted. **[KK]**
PLO-9	Able to solve physical problems comprehensively with various alternative solutions and analyze existing physical systems and predict the potential application of physical behavior in information technology in the context of scientific development and further implementation in the field of physics expertise. **[KK]**

SUB LEARNING OUTCOMES OF COURSES	
No	LO Description
LO- 1	Able to understand and explain the principles of optical micrography, thermal analysis, types of thermal analysis, and their applications
LO- 2	Able to explain the concepts of X-RAY, XRF, EDX generation and their applications independently perform virtual "practicum" in the operation of optical micrography, thermal analysis, and XRF-EDX
LO- 3	Able to explain and demonstrate the basics of electron micrography, the working principles of SEM and TEM, and their use until micrographic images are obtained and describe the results
LO- 4	Able to explain micrographic data analysis from optical microscopes, SEM, TEM and EDX
LO- 5	Able to explain the working principle of FTIR and analyze FTIR spectra
LO- 6	Able to explain the basics of crystallography
LO- 7	Able to explain the basics of crystal diffraction
SUBJECT	
Micrographic theory, Optical Micrography, Optical microscopy (MO), XRF and EDX, Thermal Analysis, Electron microscopy (SEM and TEM), FTIR, X-ray diffraction, "Practicum" optical micrography, XRF-EDX, SEM-TEM and x-ray diffraction and thermal analysis, Analysis and interpretation of secondary data: MO, XRF-EDX, SEM-TEM, x-ray diffraction and thermal data.	
REFERENCE	
No	**MAIN REFERENCE**
1	Leng, Y., 2013. Materials Characterization: Introduction to Microscopic and Spectroscopic Methods, 2 edition. ed. Wiley-VCH, Weinheim.
2	https://myscope.training/ (Theory, Simulation, Virtual Practicum)
	SUPPORTINGREFERENCE
1	https://micro.magnet.fsu.edu/primer/java/electronmicroscopy/magnify1/index.html (SEM)
2	https://wecanfigurethisout.org/VL/home.htm
3	https://www.cryst.ehu.es/ & crystallography.net (crystallography)
4	http://www.crystalimpact.com/Default.htm (x-ray diffraction)
PREREQUISITES (If applicable)	
Modern Physics	

Semester Learning Plan (RPS)
Material Characterization

Week to -	Meeting to-	Learning materials
1	1	Introduction; Micrographic theory; Optical Micrography (LO- 1)
2	2	Optical Microscope (Advanced) + Thermal Analysis (LO- 2)
3	3	X-ray generation; XRF and EDX (LO- 2)
4	4	"Practicum" Optical micography, thermal analysis &; XRF-EDX (LO- 2)
5	5	Data analysis: Optical micrography, thermal analysis, XRF-EDX (LO- 2)
6	6	Electron micrography: basics, theory of SEM &; TEM (LO- 3)
7	7	"Lab Course" SEM-TEM (LO- 4)
8	8	**MIDTERM EVALUATION (ETS)**
9	9	Micrographic data analysis: optical-SEM-TEM + EDX (LO- 4)
10	10	FTIR theory and analysis (LO- 5)
11	11	Theory of crystallography &; x-ray diffraction (LO- 6)
12	12	Basics of diffraction data analysis (LO- 6)
13	13	Practice qualitative analysis of x-ray diffraction data I (LO- 7)
14	14	Practice qualitative analysis of x-ray diffraction data II (LO- 7)
15	15	"Internship" XRD (LO- 7)
16	16	**END OF SEMESTER EVALUATION (EAS)**

CURRICULUM 2023 COURSE SYLLABUS

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER **DEPARTMENT OF PHYSICS** **STUDY PROGRAM BACHELOR (S1)**

SYLLABUS		
COURSES	Name	Advanced Material
	Code	SF234746
	Credit	2 SKS
	Semester	7

DESCRIPTION

This course is a capita selecta with special topics, including magnetic semiconductors, spintronics, superconductors, advanced magnetic materials, nano and low-dimensional materials as well as sensor and energy materials. This course is intended to develop students' insight into the development of material physics and its applications.

COURSE LEARNING OUTCOMES

No	PLO DESCRIPTION
PLO-04	Able to communicate and be responsible in applying information technology to document, store, and secure data compiled for problem solving in the field of physics expertise **[KU]**
PLO-09	Able to solve physical problems comprehensively with various alternative solutions and analyze existing physical systems and predict the potential application of physical behavior in information technology in the context of scientific development and further implementation in the field of physics expertise **[KK]**
PLO-10	Able to disseminate the results of problem studies (case studies) and physical behavior based on standard scientific principles in oral and written communication in the form of reports or scientific papers in accordance with the correct writing rules by understanding the mechanism of plagiarism and publishing it at the national or international level **[KK]**

SUB LEARNING OUTCOMES OF COURSES

No	LO Description
LO- 1	Able to explain the mechanism of charge conduction in magnetic semiconductors, provide examples of systems and their applications
LO- 2	Able to explain the symptoms *of Giant Magnetoresistance* (GMR) to the development of spintronic materials and examples
LO- 3	Able to explain the symptoms of superconductivity, classify types, examples and their development
LO- 4	Able to decipher the mechanism of 'unusual' magnetism in materials and give examples
LO- 5	Able to classify nano materials and low dimensions and their property advantages
LO- 6	Able to decipher candidate sensor materials and their development

SUBJECT

magnetic semiconductors, spintronics, superconductors, advanced magnetic materials, nano- and low-dimensional materials and sensor materials

REFERENCE	
No	**MAIN REFERENCE**
1	R.J. Singh, "Solid State Physics," Pearson: New Delhi, 2012
2	Kannan M. Krishnan, "Fundamentals and Applications of Magnetic Materials," Oxford University Press: Oxford, 2016
3	R. K. Goyal, "Nanomaterials and Nanocomposites: Synthesis, Properties, Characterization Technique, and Applications," CRC Press: Boca Raton, 2018
4	Z. Ren, Y. Lan, Q. Zhang, "Advanced Thermoelectrics: Materials, Contact, Devices, and Systems," CRC Press: Boca Raton, 2017
	SUPPORTINGREFERENCE
1	H. Ibach and H. Luth, "Solid-State Physics: An Introduction to Principles of Materials Science," Springer: New York, 2009
2	S. Blundell, "Magnetism in Condensed Matter," Oxford University Press: Oxford, 2001
3	J.F. Annett, "Superconductivity, Superfluids and Condensates," Oxford University Press: Oxford, 2004
PREREQUISITES (If applicable)	
Quantum Physics, Material Structure	

Semester Learning Plan (RPS)

Advanced Material

Week to -	Meeting to-	Learning materials
1	1	Introduction, Introduction to Semiconductors (LO- 1)
2	2	Magnetic semiconductors and their development (LO- 1)
3	3	Gejala *Giant Magnetoresistance* (GMR) dan spintronik (LO- 2)
4	4	Examples of spintronic systems and developments (LO- 2)
5	5	Symptoms of superconductivity and their classification (LO- 3)
6	6	Development of superconducting materials (LO- 3)
7	7	Project presentation 1
8	8	**Midterm Evaluation (ETS)**
9	9	Magnetism and its characterization (LO- 4)
10	10	Examples of 'unusual' magnetism and its development (LO- 4)
11	11	Nanomaterials and low dimensions: examples, their properties and advantages (LO- 5)
12	12	Development of nanotechnology and low-dimensional materials (LO- 5)
13	13	Sensor and energy material candidate (LO- 6)
14	14	Development of sensor materials and energy (LO- 6)
15	15	Project presentation 2
16	16	**End of Semester Evaluation (EAS)**

ELECTIVE COURSES IN APPLIED OPTOELECTRONICS &; EM
PRODI SARJANA FISIKA
DEPARTMENT OF PHYSICS
FSAD – ITS

CURRICULUM 2023 COURSE SYLLABUS

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER **DEPARTMENT OF PHYSICS** **STUDY PROGRAM BACHELOR (S1)**

SYLLABUS		
COURSES	Name	Optoelectronics
	Code	SF234547
	Credit	2 sks
	Semester	5

DESCRIPTION

In this course, we will discuss the interaction of light with materials in the gas, liquid or solid phase, and devices that depend on their interaction. Study materials include Light sources, Light modulation, Waveguides, photodetectors, and display devices.

COURSE LEARNING OUTCOMES

No	PLO DESCRIPTION
PLO-05	Able to understand and apply the theoretical concepts of classical physics and modern physics in depth through the identification of physical properties of a physical system. [P]
PLO-07	Able to apply relevant and cutting-edge principles, characteristics, functions, and technological applications in the field of physics and software applications. [P]

SUB LEARNING OUTCOMES OF COURSES

No	LO Description
LO- 1	Able to understand and apply the concepts of modern physical theory in depth through the identification of physical properties of a physical system related to semiconductor materials as a light source.
LO- 2	Able to understand and apply the concepts of modern physical theory in depth through identifying the physical properties of a physical system related to optical detectors
LO- 3	Able to apply the principles, characteristics, functions, and applications of relevant and cutting-edge technology in the field of physics applications, especially related to modulators and optical waveguides.
LO- 4	Able to understand and apply the concepts of modern physical theory in depth through the identification of physical properties of a physical system related to display devices in optoelectronic systems.

SUBJECT

- Semiconductors and Light Sources: Energy Bands in Conductors, Semiconductors and Insulators. Electrical conductivity, Semiconductor type, radiation emission and absorption, laser mode, Laser classification, Laser application
- Light Modulation: Light polarization, Double bias, optical activity, electro optical effect, Magneto optics, Optical acuto effect,
- Optical Wave Guide: Total inner reflection, Optical wavelength, Optical fiber, fiber optic connector, fiber optic characteristic measurement, Fiber optic material and its manufacture
- Potodetector : Detector parameters, Temperature detector, Photon device
- Perangkat Display : luminescence, tabung katode, LED, display plasma, liquid crystal display

REFERENCE	
No	**MAIN REFERENCE**
1	John Wilson & Hawkes," Optoelctronics An Introduction' Third Edition, Prentice Hall, mexico, Paris 1998
2	G. Yudoyono, dkk. "Optoelektronika", Jurusan Fisika ITS, 2001
	SUPPORTINGREFERENCE
1	Didier Decoster, J. Harari, "Optoelectronic Sensors", John Wiley & Sons, Inc., New York, 2009
2	K.Zhang D.Li,'Electromagnetic Theory for microwaves and Optoelectronics", Springer, Beijing, 1998
3	Shun Lien Chuang,"physics of Optoelectronic Devices", John Wiley & Sons, New York, 1995
PREREQUISITES (If applicable)	
Modern Physics	

Semester Learning Plan (RPS)

Optoelectronics

Week to -	Meeting to-	Learning materials
1	1	Establishment of optoelectronic systems
2	2	Light source (Electrical conductivity, Semiconductor Type)
3	3	Light source (Electrical conductivity, Semiconductor Type)
4	4	Light source (Electrical conductivity, Semiconductor Type)
5	5	Light modulation (double bias, optical activity)
6	6	Light modulation (double bias, optical activity)
7	7	Waveguide: total inner reflection; Fiber optic waveguide
8	8	**Midterm Evaluation (ETS)**
9	9	Photodetector: working principle of photodetector
10	10	Photodetector: working principle of photodetector
11	11	Photodetector: parameter detector, detector termal, detector termoelectric
12	12	Photodetector: parameter detector, detector termal, detector termoelectric
13	13	Display devices: the process of displaying signals in general
14	14	Display devices: the process of displaying signals in general
15	15	Piranti display: luminescensi, tabung katode, led, display plasma, liquid crystal display
16	16	**End of Semester Evaluation (EAS)**

CURRICULUM 2023 COURSE SYLLABUS

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER **DEPARTMENT OF PHYSICS** **STUDY PROGRAM BACHELOR (S1)**

SYLLABUS		
COURSES	Name	Fiber Optik Sensor
	Code	SF234548
	Credit	3 sks
	Semester	5

DESCRIPTION

This subject discusses the structure, mode of optical fiber and the principle of light guidance in optical fiber. The use of optical fiber as a sensor is discussed in this course, which begins with the basic concept of fiber optic sensors and the use of optical phenomena such as interference, polarization in optical sensors. The understanding of the concept of fiber optic sensor is complemented by experimental activities in the laboratory for a simple fiber optic sensor system.

COURSE LEARNING OUTCOMES

No	PLO DESCRIPTION
PLO-05	Able to understand and apply the theoretical concepts of classical physics and modern physics in depth through the identification of physical properties of a physical system. [P]
PLO-08	Able to formulate physical phenomena and problems and able to make mathematical or physical modeling / simulations in accordance with hypotheses based on the results of observations and experiments conducted. [KK]

SUB LEARNING OUTCOMES OF COURSES

No	LO Description
LO- 1	Students are able to understand and apply the concepts of modern physics theory in depth through fiber optic structures and light guidance principles.
LO- 2	Students are able to understand and apply the concepts of modern physical theory in depth through attenuation and dispersion events.
LO- 3	Able to understand fiber optic sensors based on intensity and spectrum as well as interference and polarization phenomena and use equations related to learning topics.
LO- 4	Able to make fiber optic sensor modeling through experiments conducted.

SUBJECT

- Fiber optic structure and light guidance principle
- Optical signal attenuation and dispersion
- Fiber optic sensors based on intensity and spectrum
- Fiber optic sensors based on interference, polarization, speckle, and grating
- Manufacture of fiber optic sensor systems in the laboratory

REFERENCE

No	**MAIN REFERENCE**
1	G. Keiser, “Fiber Optic Communications”, Springer, 2021
2	S. Yin, P.B. Ruffin, F.T.S Yu, “Fiber Optic Sensors”, CRC Press, 2008

	SUPPORTINGREFERENCE
1	B. Glisic, D. Inaudi, "Fibre Optic Methods for Structural Health Monitoring", John Wiley & Sons, 2007
2	M.G. Kuzyk, "Polymer Fiber Optics", Taylor & Francis, 2007
PREREQUISITES (If applicable)	
Gelombang	

Semester Learning Plan (RPS)

Fiber Optik Sensor

Week to -	Meeting to-	Learning materials
1	1	The Nature of Light; Basic laws and definitions of Optics
2	2	Fiber Optic and Moda configuration; Mode on Circular Waveguides
3	3	Single-Mode Fibers; Graded-Index Fibers; Optical Fiber Materials
4	4	**Evaluation 1**; Fiber optic structure and light guidance principle
5	5	fiber attenuation; Effects of Optical Signal Dispersion
6	6	Desain dan Karakteristik SFMs; Character of Multicore Optical Fibers
7	7	Basic Concept and Fiber Optic Sensor Based on Intensity and Spectrum
8	8	**Evaluation 2**; Optical Signal Attenuation and Dispersion
9	9	Fiber Optik Sensor Berdasar Interferometrik; Sensor Polarimetrik; Formasi Fiber Speklegram; Respon Spektral; Multiplexing dan Demultiplexing; Analisa Coupled-Mode; Spekelgram; Fiber Bragg Grating Sensors
10	10	Fiber Optik Sensor Berdasar Interferometrik; Sensor Polarimetrik; Formasi Fiber Speklegram; Respon Spektral; Multiplexing dan Demultiplexing; Analisa Coupled-Mode; Spekelgram; Fiber Bragg Grating Sensors
11	11	Fiber Optik Sensor Berdasar Interferometrik; Sensor Polarimetrik; Formasi Fiber Speklegram; Respon Spektral; Multiplexing dan Demultiplexing; Analisa Coupled-Mode; Spekelgram; Fiber Bragg Grating Sensors
12	12	**Evaluation 3**; Fiber Optic Sensor Based on Interference, Polarization, Speckle, and Grating
13	13	Manufacture of fiber optic sensor systems in the laboratory
14	14	Manufacture of fiber optic sensor systems in the laboratory
15	15	Manufacture of fiber optic sensor systems in the laboratory
16	16	**End of Semester Evaluation (EAS)**

CURRICULUM 2023 COURSE SYLLABUS

INSTITUT TEKNOLOGI SEPULUH NOPEMBER
DEPARTMENT OF PHYSICS
STUDY PROGRAM BACHELOR (S1)

SYLLABUS

COURSES	Name	Photonics
	Code	SF234549
	Credit	3 sks
	Semester	5

DESCRIPTION

In this course, students will learn about light reflection and refraction, anisotropic media, liquid crystals, one-, two-, and three-dimensional photonic crystals. Planar waveguide, two-dimensional waveguide, photonic crystal waveguide, optical coupling inside waveguide; Interaction of light with sound, acusto-optical devices, anisotropic media acusto-optics. In addition, students will learn the principles of electro-optics, electro-optics of anisotropic media, electro-optics of liquid crystals, photo-refractivity, electro-absorption.

COURSE LEARNING OUTCOMES

No	PLO DESCRIPTION
PLO-05	Able to understand and apply the theoretical concepts of classical physics and modern physics in depth through the identification of physical properties of a physical system. [P]
PLO-07	Able to apply relevant and cutting-edge principles, characteristics, functions, and technological applications in the field of physics and software applications. [P]

SUB LEARNING OUTCOMES OF COURSES

No	LO Description
LO- 1	Students are able to explain the concept of planar wave guide
LO- 2	Students are able to explain the concept of coupling on two wave guides
LO- 3	Students are able to explain the concept of acusto-optical devices
LO- 4	Students are able to explain the concept of electro-optical devices
LO- 5	Students are able to explain the concept of EM wave propagation in anisotropic medium

SUBJECT

- Planar Waveguide: Review of EM waves; Planar optical waveguide; Guided Mode; Wave propagation on planar optical waveguides
- Coupling on two waveguides: Coupled Mode Theory ;D Optical on Directional Coupler; Effective influx method
- Optical Acusto Device: The interaction of light with sound; Akusto optical effect; Bragg diffraction; Effectiveness
- Electro-Optical Device: Pokels effect and Kerr effect; electrooptical modulator; Intensity modulator; Directional Coupler (DC)
- Anisotropic Medium: Susceptibility of Anisotropic Crystals; EM Wave Propagation in Anisotropic Medium

REFERENCE

No	**MAIN REFERENCE**
1	Bahaa E.A. Saleh and Malvin Carl Teich, “Fundamentals of Photonics”, 3th Ed., A John Wiley & Sons, Inc Publication, New Jersey, 2019.

2	Keico iizuka, "Elements of Photonics", Vol. I & II, A John Wiley & Sons, Inc Publication, New York, 2002.
3	Tamir,T.,"Guided-wave Optoelectronics", Springer-Verlag, Berlin, 1990.
	SUPPORTINGREFERENCE
1	Hunspenger,R.G., "Integrated Optics: Theory and Technology", 6th Ed, Springger-Verlag Berlin, 2009.
2	Amnon Yariv, "Optical Electronics", 4th Ed.,Harcourt Brace Jovanoviel College Publishers, New York, 1991.
PREREQUISITES (If applicable)	
Gelombang	

Semester Learning Plan (RPS)

Photonics

Week to -	Meeting to-	Learning materials
1	1	Review of EM waves; Planar optical waveguide; Guided Mode
2	2	Review of EM waves; Planar optical waveguide; Guided Mode
3	3	Wave propagation on planar optical waveguides
4	4	Wave propagation on planar optical waveguides
5	5	Coupling on two waveguides: Coupled Mode Theory ;D Optical on Directional Coupler; Effective influx method
6	6	Coupling on two waveguides: Coupled Mode Theory ;D Optical on Directional Coupler; Effective influx method
7	7	The interaction of light with sound; Akusto optical effect; Bragg diffraction; Effectiveness
8	8	**Midterm Evaluation (ETS)**
9	9	Akusto optical effect; Bragg diffraction; Effectiveness
10	10	Electro-Optical Device: Pokels effect and Kerr effect; electrooptical modulator; Intensity modulator; Directional Coupler (DC)
11	11	Electro-Optical Device: Pokels effect and Kerr effect; electrooptical modulator; Intensity modulator; Directional Coupler (DC)
12	12	Electro-Optical Device: Pokels effect and Kerr effect; electrooptical modulator; Intensity modulator; Directional Coupler (DC)
13	13	Anisotropic Medium: Susceptibility of Anisotropic Crystals; EM Wave Propagation in Anisotropic Medium
14	14	Anisotropic Medium: Susceptibility of Anisotropic Crystals; EM Wave Propagation in Anisotropic Medium
15	15	Anisotropic Medium: Susceptibility of Anisotropic Crystals; EM Wave Propagation in Anisotropic Medium
16	16	**End of Semester Evaluation (EAS)**

CURRICULUM 2023 COURSE SYLLABUS

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER **DEPARTMENT OF PHYSICS** **STUDY PROGRAM BACHELOR (S1)**

SYLLABUS		
COURSES	Name	Antenna and Propagation
	Code	SF234650
	Credit	2 sks
	Semester	6

DESCRIPTION

In this course, students will learn about Maxwell's theory in more detail in calculating wave parameters in transmission lines. Students will learn to understand the polarization of EM waves, the propagation of EM waves in waveguides and calculate several attenuation factors in EM wave propagation due to the curvature of the earth's surface. Students will learn several applications of EM waves: antennas, microstrips, radar, fiber optics, and satellite technology.

COURSE LEARNING OUTCOMES

No	PLO DESCRIPTION
PLO-06	Able to apply the principles and applications of mathematical physics, computational physics, and instrumentation both in how to operate physical instruments in general and analyze data and information from these instruments. [P]
PLO-07	Able to apply relevant and cutting-edge principles, characteristics, functions, and technological applications in the field of physics and software applications. [P]
PLO-08	Able to formulate physical phenomena and problems and able to make mathematical or physical modeling / simulations in accordance with hypotheses based on the results of observations and experiments conducted. [KK]

SUB LEARNING OUTCOMES OF COURSES

No	LO Description
LO- 1	Able to apply physical principles and technological applications, and able to formulate based on observations and experiments related to wave parameters in transmission lines
LO- 2	Able to apply physical principles and technological applications, and able to formulate based on observations and experiments related to impedance calculations with Gaftar Smith (Smith Chart), impedance matching, and quarter wavelength utilization
LO- 3	Able to apply physical principles and technological applications, and able to formulate based on observations and experiments related to the polarization of EM waves and the introduction of Poincare spheres
LO- 4	Able to apply physical principles and technological applications, and able to formulate based on observations and experiments related to EM wave propagation on waveguides
LO- 5	Able to apply physical principles and technological applications, and able to formulate based on observations and experiments related to the attenuation factor of EM wave propagation due to the curvature of the earth's surface

LO- 6	Able to apply physical principles and technological applications, and able to formulate based on observations and experiments related to several EM wave applications
SUBJECT	
• Calculates the wave parameters in the transmission line (propagation constant and impedance) of the Maxwell equation derivation • Calculating impedance with Gaftar Smith (Smith Chart): Single and Double Stub, Matching impedance, and quarter wavelength utilization • EM wave polarization and Poincare ball introduction • EM wave propagation on waveguides • Calculate several attenuation factors in EM wave propagation due to curvature of the earth's surface • Some applications of EM waves: antennas, microstrips, radar, fiber optics, and satellite technology	
REFERENCE	
No	**MAIN REFERENCE**
1	R. E. Collins, Antennas and Radio Wave Propagation, Mc.Graw-Hill Int, 1985
	SUPPORTINGREFERENCE
1	S. Y. Liao, Engineering Applications of Electromagnetic Theory, Info Acces Dist, 1992
2	J. D. Kraus, Electromagnetics, Mc.Graw-Hil, 4th.ed, 1992
PREREQUISITES (If applicable)	
While the European Championships	

Semester Learning Plan (RPS)

Antenna and Propagation

Week to -	Meeting to-	Learning materials
1	1	Calculating wave parameters in a transmission line from Maxwell's equations
2	2	Calculating Impedance with Smith Chart: Single and Double Stub
3	3	Matching impedance dan pemanfaatan quarter wavelength
4	4	EM wave polarization and Poincare ball introduction
5	5	EM wave propagation on waveguides
6	6	EM wave propagation on waveguides
7	7	Some attenuation factors of EM wave propagation due to curvature of the earth's surface
8	8	**Midterm Evaluation (ETS)**
9	9	Application of EM waves on antennas
10	10	Application of EM waves on antennas
11	11	Application of EM waves on microstrips
12	12	Application of EM waves on microstrips
13	13	Application of EM waves on radar
14	14	Application of EM waves in optical fibers
15	15	Application of EM waves in satellite technology
16	16	**End of Semester Evaluation (EAS)**

CURRICULUM 2023 COURSE SYLLABUS

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER **DEPARTMENT OF PHYSICS** **STUDY PROGRAM BACHELOR (S1)**

SYLLABUS		
COURSES	Name	Optical and Antenna Modeling
	Code	SF234751
	Credit	3 sks
	Semester	7

DESCRIPTION

In this course, students will learn: 1. Finite Numerical and Computational Methods of Finite Difference, FDTD, and FDBPM to apply Maxwell's equations in the phenomenon of microwave propagation and optical waves in free space and in waveguides, 2. analyze and calculate the reflection and transmission coefficients of microwaves and optical waves in various structures of medium both one- and two-dimensional, 3. programming the issue of limit requirements in many cases transmission medium both PML and MURR methods, 4. integrated programming of Fourier transformations in finite difference methods to obtain reflection and transmission coefficients in the frequency domain, and 5. Calculates parameters such as the characteristic impedance of a material and the radiation pattern of power.

COURSE LEARNING OUTCOMES

No	PLO DESCRIPTION
PLO-06	Able to apply the principles and applications of mathematical physics, computational physics, and instrumentation both in how to operate physical instruments in general and analyze data and information from these instruments. [P]
PLO-09	Able to solve physics problems comprehensively with various alternative solutions and analyze existing physics systems and predict the potential application of physics behavior in information technology in the context of scientific development and further implementation in the field of physics expertise. [KK]

SUB LEARNING OUTCOMES OF COURSES

No	LO Description
LO- 1	Able to apply mathematical physics and computational physics in writing Maxwell equations in programming languages
LO- 2	Able to apply mathematical physics, computational physics, and instrumentation in optical and antenna modeling comprehensively to solve problems with electromagnetic field limit requirements
LO- 3	Able to apply mathematical physics and computational physics in writing programming languages and numerical calculations for comprehensive optical and antenna modeling
LO- 4	Able to apply mathematical physics and computational physics in optical and electromagnetic programming writing for the completion of optical and antenna models

LO- 5	Able to apply mathematical physics, computational physics, and instrumentation in optical and antenna modeling comprehensively for solving problems of making antenna structure programs
LO- 6	Able to apply mathematical physics, computational physics, and instrumentation in optical and antenna modeling comprehensively for solving problems of making optical waveguide structure programs

SUBJECT

- Review of Maxwell's equations and their writing in programming languages
- Problem of limit requirements: electric field and magnetic field in medium, lossy medium, lossless, dielectric material and conductor material
- Writing programming languages and numerical methods: differential and integral equations, ordinary and partial differential equations, Crank Nicholson method, Tridiagonal matrix, Gauss Jordan, FFT scheme, and finite difference approximation.
- Optical and electromagnetic programming writing: TE, TM, and TEM waves in linear and nonlinear materials, reflection, refraction, and transmission of optical waves in planar waveguides
- Antenna structure program creation: Microwave guide, Transmission Line, Impedance characteristics, reflection coefficient, transmission coefficient, VSWR and Radiation Pattern
- Creation of optical waveguide structure programs

REFERENCE

No	**MAIN REFERENCE**
1	William Mc. Donald, et al, Wave and Optics Simulations, The Consorcium for Upper-Level Physics Software, John Wiley & Sons INC, 1993
	SUPPORTINGREFERENCE
1	William Mc. Donald, et al, Wave and Optics Simulations, The Consorcium for Upper-Level Physics Software, John Wiley & Sons INC, 1993
2	Richard H. Enns and George C. Mc Guire, Nonlinear Physics with Mathematica for sicientists and Engineers, Birkhauser, Boston, 2001

PREREQUISITES (If applicable)

EM Field, Computational Physics

Semester Learning Plan (RPS)

Optical and Antenna Modeling

Week to -	Meeting to-	Learning materials
1	1	Review of Maxwell's equations and their writing in programming languages
2	2	Boundary requirements: electric field and magnetic field in the medium
3	3	Limit requirement questions: lossy medium, lossless, dielectric material and conductor material
4	4	Writing programming languages and numerical methods: differential and integral equations, ordinary and partial differential equations
5	5	Writing programming languages and numerical methods: Crank Nicholson method, Tridiagonal matrix, Gauss Jordan, FFT scheme, and finite difference approach
6	6	Optical and electromagnetic programming writing: TE, TM, and TEM waves in linear and nonlinear materials
7	7	Optical and electromagnetic programming writing: reflection, refraction, and forwarding of optical waves in planar waveguides
8	8	**Midterm Evaluation (ETS)**
9	9	Antenna structure programming : Microwave guide
10	10	Programmatic creation of antenna structure: Transmission Line, Impedance characteristics
11	11	Programmatic creation of antenna structures : reflection coefficient, transmission coefficient, VSWR
12	12	Antenna structure program: Radiation Patterns
13	13	Creation of optical waveguide structure programs
14	14	Creation of optical waveguide structure programs
15	15	Creation of optical waveguide structure programs
16	16	**End of Semester Evaluation (EAS)**

CURRICULUM 2023 COURSE SYLLABUS

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER **DEPARTMENT OF PHYSICS** **STUDY PROGRAM BACHELOR (S1)**

SYLLABUS		
COURSES	Name	Image Processing
	Code	SF234752
	Credit	2 sks
	Semester	7

DESCRIPTION

In this course, students will learn to understand the concept of digital imagery, basic image operations, histograms, convolutions, morphology, transformation, image quality improvement, image edge detection and its application in various fields of physics, as well as being able to analyze and present a scientific article on digital image processing and its applications.

COURSE LEARNING OUTCOMES

No	PLO DESCRIPTION
PLO-06	Able to apply the principles and applications of mathematical physics, computational physics, and instrumentation both in how to operate physical instruments in general and analyze data and information from these instruments. [P]
PLO-09	Able to solve physics problems comprehensively with various alternative solutions and analyze existing physics systems and predict the potential application of physics behavior in information technology in the context of scientific development and further implementation in the field of physics expertise. [KK]

SUB LEARNING OUTCOMES OF COURSES

No	LO Description
LO- 1	Able to apply image processing based on physical principles and use it for comprehensive solving of physics problems
LO- 2	Able to apply basic image operations to solve some physics problems comprehensively
LO- 3	Able to apply histograms, convolutions, morphology, and digital image transformation to solve several physics problems comprehensively
LO- 4	Able to apply image quality improvements to solve several physics problems comprehensively
LO- 5	Able to apply image edge detection to solve several physics problems comprehensively
LO- 6	Able to present scientific articles on image processing and its application in various fields of physics

SUBJECT

- Digital Image Concept
- Basic Operations of Digital Imagery
- Histogram Citra Digital
- Konvolusi Citra Digital
- Morfologi Citra Digital

• Transformasi Citra Digital • Digital Image Quality Improvement • Digital Image Edge Detection • Study of Digital Image Processing Scientific Articles	
REFERENCE	
No	**MAIN REFERENCE**
	Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing, Second Ed., Prentice Hall Upper Saddle River, NJ 07458
	SUPPORTINGREFERENCE
	Gabriel Cristobal, Peter Schelkens, and Hugo Thienpont, Optical and Digital Image Processing: Fundamentals and Applications, Wiley VCH
	Robert Koprowski and Zygmunt Wrobel, Image Processing in Optical Tomography Coherence Using Matlab, University of Silesia, 2011
PREREQUISITES (If applicable)	
Computational Physics	

Semester Learning Plan (RPS)

Image Processing

Week to -	Meeting to-	Learning materials
1	1	Digital Image Concept
2	2	Basic Operations of Digital Imagery
3	3	Basic Operations of Digital Imagery (advanced)
4	4	Histogram Citra Digital
5	5	Konvolusi Citra Digital
6	6	Morfologi Citra Digital
7	7	Digital Image Morphology (continued)
8	8	**Midterm Evaluation (ETS)**
9	9	Transformasi Citra Digital
10	10	Digital Image Quality Improvement
11	11	Digital Image Quality Improvement (advanced)
12	12	Digital Image Edge Detection
13	13	Digital Image Edge Detection (advanced)
14	14	Study of Digital Image Processing Scientific Articles
15	15	Study of Digital Image Processing Scientific Articles (continued)
16	16	**End of Semester Evaluation (EAS)**

INSTRUMENTATION ELECTIVE COURSES
PRODI SARJANA FISIKA
DEPARTMENT OF PHYSICS
FSAD – ITS

CURRICULUM 2023 COURSE SYLLABUS

INSTITUT TEKNOLOGI SEPULUH NOPEMBER
DEPARTMENT OF PHYSICS
STUDY PROGRAM BACHELOR (S1)

SYLLABUS

COURSES	Name	Instrumentation Physics
	Code	SF234553
	Credit	2 sks
	Semester	5

DESCRIPTION

In this course, physical phenomena, blog schemes, electrical measurement diagrams, electrical measuring instruments, direct and alternating electric currents will be studied. In addition, the use of each electronic component in carrying out electronic measurements, signal processing and data analysis and displaying measurement data.

COURSE LEARNING OUTCOMES

No	PLO DESCRIPTION
PLO-2	Able to study and utilize science and technology in order to apply it to the field of Physics expertise, and able to make appropriate decisions from the results of their own work or group work in the form of final project reports or other forms of learning activities whose output is equivalent to the final project through logical, critical, systematic and innovative thinking. [KU]
PLO-4	Able to communicate and be responsible in applying information technology to document, store, and secure data compiled for problem solving in the field of physics expertise. [KU]
PLO-11	Able to adapt, collaborate, create, contribute and innovate in applying science in social life and have a global perspective in its role as a global citizen, and able to use international languages. [KK]

SUB LEARNING OUTCOMES OF COURSES

No	LO Description
LO- 1	Able to perform instrument system identification
LO- 2	Able to measure electrical quantities
LO- 3	Able to understand semiconductor concepts and applications
LO- 4	Able to design signal processing systems
LO- 5	Able to understand the concept of interface and ADC/DAC conversion

SUBJECT

1. System instrument
    a. Measurement diagram blog
2. Electrical measuring instruments
    a. Current measurement
    b. Voltage measurement
    c. Power measurement
3. Rectifier Network
    a. Bahan semikonduktor
    b. Diodes and rectifiers
    c. Half-wave angler
    d. Full wave pointer

e. SMPS

4. Booster circuit
    a. Operational amplifier
    b. Integrator suite
    c. Differentiator circuit
    d. Instrumentation amplifier
5. Signal processing
6. Analog to Digital Converter/ DAC
7. Project

REFERENCE	
No	**MAIN REFERENCE**
1	Principles_and_Applications_of_Electrica
2	Sutrisno jilid 1, 2, 3
3	Instrumentation, Bachtera Indarto
	SUPPORTINGREFERENCE
PREREQUISITES (If applicable)	

Semester Learning Plan (RPS)
Instrumentation Physics

Week to -	Meeting to-	Learning materials
1	1	System instrument
2	2	Electrical measuring instruments
3	3	Current and voltage measurement
4	4	Semiconducting materials
5	5	Rectifier circuit
6	6	Operational amplifier circuit
7	7	Project 1
8	8	**Midterm Evaluation (ETS)**
9	9	Instrumentation amplifier
10	10	Analog signals and digital signals
11	11	Signal processing
12	12	ADC
13	13	DAC
14	14	Display
15	15	Final project
16	16	**End of Semester Evaluation (EAS)**

CURRICULUM 2023 COURSE SYLLABUS

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER **DEPARTMENT OF PHYSICS** **STUDY PROGRAM BACHELOR (S1)**

SYLLABUS		
COURSES	Name	Sensors and Transducers
	Code	SF234554
	Credit	2 sks
	Semester	5

DESCRIPTION

In this course, students will learn to understand the basics of sensors and transducers, sensor characteristics, understanding mechanical sensors, optical sensors, acoustic sensors, temperature sensors, chemical sensors and material sensors.

COURSE LEARNING OUTCOMES

No	PLO DESCRIPTION
PLO-02	Students are able to study and utilize science and technology in order to apply it to certain areas of expertise, and are able to make appropriate decisions from their own work or group work in the form of final project reports or other forms of learning activities whose output is equivalent to the final project through logical, critical, systematic and innovative thinking.
PLO-06	Students are able to apply the principles and applications of mathematical physics, computational physics, and instrumentation both in how to operate physical instruments in general and analyze data and information from instrumentation
PLO-07	Students are able to apply relevant and cutting-edge principles, characteristics, functions, and technology applications in the field of physics and software applications

SUB LEARNING OUTCOMES OF COURSES

No	LO Description
LO- 1	Students are able to understand the basics of sensors and transducers
LO- 2	Students are able to understand the characteristics of sensors
LO- 3	Students are able to understand about mechanical sensors
LO- 4	Students understand about optical sensors
LO- 5	Students understand about acoustic sensors
LO- 6	Students understand about temperature sensors
LO- 7	Students understand about chemical sensors
LO- 8	Students understand about material sensors

SUBJECT

- Sensor and transducer basics
- Sensor characteristics
- Sensor mekanik: LVDT, strain gauge, load cell
- Sensor optics:
- Sensor akustik:
- Temperature sensor:
- Sensor kimia:
- Sensor material:

REFERENCE	
No	**MAIN REFERENCE**
1	Sensors Handbook, second Edition, Sabrie Solomon, Mc Graw Hill
2	Handbook of Modern Sensors: Physics, Design, and Applications Fourth Edition, Jacob Fraden, Springer
PREREQUISITES (If applicable)	
Elektronika	

Semester Learning Plan (RPS)

Sensors and Transducers

Week to -	Meeting to-	Learning materials
1	1	Introduction (Course contract), basics of sensors and transducers
2	2	Sensors and transducers
3	3	Sensor characteristics
4	4	Sensor Mekanik: LVDT, Load cell
5	5	Sensor Mekanik: Potensiometer, Strain Gauge
6	6	Sensor Optics:
7	7	Sensor Optics:
8	8	**Midterm Evaluation (ETS)**
9	9	Sensor Akustik
10	10	Sensor Akustik
11	11	Temperature Sensor:
12	12	Temperature Sensor:
13	13	Sensor Kimia:
14	14	Sensor Kimia:
15	15	Sensor Material:
16	16	**End of Semester Evaluation (EAS)**

CURRICULUM 2023 COURSE SYLLABUS

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER **DEPARTMENT OF PHYSICS** **STUDY PROGRAM BACHELOR (S1)**

SYLLABUS

COURSES	Name	Renewable energy
	Code	SF234555
	Credit	2 sks
	Semester	5

DESCRIPTION

Discusses the types of renewable energy, visibility, calculation, utilization, installation systems, energy storage.

COURSE LEARNING OUTCOMES

No	PLO DESCRIPTION
PLO-02	Able to study and utilize science and technology in order to apply it to the field of Physics expertise, and able to make appropriate decisions from the results of their own work or group work in the form of final project reports or other forms of learning activities whose output is equivalent to the final project through logical, critical, systematic and innovative thinking. [KU]
PLO-06	Students are able to apply the principles and applications of mathematical physics, computational physics, and instrumentation both in how to operate physical instruments in general and analyze data and information from instrumentation
PLO-11	Able to adapt, collaborate, create, contribute and innovate in applying science in social life and have a global perspective in its role as a global citizen, and able to use international languages. [KK]

SUB LEARNING OUTCOMES OF COURSES

No	LO Description
LO- 1	Able to identify potential scattered energy sources
LO- 2	Able to convert renewable energy into electrical energy
LO- 3	Able to calculate the potential and needs of electrical power
LO- 4	Able to build installations and transmission of electrical energy

SUBJECT

- Types of renewable energy
- Energy conversion
- Energy calculation
- Installation system
- Energy storage system: Battery, capacitor

REFERENCE

No	**MAIN REFERENCE**
1	
2	
	SUPPORTINGREFERENCE
1	
2	

PREREQUISITES (If applicable)

Semester Learning Plan (RPS)

Renewable Energy

Week to -	Meeting to-	Learning materials
1	1	Explanation of the meaning of renewable energy and types
2	2	NRE Potential
3	3	Impact
4	4	Physical to Electric Conversion
5	5	Rating 1
6	6	Types of conversions
7	7	Case study 1
8	8	**Midterm Evaluation (ETS)**
9	9	Calculation of electrical potential
10	10	Load calculation
11	11	Installation System
12	12	Storage
13	13	Electricity Conversion (DC/AC)
14	14	Transmission
15	15	Case study 2
16	16	**End of Semester Evaluation (EAS)**

CURRICULUM 2023 COURSE SYLLABUS

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER **DEPARTMENT OF PHYSICS** **STUDY PROGRAM BACHELOR (S1)**

SYLLABUS

COURSES	Name	Building Physics
	Code	SF234556
	Credit	2 sks
	Semester	5

DESCRIPTION

This paper aims to provide an understanding of Physical phenomena in buildings which include aspects of lighting, thermal, electrical and fire hazards.

COURSE LEARNING OUTCOMES

No	PLO DESCRIPTION
PLO-02	Able to study and utilize science and technology in order to apply it to the field of Physics expertise, and able to make appropriate decisions from the results of their own work or group work in the form of final project reports or other forms of learning activities whose output is equivalent to the final project through logical, critical, systematic and innovative thinking. [KU]
PLO-07	Able to apply relevant and cutting-edge principles, characteristics, functions, and technological applications in the field of physics and software applications. [P]
PLO-11	Able to adapt, collaborate, create, contribute and innovate in applying science in social life and have a global perspective in its role as a global citizen, and able to use international languages. [KK]

SUB LEARNING OUTCOMES OF COURSES

No	LO Description
LO- 1	Students are able to understand physics concepts in buildings
LO- 2	Able to understand the concept of lighting in buildings
LO- 3	Able to design and calculate lighting and electrical systems in buildings
LO- 4	Able to understand and analyze ventilation systems in buildings
LO- 5	Able to analyze potential and fire protection in buildings

SUBJECT

- Scope of Building Physics
- Lighting System
- Electricity in buildings
- Ventilation system (airing)
- Fire protection

REFERENCE

No	**MAIN REFERENCE**
1	
2	
	SUPPORTINGREFERENCE

PREREQUISITES (If applicable)

Semester Learning Plan (RPS)

Building Physics

Week to -	Meeting to-	Learning materials
1	1	Development: The Scope of Building Physics
2	2	Lighting concept, amount of lighting
3	3	Color rendering index, color temperature index
4	4	Types of lighting: Natural lighting and Artificial lighting
5	5	Indoor lighting planning
6	6	Lighting case studies
7	7	Electricity in Buildings: quantities and calculations; Cable type & type
8	8	**Midterm Evaluation (ETS)**
9	9	Ventilation system Magnitude Physics in the ventilation system
10	10	Types of ventilation systems: natural and artificial ventilation
11	11	System HVAC (Heat Ventilation and Air Conditioning)
12	12	Air conditioning system case study
13	13	Fire protection: definition of flash over, triple helix concept in fire
14	14	Ventilation system Magnitude Physics in the ventilation system
15	15	Review materi
16	16	**End of Semester Evaluation (EAS)**

CURRICULUM 2023 COURSE SYLLABUS

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER **DEPARTMENT OF PHYSICS** **STUDY PROGRAM BACHELOR (S1)**

SYLLABUS		
COURSES	Name	Fisika Akustik
	Code	SF234657
	Credit	2 sks
	Semester	6

DESCRIPTION

In this course, students will learn to understand the acoustic scope, acoustic magnitude, hearing mechanism, room acoustics, acoustic materials and noise.

COURSE LEARNING OUTCOMES

No	PLO DESCRIPTION
PLO-2	Able to study and utilize science and technology in order to apply it to certain areas of expertise, and able to make appropriate decisions from the results of their own work or group work in the form of final project reports or other forms of learning activities whose output is equivalent to the final project through logical, critical, systematic and innovative thinking
PLO-4	Able to communicate and be responsible in applying information technology to document, store, and secure data compiled for problem solving in the field of physics expertise
PLO-10	Able to disseminate the results of problem studies (case studies) and physical behavior based on standard scientific principles in oral and written communication in the form of reports or scientific papers in accordance with the correct writing rules by understanding the mechanism of plagiarism and publishing it at the national or international level

SUB LEARNING OUTCOMES OF COURSES

No	LO Description
LO- 1	Able to know about acoustic scopes
LO- 2	Able to explain some basic acoustic quantities
LO- 3	Able to calculate and complete case studies related to decibel magnitude and decibel addition
LO- 4	Able to explain sound attenuation due to distance
LO- 5	Able to explain auditory mechanisms, loudness, audiometry, and hearing defects
LO- 6	Able to explain about room acoustics, sound propagation in space, reflection, sound absorption, drone time and sound isolation
LO- 7	Able to explain related acoustic materials
LO- 8	Able to explain the nature of noise, noise sources, the influence of noise and noise control

SUBJECT

- scope akustik
- besaran dasar akustik
- Decibel magnitude and decibel sum
- attenuation of sound due to distance

• Hearing mechanisms, loudness, audiometry, and hearing defects • Chamber acoustics, indoor sound propagation, reflection, sound absorption, drone timing and sound isolation • material akustik • The nature of noise, noise sources, the influence of noise and noise control	
REFERENCE	
No	**MAIN REFERENCE**
1	L.L.Beranek, " Acoustics ", McGrawHill, London, 1954
2	B.J.Smith, R.J.Peters, S.Owen, "Acoustics and Noise Control ", Addison Wesley Longman Ltd, England, 1996
3	L.L.Doelle, "Environmental Acoustics ", McGrawHill, NewYork, 1972
4	M.D.Egan, "Architectural Acoustics ", McGrawHill, New York, 1988
	SUPPORTINGREFERENCE
1	*L.K.Irvine, R.L.Richards, "Acoustics and Noise Control Handbook for Architects and Builders ", Krieger Publishing Co, Florida, 1998*
2	*M.Mehta, J.Johnson, J.Rocafort, "Architectural Acoustics ", Prentice Hall, New Jersey, 1999*
3	*A.B.Lawren*Halliday, Resnic, Jearl Walker; 'Fundamental of Physics'. John Wiley and Sons, 10th ed, New York, 2014
PREREQUISITES (If applicable)	
Gelombang	

Semester Learning Plan (RPS)

Fisika Akustik

Week to -	Meeting to-	Learning materials
1	1	Introduction (Course contract), Acoustic scope
2	2	Besaran dasar akustik Frequency and SPL, sound wave propagation
3	3	Decibel magnitude and decibel sum
4	4	Attenuation of sound due to jara
5	5	Case study 1
6	6	Hearing, Hearing mechanism, loudness
7	7	Audimetry & hearing defects, hearing threshold shift
8	8	**Midterm Evaluation (ETS)**
9	9	Room Acoustics (Indoor sound propagation; reflection, sound absorption)
10	10	Room acoustics (drone time, sound isolation)
11	11	Material akustik(absorber, reflector, diffuser)
12	12	Case study measuring absorbs and transmission loss coefficients
13	13	Noise is inherent, noise sources
14	14	Noise Influence of noise and noise control
15	15	Project discussion
16	16	**End of Semester Evaluation (EAS)**

CURRICULUM 2023 COURSE SYLLABUS

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER **DEPARTMENT OF PHYSICS** **STUDY PROGRAM BACHELOR (S1)**

SYLLABUS		
COURSES	Name	Data control and analysis systems
	Code	SF234758
	Credit	3 SKS
	Semester	7

DESCRIPTION
In this course, students learn the basics of control systems, how to work and analyze the data generated.

COURSE LEARNING OUTCOMES	
No	PLO DESCRIPTION
PLO-2	Able to study and utilize science and technology in order to apply it to the field of Physics expertise, and able to make appropriate decisions from the results of their own work and group work in the form of final project reports or other forms of learning activities whose output is equivalent to the final project through logical, critical, systematic and innovative thinking
PLO-4	Able to communicate and be responsible in applying information technology to document, store, and secure data compiled for problem solving in the field of physics expertise
PLO-6	Able to apply the principles and applications of mathematical physics, computational physics, and instrumentation both in how to operate physical instruments in general and analyze data and information from these instruments.
PLO-7	Able to apply relevant and cutting-edge principles, characteristics, functions, and technological applications in the field of physics and software applications.

SUB LEARNING OUTCOMES OF COURSES	
No	LO Description
LO- 1	Students are able to understand the meaning of microcontrollers and their differences with microprocessors and understand the basic architecture of microprocessors, process mechanisms, and their constituent logic components
LO- 2	Students are able to understand various forms of observation, instruction sets and microprocessor standard opcodes, and are able to analyze work processes that occur and compile and evaluate basic microprocessor programs.
LO- 3	Students are able to understand the architecture of AVR microcontrollers and Arduino platforms and are able to understand memory maps, register status, and AVR microcontroller I/O ports.
LO- 4	Students are able to design and create a series of simple applications (simple projects*) and are able to analyze the working principles of a series of applications based on microcontroller systems.*
LO- 5	Students are able to know, understand and analyze the types of control systems both conventional and modern
LO- 6	Students are able to solve problems related to mathematical modeling of control systems, mathematical modeling for mechanical, electrical, fluid and thermal systems, as well as transient response analysis, root positioning method, stability analysis, frequency analysis, space-state analysis, control system design with root positioning method and control system design with frequency response method

LO- 7	Students are able to understand the types and types of PID, PLC and Fuzy Logic controls
LO- 8	Students are able to analyze digital data from the controls used

SUBJECT

Introduction to microcontroller technology, AVR microcontroller architecture and Arduino Platform, AVR microcontroller I/O registers and ports, Instruction Set on AVR microcontroller, Arduino Board and Interface Concepts, Arduino Interrupt Programming, Timer and Counter AVR microcontroller, Arduino-based simple project suite; Students will learn about the principles and working mechanisms of microprocessor systems, how microprocessors perform operations, translation of program code, and execution of program lines. It will also learn about control signals and microprocessor interfaces with memory and I/O systems in data exchange. There is also a comparison between the processor used in x86-based computers/PCs with ARM-based embedded systems. In addition, material was also given about the device interface between the microprocessor and supporting peripherals in the computer system and the form of signals, such as memory, basic I/O, communication, DMA, and Interruptions.

Introduction to control systems, mathematical background: matrix and laplace transformation, mathematical modeling of control systems, mathematical modeling for mechanical, electrical, fluid and thermal systems, transient response analysis, root positioning method, stability analysis, response-frequency analysis, space-state analysis, control system design with root positioning method and control system design with frequency response method.

REFERENCE

No	**MAIN REFERENCE**
1	Douglas V Hall. Microprocessor and Interfacing. Prentice Hall
2	Barry B. Brey. The Intel Microprocessor: Architecture, Programming, and Interfacing. Prentice Hall
3	Ogata, K., "Modern Control Engineering, 4th edition", Prentice Hall, 2010
4	R. C. Dorf and R.H. Bishop., "Modern Control System, 12th editiom", Prentice Hall, 2010.
	SUPPORTINGREFERENCE
5	J.-S.R.Jang, C-T. Sun, E. Mizutani, Neuro-Fuzzy and Soft Computing, Prentice Hall International, Inc, 2014
6	Satish Kumar, Neural Networks: A Classroom Approach, Mc.Graw Hill, 2005

PREREQUISITES (If applicable)

Semester Learning Plan (RPS)

Data control and analysis systems

Week to -	Meeting to-	Learning materials
1	1	Introduction to microcontroller technology Introduction to control technology
2	2	AVR microcontroller architecture and Arduino Platform
3	3	AVR micro-experiment
4	4	Instruction Set on AVR microcontroller, Arduino Board and Interface Concept
5	5	Arduino Interrupt Programming, AVR Microcontroller Timer and Counter, Simple application suite, program code translation, and program line execution
6	6	Use of sensors and actuators in micro systems
7	7	Simple project experiments
8	8	**Project 1**
9	9	Control system technology
10	10	Open LOOP and Closed LOOP control systems
11	11	PID control system
12	12	PID control optimization programming
13	13	Simple control experiment
14	14	PLC control system dan Fuzy Logic
15	15	Analyzes date
16	16	**Project 2**

CURRICULUM 2023 COURSE SYLLABUS

INSTITUT TEKNOLOGI SEPULUH NOPEMBER
DEPARTMENT OF PHYSICS
STUDY PROGRAM BACHELOR (S1)

SYLLABUS

COURSES	Name	Electroacoustics
	Code	SF234759
	Credit	2 SKS
	Semester	7

DESCRIPTION

This course aims to provide an understanding of sound physics phenomena through an Electronics approach.

COURSE LEARNING OUTCOMES

No	PLO DESCRIPTION
PLO-2	Able to study and utilize science and technology in order to apply it to the field of Physics expertise, and able to make appropriate decisions from the results of their own work or group work in the form of final project reports or other forms of learning activities whose output is equivalent to the final project through logical, critical, systematic and innovative thinking. [KU]
PLO-7	Able to apply relevant and cutting-edge principles, characteristics, functions, and technological applications in the field of physics and software applications. [P]
PLO-11	Able to adapt, collaborate, create, contribute and innovate in applying science in social life and have a global perspective in its role as a global citizen, and able to use international languages. [KK]

SUB LEARNING OUTCOMES OF COURSES

No	LO Description
LO- 1	Students are able to understand the concept of sound sources
LO- 2	Able to approach calculations and their application sound sources
LO- 3	Able to design sound sources and control sound

SUBJECT

- **Acoustic mechano circuit**: An explanation of the electro mechano acoustics circuit
- **Helmhots Resonator** : and sound propagation in free space
- **Microphone**: explains the working principle of the microphone, types, types and characteristics of the microphone
- **Speaker** : explains the working principle of the speaker, usability and response as well as the directness factor of the speaker
- **Horn Loudspeaker:**
- **Radiation**
- **Speaker enclouser** : explains the design concept of speakers in the Box.

REFERENCE

No	MAIN REFERENCE
1	L.L.Beranek, " Acoustics ", McGrawHill, London, 1954
2	B.J.Smith, R.J.Peters, S.Owen, "Acoustics and Noise Control ", Addison Wesley Longman Ltd, England, 1996

3	L.L.Doelle, ″Environmental Acoustics ″, McGrawHill, NewYork, 1972
	M.D.Egan, ″Architectural Acoustics ″, McGrawHill, New York, 1988
	SUPPORTINGREFERENCE
	L.K.Irvine, R.L.Richards, "Acoustics and Noise Control Handbook for Architects and Builders ", Krieger Publishing Co, Florida, 1998
	*A.B.Lawren*Halliday, Resnic, Jearl Walker; 'Fundamental of Physics'. John Wiley and Sons, 10th ed, New York, 2014
PREREQUISITES (If applicable)	

Semester Learning Plan (RPS)

Electroacoustics

Week to -	Meeting to-	Learning materials
1	1	Application: scope of electroacoustics
2	2	Electro-mechano-acoustic circuit
3	3	Acoustic, Mechanical, Electronic Components
4	4	Resonator circuit
5	5	Acoustic Instrumentation
6	6	Acoustic Instrumentation
7	7	Case study 1
8	8	**Midterm Evaluation (ETS)**
9	9	Acoustic Sensors and Transducers
10	10	Mikrophone
11	11	Loudspeaker
12	12	Enclosed indoor speakers
13	13	Sound radiation
14	14	Sound source direction factor
15	15	Case study 2
16	16	**End of Semester Evaluation (EAS)**

ELECTIVE COURSES IN GEOPHYSICS
PRODI SARJANA FISIKA
DEPARTMENT OF PHYSICS
FSAD – ITS

CURRICULUM 2023 COURSE SYLLABUS

INSTITUT TEKNOLOGI SEPULUH NOPEMBER
DEPARTMENT OF PHYSICS
STUDY PROGRAM BACHELOR (S1)

SYLLABUS

COURSES	Name	Geoelectric Exploration
	Code	SF234560
	Credit	2 credits
	Semester	5

DESCRIPTION

This Geoelectric and Electromagnetic Exploration **course** studies the basic concepts, observation, data analysis, and interpretation of geoelectric methods (resistivity, self-potential, and induced polarization) and electromagnetic-based methods (magnetotelluric, control sourced magnetotelluric, very low frequency, ground penetrating radar, transient electromagnetic, and others).

COURSE LEARNING OUTCOMES

No	PLO DESCRIPTION
PLO-6	Able to apply the principles and applications of mathematical physics, computational physics, and instrumentation both in how to operate physical instruments in general and analyze data and information from these instruments.
PLO-7	Able to apply relevant and cutting-edge principles, characteristics, functions, and technological applications in the field of physics and software applications.
PLO-8	Able to formulate physical phenomena and problems and able to make mathematical or physical modeling / simulations in accordance with hypotheses based on the results of observations and experiments conducted.
PLO-10	Able to disseminate the results of problem studies (case studies) and physical behavior based on standard scientific principles in oral and written communication in the form of reports or scientific papers in accordance with the rules of correct writing by understanding the mechanism of plagiarism and publishing it at the national or international level.

SUB LEARNING OUTCOMES OF COURSES

No	LO Description
LO- 1	Able to explain the properties of rock electricity related to geoelectric methods (resistivity, SP and IP)
LO- 2	Able to understand the weaknesses and advantages of each geoelectric method (resistivity, SP and IP)
LO- 3	Able to explain the principles of measurement, data analysis and interpretation of each geoelectric method (resistivity, SP and IP)
LO- 4	Able to investigate the subsurface conditions of the earth through measurement, data analysis, and interpretation of geoelectric data (resistivity, SP and IP)

SUBJECT

- **Geoelectric method:** basic principles of Geoelectric method, electrical basis of rocks, Ohm's Law and Archie's Law
- **Resistivity Methods: Resistance and Resistivity, current propagation in homogeneous and inhomogeneous mediums, electrode configuration, Electrode configuration characteristics, apparent resistivity, Vertical Electrical Sounding (VES) observation, VES data analysis and interpretation, VES ambiguity, Mapping resistivity, tomography resisivity measurement (2-D**

and 3-D), data analysis and interpretation of resistivity tomography, measurement of anisotropy on resistivity, data analysis, and interpretation.

- **Self-potential (SP):** basic concepts, data observation, data correction, data filtering, data analysis and interpretation.
- **Induced Polarisation (IP):** basic concepts, measurement, data analysis, and interpretation.

REFERENCE

No	**MAIN REFERENCE**
1	Zhdanov, M.S., Keller, G.V., 1994, The Geoelectrical Methods in Geophysical Exploration, Elsevier.
2	Revil, A., Jardani, A., 2013, The self-potential method : theory and applications in environmental geosciences, Cambridge University Press
3	Reynolds, J.M., 1997, An Introduction to Applied and Environmental Geophysics, Wiley
4	Telford, W.M., Geldart, L.P., Sheriff, R.E., 1990, Applied Geophysics (2nd edition), Cambridge
	SUPPORTINGREFERENCE
1	Everett, M.E., 2013, Near-surface applied geophysics, Cambridge University Press
2	Hauck, C., Kneisel, C., 2008, Applied geophysics in periglacial environments, Cambridge University Press

PREREQUISITES (If applicable)

1. Mathematical Physics I and II
2. Elektronika

Semester Learning Plan (RPS)
Geoelectric Exploration

Week to -	Learning materials
1	**Introduction to Geoelectric Methods**: Basic Principles of Geoelectric Methods, Electrical basis of rocks and Archie's Law, Division of geoelectric methods
2	**Resistivity Method:** Basic principle of resistivity method, EquiPotential, Principle of Subsurface Homogeneity of the Earth
3-4	**Resistivity Method**: Resistance and resistivity, Electrode Configuration (Wenner, Schlumberger, Wenner-Schlumberger, Pole-Dipole, Pole-pole, Dipole-dipole, gradient) and Geometry Factor, weaknesses and advantages of each electrode configuration, Apparent resistivity
5	**Resistivity Methods:** Vertical Electrical Sounding (VES) (1-D resistivity), Mapping resistivity, tomography resistivity (2-D and 3D), anisotropy resistivity, *datum point arrangement*
6	**1-D Resistivity Practicum and Anisotropy**: Introduction to the arrangement and displacement of electrodes of each configuration, data analysis and interpretation of field practicum results.
7	**Practicum resistivity mapping and tomography (2-D):** Introduction to the arrangement and displacement of electrodes of each configuration, data analysis and interpretation of field practicum results.
8	Midterm Evaluation (ETS)
9-10	**Self-potential (SP) method:** Basic concepts, methods of measurement, correction and filter of SP data, inversion and interpretation of SP data
11	**Practicum**: Measurement, analysis and interpretation of SP data.
12	**Induced Polarization (IP):** Basic principles of IP Method, Principle of Chargeability, Resistivity and IP differences
13	**Induced Polarization (IP):** Data Processing Techniques, 1-D and 2-D data analysis
14	**Induced Polarization (IP):** Interpretation of IP data analysis results (resistivity and chargeability), IP Method Applications (geotechnical, environmental, and mining fields)
15	**Data processing practicum and IP data interpretation**
16	**End of Semester Evaluation (EAS)**

CURRICULUM 2023 COURSE SYLLABUS

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER **DEPARTMENT OF PHYSICS** **STUDY PROGRAM BACHELOR (S1)**

SYLLABUS		
COURSES	Name	Geologi
	Code	SF234561
	Credit	2 credits
	Semester	5

DESCRIPTION

In this course, students will learn about geological theories and phenomena on Earth, ranging from rock geology, minerals to tectonism and volcanism. In this lecture, students are expected to be able to describe and explain the types and processes of rock formation, minerals in rocks, know the physical properties of rocks, and be able to read and understand geological maps.

COURSE LEARNING OUTCOMES

No	PLO DESCRIPTION
PLO-02	Able to study and utilize science and technology in order to apply it to the field of Physics expertise, and able to make appropriate decisions from the results of their own work or group work in the form of final project reports or other forms of learning activities whose output is equivalent to the final project through logical, critical, systematic and innovative thinking.
PLO-04	Able to communicate and be responsible in applying information technology to document, store, and secure data compiled for problem solving in the field of physics expertise.
PLO-10	Able to solve physical problems comprehensively with various alternative solutions and analyze existing physical systems and predict the potential application of physical behavior in information technology in the context of scientific development and further implementation in the field of physics expertise.

SUB LEARNING OUTCOMES OF COURSES

No	LO Description
LO- 1	Able to understand the concept of plate tectonics and its implementation in natural resources and disasters
LO- 2	Able to understand about the Process of Volcanism and Tectonism
LO- 3	Able to understand the content and formation of minerals and rocks
LO- 4	Able to understand the types of rock minerals.
LO- 5	Able to identify rocks either in the laboratory or field.

SUBJECT

- **Plate tectonics theory:** geological concepts, layers of the earth, the interior of the earth and its internal processes, avoiding geological hazards, *the concept of tectonic plates, the* potential of continental flotation, endogenous and exogenous processes.
- **Igneous rocks: magma, types of igneous rocks, igneous rock textures, plutons, igneous rock minerals.**
- **Metamorphic Rocks:** Factors affecting metamorphic, a type of metamorphic rock
- **Weathering processes:** mechanical weathering, chemical weathering, biological weathering, factors affecting weathering

- **Sedimentary Rocks:** Sedimentation law, Sediment formation process, sediment composition, classification of sedimentary rocks, sedimentary structure
- **Minerals:** classification of minerals, how to recognize minerals, physical properties of minerals, chemical analysis of minerals.
- **Age of Rocks:** How to find out the age of a rock, Methods for determining relative age, Order of geological time division
- **Geologic Map:** Map parts and map types

REFERENCE

No	**MAIN REFERENCE**
1	Knödel, K., Lange, G., Voigt, H.J., 2007. Environmental Geology: Handbook of Field Methods and Case Studies, Springer
2	Bell, F.G., 2007, Engineering Geology, Second Edition, Elsevier
3	Carlson, D.H., Plummer, C.C., McGeary, D., 2010, Physical Geology : Earth Revealed , 9th Edition, McGraw-Hill
4	Thompson, G.R., Turk, J., 1997, Introduction to Physical Geology, Brooks Cole
5	Rothery, D. A., 2016, Geology: A Complete Introduction. Hodder & Stoughton General Division
No	**SUPPORTINGREFERENCE**
1	Pellant, C., 2010, Rocks and Minerals, Dorling Kindersley Ltd
2	Hefferan, K., O'Brien, J., 2010, Earth Materials. Wiley-Blackwel
3	Murck, B.W., 2001, Geology: A Self-Teaching Guide, Wiley

PREREQUISITES (If applicable)

Semester Learning Plan (RPS)
Geologi

Week To-	Learning materials
1-2	**Plate tectonics theory:** geological concepts, earth layers, earth's interior and internal processes, geological hazard avoidance, *tectonic plate* concepts (divergent *boundaries, convergent* boundaries*, transform boundaries*), continental flotation (shoreline compatibility, fossil distribution, rock type similarity, ancient climate evidence, paleomagnetism), endogenous processes (magmatic activity / volcanism, earthquakes, orogenesa &; epirogenesa), processes exogenous (weathering, erosion/mass wasting sedimentation)
3-4	**Batuan** Beku: magma (Magma Basa, Magma Intermedier, Magma Asam), Batuan Beku (Ekstrusif, Intrusive), Tekstur Batuan Beku (Phanerite, Pegmatite, Aphenite, Phenocrysts, Porphyry, Glassy), Pluto (Minor: Dike, Sill, Laccolith, Major: Batholith, Xenolith, Stocks), Mineral-mineral batuan beku (plagioclase, feldspar, K-feldspar, quartz, muscovite mica, biotite mica, amphibole, olivine, dan calcite).
5	**Weathering process:** Mechanical weathering (Fracture, Crystal, Ice pressure, Effect of temperature), Chemical weathering (Hydrolysis, Oxidation, dissolution), Biological weathering (Sprouted seed, Weathering by tree roots, Hollow animals), Factors affecting weathering (Rock type and structure, Slope, Climate, Living Things, Time)
6	**Metamorphic Rocks:** Factors Influencing Metamorphism (Rock composition of origin, Temperature and pressure, Time), Types of Metamorphism (Catachlastic Metamorphism, Contact Metamorphism, Heap Metamorphism, Regional Metamorphism)
7	**Sedimentary Rocks:** Sedimentation laws (Horizontalist, Super position, Lateral continuity), Sediment formation process (Lithification, Diagenesa), Sediment composition (Fragments, Autoganic material, Allochem material), Classification of sedimentary rocks (Clastic, Non-clastic), Sedimentary Structure (Graded bedding, Cross bedding, Wave Overtime/Riplemark, Mud Cracks)
8	**Midterm Evaluation (ETS)**
9	Field Trip
10-11	**Minerals: mineral classification, How to recognize minerals (Analysis of chemical properties, Physical properties of minerals), Physical properties of minerals (Crystal form, specific gravity, fracture, Color, Hardness, streak, and Gloss / luster), chemical analysis of minerals (Silicate Minerals: Ferromagnesium and Non-ferromagnesium, Non-Silicate Minerals: Oxides, Sulfides, Carbonates and Sulfates).**
12-13	**Age of Rocks:** How to determine the age of a rock (Relative age scale, Absolute age scale), Method for determining relative age (Steno's Law: Superposition and horizontality, James Hutton: cross cutting relationship, Fossil Sequence, Inclusion Principle), Order of geological time division (Period / Eor, Period / Era, Age / Period, Kala / Epoch)
14	**Geologic Map:** Map parts (Map title, Map legend, Map scale, Coordinate line, Altitude line, Year of map creation, Declination), Map type (By scale, Based on content and function, Based on purpose)

15	Field Trip
16	**End of Semester Evaluation (EAS)**

CURRICULUM 2023 COURSE SYLLABUS

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER **DEPARTMENT OF PHYSICS** **STUDY PROGRAM BACHELOR (S1)**

SYLLABUS		
COURSES	Name	Seismology
	Code	SF234562
	Credit	2 credits
	Semester	5

DESCRIPTION

In this course, students will learn about: A brief history and insights from seismology. The concept of elasticity and the equation of continuous motion. Types of seismic waves and their character. Earthquake mechanisms and the types of faults that cause earthquakes. Working principle of seismometer. Estimation of earthquake location and size of earthquake strength. Introduction to earthquake risk mitigation analysis with applied seismology. Students are expected to be familiar with programming languages, especially MATLAB because all *code* in this course is written in MATLAB.

COURSE LEARNING OUTCOMES

No	PLO DESCRIPTION
PLO-6	Able to apply the principles and applications of mathematical physics, computational physics, and instrumentation both in how to operate physical instruments in general and analyze data and information from these instruments.
PLO-7	Able to apply relevant and cutting-edge principles, characteristics, functions, and technological applications in the field of physics and software applications.
PLO-8	Able to formulate physical phenomena and problems and able to make mathematical or physical modeling / simulations in accordance with hypotheses based on the results of observations and experiments conducted.
PLO-9	Able to solve physical problems comprehensively with various alternative solutions and analyze existing physical systems and predict the potential application of physical behavior in information technology in the context of scientific development and further implementation in the field of physics expertise.

SUB LEARNING OUTCOMES OF COURSES

No	LO Description
LO- 1	Able to understand seismological insights, elasticity concepts, and continuity equations to solve body and surface wave equations
LO- 2	Able to distinguish the characteristics of body waves (P and S) and surface waves (Rayleigh and Love)
LO- 3	Able to understand the theory of plate tectonics as well as the types of faults that can cause earthquakes.
LO- 4	Able to understand the working concept of a seismometer and determine the epicenter of an earthquake from seismic data
LO- 5	Able to understand focal mechanisms and types of earthquake magnitudes
LO- 6	Able to apply seismology for earthquake mitigation using seismic data and microtremor data

SUBJECT	
• **History and insights from seismology**: A brief explanation from the world's first seismometer to seismological applications in modern times. Exposure, aspects of seismology in the field of science and its application. • **Elasticity and continuity equations: basic concepts of stress, strain, tensor, and continuity equations.** • **Seismic waves:** The concept of body waves (P and S) and surface waves (Love and Rayleigh). • **Types of earthquakes and their mechanisms: Types** of earthquakes in terms of their causes and basic concepts of earthquake mechanisms. • **Working principle of seismometer**: basic principles of seismometer in recording seismic waves • **Earthquake location**: Determination of earthquake epicenter with seismic data • **Earthquake strength measures**: Types of earthquake magnitude and earthquake energy. • **Seismological applications**: Characterization of soil amplification due to local geological effects. • **Seismic microzoning**: The use of microtremors in the determination of the Earth's subsurface profile	
REFERENCE	
No	**MAIN REFERENCE**
1.	Stein S. and Wysession M .2003. An Introduction to Seismology, Earthquakes, and Earth Structure. Blackwell publishing.
2.	Shearer P.M. 2009. Introduction to Seismology. Cambridge University Press.
	SUPPORTINGREFERENCE
1.	Afnimar. 2009. Seismology. ITB Publisher.
2.	Pawirodikromo, W. 2012. Technical Seismology and Uproar Engineering. StudentREFERENCE
PREREQUISITES (If applicable)	
Gelombang	

Semester Learning Plan (RPS)

Seismology

Week to -	Meeting to-	Learning materials
1	1	**A brief history and aspects of seismology**: A brief description of the world's first seismometer to seismological applications in modern times. Exposure, aspects of seismology in the field of science and engineering (LO- 1)
2,3	2,3	**Elasticity and continuity equations: basic concepts of stress, strain, tensor, and continuity equations (**LO- 1)
4,5	4,5	**Seismic waves:** Concepts of body waves (P and S) and surface waves (Love and Rayleigh) (LO- 2)
6	6	**QUIZ 1**
7	7	**Types of earthquakes and mechanisms: Types** of earthquakes in terms of their causes and basic concepts of earthquake mechanisms (LO- 3)
8	8	**ETS**
9	9	**Working principle of seismometer: basic principle of seismometer in recording seismic waves (**LO- 4)
10	10	**Earthquake location**: Determination of earthquake epicenter with seismic data (LO- 4)
11	11	**QUIZ 2**
12	12	**Earthquake strength measures**: Types of earthquake magnitude and earthquake energy (LO- 5)
13,14	13,14	**Applied seismology:** Characterization of ground movement movements and local geological effects (LO- 6)
15	15	**Seismic microzoning:** Use of microtremors in the determination of the Earth's subsurface profile (LO- 6)
16	16	**EAS**

CURRICULUM 2023 COURSE SYLLABUS

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER **DEPARTMENT OF PHYSICS** **STUDY PROGRAM BACHELOR (S1)**

SYLLABUS		
COURSES	Name	Gravitational and Magnetic Exploration
	Code	SF234563
	Credit	2 SKS
	Semester	5

DESCRIPTION

This subject is a course that examines the characteristics and subsurface coating based on the gravity and magnetic values of the earth. The materials included include: gravitational field theory, newton and magnetic potential fields, principles and measurements of gravity methods, correction of gravity measurement data, rock density, magnetic field, rock susceptibility, magnetic flux, correction of magnetic measurement data, signal analysis for interpretation of gravity and magnetic data, as well as forward modeling and inversion of gravity and magnetic data.

COURSE LEARNING OUTCOMES

No	CP-MK
PLO-6	Able to apply the principles and applications of mathematical physics, computational physics, and instrumentation both in how to operate physical instruments in general and analyze data and information from these instruments.
PLO-8	Able to formulate physical phenomena and problems and able to make mathematical or physical modeling / simulations in accordance with hypotheses based on the results of observations and experiments conducted.
PLO-9	Able to solve physical problems comprehensively with various alternative solutions and analyze existing physical systems and predict the potential application of physical behavior in information technology in the context of scientific development and further implementation in the field of physics expertise.
PLO-10	Able to disseminate the results of problem studies (case studies) and physical behavior based on standard scientific principles in oral and written communication in the form of reports or scientific papers in accordance with the rules of correct writing by understanding the mechanism of plagiarism and publishing it at the national or international level.

SUB LEARNING OUTCOMES OF COURSES

No	LO Description
LO- 1	Able to understand the concept of gravitational and magnetic potentials
LO- 2	Able to correct magnetic data and measurement gravity data
LO- 3	Able to understand and apply signal analysis methods for gravity and magnetic data
LO- 4	Able to determine the position of anomalous sources of gravity and magnetic data based on signal analysis
LO- 5	Able to create subsurface models from gravity and magnetic data

SUBJECT

- Potential Theory: gravitational and magnetic potentials
- Gravity data measurement and correction: gravity data measurement system, gravity data

corrections include tidal, drift, Latitude, Free-air, Bouger, and terrain corrections.

- Magnetic data measurement and correction: magnetic method measurement system, magnetic data corrections including IGRF, drift, and flat plane corrections.
- Signal analysis on magnetic and gravity data: Fast Fourier Transform (FFT) concept, signal decomposition, separation of local and regional anomalies, *first vertical and horizontal derivatives*, second vertical derivative *(SVD), Euler deconvolution, Hilbert transform, and* reduction to pole *(RTP).*
- Forward modeling: Forward modeling for simple and complex models for gravity and magnetic data
- Inversion method: An inversion method used to generate subsurface models for gravity and magnetic data

REFERENCE

No	**MAIN REFERENCE**
1.	William J. Hinze, Ralph R. B. von Frese, Afif H. Saad, 2013, Gravity and Magnetic Exploration: Principles, Practices, and Applications, Cambridge University Press.
2.	Richard J. Blakely, 1996, Potential theory in Gravity and magnetic applications, Cambridge university
3	Kumar Roy, K., 2008, Potential theory in applied geophysics, Springer
	SUPPORTINGREFERENCE
1.	Everett, M. E. 2013. Near-surface Applied Geophysics. 2nd Edition. New York: Cambridge University Press, US. pp.1-422
2.	Reynold, J. M., 2011., An Introduction To Applied and Environmental Geophysics.

PREREQUISITES (If applicable)

Semester Learning Plan (RPS)

Gravitational and Magnetic Exploration

Week to -	Meeting to-	Learning materials
1	1	Teori Medan Gravitasi
2	2	Newton's concept of potential in gravity
3	3	Density and Gravity Measurement
4	4	Future modeling of Gravity data
5,6	5,6	Gravity Data Correction
7	7	Suceptibility and Magnetic Method
8	8	**ETS**
9	9	Potential magnetic concept and future modeling of magnetic data
10	10	Magnetic Measurement and its correction
11	11	Separation of Local and Regional Anomalies (Magnetic and Gravity Data)
12	12	Qualitative and Quantitative Interpretation of Gravity Methods
13	13	Practicum of Measurement and Analysis of Gravity Data
14	14	Qualitative and Quantitative Analysis of Magnetic Methods
15	15	Practicum Measurement and analysis of magnetic data
16	16	**EAS**

CURRICULUM 2023 COURSE SYLLABUS

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER **DEPARTMENT OF PHYSICS** **STUDY PROGRAM BACHELOR (S1)**

SYLLABUS		
COURSES	Name	Inversion Method
	Code	SF234664
	Credit	2 SKS
	Semester	6

DESCRIPTION

In this course, students are presented with the difference between inversion modeling and future modeling and explained the inversion methods to produce models along with the advantages and disadvantages of each method. Moreover, the application of the inversion method in the field of geophysics is also described. Students are expected to be familiar with programming languages, especially MATLAB because all *code* in this course is written in MATLAB.

COURSE LEARNING OUTCOMES

No	PLO DESCRIPTION
PLO-7	Able to apply relevant and cutting-edge principles, characteristics, functions, and technology applications in the field of physics and software applications
PLO-8	Able to formulate physical phenomena and problems and able to make mathematical or physical modeling / simulations in accordance with hypotheses based on the results of observations and experiments conducted.
PLO-9	Able to solve physical problems comprehensively with various alternative solutions and analyze existing physical systems and predict the potential application of physical behavior in information technology in the context of scientific development and further implementation in the field of physics expertise.

SUB LEARNING OUTCOMES OF COURSES

No	LO Description
LO- 1	Able to explain basic concepts in geophysics with the deignence of forward modeling and inversion, modeling aspects, and examples of applications of inversion methods
LO- 2	able to solve linear regression problems, statistical aspects of *the Least Squares* (L2-norm) method, *L1-norm-based regression*
LO- 3	able to describe the concepts of maximum likelihood, *resolution* and covariance model *for inversion models (under* and over determined*), mean of* non-uniqueness *models, Gaussian inversion problems* and Non-Gaussian Statistics
LO- 4	Able to formulate linear inversion problems and estimate model parameters
LO- 5	able to explain the advantages and disadvantages of linear inversion problems, inversion using several a priori, reference models, model smoothing, general forms of a priori models
LO- 6	Able to solve nonlinear inversion problems using a linear approach and the concept of model parameterization
LO- 7	able to understand the concept and completion of global optimization for nonlinear cases using *Monte Carlo, Genetic Algorithm, and Simulated Annealing*

SUBJECT	
• **Forward modeling and inversion modeling:** basic concepts in geophysics (measurement and data analysis), forward modeling and inversion, modeling aspects, and examples of application of inversion methods • **Linear Regression**: introduction to linear regression, statistical aspects of the Least Squares (L2-norm) method, unknown measurement standard deviation, L1-norm-based regression • **Probability Theory:** noise measurement, Gaussian Probability Density function, Gaussian statistics, Confidence interval • **Linear inversion problem (simple approach):** formulation of linear inversion problem, estimation of model parameters, density probability function, and its application • **Linear inversion problems**: maximum likelihood, resolution and covariance models for inversion models (under and over determined), averages of non-uniqueness models, statistics on Gaussian inversion problems and Non-Gaussian Statistics, and their applications • **Linear inversion problems using priori: advantages and disadvantages of linear inversion problems, under-determined problems, mixed-determined problems, inversions using several a priori, reference models, model smoothing, general forms of a priori models, applications;** • **Nonlinear inversion using a linear approach: model parameterization, problem inversion Nonlinear using linear approach, Gauss-Newton method, Lavemberg-Marquardt method, Occam method, nonlinear inversion using iterative method, nonlinear inversion using Singular value decomposition, and its application** • **Global optimization**: lack of nonlinear inversion using linear approaches, *Monte Carlo, Genetic Algorithm, Simulated Annealing,* and their applications	
REFERENCE	
No	**MAIN REFERENCE**
1	Menke, W., 2012. Geophysical data analysis : discrete inverse theory, 3rd Editions, Elsevier Academic Press, Palisades, New York.
2	Grandis, H., 2009. Pengantar Pemodelan Inversi Geofisika, Himpunan Ahli Geofisika
	SUPPORTINGREFERENCE
3	Sen, M. K., Stoffa, P.L., 2013. Global Optimization Methods in Geophysical Inversion, 2nd Edition, Cambridge university press.
4	Michael Zhdanov, 2002. Geophysical Inverse Theory and Regularization Problems, Elsevier Academic Press
PREREQUISITES (If applicable)	
Computational Physics I, Mathematical Physics I, and Mathematical Physics II	

Semester Learning Plan (RPS)

Inversion Method

Week to -	Meeting to-	Learning materials
1	1	**Forward modeling and inversion modeling:** basic concepts in geophysics (measurement and data analysis), forward and inversion modeling, modeling aspects, and application of inversion methods (LO- 1)
2,3	2,3	**Linear Regression**: introduction to linear regression, statistical aspects of the Least Squares method *(L2-norm), unknown measurement standard deviation,* L1-norm-based regression (LO- *2)*
4	4	**Probability Theory:** noise measurement, Gaussian Probability Density function, Gaussian statistics, Confidence interval (LO- 3)
5	5	**Linear inversion problem (simple approach):** formulation of linear inversion problem, estimation of model parameters, density probability function, application (LO- 4)
6	6	**QUIZ 1**
7	7	**Linear inversion problems**: maximum likelihood, resolution and covariance models for inversion models (under and over determined), averages of non-uniqueness models, on Gaussian inversion problems and Non-Gaussian Statistics and their applications (LO- 4)
		ETS
8,9	8,9	**Linear inversion problems using priori: advantages and disadvantages of** linear inversion problems, under-determined problems, mixed-determined problems, inversions using several a priori, reference models, model smoothing, general forms of a priori models, and applications (LO- 5)
10,11	10,11	**Nonlinear inversion using a linear approach: model parameterization, problem inversion Nonlinear using linear approach, Gauss-Newton method, Lavemberg-Marquardt method, Occam method, nonlinear inversion using iterative method, nonlinear inversion using Singular value decomposition, and its application** (LO- 6)
12	12	**QUIZ 2**
13-15	13-15	**Global optimization**: lack of nonlinear inversion using linear approaches, Monte Carlo, Genetic Algorithm, Simulated Annealing, and their applications (LO- 7)
16	16	**EAS**

CURRICULUM 2023 COURSE SYLLABUS

INSTITUT TEKNOLOGI SEPULUH NOPEMBER
DEPARTMENT OF PHYSICS
STUDY PROGRAM BACHELOR (S1)

SYLLABUS

COURSES	Name	Seismic Exploration
	Code	SF234765
	Credit	3 SKS
	Semester	7

DESCRIPTION

In this Seismic Exploration course, students will learn about the principles of seismic wave propagation, types of seismic acquisition, excellence, weaknesses of each seismic method, and so on. Students are familiar with the theory and application of wave propagation in seismic surveys. Students understand the procedures and stages in the acquisition of bounce seismic data and the initial steps of processing. Students are able to use reflected seismic data processing techniques to track, analyze and make interpretations about rock layering structures and their physical characters.

COURSE LEARNING OUTCOMES

No	PLO DESCRIPTION
PLO-6	Able to apply the principles and applications of mathematical physics, computational physics, and instrumentation both in how to operate physical instruments in general and analyze data and information from these instruments.
PLO-7	Able to apply relevant and cutting-edge principles, characteristics, functions, and technological applications in the field of physics and software applications.
PLO-8	Able to formulate physical phenomena and problems and able to make mathematical or physical modeling / simulations in accordance with hypotheses based on the results of observations and experiments conducted.

SUB LEARNING OUTCOMES OF COURSES

No	LO Description
LO- 1	Able to design and conduct surveys using seismic methods, as well as carry out modeling and interpretation according to survey objectives.
LO- 2	Able to write seismic data simulation programs.
LO- 3	Ability in acquisition/acquisition of reflection seismic data.
LO- 4	The ability to process seismic data is very large.
LO- 5	Ability in the interpretation of seismic cross sections.

SUBJECT

- Introduction to seismic reflection methods,
- Instrumentation and measurement equipment of bounce seismic data, theory of propagation of reflected seismic waves,
- Rock physics: seismic speed, factors affecting it and methods of measurement; filter theory and noise elimination, deconvolution, normal-moveout (NMO), velocity analysis and static correction, dip-moveout (DMO), migration (pre-stack and post-stack in the time and depth domain), interpretation methods and introduction to reservoir geophysics.

REFERENCE	
No	**MAIN REFERENCE**
1	Gubbins, M., 2001., Geophysical Data Measurement and Analysis. , 2nd Edition, Cambridge University Press
2	Philip Kearey, Michael Brooks, Ian Hill, An Introduction to Geophysical Exploration, THIRD EDITION
3	Sheriff, R. E. and Geldart, L. P., Exploration Seismology, Vol. I, Cambridge University Press, 1982.
4	W.M. Telford, L.P. Geldart, R.E. Sheriff, Applied Geophysics (2nd edition), Cambridge, 1990.
5	Yilmaz, Öz, Seismic Data Analysis, Vol. I, Society of Exploration Geophysicists, 2001.
	SUPPORTINGREFERENCE
1	Costain , John K. and Cahit Çoruh, 2004, Basic Theory Of Exploration Seismology, Department of Geological Sciences, Virginia Polytechnic Institute and State University, Blacksburg, VA, U.S.A.
2	J.M. Reynolds, An Introduction to Applied and Environmental Geophysics, Wiley, 1998.
3	M. Nabigian (ed.), Electromagnetic methods in Applied Geophysics, vol. 1 Theory, vol. 2 Application, Society of Exploration Geophysicists, 1989.
4	M.S. Zhdanov, G.V. Keller, The Geoelectrical Methods in Geophysical Exploration, Elsevier, 1994
5	Menke, W., 2012., Geophysical Data Analysis: Discrete Inverse Theory, 3rd Edition, Matlab Edition, Academic Press
6	Miller, R., Bradford, J.H. and Holliger, K. Advances in near surface Seismology and Ground-penetration Radar. American Geophysical Union, 2010.

PREREQUISITES (If applicable)

3. Mathematical Physics I and II
4. Computational Physics
5. Seismology

Semester Learning Plan (RPS)
Seismic Exploration

Week to -	Learning materials
1	Lecture contracts, DESCRIPTION s, applications in the work environment, general over view.
2	Students will learn about the types of seismic acquisition, advantages, weaknesses of each seismic method, and so on.
3	Students will learn about the principles of seismic wave propagation, types of seismic waves, get to know the theory and application of wave propagation in seismic surveys.
4	Students understand the procedures and stages in seismic data acquisition (Seismic Acquisition), CDP, CMP, Mid point, off set, travel time equations.
5	Students understand the procedures and stages in the initial steps of processing (pre processing seismic), standard processing seismic data.
6	Deconvolution, normal-moveout (NMO), velocity analysis and static correction, dip-moveout (DMO), migration (pre-stack and post-stack in time and depth domains
7	Students are able to use reflected seismic data processing techniques to track, analyze and make interpretations about rock layering structures and their physical characters.
8	ETS (Midterm Evaluation)
9	Analyze and make seismic section interpretations of rock layering structures and their physical characters.
10	Analysis and geological interpretation of rock structures from seismic sections.
11	3D Seismic
12	Common Reflection Surface (CRS)
13	Optimization of seismic processing (Nelder Mead Method, Conjugate Method, Powel Method)
14	Methods of interpretation and introduction to reservoir geophysics
15	Seismic data processing project
16	EAS (End of Semester Evaluation)

CURRICULUM 2023 COURSE SYLLABUS

INSTITUT TEKNOLOGI SEPULUH NOPEMBER
DEPARTMENT OF PHYSICS
STUDY PROGRAM BACHELOR (S1)

SYLLABUS

COURSES	Name	Electromagnetic Exploration
	Code	SF234766
	Credit	2 SKS
	Semester	7

DESCRIPTION

This Electromagnetic Exploration **course** studies the basic concepts, observation, data analysis, and interpretation of electromagnetic-based methods (magnetotelluric, control sourced magnetotelluric, very low frequency, ground penetrating radar, transient electromagnetic, and others).

COURSE LEARNING OUTCOMES

No	PLO DESCRIPTION
PLO-6	Able to apply the principles and applications of mathematical physics, computational physics, and instrumentation both in how to operate physical instruments in general and analyze data and information from these instruments.
PLO-7	Able to apply relevant and cutting-edge principles, characteristics, functions, and technological applications in the field of physics and software applications.
PLO-8	Able to formulate physical phenomena and problems and able to make mathematical or physical modeling / simulations in accordance with hypotheses based on the results of observations and experiments conducted.
PLO-10	Able to disseminate the results of problem studies (case studies) and physical behavior based on standard scientific principles in oral and written communication in the form of reports or scientific papers in accordance with the rules of correct writing by understanding the mechanism of plagiarism and publishing it at the national or international level.

SUB LEARNING OUTCOMES OF COURSES

No	LO Description
LO- 1	Able to explain the physical properties of rocks related to electromagnetic methods
LO- 2	Able to understand the weaknesses and advantages of each electromagnetic method
LO- 3	Able to explain the principles of measurement, data analysis and interpretation of each electromagnetic method
LO- 4	Able to explain and apply electromagnetic methods (magnetotelluric, control sourced magnetotelluric, very low frequency, ground penetrating radar, transient electromagnetic), in terms of measurement, processing and interpretation of data

SUBJECT

- **Basic electromagnetic theory**: Impedance of homogeneous earth and horizontal layered earth, Maxwell's equation, Apparent resistivity, Phase, and Skin depth.
- **Electromagnetic method**: basic principles, domains in electromagnetic methods (time and frequency domains), application of Electromagnetic methods in general.

- **Magnetotelluric method: basic concepts, data retrieval by magnetotelluric (MT) method using natural sources/MT and artificial sources/CSMT), Magnetic and Electrical transfer modes, magnetotelluric data analysis, and Data interpretation.**
- **Very low frequency (VLF**) method: Basic principles of VLF method, Signal source in VLF method, EM Mode and Resistivity Mode, Analysis and Interpretation of VLF data.
- **Transient electromagnetic (TEM):** The basic principles of the TEM method, measurement of TEM data, analysis of TEM data, and its inversion.
- **Ground Penetrating Radar (GPR):** Basic principles of GPR, Dielectric coefficient, Application of GPR method, GPR data analysis and interpretation.

REFERENCE

No	MAIN REFERENCE
1	Chave A.D., Jones A.G. (eds), 2012, The Magnetotelluric Method: Theory and Practice, Cambridge University Press
2	Jol, H.M., 2009, Ground Penetrating Radar Theory and Applications, Elsevier
3	Reynolds, J.M., 1997, An Introduction to Applied and Environmental Geophysics, Wiley
4	Telford, W.M., Geldart, L.P., Sheriff, R.E., 1990, Applied Geophysics (2nd edition), Cambridge
	SUPPORTINGREFERENCE
1	M. Nabigian (ed.), Electromagnetic methods in Applied Geophysics, vol. 1 Theory, vol. 2 Application, Society of Exploration Geophysicists, 1989.
2	Everett, M.E., 2013, Near-surface applied geophysics, Cambridge University Press
3	Hauck, C., Kneisel, C., 2008, Applied geophysics in periglacial environments, Cambridge University Press

PREREQUISITES (If applicable)

6. Mathematical Physics I and II
7. IN

Semester Learning Plan (RPS)
Electromagnetic Exploration

Week to -	Learning materials
1	**Basic electromagnetic theory:** Homogeneous earth impedance, horizontally layered earth impedance, Maxwell's equation, Apparent resistivity, Phase, and Skin depth
2	**Basic principles of electromagnetic method:** Transmitter, Receiver, Telluric current, Frequency spectrum, EM method signal source, Noise causes
3	**Electromagnetic method:** basic principles, domains in electromagnetic methods (time and frequency domains), application of Electromagnetic methods in general.
4-5	**Magnetotelluric** field: Equipment and data retrieval by magnetotelluric method (using natural sources and artificial sources), Magnetotelluric (MT) and *control sourced* MT (CSAMT) Equipment components, Magnetic and Electrical transfer modes
6	**Magnetotelluric data analysis:** 1D and 2D data processing, Interpretation
7	**Very low frequency (VLF)** method: Basic principles of VLF method, Signal source in VLF method, EM Mode and Resistivity Mode
8	Midterm Evaluation (ETS)
9	**Very low frequency (VLF) method: VLF-EM data filter (**empirical mode decomposition, moving average*), Qualitative analysis (Fraser and Karous-Hjelt), quantitative analysis (inversion), VLF data interpretation*
10	**VLF Method Practicum**: Measurement, data analysis, and interpretation
11-12	**Ground Penetrating Radar (GPR)**: Prinsip dasar GPR, Koefesien dielektrik, Aplikasi metode GPR, analisa data GPR (Adjust signal position, Mean Spatial Filter, High Pass, Low Pass, Gain, 1D velocity model, 1D fase shifting migration, Time to depth convertion) beserta interpretasinya.
13-14	**Electromagnetic Induction Method: Basic principles of electromagnetic induction method, Conductivity and relative susceptibility, Electromagnetic induction instrument, Coil configuration, Depth of investigation, Data analysis and interpretation**
15	**Transient electromagnetic (TEM):** The basic principles of the TEM method, measurement of TEM data, analysis of TEM data, and its inversion.
16	**End of semester evaluation (EAS)**

ELECTIVE COURSES IN MEDICAL PHYSICS AND BIOPHYSICS
PRODI SARJANA FISIKA
DEPARTMENT OF PHYSICS
FSAD – ITS

CURRICULUM 2023 COURSE SYLLABUS

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER **DEPARTMENT OF PHYSICS** **STUDY PROGRAM BACHELOR (S1)**

SYLLABUS

COURSES	Name	Anatomy and Physiology
	Code	SF234567
	Credit	2 credits
	Semester	5

DESCRIPTION

In this course, students will learn to understand medical terminology, roughly identify anatomical structures, define most organ systems, and describe physiological mechanisms for repair, maintenance, and growth.

COURSE LEARNING OUTCOMES

No	PLO DESCRIPTION
PLO-2	Able to study and utilize science and technology in order to apply it to the field of Physics expertise, and able to make appropriate decisions from the results of their own work or group work in the form of final project reports or other forms of learning activities whose output is equivalent to the final project through logical, critical, systematic and innovative thinking. [KU]
PLO-4	Able to communicate and be responsible in applying information technology to document, store, and secure data compiled for problem solving in the field of physics expertise. [KU]

SUB LEARNING OUTCOMES OF COURSES

No	LO Description
LO- 1	Students understand medical terminology, and are able to roughly identify anatomical structures
LO- 2	Students are able to define the skeletal and cardiovascular systems
LO- 3	Students are able to define the respiratory system and digestive system
LO- 4	Students are able to define the urinary system and reproductive system
LO- 5	Students are able to define the circulatory system and describe physical principles and physiological mechanisms for repair, maintenance, and growth
LO- 6	Students understand pathology in medical

SUBJECT

- Anatomical nomenclature: basic medical terms, as a basis for understanding lectures in general
- Bone: skeletal system in general, macroscopic division of bones
- Spinal column: the constituent of the vertebral columna and its associated structures
- Thorax: the constituent components of the thoracic cavity, namely bones, muscles, and other supporting structures, along with the organs inside
- Abdomen: the constituent components of the abdominal cavity, namely muscles, and other supporting structures, along with their internal organs
- Respiratory system: organs included in the respiratory system, how the respiratory system works
- Digestive system: organs included in the digestive system, how the digestive system works
- Urinary system: organs included in the urinary system, how the urinary system works

- Reproductive system: organs included in the reproductive system, how the reproductive system works
- Circulatory system: the organs included in the circulatory system, how the circulatory system works.
- Physical principles and physiological mechanisms for repair, maintenance, and growth
- Pathology: changes in structure and function during illness

REFERENCE	
No	**MAIN REFERENCE**
1	R. Putz and R. Pabst, Sobotta's Atlas of Human Anatomy. (EGC, 2010)
2	Serwood, Human Physiology: from cells to systems. (EGC, 2001)
	SUPPORTINGREFERENCE
1	Drake RL, Vogl AW, Mitchell AWM, 2015. Gray's Anatomy for Students, 3rd ed., Churchill Livingstone Elsevier.
2	Netter FH. Netter Atlas of Human Anatomy, Elsevier.

PREREQUISITES (If applicable)

Biologi

Semester Learning Plan (RPS)
Anatomy and Physiology

Week to -	Learning materials
1	Istilah-istilah anatomi, bidang-bidang anatomi
2	Istilah-istilah anatomi, bidang-bidang anatomi
3	System skeletal
4	**Quiz 1**
5	Cardiovascular system
6	Respiration system
7	Sistem pencernaan
8	**Midterm Evaluation (ETS)**
9	Urinary system
10	Reproductive system
11	Circulatory system
12	**Quiz 2**
13-14	Introduction to faal, physical aspects of anatomy and physiology
15	Patologi
16	**End of semester evaluation (EAS)**



