MODULE HANDBOOK 2025

MASTER PROGRAM IN PHYSICS

DEPARTMENT OF PHYSICS

FACULTY OF MATHEMATICS AND NATURAL SCIENCES

UNIVERSITAS PADJADJARAN

Table of Contents

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	140820-UND202511001	Electrodynamics	A	3
	140820-UND202511002	Computational Science	A	3
	140820-UND202511003	Scientific Writing	B	3
	140820-UND202511004	Statistical Mechanics*	B	3
	140820-UND202511005	Classical Mechanics*	B	3
	140820-UND2025110XX	Elective Course	C	3
	140820-UND2025110XX	Elective Course	C	3
	Total Credit 1st Semester			**15**
2	140820-UND202522006	Quantum Mechanics	A	3
	140820-UND202522007	Project Management	A	3
	140820-UND202522008	Transport Phenomena*	B	3
	140820-UND202522009	Crystallography and Diffraction Techniques*	B	3
	140820-UND202522010	Sensor Technology and Instrumentation*	B	3
	140820-UND202522010	Sensor Technology and Instrumentation*	A	3
	140820-UND202502011	Research Proposal Seminar	D	3
	140820-UND2025220XX	Elective Course	C	3
	140820-UND2025220XX	Elective Course	C	3
	*at least 6 credits (2 courses) from 14 credits (5 courses)			
	Total Credit 2nd Semester			**15**
3	140820-UND202533012	Entrepreneurship	B	3
	140820-UND202503013	Research Progress Seminar	D	3
	140820-UND2025330XX	Elective Course	C	3
	140820-UND2025330XX	Elective Course	C	3
	Total Credit 3rd Semester			**6**
4	140820-UND20250414	Thesis	D	9
	Total Credit 4th Semester			**9**

	Compulsory courses	A	**24**
	Supporting courses for final project and publication, and thesis	B	**18**
	Elective courses	C	**12**
	Total Credit for Master Program in Physics		**54**

CHAPTER II

MODULE HANDBOOK

1. 140820-UND202522001 - Electrodynamics

Code/ Semester	140820-UND202511001 / Semester 1
Course/ Credit points	Electrodynamics / 3 credits ~ 5.4 ECTS
Language	Indonesian
Responsible Lecturer	Ayi Bahtiar
Team teaching	Ayi Bahtiar, Togar Saragi, Lusi Safriani
Workload	1. Lectures : 3 x 50 = 150 minutes per week. 2. Assignments : 3 x 60 = 180 minutes per week. 3. Private learning : 3 x 60 = 180 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	Registered in this course Minimum 80% attendance in this course

examination regulations	
Reading list	1. Classical Electrodynamics, Third Edition, by John David Jackson, John Wiley and Sons, (1998). 2. Tjia, M.O. 1998. Teori Elektrodinamika Klasik, Dept. Fisika ITB, Bandung.
Assessment Guidance	Case-based rubric (25%); Assignments (25%); Midterm Exams (25%); Final Exams (25%)

2. 140820-UND202511002 - Computational Science

Code/ Semester	140820-UND202511002 / Semester 1
Course/ Credit points	Computational Science / 3 credits ~ 5.4 ECTS
Language	Indonesian
Responsible Lecturer	Budi Adiperdana
Team Teaching	Budi Adiperdana, Yudi Rosandi
Workload	1. Lectures : 3 x 50 = 150 minutes per week. 2. Assignments : 3 x 60 = 180 minutes per week. 3. Private learning : 3 x 60 = 180 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. Michael de Podesta. 1996. Understanding the Properties of Matter. UCL Press, London. 2. Daan Frenkel & Berend Smit. 1996. Undertsnading Molecular Simulation. Academic Press. London. 3. Roger Smith et. Al. 1997. Atomic and Ionic Collisions in Solids and at Surface. Cambridge University Press. 4. Mike Finnis. 2005. Interatomic Forces in Condesed Matter. Oxford University Press. 5. Peter W. Atkins & Ronald S. Friedman. 2010. Molecular Quantum Mechanics 5th Edition. Oxford University Press. 6. Richard M. Martin. 2012. Electronic Structure - Basic Theory and Practical Methods. Cambridge University Press.
Assessment Guidance	Case-based rubric (25%); Assignments (25%); Midterm Exams (25%); Final Exams (25%)

3. 140820-UND202511003 - Scientific Writing

Code/ Semester	140820-UND202511003 / Semester 1
Course/ Credit points	Scientific Writing / 3 credits ~ 5.4 ECTS
Language	Indonesian
Responsible Lecturer	Risdiana
Team Teaching	Risdiana
Workload	1. Lectures : 3 x 50 = 150 minutes per week. 2. Assignments : 3 x 60 = 180 minutes per week. 3. Private learning : 3 x 60 = 180 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. Lame, Guillaume, Systematic Literature Review:An Introduction, International Conference on Engineering Design, ICED19, Delf, The Netherlands. 2. Angela Boland, Gemma Cherry, Rumona Dikson, Doing a Systematic Review, Second edition, Sage Publishing.

	3. Andrew Booth, Anthea Sutton, Mark Clower, Marrissa Martyn-St James, Systematic Approaches to a Successful Literature Review, ISBN: 1529711843.
Assessment Guidance	Case-based rubric (25%); Assignments (25%); Midterm Exams (25%); Final Exams (25%)

4. 140820-UND202511004 - Statistical Mechanics

Code/ Semester	140820-UND202511004 / Semester 1
Course/ Credit points	Statistical Mechanics / 3 credits ~ 5.4 ECTS
Language	Indonesian
Responsible Lecturer	I Made Joni
Team Teaching	I Made Joni, Nowo Riveli
Workload	1. Lectures : 3 x 50 = 150 minutes per week. 2. Assignments : 3 x 60 = 180 minutes per week. 3. Private learning : 3 x 60 = 180 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. Kerson Huang, Statistical Mechanics. 2. Mikrajuddin Abdullah, Mekanika Statistik.
Assessment Guidance	Assignments (60%); Midterm Exam (20%); Final Exam (20%)

5. 140820-UND202522005 - Classical Mechanics

Code/ Semester	140820-UND202522005 / Semester 2
Course/ Credit points	Classical Mechanics / 3 credits ~ 5.4 ECTS
Language	Indonesian
Responsible Lecturer	Risdiana
Team Teaching	Risdiana
Workload	1. Lectures : 3 x 50 = 150 minutes per week. 2. Assignments : 3 x 60 = 180 minutes per week. 3. Private learning : 3 x 60 = 180 minutes per week.
Contents	The Classical 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 is designed to equip graduate students with a deep and structured understanding of classical mechanics through an outcome-based approach. The course emphasizes the development of analytical and problem-solving skills using advanced formulations such as Lagrangian and Hamiltonian mechanics. Through a systematic study of variational principles, symmetries, conserved quantities, rigid body dynamics, and canonical transformations, students will gain foundational competencies that bridge to quantum mechanics and other advanced topics in physics. The learning process encourages critical thinking, mathematical rigor, and the ability to apply classical mechanics to complex physical systems.
Objectives	1. Able to formulate equations of motion for mechanical systems using Lagrangian and Hamiltonian mechanics. (C3) 2. Able to apply variational principles to derive the dynamics of constrained and unconstrained systems. (C4) 3. Able to analyze physical systems using conservation laws derived from symmetries via Noether's theorem. (C4) 4. Able to evaluate central force and rigid body problems using advanced analytical techniques. (C5) 5. Able to demonstrate understanding of phase space, Poisson brackets, and canonical transformations. (C3, C4) 6. Able to apply Hamilton–Jacobi theory to solve mechanical problems and interpret classical–quantum links. (C5) 7. Able to communicate solutions and reasoning effectively in both written and oral scientific formats. (A3)
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. Goldstein, H., Poole, C., & Safko, J. *Classical Mechanics* (3rd Edition). Addison-Wesley, 2002. 2. Landau, L.D., & Lifshitz, E.M. Mechanics (Volume 1 of Course of Theoretical Physics). Pergamon Press, 1976. 3. Jose, J.V., & Saletan, E.J. Classical Dynamics: A Contemporary Approach Cambridge University Press, 1998.
Assessment Guidance	SGD Rubric (25); Assignment/Evaluation (25%); Midterm Exams (25%); Final Exams (25%)

6. 140820-UND202522006 - Quantum Mechanics

Code/ Semester	140820-UND202522006 / Semester 2
Course/ Credit points	Quantum Mechanics / 3 credits ~ 5.4 ECTS
Language	Indonesian
Responsible Lecturer	Annisa Aprilia
Team Teaching	Annisa Aprilia, I Made Joni
Workload	1. Lectures : 3 x 50 = 150 minutes per week. 2. Assignments : 3 x 60 = 180 minutes per week. 3. Private learning : 3 x 60 = 180 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, New Age Internatiinal New delhi. 1995. 2. Mekanika Kuantum, M.O. Tjia, ITB press. 3. Modern Quantum Mechanics, J.J. Sakurai, Third Edition. Cambridge University Pres. 4. David Tong; Quantum Mechanics.
Assessment Guidance	SGD Rubric (25); Assignment/Evaluation (25%); Midterm Exams (25%); Final Exams (25%)

7. 140820-UND202522007 - Project Management

Code/ Semester	140820-UND202522007 / Semester 2
Course/ Credit points	Project Management / 3 credits ~ 5.4 ECTS
Language	Indonesian
Responsible Lecturer	Camellia Panatarani
Team Teaching	Camellia Panatarani
Workload	1. Lectures : 3 x 50 = 150 minutes per week. 2. Assignments : 3 x 60 = 180 minutes per week. 3. Private learning : 3 x 60 = 180 minutes per week.
Contents	This course is designed to equip students with the knowledge and skills to plan and manage academic and professional career development after completing their studies. Through this course, students are encouraged to evaluate their potential, understand work and academic trends, and develop career strategies that are in line with their long-term goals.
Objectives	1. Able to to design and manage research and technology based projects. 2. Able to use project management tools (Gantt Chart, WBS, etc.). 3. Able to create professional project reports and documentation.
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. PMI (2021). A Guide to the Project Management Body of Knowledge (PMBOK Guide), 7th Edition. 2. Kerzner, H. (2022). Project Management: A Systems Approach to Planning, Scheduling, and Controlling. Wiley. 3. Meredith, J. R., & Mantel, S. J. (2020). Project Management: A Managerial Approach. Wiley.
Assessment Guidance	Assignments (70%); Midterm Exams (15%); Final Exams (15%)

8. 140820-UND202522008 - Transport Phenomena

Code/ Semester	140820-UND202522008 / Semester 2
Course/ Credit points	Transport Phenomena / 3 credits ~ 5.4 ECTS
Language	Indonesian
Responsible Lecturer	Irwan Ary Dharmawan
Team Teaching	Irwan Ary Dharmawan, Imran Hilman Mohammad
Workload	1. Lectures : 3 x 50 = 150 minutes per week. 2. Assignments : 3 x 60 = 180 minutes per week. 3. Private learning : 3 x 60 = 180 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. Bird, R. B. (2002). Transport phenomena. Appl. Mech. Rev., 55(1), R1-R4. 2. Turcotte, D. L., & Schubert, G. (2002). Geodynamics. Cambridge university press.
Assessment Guidance	Assignments (70%); Midterm Exams (15%); Final Exams (15%)

9. 140820-UND20252209 - Crystallography and Diffraction Techniques

Code/ Semester	140820-UND202522009 / Semester 2
Course/ Credit points	Crystallography and Diffraction Techniques / 3 credits ~ 5.4 ECTS
Language	Indonesian
Responsible Lecturer	Risdiana
Team Teaching	Risdiana
Workload	1. Lectures : 3 x 50 = 150 minutes per week. 2. Assignments : 3 x 60 = 180 minutes per week. 3. Private learning : 3 x 60 = 180 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, Prentice Hall, 2001. 2. F.C. Phillips, An Introduction to Crystallography, Longman, London 1970. 3. Giacovazzo et. Al., Fundamental of Crystallography, IUCr, Oxford Science, 2001.
Assessment Guidance	Quiz/Task/Assignments (80%); Midterm Exams (10%); Final Exams (10%)

10. 140820-UND202522010 - Sensor and Instrumentation Technology

Code/ Semester	140820-UND202522010 / Semester 2
Course/ Credit points	Sensor and Instrumentation Technology / 3 credits ~ 5.4 ECTS
Language	Indonesian
Responsible Lecturer	I Made Joni
Team Teaching	I Made Joni, Andri Abdurrochman, Ferry Faizal
Workload	1. Lectures: 3 x 50 = 150 minutes per week. 2. Assignments: 3 x 60 = 180 minutes per week. 3. Private learning: 3 x 60 = 180 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. Sabrie Soloman, SENSORS HANDBOOK, 2nd, McGraw Hill, New York, 2009. 2. Jacob Fraden, Handbook of Modern Sensors: Physics, Designs, and Applications, Fourth Edition, Springer, New York, 2010 3. William C. Dunn, Fundamentals of Industrial Instrumentation and Process Control, McGraw-Hill, 2005
Assessment Guidance	Resume Papers and Presentation (80%); Final Exams (20%)

11. 140820-UND2025220011 - Research Proposal Seminar

Code/ Semester	140820-UND202522011 / Semester 2
Course/ Credit points	Research Proposal Seminar / 3 credits ~ 5.4 ECTS
Language	Indonesian
Responsible Lecturer	Risdiana
Team Teaching	Risdiana
Workload	1. Lectures : 3 x 50 = 150 minutes per week. 2. Assignments : 3 x 60 = 180 minutes per week. 3. Private learning : 3 x 60 = 180 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, Research Design, Sage Publications, 2014. 3. Bahasa Indonesia Ejaan yang Disempurnakan.
Assessment Guidance	Proposal Research content (50%); Presentation content (10%); Discussion (30%); Performance of Presentation (10%)

12. 140820-UND202533012 - Technology Entrepreneurship

Code/ Semester	140820-UND202533012 / Semester 3
Course/ Credit points	Entrepreneurship / 3 credits ~ 5.4 ECTS
Language	Indonesian
Responsible Lecturer	I Made Joni
Team Teaching	I Made Joni
Workload	1. Lectures : 3 x 50 = 150 minutes per week. 2. Assignments : 3 x 60 = 180 minutes per week. 3. Private learning : 3 x 60 = 180 minutes per week.
Contents	This course encourages students to create economic value based on scientific and technological innovation.
Objectives	1. Able to Identify technology-based business opportunities. 2. Able to design a business plan based on research results. 3. Able to understand science-based business regulations and ethics.
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. Byers, T., Dorf, R., & Nelson, A. Technology Ventures: From Idea to Enterprise (5th Edition) McGraw-Hill Education, 2021. 2. Schilling, M. A. Strategic Management of Technological Innovation (6th Edition) McGraw-Hill Education, 2022. 3. Blank, S., & Dorf, B. The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company K&S Ranch, 2012.
Assessment Guidance	Assignments (70%); Midterm Exams (15%); Final Exams (15%)

13. 140820-UND202503013 - Research Progress Seminar

Code/ Semester	140820-UND202503013 / Semester 3
Course/ Credit points	Research Progress Seminar / 3 credits ~ 5.4 ECTS
Language	Indonesian
Responsible Lecturer	Risdiana
Team Teaching	Risdiana
Workload	1. Lectures : 3 x 50 = 150 minutes per week. 2. Assignments : 3 x 60 = 180 minutes per week. 3. Private learning : 3 x 60 = 180 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%)

14. 140820-UND202504014 - Thesis

Code/ Semester	140820-UND202504014 / Semester 4
Course/ Credit points	Thesis / 9 credits ~ 16.2 ECTS
Language	Indonesian
Responsible Lecturer	Risdiana
Team Teaching	Risdiana
Workload	1. Lectures : 9 x 50 = 450 minutes per week. 2. Assignments : 9 x 60 = 540 minutes per week. 3. Private learning : 9 x 60 = 540 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. Panduan penulisan Tesis Unpad. 2. Bahasa Indonesia Ejaan yang Disempurnakan. 3. J. W. Creswell, Research Design, Sage Publications, 2014.
Assessment Guidance	Research content (50%); Presentation content (10%); Discussion (30%); Performance of Presentation (10%)

15. 140820-UND202511015 - Advanced Materials for Environmental Applications

Code/ Semester	140820-UND202511015 / Semester 1
Course/ Credit points	Advanced Materials for Environmental Applications / 3 credits ~ 5.4 ECTS
Language	Indonesian
Responsible Lecturer	Fitrilawati
Team Teaching	Fitrilawati, Annisa Aprilia
Workload	1. Lectures : 3 x 50 = 150 minutes per week. 2. Assignments : 3 x 60 = 180 minutes per week. 3. Private learning : 3 x 60 = 180 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. Smart Materials for Adnvanced Environmental Applications, RSC Smart Materias, Edited by Peng Wang, 2020. 2. Environmental applications of graphene-based nanomaterials, F Perreault, AF De Faria, M Elimelech - Chemical Society Reviews, 2015,44, 5861.
Assessment Guidance	Case-based rubric (25%); Assignments (25%); Midterm Exams (25%); Final Exams (25%)

16. 140820-UND202511016 – Battery Technology

Code/ Semester	140820-UND202511016 / Semester 1
Course/ Credit points	Battery Technology / 3 credits ~ 5.4 ECTS
Language	Indonesian
Responsible Lecturer	Sahrul Hidayat
Team Teaching	Sahrul Hidayat, Camellia Panatarani
Workload	1. Lectures : 3 x 50 = 150 minutes per week. 2. Assignments : 3 x 60 = 180 minutes per week. 3. Private learning : 3 x 60 = 180 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 examination regulations	Registered in this course Minimum 80% attendance in this course
Reading list	1. Handbook of Batteries 3th edition, David Linden, Thomas B. Reddy. McGraw-Hill, 2002. 2. Electrochemical Energy Storage, Expert Verlag 2003.
Assessment Guidance	Case-based rubric (25%); Assignments (25%); Midterm Exams (25%); Final Exams (25%)

17. 140820-UND202511017 - Informatics Physics

Code/ Semester	140820-UND202511017 / Semester 1
Course/ Credit points	Informatics Physics / 3 credits ~ 5.4 ECTS
Language	Indonesian
Responsible Lecturer	I Made Joni
Team Teaching	I Made Joni, Andri Abdurrochman
Workload	1. Lectures : 3 x 50 = 150 minutes per week. 2. Assignments : 3 x 60 = 180 minutes per week. 3. Private learning : 3 x 60 = 180 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. Rajkumar Buyya, dkk, Big Data Principles and Paradigms, Elsevier, 2019, ISBN: 978-0-12-805394-2. 2. Shai Shalev-Shwartz and Shai Ben-David, Understanding Machine Learning:From Theory to Algorithms.

	3. Y. Polyanskiy, Y. Wu, Lecture note on Information Theory, (2017). 4. Roberto Togneri, Christopher J.S. deSilva, Fundamental of Information Theory and Coding Design, 2002, CHAPMAN & HALL/CRC. 5. Thomas M. Cover, Joy A. Thomas, Elements of Information Theory, John Wiley&Sons INC., 1991. 6. Peter D. Gr¨unwald & Paul M.B. Vit´anyi, Algorithmic Information Theory, July 30, 2007. 7. Paul A. LaViolette, ENTROPY and NEGENTROPY, Portland State University, 2013.
Assessment Guidance	Case-based rubric (25%); Assignments (25%); Midterm Exams (25%); Final Exams (25%)

18. 140820-UND202511018 - Geophysics in Environmental Engineering

Code/ Semester	140820-UND202511018 / Semester 1
Course/ Credit points	Geophysics in Environmental Engineering / 3 credits ~ 5.4 ECTS
Language	Indonesian
Responsible Lecturer	Eleonora Agustine
Team Teaching	Eleonora Agustine, Dini Fitriani
Workload	1. Lectures : 3 x 50 = 150 minutes per week. 2. Assignments : 3 x 60 = 180 minutes per week. 3. Private learning : 3 x 60 = 180 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 introduces various geophysical methods and their applications in environmental studies. Topics include gravity, geomagnetic, geoelectric, electromagnetic, and rock magnetism methods. Emphasis is placed on selecting appropriate methods for specific environmental problems. The course covers potential field, magnetic, electric, and electromagnetic techniques relevant to environmental applications.
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. An Introduction to Applied and Environmental Geophysics, 2nd ed, John M. Reynolds, 2011.
Assessment Guidance	Case-based rubric (25%); Assignments (25%); Midterm Exams (25%); Final Exams (25%)

19. 140820-UND202511019 - Career Development

Code/ Semester	140820-UND202511019 / Semester 1
Course/ Credit points	Career Development / 3 credits ~ 5.4 ECTS
Language	Indonesian
Responsible Lecturer	Risdiana
Team Teaching	Risdiana
Workload	1. Lectures : 3 x 50 = 150 minutes per week. 2. Assignments : 3 x 60 = 180 minutes per week. 3. Private learning : 3 x 60 = 180 minutes per week.
Contents	This course helps students in developing post-study academic and professional career plans.
Objectives	1. Able to design a research, industrial, or entrepreneurial career path. 2. Able to master scientific presentation skills, negotiation, and effective communication. 3. Able to recognize one's potential and strengths through self-assessment
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. Bolles, R. N. (2022). What Color Is Your Parachute? A Practical Manual for Job-Hunters and Career-Changers. 2. APS (2023). Careers Toolbox for Physics Students. 3. Katz, M. J. (2021). The Everything Guide to Careers in Science. Wiley.
Assessment Guidance	Assignments (70%); Midterm Exams (15%); Final Exams (15%)

20. 140820-UND202522020 - Functional Polymers

Code/ Semester	140820-UND202522020 / Semester 2
Course/ Credit points	Functional Polymers / 3 credits ~ 5.4 ECTS
Language	Indonesian
Responsible Lecturer	Fitrilawati
Team Teaching	Fitrilawati, Lusi Safriani
Workload	1. Lectures : 3 x 50 = 150 minutes per week. 2. Assignments : 3 x 60 = 180 minutes per week. 3. Private learning : 3 x 60 = 180 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	Registered in this course Minimum 80% attendance in this course

examination regulations	
Reading list	1. Polymer: Chemistry and Physics of Modern Materials, J.M.G. Cowie and Valeria Arrighi, Third Edition, CRC Press, 2008. 2. Handbook of Conducting Polymer, Terje A. Skotheim, Ronald L. Elsenbaumer and John R. Reynolds, Second Edition, New Yorl, Marcel Dekker, 1998. 3. Elham Abbasi el.al, Dendrimers: synthesis, applications, and properties, Nanoscale Research Letters 2014, 9:247. 4. Hongbo Feng et.al, Block copolymers: synthesis, self-assembly and applications, Polymers 2017, 9, 494; doi:10.3390/polym9100494. 5. An Introduction to Polymer Science, Hans-Georg Elias, 1-ed., Wenheim, New York, Basel, Cambridge, Tokyo, 1997. 6. Handbook of Polymer Synthesis, Characterization, and Processing, Editor(s): Enrique Saldívar-Guerra Eduardo Vivaldo-Lima, Print ISBN:9780470630327.
Assessment Guidance	Case-based rubric (25%); Assignments (25%); Midterm Exams (25%); Final Exams (25%)

21. 140820-UND202522021- Carbon Technology

Code/ Semester	140820-UND202522021 / Semester 2
Course/ Credit points	Carbon Technology / 3 credits ~ 5.4 ECTS
Language	Indonesian
Responsible Lecturer	Sahrul Hidayat
Team Teaching	Sahrul Hidayat, Otong Nurhilal
Workload	1. Lectures : 3 x 50 = 150 minutes per week. 2. Assignments : 3 x 60 = 180 minutes per week. 3. Private learning : 3 x 60 = 180 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. Marsh, H. & Rodríguez-Reinoso, F. Activated carbon. (Elsevier, 2006). 2. Soroush Nazarpour and Stephen: Graphene Technology; from laboratory to Fabrication. (Wiley-VCH, 2016). 3. Wonbong Choi and Jo-won Lee. Graphene; Synthesis and Applications. (Taylor & Francis Group, 2012).
Assessment Guidance	Assignments (65%); Midterm Exams (15%); Final Exams (20%)

22. 140820-UND202522022 - Advanced Materials for Energy and Medical Applications

Code/ Semester	140820-UND2025220122 / Semester 2
Course/ Credit points	Advanced Materials for Energy and Medical Application / 3 credits ~ 5.4 ECTS
Language	Indonesian
Responsible Lecturer	Risdiana
Team Teaching	Risdiana, Lusi Safriani
Workload	1. Lectures : 3 x 50 = 150 minutes per week. 2. Assignments : 3 x 60 = 180 minutes per week. 3. Private learning : 3 x 60 = 180 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 covers the concepts, classification, and properties of advanced materials for energy and health applications. The course is conducted using Collaborative Learning, Discovery Learning, Small Group Discussion, and Contextual Instruction methods. Prior to each class session, students are expected to study the upcoming course materials and discuss them in groups. Students are then required to present their discussions in front of the class to reach a collective conclusion.
Objectives	1. Able to understand and classify advanced materials for energy and health applications through systematic independent work and measured discussions (C3, A4, P4). 2. Able to understand concepts and perform advanced preparations for energy and health applications through systematic independent work and measured discussions (C5, A4, P4). 3. Able to analyze advanced characterizations for energy and health applications through measured independent work (C5, A4, P4).
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. Colthurst, M J. Williams, R L. Hiscott, P S. dan Grierson, I. (2000). Biomaterial Used In The Posterior Segment of The Eye. *Biomaterials*, 21 (7): 649-65. 2. Caramoy, A. Schröder, S. Fauser, S. dan Kirchhof, B. (2010). In Vitro Emulsification Assessment of New Silicone Oils. *Br. J. Ophthalmol.*,94 (4):, 509–512.

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

23. 140820-UND202522023 - Control Systems and Instrumentation

Code/ Semester	140820-UND202522023 / Semester 2
Course/ Credit points	Control Systems and Instrumentation / 3 credits ~ 5.4 ECTS
Language	Indonesian
Responsible Lecturer	Andri Abdurrochman
Team Teaching	Andri Abdurrochman, Ferry Faizal
Workload	1. Lectures : 3 x 50 = 150 minutes per week. 2. Assignments : 3 x 60 = 180 minutes per week. 3. Private learning : 3 x 60 = 180 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	-
Assessment Guidance	Case-based rubric (25%); Assignments (25%); Midterm Exams (25%); Final Exams (25%)

24. 140820-UND202522024 - Big Data

Code/ Semester	140820-UND202522024 / Semester 2
Course/ Credit points	Big Data / 3 credits ~ 5.4 ECTS
Language	Indonesian
Responsible Lecturer	Budi Adiperdana
Team Teaching	Budi Adiperdana, I Made Joni
Workload	1. Lectures : 3 x 50 = 150 minutes per week. 2. Assignments : 3 x 60 = 180 minutes per week. 3. Private learning : 3 x 60 = 180 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. Rajkumar Buyya et. al. 2016. Big Data: Principles and Paradigms. Morgan Kaufmann. 2. Alan Nugent, Fern Halper & Judith S. Hurwitz. 2013. Big Data For Dummies. For Dummies.

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

25. 140820-UND202522025 - Exploration Geophysics

Code/ Semester	140820-UND202522025 / Semester 2
Course/ Credit points	Exploration Geophysics / 3 credits ~ 5.4 ECTS
Language	Indonesian
Responsible Lecturer	Eleonora Agustine
Team Teaching	Eleonora Agustine, Asep Harja
Workload	1. Lectures : 3 x 50 = 150 minutes per week. 2. Assignments : 3 x 60 = 180 minutes per week. 3. Private learning : 3 x 60 = 180 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. Mamdouh R. Gadallah, Ray Fisher, Exploration Geophysics, 2009, Springer. 2. A. E. Beck, Physical Principles of Exploration Methods: An Introductory, 1981, John Wiley & Sons.

	3. T F Gaskell, Techniques of geophysical exploration, British Journal of Applied Physics, 1962, Volume 13, Number 11, IOP Publishing Ltd.
Assessment Guidance	Case-based rubric (25%); Assignments (25%); Midterm Exams (25%); Final Exams (25%)

26. 140820-UND202502026 - Laboratorium Management

Code/ Semester	140820-UND202502026 / Semester 2
Course/ Credit points	Laboratorium Management / 3 credits ~ 5.4 ECTS
Language	Indonesian
Responsible Lecturer	Ayi Bahtiar
Team Teaching	Ayi Bahtiar
Workload	1. Lectures : 3 x 50 = 150 minutes per week. 2. Assignments : 3 x 60 = 180 minutes per week. 3. Private learning : 3 x 60 = 180 minutes per week.
Contents	This course discusses the principles and practices of operational management of research laboratories. The main focus includes equipment and facility management, implementation of work safety procedures, documentation and recording systems, and optimization of the use of experimental results. Students will be equipped with the managerial skills needed to ensure that the laboratory runs efficiently, safely, and supports quality research activities.
Objectives	1. Able to understand modern laboratory management systems 2. Able to design operational systems, SOPs, and asset management. 3. Able to apply GLP principles and work safety.
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. Caprette, D. R. (2021). Laboratory Management for Science and Engineering Students. Academic Press. 2. Wilson, J. R. (2022). Laboratory Management. Springer. 3. ISO/IEC 17025:2017. General Requirements for the Competence of Testing and Calibration Laboratories.
Assessment Guidance	Assignments (70%); Midterm Exams (15%); Final Exams (15%)

27. 140820-UND202533027 - Magnetism and Superconductivity

Code/ Semester	140820-UND202533027 / Semester 3
Course/ Credit points	Magnetism and Superconductivity / 3 credits ~ 5.4 ECTS
Language	Indonesian
Responsible Lecturer	Risdiana
Team Teaching	Risdiana, Togar Saragi
Workload	1. Lectures : 3 x 50 = 150 minutes per week. 2. Assignments : 3 x 60 = 180 minutes per week. 3. Private learning : 3 x 60 = 180 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 (1998), Introduction to Magnetism and Magnetic Materials, Chapman & Hall/CRC. 2. S. Blundell (2003), Magnetism in Condensed Matter, Oxford University Press. 3. A. Mourachkine (2003), Room-Temperature Superconductivity, Cambridge.

	4. Risdiana (2015), Sifat dan Bahan Superkonduktor, Unpad Press.
Assessment Guidance	Assignments (60%); Midterm Exams (20%); Final Exams (20%)

28. 140820-UND202533028 - Computational Materials Science

Code/ Semester	140820-UND202533028 / Semester 3
Course/ Credit points	Computational Materials Science / 3 credits ~ 5.4 ECTS
Language	Indonesian
Responsible Lecturer	Budi Adiperdana
Team Teaching	Budi Adiperdana, Sahrul Hidayat
Workload	1. Lectures : 3 x 50 = 150 minutes per week. 2. Assignments : 3 x 60 = 180 minutes per week. 3. Private learning : 3 x 60 = 180 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. Atkins and Friedman. 2011. Molecular Quantum Mechanics. 4th Ed. Oxford University Press. 2. Martin. 2004. Electronic Structure: Basic Theory and Practical Methods. Cambridge University Press. 3. Kittel. 1996. Introduction to Solid State Physics, 7th Ed. John Wiley & Sons.

	4. Ashcroft & Mermin. 1976. Solid State Physics. Brook & Cole Cengage Learning.
Assessment Guidance	Case-based rubric (25%); Assignments (25%); Midterm Exams (25%); Final Exams (25%)

29. 140820-UND202533029 - Artificial Intelligence

Code/ Semester	140820-UND202533029 / Semester 3
Course/ Credit points	Artificial Intelligence / 3 credits ~ 5.4 ECTS
Language	Indonesian
Responsible Lecturer	Budi Adiperdana
Team Teaching	Budi Adiperdana, Ferry Faizal, I Made Joni
Workload	1. Lectures : 3 x 50 = 150 minutes per week. 2. Assignments : 3 x 60 = 180 minutes per week. 3. Private learning : 3 x 60 = 180 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. Russel, Norvig. 1995. Artificial Intelligence: A Modern Approach. 2. Tim Jones. 2008. Artificial Intelligence: A System Approach.

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

30. 140820-UND202533030 - Earth Science Computation

Code/ Semester	140820-UND202533030 / Semester 3
Course/ Credit points	Earth Science Computation / 3 credits ~ 5.4 ECTS
Language	Indonesian
Responsible Lecturer	Irwan Ary Dharmawan
Team Teaching	Irwan Ary Dharmawan, Imran Hilman Mohammad
Workload	1. Lectures : 3 x 50 = 150 minutes per week. 2. Assignments : 3 x 60 = 180 minutes per week. 3. Private learning : 3 x 60 = 180 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. Taflove A., and Hagness S.C., & Piket-May, M. 2005. Computational Electrodynamics: The Finite Difference Time Domain Method. The Electrical Engineering Handbook, 3. 2. LeVeque, R.J. 2007. Finite Difference Methods for Ordinary and Partial Differential Equations. SIAM. 3. Turcotte, D.L., & Schubert, G. 2002. Geodynamics. Cambridge University Press

	4. Telford, W.M., Geldart, L.P., & Sheriff, R.E. 1990. Applied Geophysics. Cambridge University Press.
Assessment Guidance	Case-based rubric (25%); Assignments (25%); Midterm Exams (25%); Final Exams (25%)

31. 140820-UND202544031 - Nanotechnology

Code/ Semester	140820-UND202544031 / Semester 4
Course/ Credit points	Nanotechnology / 3 credits ~ 5.4 ECTS
Language	Indonesian
Responsible Lecturer	Camellia Panatarani
Team Teaching	Camellia Panatarani, I Made Joni
Workload	1. Lectures: 2 x 50 = 100 minutes per week 2. Assignments: 2 x 60 = 120 minutes per week 3. Independent learning: 2 x 60 = 120 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. Bharat Bhushan, Dan Luo, Scott R. Schricker • Wolfgang Sigmund, Stefan Zauscher (Eds), Handbook of Nanomaterials Properties, Springer Heidelberg New York Dordrecht London, 2014 2. C. Dupas P. Houdy M. Lahmani (Eds.), Nanoscience Nanotechnologies and Nanophysics, Springer, Berlin 2006 3. Dieter Vollath, Franz Dieter Fischer, and David Holec, Surface energy of nanoparticles – influence of particle size and structure, J. Nanotechnol. 2018, 9, 2265–2276.
Assessment Guidance	Collaborative learning rubric (25%); Laboratory work (50%); discovery learning (25%)

32. 140820-UND202544032 - Supercapacitors

Code/ Semester	140820-UND202544032 / Semester 4
Course/ Credit points	Supercapacitors / 3 credits ~ 5.4 ECTS
Language	Indonesian
Responsible Lecturer	Fitrilawati
Team Teaching	Fitrilawati, Ayi Bahtiar
Workload	1. Lectures : 3 x 50 = 150 minutes per week. 2. Assignments : 3 x 60 = 180 minutes per week. 3. Private learning : 3 x 60 = 180 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 and E. Frackowiak, "Supercapacitors: Materials, Systems, and Applications", Wiley-VCH Verlag GmbH & Co KGaA, Weinheim, Germany, 2013. 2. V. S. Bagotsky, A. M. Skundin, Y. M. Volfkovich, “Electrochemical Power Sources: Batteries, Fuel Cells, and Supercapacitors”, John Wiley & Sons, Inc, New York, USA, 2015. 3. K. K. Kar (Ed.), "Handbook of Nanocomposite Supercapacitor Materials II", Springer, Cham., 2020.

	4. Artikel-artikel ilmiah terkini tentang superkapasitor.
Assessment Guidance	Case-based rubric (40%); Assignments (30%); Midterm Exams (15%); Final Exams (15%)

33. 140820-UND202544033 - Signal and Image Analysis

Code/ Semester	140820-UND202544033 / Semester 4
Course/ Credit points	Signal and Image Analysis / 3 credits ~ 5.4 ECTS
Language	Indonesian
Responsible Lecturer	Andri Abdurrochman
Team Teaching	Andri Abdurrochman, Ferry Faizal
Workload	1. Lectures : 3 x 50 = 150 minutes per week. 2. Assignments : 3 x 60 = 180 minutes per week. 3. Private learning : 3 x 60 = 180 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. Digital Signal Processing: A Practical Approach (Ifeachor & Jervis, 1995, Addison-Wesley) 2. Analog and Digital Signal Processing (Ambardar, A., 1999, Brooks/Cole Publishing
Assessment Guidance	Assignments (80%); Final Exams (20%)

34. 140820-UND202544034 - Global and Planetary Geophysics

Code/ Semester	140820-UND202544034 / Semester 4
Course/ Credit points	Global and Planetary Geophysics / 3 credits ~ 5.4 ECTS
Language	Indonesian
Responsible Lecturer	Yudi Rosandi
Team Teaching	Yudi Rosandi, Kartika Hajar Kirana
Workload	1. Lectures : 3 x 50 = 150 minutes per week. 2. Assignments : 3 x 60 = 180 minutes per week. 3. Private learning : 3 x 60 = 180 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. Astrophysics of planet formation, philip j. armitage. 2. Planetary surface processes, jay melosh. 3. Introduction to physics of the earth's interior, jean-paul poirier. 4. The Solid Earth: An Introduction to Global Geophysics. 5. The Solid Earth: An Introduction to Global Geophysics.
Assessment Guidance	Case-based rubric (25%); Assignments (25%); Midterm Exams (25%); Final Exams (25%)

35. 140820-UND202544035 - Science and Technology of Solar Cells

Code/ Semester	140820-UND202544035 / Semester 4
Course/ Credit points	Science and Technology of Solar Cells / 3 credits ~ 5.4 ECTS
Language	Indonesian
Responsible Lecturer	Ayi Bahtiar
Team Teaching	Ayi Bahtiar, Annisa Aprilia
Workload	1. Lectures : 3 x 50 = 150 minutes per week. 2. Assignments : 3 x 60 = 180 minutes per week. 3. Private learning : 3 x 60 = 180 minutes per week.
Contents	This course covers the fundamental principles of physics, materials, fabrication technology, and characterization of solar cells, particularly the latest generation of solar cells, which emphasize new technologies and innovations. The focus is on photovoltaic mechanisms (basic theory), the structure and performance of new-generation solar cells (organic, DSSC, and perovskite), as well as challenges in improving efficiency, stability, and production potential and commercialization. Students will study the relationship between the fundamental properties of the active materials and their photovoltaic response, and evaluate performance based on experimental and computational data. This course is designed to provide a deep understanding for master's students interested in research and applications in the fields of renewable energy, photonics, and functional materials.
Objectives	1. Students are able to analyze the relationship between the electronic and optical properties of materials (such as bandgap, mobility, and lifetime) and solar cell performance, including the physical phenomena underlying the photovoltaic process. [C4] 2. Students are able to evaluate the performance, advantages, and limitations of various modern solar cell technologies such as perovskite, tandem, and DSSC based on characterization results and scientific literature. [C5] 3. Students are able to integrate technical understanding with social issues such as environmental sustainability, recycling, material toxicity, and energy policy, in the context of solar cell technology development. [C5]
Course Method	a. Introduction by lecturer/facilitator b. Case studies and literature review c. Structured group discussions d. Laboratory sessions and guided use of software/simulations e. Interactive presentations and peer feedback
Prerequisites	-
Requirements according to the examination regulations	Registered in this course Minimum 80% attendance in this course

Reading list	1. Aparna Thankappan. 2021. Perovskite Photovoltaics: Basic to Advanced Concepts and Implementation. 2. A. Martí & A. Luque. 2020. **Next Generation Solar Photovoltaics: 3rd Generation and Beyond** (2nd Edition). 3. Leonid A. Kosyachenko, 2022. Dye-Sensitized Solar Cells: Materials, Technologies and Applications.
Assessment Guidance	Case study (Project): 30% Participation: 20% Midterm exam: 15% Assignments: 10% Quizzes: 10% Final exam: 15%

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