UNPAD PHYSICS

MODULE HANDBOOK

MASTER PROGRAM IN PHYSICS

FACULTY OF MATHEMATICS AND NATURAL SCIENCES
UNIVERSITAS PADJADJARAN
2021

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CHAPTER I

OBJECTIVE, LEARNING OUTCOMES, AND CURRICULUM STRUCTURE OF MASTER PROGRAM IN PHYSICS

1.1 OBJECTIVE

1. To provide graduates who are able to master advanced physics and its applications, capable of communicating science to the community, have entrepreneurial skills, and are able to compete at the international level.
2. To create an excellent academic atmosphere for the implementation of the education and research process.
3. To provide graduates who contribute to society with their knowledge of physics and its applications.
4. To establish collaboration with domestic and foreign institutions to improve the quality of education, research, and community service.
5. To provide graduates with a culture of RESPECT (Responsibility, Excellence, Scientific, Professionalism, Encouragement, Creative, and Trust).

1.2 LEARNING OUTCOMES

1. To be able to formulate and analyze problems in instrumentation, materials, energy, and geophysics (LO1).
2. To be able to apply physics theories, computations, and experimental methods to solve complex problems in instrumentation, materials, energy, and geophysics (LO2).
3. To be able to communicate their works and scientific ideas orally and in writing. (LO3)
4. To be able to collaborate, take responsibility in teamwork, and display academic leadership (LO4).
5. To be able to use long-life learning principles to enhance their knowledge and actual issues in physics in the fields of instrumentation, materials, energy, and geophysics (LO5).
6. To be able to demonstrate a sense of responsibility and commitment to upholding the law, ethics, social norms, and environmental sustainability (LO6).

1.3 CURRICULUM STRUCTURE

The list of courses in each semester is shown in Table below.

Semester	Code	Courses	Type	Credit
1	D20H3101	Electrodynamics	A	4
	D20H3102	Computational Science	A	2
	D20H3103	Scientific Writing	B	2
	D20H3104	Research Proposal Seminar	B	2
	D20H41XX	Elective Course	C	2
	Total Credit 1st Semester			**12**
2	D20H3201	Quantum Mechanics*	A	4
	D20H3202	Crystallography and Diffraction Techniques*	A	2
	D20H3203	Transport Phenomena*	A	4
	D20H3204	Statistical Mechanics*	A	2
	D20H3206	Sensor Technology and Instrumentation*	A	2
	D20H42XX	Elective Course	C	2
	D20H42XX	Elective Course	C	2
	D20H42XX	Elective Course	C	2
	*at least 6 credits (2 courses) from 14 credits (5 courses)			
	Total Credit 2nd Semester			**12**
3	D20H3301	Research Progress Seminar	B	2
	D20H41XX	Elective Course	C	2
	Total Credit 3rd Semester			**4**
4	D20H3302	Thesis	B	8
	Total Credit 4th Semester			**8**
	Compulsory courses		A	**12**
	Supporting courses for final project and publication, and thesis		B	**14**
	Elective courses		C	**10**
	Total Credit for Master Program in Physics			**36**

CHAPTER II

MODULE HANDBOOK

1. D20H3101 - Electrodynamics

Code/ Semester	D20H3101 / Semester 1
Course/ Credit points	Electrodynamics / 4 credits ~ 7.24 ECTS
Language	Indonesian
Responsible Person	Ayi Bahtiar
Lecturer	Ayi Bahtiar, Togar Saragi, Lusi Safriani
Workload	1. Lectures : 4 x 50 = 200 minutes per week. 2. Assignments : 4 x 60 = 240 minutes per week. 3. Private learning : 4 x 60 = 240 minutes per week.
Contents	Electrodynamics is a compulsory course for students in the Master's Program in Physics, Faculty of Mathematics and Natural Sciences, Universitas Padjadjaran (UNPAD). The Electrodynamics course is designed for graduate students who already have a fundamental knowledge of electric and magnetic fields. The course content begins with a review of the basic theory of electromagnetic waves and then delves into waveguides, covering topics such as waveguide structure, propagation mechanisms, modes in waveguides, and waveguide characteristics. It also includes discussions on scattering and diffraction, covering topics like scattering of plane waves by spheres and Rayleigh scattering, as well as diffraction theory. The course further explores radiation fields, including antenna systems, radiation fields of charged particles, and Vavilov-Cherenkov radiation. Topics covered include: Basic Theory of Electromagnetic Waves (C3), Wave Propagation in Waveguides (C4), Scattering and Diffraction (C5), Radiation Fields (C5)
Objectives	1. To be able to understand electrodynamics wave theory with systematic independent work and measurable discussions 2. To be able to understand wave propagation in waveguides with systematic independent work and measurable discussions 3. To be able to analyze various case related to scattering and diffraction with systematic independent work and measurable discussions 4. To be able to analyze various case related to radiation fields with systematic independent work and measurable discussions
Course Method	At the beginning of the course, it is conducted through the lecture method, and subsequent meetings are carried out using the case-based study method, with supplementary learning materials provided in the form of instructional videos and lecture notes
Prerequisites	-
Requirements according to the examination regulations	Registered in this course Minimum 80% attendance in this course

Reading list	1. J. D. Jackson, “Classical Electrodynamics: International Adaptation Paperback”, Wiley, 2021. 2. M O. Tjia, “Teori Elektrodinamika Klasik”, Dept. Fisika ITB, Bandung, 1998. 3. A. Zangwill, “Modern Electrodynamics”, Cambridge University Press, UK, 2013.
Assessment Guidance	Case-based rubric (25%); Assignments (25%); Midterm Exams (25%); Final Exams (25%)

2. D20H3102 - Computational Science

Code/ Semester	D20H3102 / Semester 1
Course/ Credit points	Computational Science / 2 credits ~ 3.62 ECTS
Language	Indonesian
Responsible Person	Yudi Rosandi
Lecturer	Budi Adiperdana, Yudi Rosandi
Workload	1. Lectures : 2 x 50 = 100 minutes per week. 2. Assignments : 2 x 60 = 120 minutes per week. 3. Private learning : 2 x 60 = 120 minutes per week.
Contents	Computational Science is a compulsory course for students in the Master's Program in Physics, Faculty of Mathematics and Natural Sciences, Universitas Padjadjaran (UNPAD). The course covers classical and quantum approaches to predict the mechanical, electronic, and magnetic properties of materials. Atomic-scale classical approach is done using the Molecular Dynamics (MD) method, while the electronic-scale quantum approach is conducted using the Density Functional Theory (DFT) approach [C3-C6]. Topics covered include Introduction, Solid-State Structure, Atom-Atom Interactions, Particle Motion Equations, Metal Melting Phenomena, Quantum Physics and Many-Particle Schrödinger Equations, Born-Oppenheimer Approximation, Hartree and Hartree-Fock, Density Functional Theory Approximations (Hohenberg-Kohn and Kohn-Sham), DFT Simulations using Quantum Espresso (Basis, Pseudopotential, SCF, Structure Optimization, Density of State, Band Structure, and Spin).
Objectives	1. To be able to analyze the foundation and fundamentals and modeling of physical systems, with systematic independent work and measurable discussion [C4]. 2. To be able to analyze the structure of solids and interactions between atoms with measurable independent work [C4]. 3. To be able to analyze and calculate particle motion equations with systematic independent work and measurable discussions [C5]. 4. To be able to analyze and reconstruct the phenomenon of metal melting with systematic independent work and measurable discussion [C6]. 5. To be able to analyze the need for a many-particle Schrodinger equation for certain cases with systematic independent work and measurable discussion [C4]. 6. To be able to analyze the need for approximation in abintio and DFT simulation approaches with systematic independent work and measurable discussion [C4]. 7. To be able to analyze and design predictions of physical properties using the DFT approach with systematic independent work and measurable discussions [C6].
Course Method	At the beginning of the course, it is conducted through the lecture method, and subsequent meetings are carried out using the case-based study method, with supplementary learning materials provided in the form of instructional videos and lecture notes

Prerequisites	-

Requirements according to the examination regulations	Registered in this course Minimum 80% attendance in this course
Reading list	1. M. de Podesta, Understanding the Properties of Matter, 2nd Edition, CRC Press, 2002. 2. D. Frenkel, B. Smit, Understanding Molecular Simulation: From Algorithms to Applications. Academic Press, 2023. 1. R. Smith (Ed.), Atomic and Ionic Collisions in Solids and at Surface, Cambridge University Press, 2009. 2. M. Finnis, Interatomic Forces in Condesed Matter, Oxford University Press, 2005. 3. P. W. Atkins, R. S. Friedman, Molecular Quantum Mechanics, 5th Edition, Oxford University Press, 2010. 4. R. M. Martin, Electronic Structure: Basic Theory and Practical Methods, Cambridge University Press, 2012.
Assessment Guidance	Case-based rubric (25%); Assignments (25%); Midterm Exams (25%); Final Exams (25%)

3. D20H3103 - Scientific Writing

Code/ Semester	D20H3103 / Semester 1
Course/ Credit points	Scientific Writing / 2 credits ~ 3.62 ECTS
Language	Indonesian
Responsible Person	Risdiana
Lecturer	Risdiana
Workload	1. Lectures : 2 x 50 = 100 minutes per week. 2. Assignments : 2 x 60 = 120 minutes per week. 3. Private learning : 2 x 60 = 120 minutes per week.
Contents	This course is a compulsory course for students in the Master's Program in Physics, Faculty of Mathematics and Natural Sciences, Universitas Padjadjaran (UNPAD). The course covers the methods for searching scientific articles that are relevant to the research to be conducted, reviewing predetermined scientific articles, and composing a review article with a theme that aligns with the planned research. After completing this course, students will have knowledge about research conducted by other researchers worldwide. This knowledge will help students identify research gaps and determine the state of the art in their field of study during their Master's program in Physics. Topics covered include Formulating Review Questions (Keywords) and Literature Searching (C3), Literature Analysis (C4), Systematic Review Structuring (C5), and Submitting Systematic Reviews (C5).
Objectives	1. To be able to analyze and select scientific publications that have been published in reputable journals with systematic independent work and measurable discussions. 2. To be able to review scientific articles from scientific publications related to the theme of the research to be carried out with measurable independent work. 3. To be able to compile article reviews with systematic independent work and measurable discussions.
Course Method	At the beginning of the course, it is conducted through the lecture method, and subsequent meetings are carried out using the case-based study method, with supplementary learning materials provided in the form of instructional videos and lecture notes
Prerequisites	-
Requirements according to the examination regulations	Registered in this course Minimum 80% attendance in this course
Reading list	1. G. Lame, Systematic Literature Review: An Introduction, International Conference on Engineering Design, ICED19, Delf, The Netherlands, 2019. 2. A. Boland, G. Cherry, R. Dikson, Doing a Systematic Review, 2nd Edition, SAGE Publishing, 2017. 3. A. Booth, A. Sutton, M. Clower, M. M.-St James, Systematic Approaches to a Successful Literature Review, SAGE Publishing Ltd., 2021.

Assessment Guidance	Case-based rubric (25%); Assignments (25%); Midterm Exams (25%); Final Exams (25%)

4. D20H3104 - Research Proposal Seminar

Code/ Semester	D20H3104 / Semester 1
Course/ Credit points	Research Proposal Seminar / 2 credits ~ 3.62 ECTS
Language	Indonesian
Responsible Person	Risdiana
Lecturer	Risdiana
Workload	1. Lectures : 2 x 50 = 100 minutes per week. 2. Assignments : 2 x 60 = 120 minutes per week. 3. Private learning : 2 x 60 = 120 minutes per week.
Contents	Research Proposal Seminar is a compulsory course for students in the Master's Program in Physics, Faculty of Mathematics and Natural Sciences, Universitas Padjadjaran (UNPAD). The course includes the preparation of research proposals and the presentation of research proposals. Topics covered include the preparation of research proposals (C5) and the presentation of research proposals (C5).
Objectives	1. To be able to design research to be carried out (C5) with systematic independent work and measurable discussion. 2. To be able to present the research design to be carried out (C5) with measurable independent work.
Course Method	Student prepare the research proposal and discuss intensively with supervisors. Presentation of research proposal will be held at certain period at the end of this semester
Prerequisites	-
Requirements according to the examination regulations	Registered in this course Minimum 80% attendance in this course
Reading list	1. Pedoman umum penyusunan proposal penelitian Unpad. 2. J. W. Creswell, J.D. Creswell, Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, SAGE Publications Ltd., 2022. 3 ...., Pedoman Umum Ejaan Bahasa Indonesia, Kementerian Pendidikan dan Kebudayaan, 2016.
Assessment Guidance	Proposal Research content (50%); Presentation content (10%); Discussion (30%); Performance of Presentation (10%)

5. D20H3201- Quantum Mechanics

Code/ Semester	D20H3201/ Semester 2
Course/ Credit points	Quantum Mechanics / 4 credits ~ 7.24 ECTS
Language	Indonesian
Responsible Person	Annisa Aprilia
Lecturer	Annisa Aprilia, I Made Joni
Workload	1. Lectures : 4 x 50 = 200 minutes per week. 2. Assignments : 4 x 60 = 240 minutes per week. 3. Private learning : 4 x 60 = 240 minutes per week.
Contents	1. Concept and Linear Vector Space 2. Basic Principles of Quantum Mechanics 3. Quantum Dynamics, 4. Angular Momentum, 5. Invariance Principle and the Law of Conservation, 6. Many-Particle System, 7. Scattering Theory, Approximation Method, 8. Identical Particles, 9. Relativistic Wave Equation, 10. Quantitation Field, 11. Introduction to Molecular Quantum Structure, 12. Quantum Mechanics of solids.
Objectives	1. Able to understand (C2) and be able to classify and explain (C3) the historical aspects of the concept of quantum mechanics, the uncertainty principle and Copenhagen interpretation. 2. Able to understand (C2) and be able to classify and explain (C3) Schrödinger's equation of motion, Heisenberg's equation of motion, application of the equation of motion to the interpretation of the Hydrogen atom and harmonic oscillator. 3. Able to understand (C2) and explain (C3) the definition of angular momentum, be able to solve and calculate problems and determine/classify Eigenvalues and vectors, orbital angular momentum, angular momentum and rotation, spherical tensor. 4. Able to understand (C2), explain (C3) the principle of invariance and the law of conservation, including system symmetry and the law of conservation and symmetry of space and time. 5. Able to understand (C2), explain (C3), conclude quantum mechanical phenomena in single and multiple electron systems including low energy and high energy scattering, Zeeman effect and stark effect. 6. Able to understand (C2), explain (C3), conclude on advanced quantum systems including identical particles, relativistic wave equations, and field quantization theory. 7. Able to understand (C2), explain (C3), conclude on advanced quantum systems in solid systems.
Course Method	At the beginning of the lecture, it is carried out with the lecture method and the next meeting is carried out with the CL (Contextual Learning) Small Group Discussion method, evaluation (CbL-Collaborative Learning) and provided supporting material for lecture notes.
Prerequisites	-

Requirements according to the examination regulations	Registered in this course Minimum 80% attendance in this course
Reading list	1. V.K. Thankappan, Quantum Mechanics, 4th Edition, New Academic Science, 2014. 2. J.J. Sakurai, Jim Napolitano, Modern Quantum Mechanics, Third Edition. Cambridge University Pres, 2020. 3. David Tong, Quantum Mechanics: Lecture Notes, Cambridge, 2020. 4. M.O. Tjia, Mekanika Kuantum, ITB Press, 1999.
Assessment Guidance	SGD Rubric (25); Assignment/Evaluation (25%); Midterm Exams (25%); Final Exams (25%)

6. D20H3202- Crystallography and Diffraction Techniques

Code/ Semester	D20H3202/ Semester 2
Course/ Credit points	Crystallography and Diffraction Techniques / 2 credits ~ 3.6 ECTS
Language	Indonesian
Responsible Person	Risdiana
Lecturer	Risdiana
Workload	1. Lectures : 2 x 50 = 100 minutes per week. 2. Assignments : 2 x 60 = 120 minutes per week. 3. Private learning : 2 x 60 = 120 minutes per week.
Contents	Crystallography and Diffraction Techniques course is a compulsory course for students in the Master's program in Physics at the Faculty of Mathematics and Natural Sciences (FMIPA), Universitas Padjadjaran (UNPAD). This course contains the basics of crystallography and diffraction techniques, including data analysis and evaluation. Diffraction techniques introduced in this course are Rietveld smoothing method, neutron diffraction, electron diffraction and XPS. After completing the crystallography and Diffraction Techniques course, students are able to understand crystallography and classify aspects of crystal geometry and crystal structure, analyze crystal symmetry, point group and space group, validate X-ray diffraction measurement results through the Rietveld method, detail diffraction techniques and interpret crystal diffraction data. Crystallography and crystal structure - C3, Crystal symmetry and group theory - C4, X-ray diffraction, crystal system identification, and Rietvield-C5, Diffraction techniques and data analysis - C5.
Objectives	1. Able to master the concept of crystallography and classify aspects of crystal geometry and crystal structure, with systematic independent work and measurable discussions, P2, KU1, KU2 (C4). 2. Able to analyze crystal symmetry, point group and space group with measurable independent work, P2, KU1, KU2 (C5). 3. Able to validate the results of X-ray diffraction measurements through the Rietveld method with systematic independent work and measurable discussions, P2, KU1, KU2 (C5). 4. Able to detail diffraction techniques and interpret crystal diffraction data with systematic independent work and measurable discussions, P2, KU1, KU2 (C5).
Course Method	At the beginning of the course, it is conducted through the lecture method, and subsequent meetings are carried out using the case-based study method, with supplementary learning materials provided in the form of instructional videos and lecture notes.
Prerequisites	-
Requirements according to the examination regulations	Registered in this course Minimum 80% attendance in this course
Reading list	1. B. D. Cullity dan SR Stock, Element of X-ray Diffraction, erd Edition, Prentice Hall, 2014. 2. F. Hoffman, Introduction to Crystallography, Springer, 2020.

	3. C. Giacovazzo et al., Fundamental of Crystallography, IUCr, Oxford University Press, 2011.
Assessment Guidance	Quiz/Task/Assignments (80%); Midterm Exams (10%); Final Exams (10%)

7. D20H3203- Transport Phenomena

Code/ Semester	D20H3203/ Semester 2
Course/ Credit points	Transport Phenomena / 4 credits ~ 7.24 ECTS
Language	Indonesian
Responsible Person	Irwan Ary Dharmawan
Lecturer	Irwan Ary Dharmawan, Imran Hilman Mohammad
Workload	1. Lectures : 4 x 50 = 200 minutes per week. 2. Assignments : 4 x 60 = 240 minutes per week. 3. Private learning : 4 x 60 = 240 minutes per week.
Contents	This course is a compulsory course for the Earth concentration that provides an understanding of the concept of transport phenomena from three main foundations: momentum transport, energy transport and mass transport in analyzing the dynamics of physical systems. The course provides participants with the foundations of transport phenomena needed in analyzing earth cases. The course concludes with an environmental geophysics case study to implement the learnt fundamentals on a real case. Introduction to transport phenomena, Momentum Transport: viscosity and laminar flow, Momentum Transport: isothermal systems and turbulent flow, Energy Transport: thermal conductivity and non-isothermal systems, Energy Transport in laminar and turbulent flow, Mass Transport: mass transport in laminar and turbulent flow, Darcy's Law and subsurface water flow, Case study.
Objectives	1. Able to understand the concept of equilibrium in transport phenomena: momentum transport, energy transport and mass transport in physics. 2. Able to implement the concept of transport phenomena in the analysis of physical systems. 3. Able to analyze earth cases using the concepts of transport phenomena.
Course Method	At the beginning of the course, it is conducted through the lecture method, and subsequent meetings are carried out using the case-based study method, with supplementary learning materials provided in the form of instructional videos and lecture notes.
Prerequisites	-
Requirements according to the examination regulations	Registered in this course Minimum 80% attendance in this course
Reading list	1. D. L.Turcotte, G. Schubert, Geodynamics, Cambridge university Press, 2014. 2. R. B. Bird, Transport phenomena. Appl. Mech. Rev., 55(1), R1-R4, 2002.
Assessment Guidance	Assignments (70%); Midterm Exams (15%); Final Exams (15%)

8. D20H3204- Statistical Mechanics

Code/ Semester	D20H3204/ Semester 2
Course/ Credit points	Statistical Mechanics / 2 credits ~ 3.62 ECTS
Language	Indonesian
Responsible Person	I Made Joni
Lecturer	I Made Joni, Nowo Riveli
Workload	1. Lectures : 2 x 50 = 100 minutes per week. 2. Assignments : 2 x 60 = 120 minutes per week. 3. Private learning : 2 x 60 = 120 minutes per week.
Contents	The Statistical Mechanics course is a compulsory course for students in the Master's program in Physics at the Faculty of Mathematics and Natural Sciences (FMIPA), Universitas Padjadjaran (UNPAD). This course contains classical and quantum statistical mechanics consisting of the Laws of Thermodynamics, Gas Kinetic Theory, Classical Statistical Mechanics, Canonical Ensembles and Large Canonical Ensembles, Quantum Statistical Mechanics, Fermi System, Bose System, and Special Topics on Superfluid and Ising Model. Laws of Thermodynamics - C3, Kinetic Theory of Gases - C4, Classical Statistical Mechanics -C5, Canonical Ensembles and Large Canonical Ensembles - C3, Quantum Statistical Mechanics - C4, Fermi System - C5, Bose System - C5, Special Topics: Superfluid and Ising Model - C5.
Objectives	1. Able to understand and analyze the theory of classical statistical mechanics (C5) with systematic independent work and measurable discussion. 2. Able to understand and analyze the theory of quantum statistical mechanics (C5) with systematic independent work and measurable discussion.
Course Method	At the beginning of the course, it is conducted through the lecture method, and subsequent meetings are carried out using the case-based study method, with supplementary learning materials provided in the form of instructional videos and lecture notes.
Prerequisites	-
Requirements according to the examination regulations	Registered in this course Minimum 80% attendance in this course
Reading list	1. K. Huang, Statistical Mechanics; 2ed Paperback, Wiley, 2004. 2. R. K. Pathria, P. D. Beale, Statictical Mechanics, 4ed Paperback, Elsevier, 2021. 3. M. Abdullah, Mekanika Statistik, e-book, Fisika ITB, 2015.
Assessment Guidance	Assignments (60%); Midterm Exam (20%); Final Exam (20%)

9. D20H3206- Sensor and Instrumentation Technology

Code/ Semester	D20H3206/ Semester 2
Course/ Credit points	Sensor and Instrumentation Technology / 2 credits ~ 3.62 ECTS
Language	Indonesian
Responsible Person	I Made Joni
Lecturer	I Made Joni, Andri Abdurrochman, Ferry Faizal
Workload	1. Lectures: 2 x 50 = 100 minutes per week. 2. Assignments: 2 x 60 = 120 minutes per week. 3. Private learning: 2 x 60 = 120 minutes per week.
Contents	(1) Design and classify sensor and instrumentation systems. (2) Analyzing the performance of sensor and instrumentation systems. (3) Application of Sensor and Instrumentation Systems to Physical Systems. (4) Testing and Validation of Sensors and Instrumentation Systems
Objectives	1. Able to design and classify sensor and instrumentation systems with systematic independent work and measurable discussions. 2. Able to analyze sensor and instrumentation systems with measurable independent work. 3. Able to give consideration and recommendation of sensor and instrumentation systems for experimental or physics research applications with systematic independent work and measurable discussions 4. Able to test and validate sensor and instrumentation systems with systematic independent work and measurable discussions
Course Method	At the beginning of the course, it is conducted through the lecture method, and subsequent meetings are carried out using the case-based study method, with supplementary learning materials provided in the form of instructional videos and lecture notes.
Prerequisites	-
Requirements according to the examination regulations	Registered in this course Minimum 80% attendance in this course
Reading list	1. S. Soloman, Sensors Handbook, 2nd Edition, McGraw Hill, New York, 2009. 2. J. Fraden, Handbook of Modern Sensors: Physics, Designs, and Applications, Fourth Edition, Springer, New York, 2010. 3. W. C. Dunn, Fundamentals of Industrial Instrumentation and Process Control, McGraw-Hill, 2005.
Assessment Guidance	Resume Papers and Presentation (80%); Final Exams (20%)

10. D20H3104 - Research Progress Seminar

Code/ Semester	D20H3301 / Semester 3
Course/ Credit points	Research Progress Seminar / 2 credits ~ 3.62 ECTS
Language	Indonesian
Responsible Person	Risdiana
Lecturer	Risdiana
Workload	1. Lectures : 2 x 50 = 100 minutes per week. 2. Assignments : 2 x 60 = 120 minutes per week. 3. Private learning : 2 x 60 = 120 minutes per week.
Contents	Research Progress Seminar is a compulsory course for students in the Master's program in Physics at the Faculty of Mathematics and Natural Sciences (FMIPA) at UNPAD. The course includes the preparation of research proposals and the presentation of research proposals. Topics covered include the preparation of research progress drafts (C5) and the presentation of research progress- C5.
Objectives	1. To be able to compile research reports (C5) with systematic independent work and measurable discussions. 2. To be able to present research results (C5) with measurable independent work.
Course Method	Student prepare the progress and discuss intensively with supervisors. Presentation of research proposal will be held at certain period at the end of this semester
Prerequisites	-
Requirements according to the examination regulations	Registered in this course Minimum 80% attendance in this course
Reading list	1. Pedoman umum penyusunan proposal penelitian Unpad.
Assessment Guidance	Research content (50%); Presentation content (10%); Discussion (30%); Performance of Presentation (10%)

11. D20H3302- Thesis

Code/ Semester	D20H3302/ Semester 4
Course/ Credit points	Thesis / 8 credits ~ 14.48 ECTS
Language	Indonesian
Responsible Person	Risdiana
Lecturer	Risdiana
Workload	1. Lectures : 8 x 50 = 400 minutes per week. 2. Assignments : 8 x 60 = 480 minutes per week. 3. Private learning : 8 x 60 = 480 minutes per week.
Contents	Thesis is a compulsory course for students in the Master's Program in Physics, Faculty of Mathematics and Natural Sciences, Universitas Padjadjaran (UNPAD). After completing the thesis course, students are able to complete a thesis document containing research results and are able to present their research results and be able to answer questions posed by examiners in progress seminars, study program seminars, and thesis seminars. Research Design, Data Analysis, Presentation Techniques, Thesis Writing.
Objectives	1. To be able to carry out research with systematic independent work and measurable discussions 2. To be able to analyze research data with measurable independent work 3. To be able to present research results with systematic and measurable discussions 4. To be able to write research results and data analysis and interpretation in the form of thesis documents with systematic independent work and measurable discussions
Course Method	Student prepare the research progress and discuss intensively with supervisors. Presentation of research proposal will be held at certain period at the end of this semester
Prerequisites	-
Requirements according to the examination regulations	Registered in this course. Finish at least 24 credit courses
Reading list	1. J. W. Creswell, J.D. Creswell, Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, SAGE Publications Ltd., 2022 2. Panduan penulisan Tesis Unpad. 3 ..... , Pedoman Umum Ejaan Bahasa Indonesia, Kementerian Pendidikan dan Kebudayaan, 2016.
Assessment Guidance	Research content (50%); Presentation content (10%); Discussion (30%); Performance of Presentation (10%)

12. 20H4101 - Advanced Materials for Environmental Applications

Code/ Semester	D20H4101 / Semester 1
Course/ Credit points	Advanced Materials for Environmental Applications / 2 credits ~ 3.62 ECTS
Language	Indonesian
Responsible Person	Fitrilawati
Lecturer	Fitrilawati, Annisa Aprilia
Workload	1. Lectures : 2 x 50 = 100 minutes per week. 2. Assignments : 2 x 60 = 120 minutes per week. 3. Private learning : 2 x 60 = 120 minutes per week.
Contents	Advanced Materials for Environmental Applications is an elective course for students in the Master's Program in Physics, Faculty of Mathematics and Natural Sciences, Universitas Padjadjaran (UNPAD). This course provides explanations and introductions regarding the definition/classification of advanced materials, especially for environmental applications. Environmental applications mentioned include water treatment systems that use specific materials as photocatalysts, membranes, and absorbent materials. The types of materials discussed are primarily focused on carbon-based and semiconductor materials. Other environmental applications such as gas sensors, self-healing materials, and their relevance to environmentally friendly energy sources are also studied in this course. Topics covered include: Introduction; Definition and classification of advanced materials, Synthesis and characterization of carbon-based advanced materials, Use of carbon-based advanced materials in environmental applications, Synthesis and characterization of semiconductor-based advanced materials, Use of semiconductor-based advanced materials for environmental.
Objectives	1. To be able to know and understand (C2) and classify (C3) types of materials categorized as advanced materials, especially carbon-based ones for environmental applications including water purification systems (photocatalysts, membranes, absorbent materials) with systematic independent work and measurable discussions. 2. To be able to explain (in detail) and analyze (C4) the characteristics of carbon materials as advanced materials for environmental applications, especially in water treatment systems (photocatalysts, membranes, absorbance materials), with measurable independent work. 3. To be able to know and understand (C2) and classify (C3) types of advanced materials, especially those based on semiconductor materials for environmental applications such as photocatalysts in water treatment systems, gas sensors, and environmentally friendly clean energy sources with systematic independent work and measurable discussions.

	4. To be able to explain (in detail) and analyze (C4) semiconductor-based materials as advanced materials for environmental applications, especially as photocatalysts in water purification systems, gas sensors, and clean energy sources with systematic independent work and measurable discussions.
Course Method	At the beginning of the course, it is conducted through the lecture method, and subsequent meetings are carried out using the case-based study method, with supplementary learning materials provided in the form of instructional videos and lecture notes
Prerequisites	-
Requirements according to the examination regulations	Registered in this course Minimum 80% attendance in this course
Reading list	1. P. Wang (Ed.), Smart Materials for Adnvanced Environmental Applications, RSC Smart Materias, 2020. 2. F. Perreault, A. F. De Faria, M. Elimelech, Environmental applications of graphene-based nanomaterials, Chemical Society Reviews Vol. 44, p. 5861, 2015.
Assessment Guidance	Case-based rubric (25%); Assignments (25%); Midterm Exams (25%); Final Exams (25%)

13. D20H4102 - Magnetism and Superconductivity

Code/ Semester	D20H4102 / Semester 1
Course/ Credit points	Magnetism and Superconductivity / 2 credits ~ 3.62 ECTS
Language	Indonesian
Responsible Person	Risdiana
Lecturer	Risdiana, Togar Saragi
Workload	1. Lectures : 2 x 50 = 100 minutes per week. 2. Assignments : 2 x 60 = 120 minutes per week. 3. Private learning : 2 x 60 = 120 minutes per week.
Contents	Magnetic Physics and Superconductivity" is an elective course for students in the Master's Program in Physics, Faculty of Mathematics and Natural Sciences, Universitas Padjadjaran (UNPAD). This course covers topics related to the properties of magnetism, the measurement of magnetic material susceptibility, characteristics and applications of ferromagnetic materials, as well as the characteristics and data analysis of superconducting materials. Topics covered include: Magnetic Properties of Materials - C3, Measurement of Magnetic Material Susceptibility - C4, Ferromagnetic Materials - C4, Superconducting Materials and Analysis of Superconducting Material Magnetic Properties - C5.
Objectives	1. To be able to understand the magnetic properties of materials and classify materials according to their magnetic properties with systematic independent work and measurable discussions 2. To be able to validate susceptibility measurement results with systematic independent work and measurable discussions 3. To be able to analyze the magnetic properties of ferromagnetic materials with measurable independent work 4. To be able to detail the typical properties of superconducting materials and interpret the susceptibility data of superconducting materials with systematic independent work and measurable discussion
Course Method	At the beginning of the course, it is conducted through the lecture method, and subsequent meetings are carried out using the case-based study method, with supplementary learning materials provided in the form of instructional videos and lecture notes
Prerequisites	-
Requirements according to the examination regulations	Registered in this course Minimum 80% attendance in this course
Reading list	1. D. Jiles, Introduction to Magnetism and Magnetic Materials, 3rd Edition, CRC Press, 2015. 2. S. Blundell, Magnetism in Condensed Matter, Oxford University Press, 2003. 3. A. Mourachkine, Room-Temperature Superconductivity, Cambridge Cambridge International Science Publishing Ltd, 2004. 4. Risdiana, Sifat dan Bahan Superkonduktor, Unpad Press, 2015.
Assessment Guidance	Assignments (60%); Midterm Exams (20%); Final Exams (20%)

14. D20H4103 - Computational Materials Science

Code/ Semester	D20H4103 / Semester 1
Course/ Credit points	Computational Materials Science / 2 credits ~ 3.62 ECTS
Language	Indonesian
Responsible Person	Budi Adiperdana
Lecturer	Budi Adiperdana
Workload	1. Lectures : 2 x 50 = 100 minutes per week. 2. Assignments : 2 x 60 = 120 minutes per week. 3. Private learning : 2 x 60 = 120 minutes per week.
Contents	This course is an independent elective course, but proficiency in numerical methods and signal processing is highly necessary as prerequisites. The course provides an explanation of the definition, problems, types, and methods of artificial intelligence. Students are expected to understand the approaches required for specific cases in artificial intelligence. Introduction and Review of Quantum Mechanics, Many-Particle Hamiltonian, Born-Oppenheimer Approximation, Hartree and Hartree-Fock, Electron Correlation, Post-Hartree-Fock Approximations, Hohenberg-Kohn and Kohn-Sham Approximations (Density Functional Theory), Exchange and Correlation, Spherical and Plane Wave Basis Sets, Pseudopotentials, Self-Consistent Field (SCF) and Structure Optimization, Density of States and Band Structure, Case Studies.
Objectives	1. To be able to know and understand the concept of material computing science in science 2. To be able to understand and solve simple many-particle hamiltonian cases 3. To be able to understand several approximations used in the density functional theory (DFT) approach 4. To be able to design and calculate the physical properties of a material using DFT
Course Method	At the beginning of the course, it is conducted through the lecture method, and subsequent meetings are carried out using the case-based study method, with supplementary learning materials provided in the form of instructional videos and lecture notes
Prerequisites	-
Requirements according to the examination regulations	Registered in this course Minimum 80% attendance in this course
Reading list	1. P. W. Atkins and R. S. Friedman, Molecular Quantum Mechanics, 4th Edition, Oxford University Press, 2011. 2. R. M. Martin, Electronic Structure: Basic Theory and Practical Methods. Cambridge University Press, 2008. 3. C. Kittel. Introduction to Solid State Physics, 8th Ed., Wiley, 2004.
Assessment Guidance	Case-based rubric (25%); Assignments (25%); Midterm Exams (25%); Final Exams (25%)

15. D20H4104 – Battery Technology

Code/ Semester	D20H4104 / Semester 1
Course/ Credit points	Battery Technology / 2 credits ~ 3.62 ECTS
Language	Indonesian
Responsible Person	Sahrul Hidayat
Lecturer	Sahrul Hidayat, Camellia Panatarani
Workload	1. Lectures : 2 x 50 = 100 minutes per week. 2. Assignments : 2 x 60 = 120 minutes per week. 3. Private learning : 2 x 60 = 120 minutes per week.
Contents	The Battery Technology course is an elective course for students in the Master's Program in Physics, Faculty of Mathematics and Natural Sciences, Universitas Padjadjaran (UNPAD). This course covers the principles of battery operation and the latest developments in battery technology. The topics covered include the basic concepts of batteries, electrochemical reactions in batteries, factors affecting battery performance, methods for testing battery performance, types of batteries, examples of primary and secondary batteries, the principles of lithium-ion batteries, and the principles of metal/air batteries. Towards the end, we will study the thermodynamics of batteries and the influence of temperature on battery performance. Battery Operation Principles - C2, Primary Batteries - C3, Secondary Batteries - C3, Testing Battery Performance Characteristics - C4, Factors Affecting Battery Performance - C4, Battery Thermodynamic Systems - C5
Objectives	1. Understand and be able to explain the principles of battery operation, common terminology of battery characteristics, and electrochemical reactions of batteries (C2) 2. To be able to identify the types of primary batteries and derive redox reaction equations for primary batteries (C3) 3. To be able to determine the types of secondary batteries and derive redox reaction equations for secondary batteries (C3) 4. To be able to determine correlations between battery performance parameters and capable of determining methods for assessing the performance of primary and secondary batteries. (C4) 5. To be able to determine correlations between physical parameters that affect battery performance and the lifespan of the battery (C4) 6. To be able to analyze and conclude the influence of temperature on battery performance in battery thermodynamic systems and energy balance in batteries (C5)
Course Method	At the beginning of the course, it is conducted through the lecture method, and subsequent meetings are carried out using the case-based study method, with supplementary learning materials provided in the form of instructional videos and lecture notes
Prerequisites	-
Requirements according to the	Registered in this course Minimum 80% attendance in this course

examination regulations	
Reading list	1. D. Linden, T. B. Reddy, Handbook of Batteries, 3th Edition, McGraw-Hill Professional, 2001. 2. S. Petrovic, P. Kurzweil, J. Garche, Electrochemical Energy Storage, 1st Edition, Mc Graw Hill, 2022. 3. P. Krivik, P. Baca, Electrochemical Energy Storage, Intechopen, 2013.
Assessment Guidance	Case-based rubric (25%); Assignments (25%); Midterm Exams (25%); Final Exams (25%)

16. D20H4105- Informatics Physics

Code/ Semester	D20H4105/ Semester 1
Course/ Credit points	Informatics Physics / 2 credits ~ 3.62 ECTS
Language	Indonesian
Responsible Person	I Made Joni
Lecturer	I Made Joni, Andri Abdurrochman
Workload	1. Lectures : 2 x 50 = 100 minutes per week. 2. Assignments : 2 x 60 = 120 minutes per week. 3. Private learning : 2 x 60 = 120 minutes per week.
Contents	The course Information Physics is an elective course for students in the Master's Program in Physics, Faculty of Mathematics and Natural Sciences, Universitas Padjadjaran (UNPAD). This course covers the latest developments in the application of physics in the field of information technology, which in the future will replace the binary system that has been used until now. This system is known as Quantum bit, which is based on the logic and memory storage of electron spin states, enabling faster data storage and processing. This technology will be revolutionary in the future. Natural systems as information processors (C3 & C4), Computers as natural system information processors (C5).
Objectives	1. To be able to understand and analyze the concept and show examples of information processing in natural systems (C3) with systematic independent work and measurable discussions. 2. To be able to analyze the classical physics system of Hamiltonian and Thermodynamics and its application to the physics information system (C4) with measurable independent work. 3. To be able to provide system analysis with Quantum Physics (Qbit) and apply it to information systems (C5) with systematic independent work and measurable discussions. 4. To be able to build computational algorithms from Qbit logic and test them for various applications (C5) with systematic independent work and measurable discussion
Course Method	At the beginning of the course, it is conducted through the lecture method, and subsequent meetings are carried out using the case-based study method, with supplementary learning materials provided in the form of instructional videos and lecture notes
Prerequisites	-
Requirements according to the examination regulations	Registered in this course Minimum 80% attendance in this course
Reading list	1. R. Buyya et al, Big Data Principles and Paradigms, Elsevier, 2019. 2. S. S. Shwartz, S. B. David, Understanding Machine Learning: From Theory to Algorithms, Cambridge University Press, 2014. 3. P. F. Kisak, Entropy and Negentropy: The End and The Beginning, Portland State University, 2014.

	4. R. Togneri, C. J.S. deSilva, Fundamental of Information Theory and Coding Design, Chapman & Hall/CRC, 2003.
Assessment Guidance	Case-based rubric (25%); Assignments (25%); Midterm Exams (25%); Final Exams (25%)

17. D20H4106- Artificial Intelligence

Code/ Semester	D20H4106/ Semester 1
Course/ Credit points	Artificial Intelligence / 2 credits ~ 3.62 ECTS
Language	Indonesian
Responsible Person	Ferry Faizal
Lecturer	Ferry Faizal, I Made Joni
Workload	1. Lectures : 2 x 50 = 100 minutes per week. 2. Assignments : 2 x 60 = 120 minutes per week. 3. Private learning : 2 x 60 = 120 minutes per week.
Contents	This course is an independent elective course, but proficiency in numerical methods and signal processing is highly necessary as prerequisites. The course provides an explanation of the definition, problems, types, and methods of artificial intelligence. Students are expected to understand the approaches required for specific cases in artificial intelligence. History and Fundamentals of Artificial Intelligence, Agents and Environments, Machine Learning, Artificial Neural Networks: Basics, Artificial Neural Networks: Backpropagation Learning, Other Neural Network Architectures (CNN and RNN), Tips for Building Artificial Neural Networks, Input Formation for Artificial Neural Networks, Overview of Digital Signal and Image Processing, Unsupervised Learning 1 (Hebbian Learning, Simple Competitive Learning), Unsupervised Learning 2 (k-Mean Clustering, Adaptive Resonance Theory, and Hopfield Auto-Associative Model), Case Examples
Objectives	1. To be able to understand the concepts of artificial intelligence in general and specific terms, as well as several approaches of artificial intelligence that can be used. 2. To be able to design mathematical equations and find solutions for simple artificial intelligence cases. 3. To be able to create and process input for use in artificial intelligence, especially artificial neural network types. 4. To be able to design artificial neural network architectures for specific cases.
Course Method	At the beginning of the course, it is conducted through the lecture method, and subsequent meetings are carried out using the case-based study method, with supplementary learning materials provided in the form of instructional videos and lecture notes
Prerequisites	-
Requirements according to the examination regulations	Registered in this course Minimum 80% attendance in this course
Reading list	1. S. Russel, P. Norvig, Artificial Intelligence: A Modern Approach, Pearson, 2009. 2. T. Jones, Artificial Intelligence: A System Approach, 1st Edition, Jones & Bartlett Learning, 2009.

Assessment Guidance	Case-based rubric (25%); Assignments (25%); Midterm Exams (25%); Final Exams (25%)

18. D20H4107- Earth Science Computation

Code/ Semester	D20H4107/ Semester 1
Course/ Credit points	Earth Science Computation / 2 credits ~ 3.62 ECTS
Language	Indonesian
Responsible Person	Irwan Ary Dharmawan
Lecturer	Irwan Ary Dharmawan, Imran Hilman Mohammad
Workload	1. Lectures : 2 x 50 = 100 minutes per week. 2. Assignments : 2 x 60 = 120 minutes per week. 3. Private learning : 2 x 60 = 120 minutes per week.
Contents	This course is a standalone elective course, but a proficiency in numerical methods is highly necessary as a prerequisite. This course provides an explanation of finite difference modeling to solve partial differential equations in Earth science cases. Students are expected to be capable of modeling and analyzing Earth's physical systems and Earth's response to simple source excitations using the finite difference approach. Introduction and Review, Finite difference diffusion equations, Finite difference elliptic equations, Finite difference parabolic equations, Finite difference in the time domain for EM waves, Case studies in Earth science 1, Case studies in Earth science 2.
Objectives	1. To be able to recognize and comprehend the concepts of computational science in Earth science 2. To be able to understand the principles of finite difference modeling for solving differential equations in Earth science cases 3. To be able to calculate the Earth's response to simple source excitations of fields and/or waves using finite difference modeling 4. To be able to simulate and analyze simple Earth physical systems using the finite difference approach
Course Method	At the beginning of the course, it is conducted through the lecture method, and subsequent meetings are carried out using the case-based study method, with supplementary learning materials provided in the form of instructional videos and lecture notes
Prerequisites	-
Requirements according to the examination regulations	Registered in this course Minimum 80% attendance in this course
Reading list	1. A. Taflove, S. C. Hagness, Computational Electrodynamics: The Finite Difference Time Domain Method, Artech House, 2005. 2. R. J. LeVeque, Finite Difference Methods for Ordinary and Partial Differential Equations: Steady-State and Time-dependent Problems, 1st Edition, SIAM, 2007 3. D. L. Turcotte, G. Schubert, Geodynamics, Cambridge University Press, 2014.

Assessment Guidance	Case-based rubric (25%); Assignments (25%); Midterm Exams (25%); Final Exams (25%)

19. D20H4108- Geophysics in Environmental Engineering

Code/ Semester	D20H4108/ Semester 1
Course/ Credit points	Geophysics in Environmental Engineering / 2 credits ~ 3.62 ECTS
Language	Indonesian
Responsible Person	Eleonora Agustine
Lecturer	Eleonora Agustine, Dini Fitriani
Workload	1. Lectures : 2 x 50 = 100 minutes per week. 2. Assignments : 2 x 60 = 120 minutes per week. 3. Private learning : 2 x 60 = 120 minutes per week.
Contents	Geophysics in Environmental Engineering is an elective course for students in the Master's Program in Physics, Faculty of Mathematics and Natural Sciences, Universitas Padjadjaran (UNPAD). This course covers explanations and understanding of various geophysical methods and their applications in the field of environment. The geophysical methods discussed include gravity method, geomagnetic method, geoelectric method, electromagnetic method, and rock magnetism method. When applying geophysical methods in the environmental field, it is important to understand which method is most suitable for the specific problem being studied. The course includes an introduction to geophysics in the environmental field, potential field-based geophysical methods and their applications in the environment, magnetism-based geophysical methods and their applications in the environment, electric-based geophysical methods and their applications in the environment, and electromagnetic geophysical methods and their applications in the environment
Objectives	1. To be able to identify and comprehend (C2) the concepts of geophysical methods and their fundamental physical properties 2. To be able to explain (in detail) and comprehend (C2) geophysical methods, including data acquisition, data processing, and interpretation 3. To be able to recognize and comprehend (C2) and analyze (C4) various environmental studies based on the physical properties of Earth materials 4. To be able to recognize and comprehend (C2) and analyze (C4) the appropriate applications of geophysical methods according to the environmental studies being reviewed
Course Method	At the beginning of the course, it is conducted using the lecture method, and subsequent meetings are carried out using the case-based study method, with supplementary learning materials provided in the form of instructional videos and lecture notes
Prerequisites	-
Requirements according to the examination regulations	Registered in this course Minimum 80% attendance in this course
Reading list	1. J. M. Reynolds, An Introduction to Applied and Environmental Geophysics, 2nd Edition, Wiley, 2011.

Assessment Guidance	Case-based rubric (25%); Assignments (25%); Midterm Exams (25%); Final Exams (25%)

20. D20H4201- Functional Polymers

Code/ Semester	D20H4201/ Semester 2
Course/ Credit points	Functional Polymers / 2 credits ~ 3.62 ECTS
Language	Indonesian
Responsible Person	Fitrilawati
Lecturer	Fitrilawati, Lusi Safriani
Workload	1. Lectures : 2 x 50 = 100 minutes per week. 2. Assignments : 2 x 60 = 120 minutes per week. 3. Private learning : 2 x 60 = 120 minutes per week.
Contents	The Functional Polymers course is an elective course for students in the Master's program in Physics at the Faculty of Mathematics and Natural Sciences (FMIPA), Universitas Padjadjaran (UNPAD). After completing the Functional Polymers course, students are able to explain the types of monomers, polymer configuration/conformation, viscoelastic properties and polymer classification, understand the mechanism and process of polymerization and copolymerization, understand the correlation of structure and properties of conjugated polymers, and demonstrate the application of conjugated polymers for Solar Cell, Anticorrosion, Superconductor, Membrane, Sensor and Drug Delivery applications. Overview of Polymers, Mechanism and Process of Polymerization and Copolymerization, Structure and Properties of Conjugated Polymers, Applications (Solar Cells, Anticorrosion, Superconductors, Membranes, Sensors and Drug Delivery).
Objectives	1. Able to explain the types of monomers, polymer configuration/conformation, viscoelastic properties and polymer classification, with systematic independent work and measurable discussion (C1). 2. Able to understand the mechanism and process of polymerization and copolymerization, with systematic independent work and measurable discussion (C2). 3. Able to understand the correlation of structure and properties of conjugated polymers, with systematic independent work and measurable discussion (C2). 4. Able to demonstrate the application of conjugated polymers for Solar Cell, Anticorrosion, Superconductor, Membrane, Sensor and Drug Delivery applications, with systematic independent work and measurable discussion (C3).
Course Method	At the beginning of the course, it is conducted through the lecture method, and subsequent meetings are carried out using the case-based study method, with supplementary learning materials provided in the form of instructional videos and lecture notes.
Prerequisites	-
Requirements according to the examination regulations	Registered in this course Minimum 80% attendance in this course

Reading list	1. J.M.G. Cowie, V. Arrighi, Polymer: Chemistry and Physics of Modern Materials, 3rd Edition, CRC Press, 2007. 2. J. R. Reynolds, B. C. Thompson, T. A. Skotheim, Handbook of Conducting Polymers, Fourth Edition - 2 Volume Set, CRC Press, 2019. 3. H. G Elias, An Introduction to Polymer Science, Wiley, 1997.
Assessment Guidance	Case-based rubric (25%); Assignments (25%); Midterm Exams (25%); Final Exams (25%)

21. D20H4202-Nanotechnology

Code/ Semester	D20H4202/ Semester 2
Course/ Credit points	Nanotechnology / 2 credits ~ 3.62 ECTS
Language	Indonesian
Responsible Person	Camellia Panatarani
Lecturer	Camellia Panatarani, I Made Joni
Workload	1. Lectures: 1 x 50 = 50 minutes per week 2. Assignments: 1 x 60 = 60 minutes per week 3. Independent learning: 1 x 60 = 60 minutes per week 4. Laboratory Work: 1 x 170= 170 minutes per week
Contents	Nanotechnology is a technology that manipulates matter at the atomic scale and molecular scale. Nanotechnology involves the design, characterization, production, and application of nanoscale structures, devices, and systems. It builds structures, devices, and systems with at least one new characteristic or property. Nanotechnology has a considerable impact in almost all areas of industry, technology, research, and development. Nanotechnology in general provides longer-lasting, safer, cleaner, better-built, and smarter products for communication, industry, home, agriculture, transportation, and medicine. This course covers nanotechnology from theory to application and to provide experience for students in processing nanomaterials, the course will combine students' activities in the classroom and in the laboratory.
Objectives	Able to synthesize one of the nanomaterials with simple methods, characterize and communicate the results both verbally and written (C5, A3, P4)
Course Method	Collaborative Learning (CbL) Project Based Learning (PBL) Discovery Learning
Prerequisites	Solid State Physics
Requirements according to the examination regulations	Registered in this course. Minimum 80% attendance in this course
Reading list	1. B. Bhushan, D. Luo, S. R. Schricker, W. Sigmund, S. Zauscher (Eds), Handbook of Nanomaterials Properties, Springer Heidelberg, 2017. 2. C. Dupas P. Houdy M. Lahmani (Eds.), Nanoscience Nanotechnologies and Nanophysics, Springer, 2006.
Assessment Guidance	Collaborative learning rubric (25%); Laboratory work (50%); discovery learning (25%)

22. D20H4203- Carbon Technology

Code/ Semester	D20H4203/ Semester 2
Course/ Credit points	Carbon Technology / 2 credits ~ 3.62 ECTS
Language	Indonesian
Responsible Person	Sahrul Hidayat
Lecturer	Sahrul Hidayat, Otong Nurhilal
Workload	1. Lectures : 2 x 50 = 100 minutes per week. 2. Assignments : 2 x 60 = 120 minutes per week. 3. Private learning : 2 x 60 = 120 minutes per week.
Contents	This course is an elective course for students in the Master's program in Physics at the Faculty of Mathematics and Natural Sciences (FMIPA), Universitas Padjadjaran (UNPAD). This course is given to 2nd semester students with a weight of 2 credits. The course discusses carbon technology, microstructure of materials, carbon in life, carbon hybridisation, carbon allotropes, carbon phase diagram, graphite processing, activated carbon, activated carbon characterisation, physical activation process, chemical activation process, activated carbon applications for batteries/supercapacitors, activated carbon applications for the environment, graphene oxide synthesis and graphene oxide applications. Lectures are held using the group discussion method, where students will be given references of teaching materials before the lecture and questions to be discussed at the next meeting. During lecture hours, students will discuss how to answer the questions given and each student summarizes the answers with their own descriptions. Students will be divided into groups to guide the discussion at each meeting. Resumes of discussion results are collected by each student through the Learning Management System (regular live UNPAD). Lecturers monitor and direct the discussion to answer any questions given and assess students' abilities with the rubric that has been prepared. Microstructure of Materials and Carbon in life - C4, Carbon Hybridisation- C4, Carbon Allotropes-C4, Synthesis of various carbon allotropes (C5), Analysis of the physical properties of Carbon Allotropes.
Objectives	1. Able to describe the importance of carbon in life and its application in various technologies with systematic independent work and measurable discussion (C4). 2. Able to identify the factors that cause carbon hybridisation and able to explain the kinds of carbon hybridisation with systematic independent work and measurable discussion (C4). 3. Able to explain the types of carbon allotropes and their physical chemical characteristics with systematic independent work and measurable discussion (C4). 4. Able to explain the synthesis procedures of various carbon allotropes with systematic independent work and measurable discussions (C5). 5. Able to analyze various characterisation results of carbon allotropes with systematic independent work and measurable discussion (C5).

Course Method	At the beginning of the course, it is conducted through the lecture method, and subsequent meetings are carried out using the case-based study method, with supplementary learning materials provided in the form of instructional videos and lecture notes.
Prerequisites	-
Requirements according to the examination regulations	Registered in this course Minimum 80% attendance in this course
Reading list	1. H. Marsh, F. R. Reinoso, Activated Carbon, Elsevier, 2006. 2. S. Nazarpour, S. R. Waite, Graphene Technology; from Laboratory to Fabrication, Wiley, 2016. 3. W. Choi, J. W. Lee, Graphene; Synthesis and Applications, CRC Press, 2011.
Assessment Guidance	Assignments (65%); Midterm Exams (15%); Final Exams (20%)

23. D20H4204- Supercapacitors

Code/ Semester	D20H4204/ Semester 2
Course/ Credit points	Supercapacitors / 2 credits ~ 3.62 ECTS
Language	Indonesian
Responsible Person	Fitrilawati
Lecturer	Fitrilawati, Ayi Bahtiar
Workload	1. Lectures : 2 x 50 = 100 minutes per week. 2. Assignments : 2 x 60 = 120 minutes per week. 3. Private learning : 2 x 60 = 120 minutes per week.
Contents	The Supercapacitor course is an elective course for students in the Master's program in Physics at the Faculty of Mathematics and Natural Sciences (FMIPA), Universitas Padjadjaran (UNPAD). The subject matter in this course includes: differences between supercapacitors and capacitors and batteries, types of supercapacitors and their charge storage methods, supercapacitor performance parameters, supercapacitor materials, and supercapacitors in integrated devices.
Objectives	1. Able to classify supercapacitors from other types of energy storage such as batteries and capacitors with systematic independent work and measurable discussions. 2. Able to classify the types of supercapacitors and their charge storage mechanisms with systematic independent work and measurable discussion. 3. Able to analyze parameters in supercapacitor performance, with measurable independent work. 4. Able to analyze electrode materials that suitable for supercapacitors, with systematic independent work and measurable discussion. 5. Able to project supercapacitors in an integrated device, with systematic independent work and measurable discussion.
Course Method	At the beginning of the course, it is conducted through the lecture method, and subsequent meetings are carried out using the case-based study method, with supplementary learning materials provided in the form of instructional videos and lecture notes.
Prerequisites	-
Requirements according to the examination regulations	Registered in this course Minimum 80% attendance in this course
Reading list	1. F. Beguin, E. Frackowiak, Supercapacitors: Materials, Systems, and Applications, Wiley, 2013. 2. V. S. Bagotsky, A. M. Skundin, Y. M. Volfkovich, Electrochemical Power Sources: Batteries, Fuel Cells, and Supercapacitors, John Wiley & Sons, Inc, 2015. 3. K. K. Kar (Ed.), Handbook of Nanocomposite Supercapacitor Materials II, Springer, Cham., 2020. 4. Newest and up-date scientific articles related to te supercapasitor.

Assessment Guidance	Case-based rubric (40%); Assignments (30%); Midterm Exams (15%); Final Exams (15%)

24. D20H4205- Control Systems and Instrumentation

Code/ Semester	D20H4205/ Even Semester
Course/ Credit points	Control Systems and Instrumentation / 2 credits ~ 3.62 ECTS
Language	Indonesian
Responsible Person	Andri Abdurrochman
Lecturer	Andri Abdurrochman, Ferry Faizal
Workload	1. Lectures : 2 x 50 = 100 minutes per week. 2. Assignments : 2 x 60 = 120 minutes per week. 3. Private learning : 2 x 60 = 120 minutes per week.
Contents	The Control System course is an elective course for students in the Master's program in Physics at the Faculty of Mathematics and Natural Sciences (FMIPA), Universitas Padjadjaran (UNPAD). After completing the control system course, students are able to explain the basics of laplace transformation, bode function, nyquist, and state space, formulate laplace transformation applications, and analyze PID (proportional, integrated, derivative) control with systematic independent work and measurable discussions. Fundamentals of Laplace transformation (theory and matlab simulation), Bode function, nyquist, and state space, Laplace transformation application (spring, rc circuit), PID control and system modeling with State Space.
Objectives	1. Able to model linear physical systems with transfer functions and solve them with Laplace Transformation with systematic and measurable independent/group work. 2. Able to analyze the stability of physical systems through those modeled with transfer functions. 3. Able to apply classical PID control methods and analyze and report the results. 4. Able to apply the State Space approach in control systems.
Course Method	At the beginning of the course, it is conducted through the lecture method, and subsequent meetings are carried out using the case-based study method, with supplementary learning materials provided in the form of instructional videos and lecture notes.
Prerequisites	-
Requirements according to the examination regulations	Registered in this course Minimum 80% attendance in this course
Reading list	1. W. Bolton, Instrumentation and Control Systems, 3rd Edition, Elsevier, 2021. 2. K. P. Raju, Y. J. Redy, Instrumentation and Control Systems, Mc Graw Hill, 2017.
Assessment Guidance	Case-based rubric (25%); Assignments (25%); Midterm Exams (25%); Final Exams (25%)

25. D20H4206- Big Data

Code/ Semester	D20H4206/ Semester 2
Course/ Credit points	Big Data / 2 credits ~ 3.62 ECTS
Language	Indonesian
Responsible Person	Budi Adiperdana
Lecturer	Budi Adiperdana, I Made Joni
Workload	1. Lectures : 2 x 50 = 100 minutes per week. 2. Assignments : 2 x 60 = 120 minutes per week. 3. Private learning : 2 x 60 = 120 minutes per week.
Contents	The Big Data course is an elective course for students in the Master's program in Physics at the Faculty of Mathematics and Natural Sciences (FMIPA), Universitas Padjadjaran (UNPAD). This course covers the phenomenon of processing and managing extremely large data (big data), which includes storage management (HDFS), processing (Map-reduce), and visualization using Hadoop and PySparks. The detailed course materials include Data, Information, Data Storage and Processing, Big Data (History, Characteristics, Benefits, and Potential), Data Types (Structured and Unstructured), Data Mining, Parallel & Distributed Processing, Hadoop (HDFS, Map-Reduce, Architecture, Ecosystem, Installation and Configuration), Spark, Data Visualization, and Final Project.
Objectives	1. Able to analyze data and information with systematic independent work and measurable discussion [C4]. 2. Able to analyze data structures with systematic independent work and measurable discussion [C4]. 3. Able to analyze and process data in parallel with systematic independent work and measurable discussion [C4]. 4. Able to create big data architecture using Hadoop with systematic independent work and measurable discussion [C5]. 5. Able to process streaming data with systematic independent work and measurable discussion [C6].
Course Method	At the beginning of the course, it is conducted through the lecture method, and subsequent meetings are carried out using the case-based study method, with supplementary learning materials provided in the form of instructional videos and lecture notes. After all the materials and practices have been completed, students will engage in project-based learning as their final assignment.
Prerequisites	-
Requirements according to the examination regulations	Registered in this course Minimum 80% attendance in this course
Reading list	1. R. Buyya, R. N. Calheiros, A. V. Dastjerdi, Big Data: Principles and Paradigms, Morgan Kaufmann, 2016. 2. A. Nugent, F. Halper, J. S. Hurwit, Big Data For Dummies, 1st Edition, For Dummies, 2013.
Assessment Guidance	Case-based rubric (25%); Assignments (25%); Midterm Exams (25%); Final Exams (25%)

26. D20H4207- Signal and Image Analysis

Code/ Semester	D20H4207/ Semester 2
Course/ Credit points	Signal and Image Analysis / 2 credits ~ 3.62 ECTS
Language	Indonesian
Responsible Person	Andri Abdurrochman
Lecturer	Andri Abdurrochman, Ferry Faizal
Workload	1. Lectures : 2 x 50 = 100 minutes per week. 2. Assignments : 2 x 60 = 120 minutes per week. 3. Private learning : 2 x 60 = 120 minutes per week.
Contents	Signal and Image Analysis course is an elective course for students in the Master's program in Physics at the Faculty of Mathematics and Natural Sciences (FMIPA), Universitas Padjadjaran (UNPAD). After attending this course, students are expected to be able to perform processing for the analysis and interpretation of signals and images in accordance with the needs and appropriate methods. This course covers topics related to the real-time signal processing, analogue-discrete (digital) transformation, discrete & z transformation, correlation and convolution, digital filtering which will discuss FIR and IIR, as well as spectrum estimation and analysis.
Objectives	1. Able to analyze analogue-discrete (digital) transformation with systematic independent work and measurable discussion. 2. Able to analyze discrete & z transformations with systematic independent work and measurable discussions. 3. Able to analyze convolution and Correlation theory with systematic independent work and measurable discussion. 4. Able to analyze digital filters with systematic independent work and measurable discussion. 5. Able to analyze and estimate spectrum with systematic independent work and measurable discussion.
Course Method	At the beginning of the course, it is conducted through the lecture method, and subsequent meetings are carried out using the case-based study method, with supplementary learning materials provided in the form of instructional videos and lecture notes.
Prerequisites	-
Requirements according to the examination regulations	Registered in this course Minimum 80% attendance in this course
Reading list	1. E. C. Ifeachor, B. W. Jervis, Digital Signal Processing: A Practical Approach, 2nd Edition, Prentice Hall, 2001. 2. A. Ambardar, Analog and Digital Signal Processing, 2nd Edition, Cengage Learning, 1999. 3. A. Ambradar, Analog and Digital Signal Processing, Brooks/Cole Publishing, 1999.
Assessment Guidance	Assignments (80%); Final Exams (20%)

27. D20H4208- Global and Planetary Geophysics

Code/ Semester	D20H4208/ Semester 2
Course/ Credit points	Global and Planetary Geophysics / 2 credits ~ 3.62 ECTS
Language	Indonesian
Responsible Person	Yudi Rosandi
Lecturer	Yudi Rosandi, Kartika Hajar Kirana
Workload	1. Lectures : 2 x 50 = 100 minutes per week. 2. Assignments : 2 x 60 = 120 minutes per week. 3. Private learning : 2 x 60 = 120 minutes per week.
Contents	Global and Planetary Geophysics is an elective course for students in the Master's program in Physics at the Faculty of Mathematics and Natural Sciences (FMIPA), Universitas Padjadjaran (UNPAD). The course covers topics related to the shape and dynamics of planetary surfaces, the history of Earth's formation, Earth's structure, rheology, global tectonics and volcanism, and weather and climate. Topics covered include: Shape and Dynamics of Planetary Surfaces (C4), Formation and Structure of Earth (C4), Rheology, Global Tectonics, and Volcanism (C4). Weather and Climate (C5)
Objectives	1. Able to analyze the shape and dynamics of planetary surfaces with systematic independent work and measurable discussions (C4). 2. Able to analyze the formation and structure of the earth with systematic independent work and measurable discussion (C4). 3. Able to analyze global rheology, tectonics and volcanism with systematic independent work and measurable discussion (C4). 4. Able to compare and analyze weather and climate characteristics with systematic independent work and measurable discussion (C5).
Course Method	At the beginning of the course, it is conducted through the lecture method, and subsequent meetings are carried out using the case-based study method, with supplementary learning materials provided in the form of instructional videos and lecture notes
Prerequisites	-
Requirements according to the examination regulations	Registered in this course Minimum 80% attendance in this course
Reading list	1. P. J. Armitage, Astrophysics of Planet Formation, 1st Edition, Cambridge University Press, 2013. 2. J. Melosh, Planetary Surface Processes, Cambridge University Press, 2011. 3. J. P. Poirier, Introduction to Physics of the Earth's Interior, Cambridge University Press, 2012. 4. C. M. R. Fowler, The Solid Earth: An Introduction to Global Geophysics, 2nd Edition, Royal Holloway London, 2014.
Assessment Guidance	Case-based rubric (25%); Assignments (25%); Midterm Exams (25%); Final Exams (25%)

28. D20H4209- Exploration Geophysics

Code/ Semester	D20H4209/ Semester 2
Course/ Credit points	Exploration Geophysics / 2 credits ~ 3.62 ECTS
Language	Indonesian
Responsible Person	Eleonora Agustine
Lecturer	Eleonora Agustine, Asep Harja
Workload	1. Lectures : 2 x 50 = 100 minutes per week. 2. Assignments : 2 x 60 = 120 minutes per week. 3. Private learning : 2 x 60 = 120 minutes per week.
Contents	Exploration Geophysics is an elective course for students in the Master's program in Physics at the Faculty of Mathematics and Natural Sciences (FMIPA), Universitas Padjadjaran (UNPAD). The course covers exploration geophysics as a whole and its various types, geophysical exploration techniques, including geological and geophysical methods such as gravity, magnetic, seismic, electric, and electromagnetic methods. It also includes a flowchart of using geophysical methods in research, and case studies based on various literature sources. Topics covered include: Exploration Geophysics as a Whole and Its Types (C3), Geophysical Exploration Techniques (C4), Flowchart of Using Geophysical Methods in Research (C5), Case Studies Based on Literature (C5)
Objectives	1. Able to classify the types of exploration with systematic independent work and measured discussion. 2. Able to analyze geophysical exploration techniques with measurable independent work 3. Able to validate usage and research flow charts using Geophysical methods with systematic independent work and measurable discussions. 4. Able to interpret and conclude various geophysical exploration cases from literature with systematic independent work and measurable discussions.
Course Method	At the beginning of the course, it is conducted through the lecture method, and subsequent meetings are carried out using the case-based study method, with supplementary learning materials provided in the form of instructional videos and lecture notes
Prerequisites	-
Requirements according to the examination regulations	Registered in this course Minimum 80% attendance in this course
Reading list	1. M. R. Gadallah, R. Fisher, Exploration Geophysics: An Introduction, Springer, 2009. 2. A. E. Beck, Physical Principles of Exploration Methods: An Introductory, John Wiley & Sons, 1981.
Assessment Guidance	Case-based rubric (25%); Assignments (25%); Midterm Exams (25%); Final Exams (25%)

Lecturer

No	Full Name	ID
1	Prof. Dr. I Made Joni, M.Sc.	0001067202
2	Prof. Dr. Risdiana, M. Eng	0005057501
3	Prof. Dr. Camellia Panatarani	0003037406
4	Prof. Dr.rer.nat. Ayi Bahtiar	0029107002
5	Prof. Dr.rer.nat. Yudi Rosandi	008087106
6	Dr. Fitrilawati, M.Sc.	0008026501
7	Dr. Sahrul Hidayat, M.Si.	0030077305
8	Dr. Togar Saragi	0026086803
9	Lusi Safriani, S.Si., M.Si., Ph.D.	0010037301
10	Dr. Andri Abdurochman, MT	0026057405
11	Dr. Annisa Aprilia	0011048202
12	Dr. Otong Nurhilal, M.Si.	0028086903
13	Dr. Irwan Ary Dharmawan, M.Si.	031057202
14	Dr. Dini Fitriani, M.Si.	004107504
15	Dr. Kartika Hajar Kirana, M.Si.	025098504
16	Nowo Riveli, Ph.D.	0029118206
17	Dr. Budi Adiperdana, M.Si	0017058206
18	Ferry Faizal, Ph.D	0031058207
19	Dr. Eleonora Agustine, M.Si.	0001087107
20	Dr. Imran Hilman Mohammad, M.Si.	0014088111
21	Dr. Asep Harja	0019046901