MODUL HANDBOOK

Ba Physics & Ma Biophysics

DEPARTEMENT OF PHYSICS
FACULTY OF MATHEMATICS & NATURAL SCIENCES
IPB UNIVERSITY
2024

Module Handbook

Module designation	*Advanced Physics Experiment*
Semester(s) in which the module is taught	*4^{th} (Fourth)*
Person responsible for the module	*Prof. Dr. Akhiruddin Maddu, M.Si*
Language	*Bahasa Indonesia*
Relation to curriculum	*Academic core course in the second year (4^{th} semester) bachelor's degree*
Teaching methods	*50 minutes lectures and 180 minutes practicum per week.*
Workload (incl. contact hours, self-study hours)	*Total workload is 75 hours per semester, which consists of 50 minutes lectures per week for 14 weeks, 60 minutes structured activities per week, 60 minutes individual study per week, 150 minutes lab work, in total is 14 weeks per semester, excluding mid exam and final exam.*
Credit points	*2 SCH x (1.5) = 3 ECTS*
Required and recommended prerequisites for joining the module	-
Module objectives/intended learning outcomes	1. *Students are able to understand the scope of the Advanced Physics Experiment course* 2. *Students are able to prove the quantization of energy in atoms* 3. *Students are able to prove the quantization of charge and determine the mass are able to charge of electrons* 4. *Students are able to prove the nature of wave-particle dualism* 5. *Students are able to relate the interaction of magnetic fields with matter* 6. *Students are able to understand the phenomenon of transport in solids* 7. *Students are able to implement the principle of measuring the speed of light* 8. *Students are able to describe the characteristics of the laser and use it in precision measurements* 9. *Students are able to use the laws of thermal radiation* 10. *Students are able to understand the distribution and absorption of nuclear radiation*

Content	*This course contains several topics of fundamental physics experiments that build quantum theory, such as the hydrogen atomic spectrum experiment, the Millikan's oil drop experiment, the Frank-Hertz experiment, the photoelectric effect, the e/m ratio experiment, the laws of thermal radiation, the speed of light, laser characteristics, Michelson interferometer, radioactive counting, Hall effect, and electron spin resonance (ESR).*
Examination forms	*Written exam.*
Study and examination requirements	*Minimum lecture attendance is 80% and 100% of the practices (according to IPB regulation). The final score is evaluated based on assignment and presence (50%), mid-semester exam (20%), and final exam (30%).*
Reading list	*1. Melissinos, A.C, Napolitano, J. Experiments in Modern Physics, Second Edition, Academic Press. 2003.* *2. Hurd, A.W, Modern Physics Laboratory Manual: Projects and Problems for Secondary Physics, Legare Street Press, 2021*

Module Handbook

Module designation	*Advanced Mathematical Physics*
Semester(s) in which the module is taught	*4^{th} (fourth)*
Person responsible for the module	*Dr. Faozan*
Language	*Bahasa Indonesia*
Relation to curriculum	*Academic core course in the second year (4^{th} semester) bachelor's degree*
Teaching methods	*100 minutes lectures and 120 minutes structured activities per week.*
Workload (incl. contact hours, self-study hours)	*Total workload is 119 hours per semester, which consists of 150 minutes lectures per week, 180 minutes structured activities per week, 180 minutes individual study per week, in total is 14 weeks per semester, excluding mid exam and final exam.*
Credit points	*3 SCH x (1.5) = 4.5 ECTS*
Required and recommended prerequisites for joining the module	*FIS1203 Mathematical Physics*
Module objectives/intended learning outcomes	*1. Students can describe functions in series, and Fourier transforms.* *2. Students can solve various forms of first and second-order linear differential equations with various methods.* *3. Students can derive the equations of motion for the dynamics of a physical system based on the principle of variation.* *4. Students can describe several physical quantities in tensor notation and their applications* *5. Students can solve problems related to several unique functions, such as factorial, gamma, and beta functions.* *6. Students can solve particular differential equations (Legendre, Bessel, Hermite, and Laguerre differential equations) in series form.* *7. Students can solve various forms of multivariable differential equations (partial differential equations)* *8. Students can solve various real integral forms in the representation of complex variables*
Content	*Fourier Series and Transform, Ordinary Differential Equations, Calculus of Variation, Tensor Analysis, Special Functions, Series Solution of Differential Equations, Partial Differential Equations and Complex Analysis.*
Examination forms	*Written Exam*

Study and examination requirements	*Minimum attendance at lectures is 80% (according to IPB regulation). Final score is evaluated based on assignment and presence (20%), mid semester exam (40%), and end semester exam (40%).*
Reading list	1. *Boas, M.L. Mathematical methods in the physical sciences. 3rd Ed, New York, Wiley. 2005* 2. *Arfken, G. Mathematical Methods for Physicists. 7th Edition, Academic Press, 2012.*

Module Handbook

Module designation	*Advanced Quantum Physics*
Semester(s) in which the module is taught	*6th (sixth)*
Person responsible for the module	*Prof. Dr. R. Tony Ibnu Sumaryada Wijaya Puspita, M.Si*
Language	*Bahasa Indonesia*
Relation to curriculum	*Compulsory course in the third year (6th semester) bachelor's degree*
Teaching methods	*100 minutes lectures and 120 minutes structured activities per week.*
Workload (incl. contact hours, self-study hours)	*Total workload is 119 hours per semester, which consists of 150 minutes lectures per week, 180 minutes structured activities per week, 180 minutes individual study per week, in total is 14 weeks per semester, excluding mid exam and final exam.*
Credit points	*3 SCH x (1.5) = 4.5 ECTS*
Required and recommended prerequisites for joining the module	*Quantum Physics*
Module objectives/intended learning outcomes	1. *Students can understand quantum phenomena, the formulation of quantum theory in the Hilbert space formalism, quantum interpretation, basic concepts Quantum entanglement and its implications.* 2. *Students are able to formulate the dynamics of the system in Schroedinger and Heisenberg pictures.* 3. *Students are able to represent angular momentum and spin operators in the matrix representation, and able to formulate the addition of angular momentum* 4. *Students are able to formulate problems of quantum systems with time-independent perturbation theory* 5. *Students are able to formulate atomic problems with many electrons* 6. *Students are able to understand and explain the principle of variation in quantum mechanics* 7. *Students can understand the mechanism of energy level transitions through time-dependent perturbation theory* 8. *Students are able to understand the method for solving the Schrodinger equation for many electron systems.*

Content	*The formalism of quantum mechanics in Hilbert space, quantum dynamics, representation of operators in matrices, summation of angular momentum,Clebsch-Gordan coefficient, time-independent perturbation theory, degenerate and non-degenerate perturbation theory, real atoms, many-electron atoms, Hartree-Fock approach, density functional theory approach, quantum interpretation, and quantum entanglement and its implications.*
Examination forms	*Written Exam*
Study and examination requirements	*Minimum attendance at lectures is 80% (according to IPB regulation). Final score is evaluated based on mid semester exam (30%), final semester exam (30%), and Assignments (40%)*
Reading list	*1. Sakurai, J.J, Napolitano, J. Modern Quantum Mechanics, 2nd Edition, Addison Wesley, 2011* *2. Auletta, B. G. The Quantum Mechanics Conundrum, Springer, 2019* *3. Griffiths, D.J. Introduction to Quantum Mechanics. 2nd, Pearson Education, 2005.* *4. Greiner, W, Bromley, D.A, Quantum Mechanics: An Introduction, 4th Edition, Springer, 2001*

Module Handbook

Module designation	*Analogue Electronics*
Semester(s) in which the module is taught	*3rd (third)*
Person responsible for the module	*Mahfuddin Zuhri, M.Si*
Language	*Bahasa Indonesia*
Relation to curriculum	*in the second year (3rd semester) bachelor’s degree*
Teaching methods	*5 minutes lectures and 180 minutes structured activities per week.*
Workload (incl. contact hours, self-study hours)	*Total workload is 79 hours per semester, which consists of 50 minutes lectures per week for 14 weeks, 60 minutes structured activities per week, 60 minutes individual study per week, 100 minutes lab work, in total is 14 weeks per semester, excluding mid exam and final exam.*
Credit points	*2 SCH x (1.5) = 3 ECTS*
Required and recommended prerequisites for joining the module	*Science and Technology Physics*
Module objectives/intended learning outcomes	*1. Students can understand the basic principles of electricity, sources of electrical energy, loading problems, electronic components, and the working principles of electrical measuring instruments.* *2. Students are able to use measuring instruments and generators of electrical quantities, such as multimeters, oscilloscopes, signal generators, and power supplies.* *3. Students can analyze and direct electronic circuits using the laws and theorems of electrical circuits.* *4. Students can design power supplies and simple signal processing circuits using Diodes, Transistors and Operational Amplifiers (Op-Amp)* *5. Students can create simple analogue circuit applications that are useful for everyday life.*

Content	1. *Basic Principles of Electricity* 2. *Electronic Components and Basic Measurements* 3. *Network Theorem* 4. *AC and RLC circuits* 5. *Semiconductor Diodes & Semiconductor Diode Circuits* 6. *Power Supply Circuit* 7. *Bipolar Junction Transistors* 8. *Bipolar Junction Transistor Amplifier Circuit* 9. *Field Effect Transistor Amplifier Circuit* 10. *Power booster circuit* 11. *Operational Amplifier (Op-Amp)* 12. *Op-Amp Amplifier Circuit* 13. *Oscillator*
Examination forms	*Written exam, and project-based exam*
Study and examination requirements	*Minimum attendance at lectures is 80% (according to IPB regulation). Final score is evaluated based on assignment and presence (65%), mid semester exam (15%), and end semester exam (15%)*
Reading list	1. *Schultz, E.M. Grob's Basic Electronics, Mc-Graw Hill, 12th Edition, 2015* 2. *Gift, S. J. G, Maundy, B, Electronic Circuit Design and Application, 1st Edition, Springer, 2021* 3. *Malvino A, Bates D, Electronics Principles, 8th edition. McGraw Hill, 2015*

Module Handbook

Module designation	*Atomic and Molecular Physics*
Semester(s) in which the module is taught	*6^{th} (Sixth)*
Person responsible for the module	*Dr. Setyanto Tri Wahyudi, M.Si*
Language	*Bahasa Indonesia*
Relation to curriculum	*Compulsory course in the third year (6^{th} semester) bachelor's degree*
Teaching methods	*100 minutes lectures and 120 minutes structured activities per week.*
Workload (incl. contact hours, self-study hours)	*Total workload is 79 hours per semester, which consists of 100 minutes lectures per week for 14 weeks, 120 minutes structured activities per week, 120 minutes individual study per week, in total is 14 weeks per semester, excluding mid exam and final exam.*
Credit points	*2 SCH x (1.5) = 3 ECTS*
Required and recommended prerequisites for joining the module	*Mathematical Physics, Advanced Mathematical Physics, and Quantum Physics.*
Module objectives/intended learning outcomes	*1. Students can explain the development of atomic and molecular theory.* *2. Students can explain the theory of atomic structure in general.* *3. Students can explain the quantum physics theory of the hydrogen atom (one electron atom).* *4. Students can explain the theory of quantum physics of atoms with more than one electron.* *5. Students can explain the theory of ionic and covalent molecular bonds.* *6. Students can explain the theory of energy levels of molecular vibrations.* *7. Students can explain the theory of molecular rotational energy levels.* *8. Students can explain the theory of molecular electronic spectra.*
Content	*Development of atomic and molecular theory, general atomic structure theory, quantum physical theory of the hydrogen atom (one-electron atom), quantum physical theory of atoms with more than one electron, theory of ionic and covalent molecular bonds, theory of energy levels of molecular vibrations, theory of molecular vibrations molecular rotational energy, and the theory of the electronic spectrum of molecules.*

Examination forms	*Written Exam*
Study and examination requirements	*Minimum attendance at lectures is 80% (according to IPB regulation). Final score is evaluated based on assignment and presence (60%), mid semester exam (20%), and end semester exam (20%)*
Reading list	1. *Colombo, L. Atomic and Molecular Physics: A primer" University of Cagliari, Italy, IOP Publishing Ltd. 2019.* 2. *Demtröder, W. An Introduction to Atomic-, Molecular and Quantum Physics, Springer-Verlag Berlin Heidelberg, 2010*

Module Handbook

Module designation	*Biomaterials*
Semester(s) in which the module is taught	*5th (fifth)*
Person responsible for the module	*Nur Aisyah Nuzulia, M.Si*
Language	*Bahasa Indonesia*
Relation to curriculum	*In-depth course in the third year (5th fifth semester) bachelor's degree*
Teaching methods	*100 minutes lectures and 120 minutes structured activities per week.*
Workload (incl. contact hours, self-study hours)	*Total workload is 79 hours per semester, which consists of 100 minutes lectures per week for 14 weeks, 120 minutes structured activities per week, 120 minutes individual study per week, in total is 14 weeks per semester, excluding mid exam and final exam.*
Credit points	*2 SCH x (1.5) = 3 ECTS*
Required and recommended prerequisites for joining the module	-
Module objectives/intended learning outcomes	1. *Students are able to understand the basic concepts of biomaterials, the history of biomaterial development, the types of biomaterials and their applications.* 2. *Students are able to understand the concept of biocompatibility and its evolution.* 3. *Students are able to understand the concept of the body's reaction to foreign objects and cell-material interactions.* 4. *Students are able to understand the concept of pre-clinical testing of biomaterials in vitro and in vivo* 5. *Students are able to understand the properties and characteristics of biomaterials and their applications in the medical field.*
Content	*Biomaterials and their types, the body's response to foreign substances, cell-material interactions, material biocompatibility, pre-clinical tests of biomaterials, metal biomaterials, polymer biomaterials, ceramic biomaterials, and composite biomaterials.*
Examination forms	*Written Exam*
Study and examination requirements	*Minimum attendance at lectures is 80% (according to IPB regulation). Final score is evaluated based on projects assignment and presence (60%), and semester exam (40%)*

Reading list	1. *Sari Y.W., Nuzulia N.A., Saputra A., Abdurrahman, Pengantar Biomaterial untuk Aplikasi Kesehatan, IPB Press, 2021 (in Indonesian)* 2. *Ratner D.B., Hoffman S.A., Schoen F.J., Lemons J.E., Biomaterial science: an introduction to materials in medicine, 3rd Edition, Acad Press, 2012*

Module Handbook

Module designation	*Biophysics*
Semester(s) in which the module is taught	*4th (fourth)*
Person responsible for the module	*Dr. Yessie Widya Sari*
Language	*Bahasa Indonesia*
Relation to curriculum	*In-depth course in the second year (4th semester) bachelor's degree*
Teaching methods	*100 minutes lectures and 120 minutes structured activities per week.*
Workload (incl. contact hours, self-study hours)	*Total workload is 79 hours per semester, which consists of 100 minutes lectures per week for 14 weeks, 120 minutes structured activities per week, 120 minutes individual study per week, in total is 14 weeks per semester, excluding mid exam and final exam.*
Credit points	*2 SCH x (1.5) = 3 ECTS*
Required and recommended prerequisites for joining the module	-
Module objectives/intended learning outcomes	1. *Students can understand the scope of biophysics* 2. *Students can understand the concept of cell biophysics* 3. *Students can understand the concept of force on the nanometer scale* 4. *Students can understand the concept of the structure and physical properties of biomolecules* 5. *Students can understand the concept of biological thermodynamics* 6. *Students can understand the concepts and applications of membrane biophysics* 7. *Students can understand the concepts and applications of photo biophysics (luminescence, photosynthesis)* 8. *Students can understand the concepts and computational applications of protein biophysics* 9. *Students can understand the concepts and applications of radiation biophysics* 10. *Students can understand the concepts and applications of the electrical and magnetic properties of cells* 11. *Students can understand the concepts and applications of bioacoustics*

Content	*Cell biophysics, forces at the nanometer scale, structure and physical properties of biomolecules, biological thermodynamics, photo biophysics (luminescence, photosynthesis), computational protein biophysics, membrane biophysics, radiation biophysics, electrical and magnetic properties of cells, bioacoustics.*
Examination forms	*Written exam*
Study and examination requirements	*Minimum attendance at lectures is 80% (according to IPB regulation). Final score is evaluated based on assignment and presence(30%), and exam (70%)*
Reading list	1. Cotterill, R, Biophysics: An Introduction 1st Edition, Wiley, 2002. 2. Lakowicz JR. *Principles of Fluorescence Spectroscopy*. Third edition. United State (US): Springer. 2006. 3. Hou HJM, Najafpour MM. Moore GF. Allakhverdiev SI. *Photosynthesis: Structures, Mechanisms, and Applications*. Cham, Switzerland: Springer. 2017. https://doi.org/10.1007/978-3-319-48873-8 4. Becker OM, MacKerell AD, Roux Jr.B, Watanabe M. 2001. *Computational Biochemistry and Biophysics*. CRC Press. ISBN: 082470455X,9780824704551 5. Baker RW. *Membrane Technology and Applications*. Second edition. West Sussex, England: John Wiley & Sons Ltd. 2004. 6. Hall, E.J. Radiobiology for Radiobiologists. Lippincottt Williams & Wilkins; 7th edition. 2011. 7. Vadivambal, R., Jayas, D.S. Applications of Thermal Imaging in Agriculture and Food Industry—A Review. Food Bioprocess Technol 4, 186–199. 2011. https://doi.org/10.1007/s11947-010-0333-5 8. Madureira, J, Barros, L, Verde, SC, Fernanda M. A. Margaça, Santos-Buelga, C. and Isabel C. F. R. Ferreira Journal of Agricultural and Food Chemistry 2020 68 (40), 11054-11067, DOI: 10.1021/acs.jafc.0c04984 9. Jeong Y. Introduction to Bioelectricity. Di dalam: Yoo HJ, van Hoof C, editor. *Bio-Medical CMOS ICs. Integrated Circuits and Systems*. Boston: Springer. 2011. Halaman 13 - 29. https://doi.org/10.1007/978-1-4419-6597-4_2 10. Kelly SG. *Mechanical Vibrations: Theory and Applications*. United State of America (USA): Global Engineering. 2012. ISBN-13: 978-1-4390-6214-2. ISBN-10: 1-4390-6214-5

Module Handbook

Module designation	*Complex System*
Semester(s) in which the module is taught	*5th (fifth)*
Person responsible for the module	*Prof. Husin Alatas*
Language	*Bahasa Indonesia*
Relation to curriculum	*Compulsory in the third year (5th fifth semester) bachelor's degree*
Teaching methods	*100 minutes lectures and 120 minutes structured activities per week.*
Workload (incl. contact hours, self-study hours)	*Total workload is 79 hours per semester, which consists of 100 minutes lectures per week for 14 weeks, 120 minutes structured activities per week, 120 minutes individual study per week, in total is 14 weeks per semester, excluding mid exam and final exam.*
Credit points	*2 SCH x (1.5) = 3 ECTS*
Required and recommended prerequisites for joining the module	-
Module objectives/intended learning outcomes	*1. Students are able to understand the importance of the complexity paradigm in reviewing physics and biology.* *2. Students are able to understand the principles of complex system modelling based on an agent-based modelling approach, as well as understand and master the basic principles of networks and their applications in simple problems.* *3. Students are able to understand and master the characteristics that appear in complex material systems and are able to understand and master aspects related to the emergence of emergent properties in materials as a consequence of collective interactions between atoms.* *4. Students are able to understand and master the characteristics that appear in biological systems, as well as understand and master aspects related to the emergence of emergent properties in molecular systems as a consequence of collective interactions between molecular groups.* *5. Students have skills in implementing the knowledge gained to describe the dynamics of social, material and biological systems.*

Content	*Introduction to Complex Systems, Complexity Paradigm, Agent-based modelling, Network analysis, Complex material structures, Functional density theory, Material design, Complex molecular structures, Newtonian dynamics for molecules, Molecular dynamics analysis, Study of dynamics of social systems using agent-based modelling, Study of system dynamics complex materials using density functional theory, dynamics studies of complex molecular systems using Newtonian dynamics.*
Examination forms	*Written Exam*
Study and examination requirements	*Minimum attendance at lectures is 80% (according to IPB regulation). Final score is evaluated based on mid semester exam (50%), and end semester exam (50%)*
Reading list	*1. Turner, S, Hanel, R, Klimek, P. Introduction to the Theory of Complex Systems. Oxford University Press. 2018.* *2. Mikhailov, A. S.Chemical Complexity: Self-Organization Processes in Molecular Systems, Springer Science, 2017.* *3. Egami, T, Billinge, S.J.S. Underneath the Bragg Peaks: Structural Analysis of Complex Materials, Pergamon Press, 2003.*

Module Handbook

Module designation	*Computational Physics*
Semester(s) in which the module is taught	*4th (fourth)*
Person responsible for the module	*Dr. Agus Kartono*
Language	*Bahasa Indonesia*
Relation to curriculum	*Academic core course in the second year (4th semester) bachelor's degree*
Teaching methods	*50 minutes lectures and 180 minutes structured activities per week.*
Workload (incl. contact hours, self-study hours)	*Total workload is 79 hours per semester, which consists of 50 minutes lectures per week for 14 weeks, 60 minutes structured activities per week, 60 minutes individual study per week, 100 minutes lab work, in total is 14 weeks per semester, excluding mid exam and final exam.*
Credit points	*2 SCH x (1.5) = 3 ECTS*
Required and recommended prerequisites for joining the module	*FIS1203 Mathematical Physics*
Module objectives/intended learning outcomes	1. *Students are able to understand the MATLAB/OCTAVE programming language.* 2. *Students are able to understand the Newton-Raphson and Secant numerical methods to find one root of non-linear and multiple non-linear equations.* 3. *Students are able to understand the Euler numerical method and the Runge-Kutta method to find numerical solutions to ordinary differential equations.* 4. *Students are able to understand ODE (ordinary differential equation) functions from the MATLAB/OCTAVE Programming Language to solve numerical solutions of ordinary differential equations.* 5. *Students are able to understand the explicit, implicit and Crank Nicolson finite differential methods to find the numerical solutions of time-dependent partial differential equations.* 6. *Students are able to understand the formulation of numerical methods of linear regression and non-linear regression to analyze experimental data sets.* 7. *Students are able to understand the use of the finite element method to find numerical solutions to partial differential equations depending on time*

Content	1. *Introduction to the MATLAB/OCTAVE programming language.* 2. *Newton-Raphson and Secant numerical methods to find one root of a non-linear equation and multiple non-linear equations.* 3. *The Euler numerical method and the Runge-Kutta method for finding numerical solutions to ordinary differential equations.* 4. *Introduction to the ODE (ordinary differential equation) function of the MATLAB/OCTAVE Programming Language.* 5. *Explicit, implicit and Crank Nicolson finite differential methods to find numerical solutions to partial differential equations.* 6. *Numerical methods of linear regression and non-linear regression to analyze experimental data sets.* 7. *Finite element method for finding numerical solutions to partial differential equations.*
Examination forms	*Written exam*
Study and examination requirements	*Minimum attendance at lectures is 80% (according to IPB regulation). Final score is evaluated based on assignment and presence (20%), mid semester exam (40%), and end semester exam (40%)*
Reading list	1. *Giordano, N.J Nakanishi, H. Computational Physics, 2nd edition, Pearson Education Inc, 2006.* 2. *Landau RH, Páez MJ, Computational Physics: Problem Solving with Python, Wiley VCH, 2015.* 3. *Syafutra, H. Kartono, A. Fisika Komputasi, PT Penerbit IPB Press, 2017 (in Indonesian).* 4. *Otto, S.R. and Denier, J.P. An Introduction to Programming and Numerical Methods in MATLAB, Springer-Verlag London Limited 2005*

Module Handbook

Module designation	*Digital Electronics*
Semester(s) in which the module is taught	*4th (fourth)*
Person responsible for the module	*Mahfuddin Zuhri, M.Si*
Language	*Bahasa Indonesia*
Relation to curriculum	*Academic core course in the second year (4th semester) bachelor's degree*
Teaching methods	*50 minutes lectures and 180 minutes structured activities per week.*
Workload (incl. contact hours, self-study hours)	*Total workload is 79 hours per semester, which consists of 50 minutes lectures per week for 14 weeks, 60 minutes structured activities per week, 60 minutes individual study per week, 100 minutes lab work, in total is 14 weeks per semester, excluding mid exam and final exam.*
Credit points	*2 SCH x (1.5) = 4,5 ETCS*
Required and recommended prerequisites for joining the module	-
Module objectives/intended learning outcomes	*1. Students can understand the basic concepts of digital systems, including the binary number system, Boolean algebra, and Karnaugh maps.* *2. Students can build digital electronic circuits based on TTL and CMOS IC (integrated circuits) to form combinational and sequential systems.* *3. Students can compile simple, functional electronic circuits, including registers, counters, memory, SAP machines, and ADC/DAC.* *4. Students understand the basic concepts of microcontrollers and know the basics of Arduino programming and its applications.*
Content	*Number systems and codes, logic gates and Boolean algebra, TTL and CMOS integrated circuits (IC), combinational circuits, digital arithmetic circuits and operations, flip-flops, registers and counters, memory, Simple as Possible (SAP) DAC/ADC machines, introduction to microcontrollers, I/O on Arduino, Arduino data displays, Arduino communication techniques*
Examination forms	*Written Exam, Projects Based Exam*

Study and examination requirements	*Minimum attendance at lectures is 80% (according to IPB regulation),Final score is evaluated based on assignment and presence (70%), mid semester exam (15%), and end semester exam (15%).*
Reading list	1. *Tocci, RJ, Widmer NS, Digital System, Principles and Applications. New Jersey: Pearson Edu, 12th Ed, 2016.* 2. *Cameron, N. Arduino Applied: Comprehensive Projects for Everyday Electronics. Apress. 2019* 3. *Maini, A.K. Digital Electronics: Principles, Devices and Applications. Wiley. 2007*

Module Handbook

Module designation	*Electrodynamics*
Semester(s) in which the module is taught	*4th (fourth)*
Person responsible for the module	*Abdul Djamil Husin, M.Sc*
Language	*Bahasa Indonesia*
Relation to curriculum	*Academic core course in the second year (4th semester) bachelor's degree*
Teaching methods	*150 minutes lectures and 180 minutes structured activities per week.*
Workload (incl. contact hours, self-study hours)	*Total workload is 119 hours per semester, which consists of 150 minutes lectures per week, 180 minutes structured activities per week, 180 minutes individual study per week, in total is 14 weeks per semester, excluding mid exam and final exam.*
Credit points	*3 SCH x (1.5) = 4.5 ECTS*
Required and recommended prerequisites for joining the module	*Physics Science and Technology, Mathematical Physics, Electrostatics*

Module objectives/intended learning outcomes	1. *Students are able to understand the Stokes theorem, coordinate transformation (cartesian, cylindrical and spherical), gradient, divergence and curl and its application in electrodynamics.* 2. *Students are able to understand electric field vectors, polarization, and electric flux density in dielectric materials and boundary conditions at the border of two media.* 3. *Students are able to understand the Laplace and Poisson equations in electromagnetics.* 4. *Students are able to understand the Biot-Savart law, Ampere's law, magnetic flux and magnetic flux density* 5. *as well as magnetic potential* 6. *Students are able to understand the magnetic field in materials and the types of magnetic materials* 7. *Students are able to understand inductors and inductances, energy in magnetic fields and flux densities* 8. *magnetic* 9. *Students are able to understand magnetic circuits, Faraday's law of induction, and Lenz's law* 10. *Students are able to understand displacement currents and Maxwell's equations* 11. *Students are able to understand continuity equations, Poynting vectors and Newton's III Law* 12. *electrodynamics* 13. *Students are able to understand electromagnetic waves in a vacuum* 14. *Students are able to understand electromagnetic waves in materials* 15. *Students are able to understand the delayed potential, the Jafimenko equation, and the Lienard-Wiechert potential* 16. *Students are able to understand electromagnetic wave radiation* 17. *Students are able to understand the Lorentz transformation for E and B*
Content	*The subject matter includes Biot-Savart Law, Faraday's Law, Magnetic Field, Magnetic Flux, Poisson and Laplace Equations, Ampere's Law, Maxwell's Equations for Electrodynamics, Electromagnetic Waves, Radiation, Magnetic Potential, Laplace Transformation for E and B.*
Examination forms	*Written exam*
Study and examination requirements	*Minimum attendance at lectures is 80% (according to IPB regulation). Final score is evaluated based on assignment and presence (35%), mid semester exam (30%), and end semester exam (35%)*
Reading list	1. *Griffiths, DJ. Introduction to Electrodynamics, 4th Edition, Prentice Hall International, 2017.* 2. *Hyat, W.H., Buck, J.A, Engineering Electromagnetics, 8th Edition, McGraw Hill, 2006.* 3. *Sadiku, M.N, Element of Electromagnetics, 4th Edition, Oxford University Press, 2007*

Module Handbook

Module designation	*Electrostatics*
Semester(s) in which the module is taught	*3rd (third)*
Person responsible for the module	*Abdul Djamil Husin, M.Sc*
Language	*Bahasa Indonesia*
Relation to curriculum	*Compulsory in the second year (3rd semester) bachelor's degree*
Teaching methods	*100 minutes lectures and 120 minutes structured activities per week.*
Workload (incl. contact hours, self-study hours)	*Total workload is 119 hours per semester, which consists of 150 minutes lectures per week, 180 minutes structured activities per week, 180 minutes individual study per week, in total is 14 weeks per semester, excluding mid exam and final exam.*
Credit points	*3 SCH x (1.5) = 4.5 ECTS*
Required and recommended prerequisites for joining the module	*(Fis 104) Science and Technology Physics*
Module objectives/intended learning outcomes	*After completing and following this course material, students are expected to be able to understand the properties of static electricity and be able to apply them in everyday life.*
Content	*Coulomb's law and electric field intensity, Electric flux density, Gauss's law, Electric dipole, Electric potential, Electric potential energy, Electric current and conductors, Polarisation, Dielectric and Capacitance Conditions for limiting electric field intensity between two dielectric mediums, Laplace's equation, Poisson's equation and shadow method.*
Examination forms	*Written exam*
Study and examination requirements	*Minimum attendance at lectures is 80% (according to IPB regulation). Final score is evaluated based on assignment and presence (40%), mid semester exam (30%), and end semester exam (30%)*
Reading list	*1. Griffiths, DJ. Introduction to Electrodynamics, 4th Edition, Prentice Hall International, 2017.* *2. Hyat, WH., Buck, J.A, Engineering Electromagnetics, 8th Edition, McGraw Hill, 2006.* *3. Sadiku, M.N, Element of Electromagnetics, 4th Edition, Oxford University Press, 2007*

Module Handbook

Module designation	*Internet Based Instrumentation System*
Semester(s) in which the module is taught	*5^{th} fifth*
Person responsible for the module	*Dr. Ir. Irmansyah, M.Si*
Language	*Bahasa Indonesia*
Relation to curriculum	*Compulsory in the third year (5^{th} fifth semester) bachelor's degree*
Teaching methods	*50 minutes lectures and 180 minutes structured activities per week.*
Workload (incl. contact hours, self-study hours)	*Total workload is 79 hours per semester, which consists of 50 minutes lectures per week for 14 weeks, 60 minutes structured activities per week, 60 minutes individual study per week, 100 minutes lab work, in total is 14 weeks per semester, excluding mid exam and final exam.*
Credit points	*3 SCH x 1.5 = 4.5 ECTS*
Required and recommended prerequisites for joining the module	-
Module objectives/intended learning outcomes	*1. Students can analyze the devices and connections which made The Internet of Things. 2. Students can build a sensor–actuator system using an Arduino microcontroller. 3. Students can create programs using Python language, which provides IoT functionality on the Raspberry Pi single-board computer. 4. Students can explore the use of Cloud and Fog technology in IoT systems. 5. Students can explain the role of IoT systems in solving global problems in manufacturing, health, agriculture or energy. 6. Students can design and build IoT to solve various problems in human life, such as energy, industry, agriculture, food and others.*
Content	*This course covers Basic Principles of Control Systems, Microcontrollers, Small Board Computers, Network Operating Systems, Network Basic Principles, Network Application Services, Network Programming Basics, and Application Programming Interface.*
Examination forms	*Written Exam*

Study and examination requirements	*Minimum attendance at lectures is 80% (according to IPB regulation). Final score is evaluated based on assignment and presence (70%), mid semester exam (15%), and end semester exam (15%).*
Reading list	*1. Sudip mIsra, Anandarup Mukherjee. Introduction to IoT, Cambridge University press, 2021.* *2. Dow, C. Internet of Things Programming Projects Build modern IoT solutions with the Raspberry Pi 3 and Python. Packt Publishing. Birmingham - Mumbai. 2018.* *3. Tripathy, B.K, Anuradha, J. Internet of Things: Technologies, Applications, Challenges, and Solution. CRC Press. 2018*

Module Handbook

Module designation	*Langrangian-Hamiltonian Mechanics*
Semester(s) in which the module is taught	*4^{th} (fourth)*
Person responsible for the module	*Prof. Husin Alatas*
Language	*Bahasa Indonesia*
Relation to curriculum	*Academic core course in the second year (3^{rd} semester) bachelor's degree*
Teaching methods	*100 minutes lectures and 120 minutes structured activities per week.*
Workload (incl. contact hours, self-study hours)	*Total workload is 119 hours per semester, which consists of 150 minutes lectures per week, 180 minutes structured activities per week, 180 minutes individual study per week, in total is 14 weeks per semester, excluding mid exam and final exam.*
Credit points	*3 SCH x (1.5) = 4.5 ECTS*
Required and recommended prerequisites for joining the module	-
Module objectives/intended learning outcomes	*1. Students are able to review Newtonian mechanics for systems of many particles* *2. Students are able to understand and master the concept of general coordinate systems and constraint equations* *3. Students are able to understand and master the principles and variations of action, the Lagrange equation and canonical momentum* *4. Students are able to understand and master the application of the Lagrange equation for several dynamic cases* *5. Students are able to understand and master the Legendre transformation and define Hamiltonian forms* *6. Students are able to understand and master Hamiltonian canonical principles and equations, as well as their application to dynamics problem* *7. Students are able to understand and master the formulation of the Hamilton-Jacobi equation and its application* *8. Students have an understanding of the transition to quantum mechanics*

Content	*Principle of work-energy of many-particle systems, D'Alembert's principle and concept of virtual displacement, General coordinate system for many-particle systems, Equation of constraints, Calculus of variations, Functional Lagrange action and Hamilton's principle, Lagrange's equations, Canonical momentum, Dynamics of controlled many-particle systems, Rigid body dynamics, Legendre transform, Hamiltonian functions, Hamiltonian functions and Hamilton principle, Canonical equations, Dynamics of simple systems based on Hamilton equations, Concept of phase space, Hamilton-Jacobi equations, Application of Hamilton-Jacobi equations in dynamics of simple systems, Poisson brackets, Integral cross Feynman, Transition to quantum mechanics*
Examination forms	*Written exam*
Study and examination requirements	*Minimum attendance at lectures is 80% (according to IPB regulation). Final score is evaluated based on assignment and presence (30%), mid semester exam (35%), and end semester exam (35%)*
Reading list	*1. Iver, H. Brevik, Linder, J. Introduction to Lagrangian and Hamiltonian Mechanics, Bookboon, 2016* *2. Goldstein H, Poole CP, Safko J, Classical Mechanics 3rd Edition, Pearson Education, 2011.* *3. Arya, A. P., Introduction to Classical Mechanics, 2nd Edition, Prentice Hall, 1998.*

Module Handbook

Module designation	*Material Characterization Methods*
Semester(s) in which the module is taught	*5th (fifth)*
Person responsible for the module	*Dr. Siti Nikmatin, M.Si*
Language	*Bahasa Indonesia*
Relation to curriculum	*Compulsory in the third year (5th fifth semester) bachelor's degree*
Teaching methods	*100 minutes lectures and 120 minutes structured activities per week.*
Workload (incl. contact hours, self-study hours)	*Total workload is 79 hours per semester, which consists of 50 minutes lectures per week for 14 weeks, 60 minutes structured activities per week, 60 minutes individual study per week, 100 minutes lab work, in total is 14 weeks per semester, excluding mid exam and final exam.*
Credit points	*3 SCH x (1.5) = 4.5 ECTS*
Required and recommended prerequisites for joining the module	-
Module objectives/intended learning outcomes	1. *Students master the concepts, theories and methods of various material characterization techniques, including electrical, thermal, optical, microstructural, and mechanical properties.* 2. *Students are able to process and analyze data generated by material characterization techniques.*

Content	1. *Fundamentals of measurement and measurement techniques, Standard and specific calibration methods on advanced research instrumentation of material characterization,* 2. *Basic principles of AAS, AES and GCMS Essential components in AAS, AES and GCMS Processing and analysis of AAS, AES and GCMS data, X-ray interaction with matter* 3. *Crystal structure and amorphous material, the principle of diffraction in the material, and the crystal orientation of the material, XRD data processing and analysis,* 4. *Overview of electromagnetic waves (ultraviolet, visible light, and infrared), Basic Principles and critical components in UV-Vis, Processing and analysis of UV-Vis's data.* 5. *Basic principles and essential components in FTIR FTIR data processing and analysis, Fundamentals of thermodynamics (endothermic, exothermic reactions, phase changes, boiling and melting points of materials),* 6. *Basic principles of DTA and DSC Measurement data analysis with DTA and DSC, Basic Principles of Fluorescence and thermoluminescence spectroscopy, Processing and analysis of fluorescence and thermoluminescence spectroscopy data* 7. *Basic Principles of Optical and electron microscopy, the source of electrons in the SEM-TEM tool, the working principle of the morphology testing technique with an optical microscope and SEM-TEM, the technique of determining grain size with a microscope* 8. *The basic principles of measuring the properties of electricity and magnetism.* 9. *Measurement data analysis, Brownian motion, potential Zeta, Mie and Rayleigh Scattering* 10. *The basic principles and measurement analysis of PSA, BET* 11. *Overview of gamma radiation with materials Types and basic principles of radiation testing on biomedical materials Processing and analysis of radiation test results data* 12. *The response of the material in receiving deformation is based on the direction of the force Tensile, elongation, impact, modulus strength and hardness*
Examination forms	*Written exam*
Study and examination requirements	*Minimum attendance at lectures is 80% (according to IPB regulation). Final score is evaluated based on assignment and presence (35%), mid semester exam and end semester exam (65%).*

Reading list	1. *ASM Handbook, Volume 10, Material Characterization, 2019* 2. *IKaltashow, I.A, Eyles, S.J. Mass Spectrometry in Biophysics, Wiley Interscience, 2005* 3. *Milbrath, B.D. Peurrung, A.J, Bliss, M, and Weber, W.J. : Radiation detector materials: An Overview. Journal of Materials Research, 23(10), 2018* 4. *Aluker, N.L, Suzdal'tseva, Y.M, Dulepova, A.S, dan Herrmann, M.E. Thermoluminescent Detectors for Surveillance Studies of Radiation Exposure of The Population, Science Evolution, 1(2), 2016* 5. *Fewster, P.F. A new theory for X-ray diffraction. Acta Crystallographica Section A Foundations and Advances. A70, 257–282, 2014* 6. *Basic Knowledge for using the SEM (https://www.jeol.co.jp/en/applications/pdf/sm/sem_atoz_all.pdf)*

Module Handbook

Module designation	*Mathematical Physics*
Semester(s) in which the module is taught	*3rd (third)*
Person responsible for the module	*Prof. Dr. R. Tony Ibnu Sumaryada Wijaya Puspita, M.Si*
Language	*Bahasa Indonesia*
Relation to curriculum	*Compulsory in the second year (3rd semester) bachelor's degree*
Teaching methods	*100 minutes lectures and 120 minutes structured activities per week.*
Workload (incl. contact hours, self-study hours)	*Total workload is 119 hours per semester, which consists of 150 minutes lectures per week, 180 minutes structured activities per week, 180 minutes individual study per week, in total is 14 weeks per semester, excluding mid exam and final exam.*
Credit points	*3 SCH x (1.5) = 4.5 ECTS*
Required and recommended prerequisites for joining the module	*MAT1104 - Calculus 1*
Module objectives/intended learning outcomes	*1. Students can understand concepts and demonstrate and use partial differentiation methods and techniques in solving physics problems in nature.* *2. Students understand concepts and can use multiple integration methods and techniques in solving physics problems in nature.* *3. Students can understand concepts and be able to use vector analysis techniques with various operators to solve physics problems in nature.* *4. Students can understand the basic concepts of multivariable linear algebra with a matrix approach, including eigenvalues and eigenvectors, and use them to solve various kinds of physics problems in nature.* *5. Students can understand the concept of complex numbers and be able to demonstrate and use them in solving various physics problems in nature.* *6. Students can understand the concept of series types of convergence series, know their physical applications and be able to solve physics problems that require a series-shaped solution.*
Content	*Partial and total differentials, multiple integrals, vector analysis, linear algebra, complex numbers, series.*

Examination forms	*Minimum attendance at lectures is 80% (according to IPB regulation). Final score is evaluated based on problem solving activity and assignments in class (50%), mid semester exam (25%), and final semester exam (25%).*
Study and examination requirements	*Written Exam*
Reading list	*1. Boas, M.L, Mathematical Methods in the Physical Sciences.", Academic Press, 3rd Edition, 2005* *2. Arfken, G, Mathematical Methods for Physicists: A Comprehensive Guide 7th Edition, Academic Press, 2012* *3. Balakrishnan V, Mathematical Physics: Applications and Problems 1st Edition, Springer, 2020.*

Module Handbook

Module designation	*Nanophysics*
Semester(s) in which the module is taught	*6th (Sixth)*
The person responsible for the module	*Prof. Dr. Akhiruddin*
Language	*Bahasa Indonesia*
Relation to curriculum	*Compulsory course in the third year (6th semester) of bachelor's degree*
Teaching methods	*100 minutes of lectures and 120 minutes structured activities per week.*
Workload (incl. contact hours, self-study hours)	*Total workload is 79 hours per semester, which consists of 100 minutes lectures per week for 14 weeks, 120 minutes structured activities per week, 120 minutes individual study per week, in total is 14 weeks per semester, excluding mid exam and final exam.*
Credit points	*2 SCH x (1.5) = 3 ECTS*
Required and recommended prerequisites for joining the module	-
Module objectives/intended learning outcomes	1. *Students are able to understand the field of nanoscience and nanotechnology.* 2. *Students are able to understand the quantum confinement effect.* 3. *Students are able to understand the concept of electronic state density and band structure.* 4. *Students are able to understand the nanomaterial characteristics.* 5. *Students are able to understand various nanomaterials synthesis methods.* 6. *Students are able to understand and explain several examples of nanomaterial structures, especially carbon-based nanomaterial.* 7. *Students are able to explain various applications of nanotechnology and nanomaterial.*
Content	*Field of nanophysics and nanomaterials, Quantum confinement effect, Band structure of nanoparticles, Density of electronic states of nanoparticles, characteristics of nanoparticles (0D/3D, 1D, and 2D), phenomena and properties of nanomaterials, synthesis of nanomaterials (Bottom-up and Top-down), characterization of nanomaterials, applications of nanomaterial and nanotechnology (electronics, energy, and health).*
Examination forms	*Written Exam*

Study and examination requirements	*Minimum attendance at lectures is 80% (according to IPB regulation). Final score is evaluated based on assignment and presence (50%), mid semester exam (30%), and end semester exam (20%)*
Reading list	1. *Wolf, E.L. Nanophysics and Nanotechnology: An Introduction to Modern Concepts in Nanoscience, Second Edition, Wiley-VCH Verlag GmbH & Co. KGaA, 2006* 2. *Murty, B.S, Shankar, P, Raj, B, Rath, B.B, Murday, J. Textbook of Nanoscience and Nanotechnology, Springer, e-ISBN 978-3-642-28030-6, DOI 10.1007/978-3-642-28030-6, 2013* 3. *Sattler, K.D (Editor), Handbook of Nanophysics: Principles and Methods, 1st Edition, CRC Press, ISBN 9781138117853, 2017* 4. *Tsusumi, T, Hirayama, H, Vacha, M, Taniyama, T. Nanoscale Physics for Materials Science, CRC Press, ISBN 978-1-4398-0059-1, 2010*

Module Handbook

Module designation	*Newtonian Mechanics*
Semester(s) in which the module is taught	*3rd (third)*
Person responsible for the module	*Dr. Mersi Kurniati*
Language	*Bahasa Indonesia*
Relation to curriculum	*Compulsory in the second year (3rd semester) bachelor's degree*
Teaching methods	*100 minutes lectures and 120 minutes structured activities per week.*
Workload (incl. contact hours, self-study hours)	*Total workload is 119 hours per semester, which consists of 150 minutes lectures per week, 180 minutes structured activities per week, 180 minutes individual study per week, in total is 14 weeks per semester, excluding mid exam and final exam.*
Credit points	*3 SCH x (1.5) = 4.5 ECTS*
Required and recommended prerequisites for joining the module	*Science and Technology Physics*
Module objectives/intended learning outcomes	*1. Students are able to formulate and understand the theoretical concepts of mechanics with a Newtonian (classical) mechanics approach and have knowledge of mathematical tools* *2. Students are able to analyze various alternative solutions to Newtonian mechanics problems* *3. Students are able to apply the theory of Newtonian mechanics and provide alternative solutions to problems encountered in its application in agricultural engineering* *4. Students are able to think critically to solve problems and adjust to technological developments related to the study of Newtonian mechanics*

Content	1. *Kinematics, Newton's laws and inertial systems, Galileo transformations, simple applications of the laws Newton, including constant applied forces, time-dependent forces and theorems energy conservation in 1D, 2D and 3D cases.* 2. *Motion in a multiparticle system: angular momentum and kinetic energy of a system, motion of two or more interacting bodies, the parallel axes theorem.* 3. *Motion in a rigid body system: center of mass, the moment of inertia, rotation about a fixed axis, angular momentum and oscillation of the pendulum.* 4. *Accelerated coordinate systems, inertial forces, rotating coordinate systems, and particle dynamics in a rotating coordinate system.* 5. *Motion under the influence of the central force. The gravitational force on a homogeneous solid ball and a hollow sphere, potential energy in a gravitational field, Kepler's laws of planetary motion.*
Examination forms	*Written exam*
Study and examination requirements	*Minimum attendance at lectures is 80% (according to IPB regulation). Final score is evaluated based on assignment and presence (20%), mid semester exam (40%), and end semester exam (40%)*
Reading list	1. *Morin, D. Introduction to Classical Mechanics.. Cambridge University Press. 2007.* 2. *Goldstein H, Poole CP, Safko J, Classical Mechanics 3rd Ed, Pearson Education, 2011.* 3. *Arya, A. P., Introduction to Classical Mechanics, 2nd Ed., Prentice Hall, 1998*

Module Handbook

Module designation	*Nuclear and Particle Physics*
Semester(s) in which the module is taught	*6^{th} (Sixth)*
Person responsible for the module	*Prof. Dr. R. Tony Ibnu Sumaryada Wijaya Puspita, M.Si*
Language	*Bahasa Indonesia*
Relation to curriculum	*Compulsory course in the third year (6^{th} semester) bachelor's degree*
Teaching methods	*100 minutes lectures and 120 minutes structured activities per week.*
Workload (incl. contact hours, self-study hours)	*Total workload is 79 hours per semester, which consists of 100 minutes lectures per week for 14 weeks, 120 minutes structured activities per week, 120 minutes individual study per week, in total is 14 weeks per semester, excluding mid exam and final exam.*
Credit points	*3 SCH x (1.5) = 4.5 ECTS*
Required and recommended prerequisites for joining the module	-
Module objectives/intended learning outcomes	1. *Students are able to describe the Standard Model of elementary particles and types of fundamental interactions and the principle of symmetry and are able to solve related physics problems* 2. *Students are able to describe the basic physical quantities in nuclear (nuclear properties) including nuclear radius, spin, magnetic dipole moment, energy, nuclear stability.* 3. *Students understand Nuclear Structure and Model and Stability. Binding energy, Liquid drop Model, Fermi Model, Magic Number, Nuclear Shell Model and solve related problems.* 4. *Students are able to understand the concept of Nuclear Reaction (fission, fusion, and decay) and its applications. Nuclear astrophysics.* 5. *Students are able to understand the use of nuclear for human life in the fields of energy, health and agriculture.* 6. *Students are able to understand the working concept of various kinds of nuclear and elementary particle detectors as well as Nuclear Physics Laboratory Facilities and elementary particles, such as CERN, Fermilab, ITER, Kamiokande, etc*

Content	*The material includes: basic structure of matter quarks and leptons and the elementary interactions responsible for their stability. Nuclear structure and reactions, decay, detectors, nuclear astrophysics. The applications of nuclear and particle physics in everyday life, such as energy problems, health, determination of the age of objects (carbon dating), research and others.*
Examination forms	*Written Exams*
Study and examination requirements	*Minimum attendance at lectures is 80% (according to IPB regulation). Final score is evaluated based on Problem based learning assignments (50%), mid semester exam (25%), and final semester exam (25%)*
Reading list	*1. Basdevant, J.L. Fundamentals in Nuclear Physics: From Nuclear Structure to Cosmology, Springer; 2005* *2. Bertulani, C, Nuclear Physics in a Nutshell, Princeton University Press; 1st edition, 2007.* *3. Belyaev A, Ross D, The Basics of Nuclear and Particle Physics (Undergraduate Texts in Physics) 1st Edition, Springer, 2021.* *4. Ferbel, D. Introduction to Nuclear and Particle Physics, World Scientific Publishing Company; 2nd edition, 2003.* *5. Perkins, D. Introduction to High Energy Physics, Cambridge University Press; 4 edition, 2000.*

Module Handbook

Module designation	*Optics and Photonics*
Semester(s) in which the module is taught	*5th (fifth)*
The person responsible for the module	*Prof. Dr. Husin Alatas*
Language	*Bahasa Indonesia*
Relation to curriculum	*Compulsory course in the third year (5th fifth semester) of bachelor's degree*
Teaching methods	*One hundred minutes of lectures and 120 minutes of structured activities per week.*
Workload (incl. contact hours, self-study hours)	*The total workload is 79 hours per semester, consisting of 100 minutes of lectures per week for 14 weeks, 120 minutes of structured activities per week, and 120 minutes of individual study per week; the total is 14 weeks per semester, excluding mid-exam and final exams.*
Credit points	*2 SCH x (1.5) = 3 ECTS*
Required and recommended prerequisites for joining the module	*Science and Technology Physics*
Module objectives/intended learning outcomes	1. *Students can explain the history of optics and photonics (light sciences)* 2. *Students can understand the properties of electromagnetic waves and Maxwell equations.* 3. *Students can understand and describe electromagnetic wave propagations in a homogenous and periodic medium.* 4. *Students are able to derive Fresnel using the boundary conditions and continuity.* 5. *Students are able to understand the dipole radiation phenomenon and its correlation with Huygens principle* 6. *Students are able to derive matter-light interaction using the Loretz and Drude approach.* 7. *Students are able to understand the formation of plasmon polariton on the surface and metamaterials.* 8. *Students are able to understand the formation of high harmonic waves and nonlinear optics phenomena.* 9. *Students are able to understand light propagation through optical fiber and optical fiber communication base principal* 10. *Students are able to understand the working and applications of optical and photonic devices.*

Content	*Introduction to Optics and Photonics, Maxwell's Equations and Electromagnetic Wave Propagation, Fresnel Equation, Total Internal Reflection, Planar Waveguides, Effects of Nonlinearity on Dielectric Materials and Their Consequences, Quantum Explanation of Atomic Energy Levels and Their Applications, Nonlinear Properties of Semiconductor Materials, Laser Principles and its applications.*
Examination forms	*Written Exam*
Study and examination requirements	*Minimum attendance at lectures is 80% (according to IPB regulation). The final score is evaluated based on assignment and presence (20%), mid semester exam (40%), and end semester exam (40%)*
Reading list	*1. Hecht, E. Optics, 5th Ed, Pearson, 2015.* *2. Pedrotti, F. L., Pedrotti, L. M., & Pedrotti, L. S. Introduction to Optics, 3rd ed, 2017.* *3. Saleh, B. E. A., & Teich, M. C. Fundamentals of Photonics, 3rd ed. Wiley-Interscience, 2019.*

Module Handbook

Module designation	*Quantum Physics*
Semester(s) in which the module is taught	*5^{th} (fifth)*
Person responsible for the module	*Dr. Agus Kartono*
Language	*Bahasa Indonesia*
Relation to curriculum	*Compulsory course in the fifth year (5^{th} fifth) bachelor's degree*
Teaching methods	*100 minutes lectures and 120 minutes structured activities per week.*
Workload (incl. contact hours, self-study hours)	*Total workload is 119 hours per semester, which consists of 150 minutes lectures per week, 180 minutes structured activities per week, 180 minutes individual study per week, in total is 14 weeks per semester, excluding mid exam and final exam.*
Credit points	*3 SCH x (1.5) = 4.5 ECTS*
Required and recommended prerequisites for joining the module	*FIS1203 Mathematical Physics, FIS1206 Advanced Mathematical Physics*
Module objectives/intended learning outcomes	*1. Students describe the emergence of quantum physics. 2. Students can analyze the properties of wave functions. 3. Students can solve the problem of particles in a box and determine the total wave function of free particles (x,t) if (x,0) is known. 4. Students can determine the solution of the Schrödinger equation for several simple one-dimensional potential cases. 5. Students can analyze the properties of the eigenvalue equation and the Hermitian operator. 6. Students can determine the eigenvalues and eigenfunctions of a harmonic oscillator using the operator method. 7. Students can construct spherical harmonics and determine angular momentum eigenvalues. 8. Students can determine the energy spectrum of the hydrogen atom. 9. Students can solve the eigenvalue equation using matrix notation. 10. Students can solve the Schrödinger equation with the disturbed Hamiltonian form, $H=H0+\lambda H'$.*

Content	*Background to the emergence of quantum physics, Theory of the properties of the wave function, Theory of the wave function for free particles and particles in a box, Analytical solutions of the Schrödinger equation for some simple one-dimensional potential cases. the properties of the eigenvalue equation and the Hermitian operator, Determination of the eigenvalues and eigenfunctions of the harmonic oscillator, Theory of spherical harmonics construction and determining the angular momentum eigenvalues, Determination of the energy spectrum of the hydrogen atom, Solving the eigenvalue equation using matrix notation, Theory solving the Schrödinger equation with disturbed Hamiltonian form.*
Examination forms	*Written exam*
Study and examination requirements	*Minimum attendance at lectures is 80% (according to IPB regulation). Final score is evaluated based on assignment and presence (40%), mid semester exam (30%), and end semester exam (30%)*
Reading list	*1. Griffith, D.J. Introduction to Quantum Mechanics, 3rd Ed, Cambridge University Press, 2018* *2. Saxon, D.S. Elementary quantum mechanics, Dover Publications, 2013* *3. Hardhienata, H. Tutorial Mekanika Kuantum Vol. 1, IPB Press, 2023 (in Indonesian)*

Module Handbook

Module designation	*Scientific Writing Method in Physics*
Semester(s) in which the module is taught	*6th (Sixth)*
Person responsible for the module	*Dr. Yessie Widya Sari*
Language	*Bahasa Indonesia*
Relation to curriculum	*Compulsory course in the third year (6th semester) bachelor's degree*
Teaching methods	*Small Group Discussion, Role-Play & Simulation, Discovery Learning, Self-Directed Learning, Cooperative Learning, Collaborative Learning, Contextual Learning, Project Based Learning, and other equivalent methods*
Workload (incl. contact hours, self-study hours)	*Total workload is 40 hours per semester, which consists of 50 minutes lectures per week for 14 weeks, 60 minutes structured activities per week, 60 minutes individual study per week, in total is 14 weeks per semester, excluding mid exam and final exam.*
Credit points	*1 SCH x (1.5) = 1.5 ECTS*
Required and recommended prerequisites for joining the module	-
Module objectives/intended learning outcomes	*1. Students are able to understand the urgency of scientific writing. 2. Students are able to understand etiquette in research and scientific writing. 3. Students are able to understand the systematic of scientific writing. 4. Students are able to further understand grammar techniques used in scientific writing. 5. Student are able to understand number writing technique, symbol, term, and scientific nomenclatures 6. Students are able to understand illustration placement technique 7. Mahasiswa dapat memahami teknik penempatan ilustrasi 8. Student are able to understand illustration placement technique 9. Mahasiswa dapat memahami teknik pengutipan pustaka dan penyusunan daftar pustaka 10. Students are able to understand the technique of citing and compiling a bibliography.*
Content	*Ethics in research and writing of scientific papers; systematics of scientific work; language techniques; writing of numbers, symbols, terms, and scientific nomenclature; illustration placement; bibliography citing and compilation of bibliography*

Examination forms	*Writing exam and Project Based exam*
Study and examination requirements	*Minimum attendance at lectures is 80% (according to IPB regulation). Final score is evaluated based on final exam (40%), and project-based exam (60%)*
Reading list	*Pedoman Penulisan Karya Ilmiah Tugas Akhir Mahasiswa Edisi Ke-4. IPB Press. 2019. ISBN: 978-623-256-142-7 (in Indonesian).*

Module Handbook

Module designation	*Sensors and Transducer*
Semester(s) in which the module is taught	*5^{th} (fifth)*
Person responsible for the module	*Dr. Irmansyah, MSi*
Language	*Bahasa Indonesia*
Relation to curriculum	*Compulsory in the third year (5^{th} fifth semester) bachelor's degree*
Teaching methods	*100 minutes lectures and 120 minutes structured activities per week.*
Workload (incl. contact hours, self-study hours)	*Total workload is 79 hours per semester, which consists of 50 minutes lectures per week for 14 weeks, 60 minutes structured activities per week, 60 minutes individual study per week, 100 minutes lab work, in total is 14 weeks per semester, excluding mid exam and final exam.*
Credit points	*3 SCH x (1.5) = 4.5 ECTS*
Required and recommended prerequisites for joining the module	-
Module objectives/intended learning outcomes	*1. Students are able to describe the classification, working mechanism, and characteristics of sensors and actuators.* *2. Students can analyze various physical phenomena, which are the concepts of various sensors and actuators.* *3. Students are able to read and interpret data sheets of various types of sensors.* *4. Students are able to design and assemble simple sensor system instruments.*
Content	*Sensor Terminology, Shift Sensors, Stress and Strain, Force and Torque Sensors, Pressure Sensors, Vibration and Acceleration Sensors, Fluid Flow Sensors, Temperature Sensors, Light Sensors, Motion Sensors, Acoustic Sensors, Biosensors, Chemical Sensors, Proximity Sensors, and Smart Sensors.*
Examination forms	*Written exam*
Study and examination requirements	*Minimum attendance at lectures is 80% (according to IPB regulation). Final score is evaluated based on project based assignment and presence (76%), mid semester and final semester exam (24%)*

Reading list	1. *Ida, N. Sensors, Actuators and their Interface Multidisciplinary. Institution of Engineering and Technology, 2020* 2. *Fraden, J. AIP Handbook of Modern Sensors, Physics, Designs and Applications, American Institute of Physics,5th Ed, 2015*

Module Handbook

Module designation	*Solid State Physics*
Semester(s) in which the module is taught	*6rd (Sixth)*
Person responsible for the module	*Dr Siti Nikmatin*
Language	*Bahasa Indonesia*
Relation to curriculum	*Compulsory course in the third year (6rd semester) bachelor's degree*
Teaching methods	*100 minutes lectures and 120 minutes structured activities per week.*
Workload (incl. contact hours, self-study hours)	*Total workload is 119 hours per semester, which consists of 150 minutes lectures per week, 180 minutes structured activities per week, 180 minutes individual study per week, in total is 14 weeks per semester, excluding mid exam and final exam.*
Credit points	*3 SCH x (1.5) = 4.5 ECTS*
Required and recommended prerequisites for joining the module	-

Module objectives/intended learning outcomes	1. *Students can describe and explain the concept of crystal structure theory* 2. *Students are able to formulate the crystalline phase in solids* 3. *Students are able to understand and explain the concept of lattice diffraction* 4. *Students are able to explain lattice vibrations and identify the dispersion relations of monatomic and diatomic 1D lattice sets and are able to identify optical and acoustic modes* 5. *Students can describe lattice vibrations* 6. *Students are able to describe the conductivity model and the assumptions used.* 7. *Students are able to understand the electrical conductivity and the ratio of the thermal and electrical conductivity of solids.* 8. *Students can explain phonon interactions and impurities and understand related models.* 9. *Students can understand the importance of the concept of the density of states.* 10. *Be able to understand the mechanism of the formation of energy bands in solids.* 11. *Students are able to understand the mechanism of the formation of energy bands in solids.* 12. *Students are able to describe the concept of density functional theory based on the Hohenberg-Kohn and Kohn-Sham theorems.* 13. *Students are able to explain the Basis Set concept of molecules in solids.*
Content	*Solid state physics is a subject given in semester 7, is a science that applies and identifies concepts related to the crystal structure of solids, wave diffraction in the reciprocal lattice, bonds and energy in crystalline materials, elastic constants and dynamics of lattice vibrations, thermal conductivity and heat of solid matter (Dulong-Petit, Einstein and Debye models), semiconductor Lorentz model, Drude model, phonon-phonon interaction, Umklapp process, Bloch function, and periodic potential model, Hall effect, molecular orbital theory, tight binding model). Energy bands and their relation to semiconductors, magnetic properties in solids, and introduction to Functional Density Theory, dynamics of monatomic and diatomic 1D lattice vibrations, phonon dispersion relations, acoustic and optical modes*
Examination forms	*Written Exam*
Study and examination requirements	*Minimum attendance at lectures is 80% (according to IPB regulation). Final score is evaluated based on assignment and presence (20%), mid semester exam (40%), and end semester exam (40%)*

Reading list	1. *Kittel, C Introduction of Solid-State Physics, 8th Ed, Wiley, 2004.* 2. *Marder, M.P, Condensed Matter Physics 2nd Edition, Wiley, 2015* 3. *Ibach H, Luth H, Solid-State Physics: An Introduction to Principles of Materials Science, 4th Edition, Springer, 2009.* 4. *Yu, P dan Cardona, M. Fundamentals of Semiconductors. 4th Ed, Springer, 2010* 5. *Hardhienata, H. Tutorial Fisika Zat Padat, Diva Press, 2023 (in Indonesian).*

Module Handbook

Module designation	*Statistical Physics*
Semester(s) in which the module is taught	*5^{th} (fifth)*
Person responsible for the module	*Dr. Mersi Kurniati*
Language	*Bahasa Indonesia*
Relation to curriculum	*Academic core course in the third year (5^{th} fifth) bachelor's degree*
Teaching methods	*100 minutes lectures and 120 minutes structured activities per weeks*
Workload (incl. contact hours, self-study hours)	*Total workload is 119 hours per semester, which consists of 150 minutes lectures per week, 180 minutes structured activities per week, 180 minutes individual study per week, in total is 14 weeks per semester, excluding mid exam and final exam.*
Credit points	*3 SCH x (1.5) = 4.5 ECTS*
Required and recommended prerequisites for joining the module	-
Module objectives/intended learning outcomes	1. *Students are able to understand physics phenomena in nature that correlate to thermodynamics concepts, energy, and phase transition either at a microscopic level or macroscopic level, using statistical tools.* 2. *Students are able to demonstrate the usage of mechanical statistic methods to solve various simple physics phenomena.*
Content	*Maxwell-Boltzmann statistics, Phase room and Canonical Ensemble concept, Determination of Statistical Parameters, Determination of Statistical Parameters, Bose-Eistein Statistics. Fermi-Dirac Statistics. State density of quantum systems. Distribution and Gas Particle Velocity Distributions and gas particles velocity. Maxwell-Boltzmann statistics applications, Bose-Einstein Statistics applications, Fermi-Dirac statistics applications*
Examination forms	*Written Exam*
Study and examination requirements	*Minimum attendance at lectures is 80% (according to IPB regulation). Final score is evaluated based on assignment and presence (30%), mid semester exam (35%), and end semester exam (35%)*

Reading list	1. *Swendsen, R. An Introduction to Statistical Mechanics and Thermodynamics. Second edition. Oxford University Press. 2020.* 2. *Huang K, Introduction to Statistical Physics 2nd Edition, Routledge, 2009* 3. *Sears & Salinger, Thermodynamics, Kinetic Theory and Statistical Thermodynamics Addison Wesley Publ. Company Massachusetts, 1976*

Module Handbook

Module designation	*Theory of Relativity*
Semester(s) in which the module is taught	*6th (sixth)*
Person responsible for the module	*Prof. Husin Alatas*
Language	*Bahasa Indonesia*
Relation to curriculum	*In-depth course in the third year (6th semester) bachelor's degree*
Teaching methods	*100 minutes lectures and 120 minutes structured activities per week.*
Workload (incl. contact hours, self-study hours)	*Total workload is 79 hours per semester, which consists of 100 minutes lectures per week for 14 weeks, 120 minutes structured activities per week, 120 minutes individual study per week, in total is 14 weeks per semester, excluding mid exam and final exam.*
Credit points	*2 SCH x (1.5) = 3 ECTS*
Required and recommended prerequisites for joining the module	-

Module objectives/intended learning outcomes	1. *Students are able to understand the importance of the formulation of the Theory of Relativity* 2. *Students are able to formulate Newtonian mechanics and the Galileo transformation in relation to the definition of an inertial frame of reference* 3. *Students are able to understand and master Einstein's postulates for the Special Theory of Relativity, Lorentz transform derivation from the principle of invariance of incident distances, consequences of Einstein's postulates: time dilation, length contraction, sum of velocity and twin paradox* 4. *Students are able to understand and master the formulation of covariant Newtonian mechanics* 5. *Students are able to understand and master the importance of reformulating Maxwell's equations in covariant form and are skilled in manipulating tensor notation* 6. *Students are able to understand and master the principles that underlie the birth of the General Theory of Relativity* 7. *Students are able to understand and master the implementation of non-Euclidean geometric concepts and their application to Einstein's concept of gravity* 8. *Students are able to understand and master the technique of solving the Einstein field equations for several physical cases and applications in the fields of astrophysics and cosmology.*
Content	*Postulates of the Special Theory of Relativity; Newtonian Paradigm; Consequences of the Postulates of the Special Theory of Relativity; Relativistic Mechanics; Covariant Maxwell's equations; The Equivalence Principle of the General Theory of Relativity; Manifolds and Riemann Geometry; Einstein's Field Equations; Schwarzschild and Kerr Solutions; Application of the General Theory of Relativity in Astrophysics and Cosmology.*
Examination forms	*Written exam*
Study and examination requirements	*Minimum attendance at lectures is 80% (according to IPB regulation). Final score is evaluated based on assignment and presence (20%), mid semester exam (40%), and end semester exam (40%)*
Reading list	1. *Hobson, MP et.al. General Relativity: An Introduction for Physicist, Cambridge University Press, 2006* 2. *Ferraro, R. Einstein's Space-Time: An Introduction to Special and General Relativity, Springer Science, 2007* 3. *Hartle, J.B, Gravity: An Introduction to Einstein's General Relativity, Pearson, 2002*

Module Handbook

Module designation	*Thermodynamics*
Semester(s) in which the module is taught	*3rd (third)*
Person responsible for the module	*Dr. Setyanto Tri Wahyudi*
Language	*Bahasa Indonesia*
Relation to curriculum	*Compulsory in the second year (3rd semester) bachelor's degree*
Teaching methods	*100 minutes lectures and 120 minutes structured activities per week.*
Workload (incl. contact hours, self-study hours)	*Total workload is 119 hours per semester, which consists of 150 minutes lectures per week, 180 minutes structured activities per week, 180 minutes individual study per week, in total is 14 weeks per semester, excluding mid exam and final exam.*
Credit points	*3 SCH x (1.5) = 4.5 ECTS*
Required and recommended prerequisites for joining the module	-
Module objectives/intended learning outcomes	1. *Students can explain the zero law of thermodynamics and the consequences of determining temperature quantities.* 2. *Students can explain the ideal gas equation and van der Waals and solve problems related to these equations.* 3. *Students can explain the 1st law of thermodynamics and its consequences and apply it to the calculations of combustion and cooling engines.* 4. *Students can explain the 2nd law of thermodynamics, use the concept of entropy, and apply it to simple systems.* 5. *Students can explain the 3rd law of thermodynamics and use it to calculate entropy changes in processes involving pure substances.* 6. *Students can explain the phases of pure substances and open systems and use mathematical methods to reformulate the 1st law of thermodynamics.* 7. *Students can demonstrate the relationship between statistical mechanics and classical thermodynamics.*

Content	*This course studies temperature, namely the macroscopic view, microscopi equilibrium and the concept of temperature; simple thermodynamic systen changes of states, mathematical theorems, intensive and extensive quantit quasi-static processes and work in simple systems; heat and the first law of system that is, heat-conducting thermal conductivity, Stefan-Boltzmann lav ideal gas equation, the second law of thermodynamics, TS diagram, Carnot and energy namely, enthalpy, Helmholtz and Gibbs functions, Maxwell's eq changes namely, Clapeyron equation, melting and evaporation, sublimatio mechanics.*
Examination forms	*Written exam*
Study and examination requirements	*Minimum attendance at lectures is 80% (according to IPB regulation). Final score is evaluated based on assignment and presence (20%), mid semester exam (40%), and end semester exam (40%)*
Reading list	*1. Sekerka, R.F, Thermal Physics: Thermodynamics and Statistical Mechanics for Scientists and Engineers 1st Edition, Elsevier, 2015.* *2. Zemansky, MW & Richard Dittman, Heat and Thermodynamics. 7th Ed, McGraw-Hill, 1997* *3. Roy, B.N, Fundamentals of Classical Statistical Thermodynamics, West Sussex: John Wiley & Sons, 2003*

Module Handbook

Module designation	*Waves*
Semester(s) in which the module is taught	*3rd (third)*
Person responsible for the module	*Abdul Djamil Husin, M.Sc*
Language	*Bahasa Indonesia*
Relation to curriculum	*Compulsory in the second year (3rd semester) bachelor's degree*
Teaching methods	*100 minutes lectures and 120 minutes structured activities per week.*
Workload (incl. contact hours, self-study hours)	*Total workload is 119 hours per semester, which consists of 150 minutes lectures per week, 180 minutes structured activities per week, 180 minutes individual study per week, in total is 14 weeks per semester, excluding mid exam and final exam.*
Credit points	*3 SCH x (1.5) = 4.5 ECTS*
Required and recommended prerequisites for joining the module	*(Fis 104) Science and Technology Physics, (MAT-103) Basic Mathematics*
Module objectives/intended learning outcomes	1. *Students can better understand the motion of harmonic oscillations* 2. *Students are expected further to understand the concept of damped oscillations and forced oscillations* 3. *Students are expected to understand coupled oscillatory motion and its applications* 4. *Students can understand and understand the wave equation and the types and characteristics of waves* 5. *Students are expected to understand and understand wave energy and impedance* 6. *Students understand the properties of waves* 7. *Students are expected to understand the nature of electromagnetic waves and their applications.*
Content	*Damped oscillatory motion and forced oscillatory motion, Coupled oscillations, which include a pendulum with a spring, a spring in the transverse and longitudinal directions, N particles longitudinally and transversely, Application of coupled oscillations, Lissajous pattern, Equation of waves and types of waves, Fourier series and its application to waves, travelling waves and their properties, standing waves and their properties, calculating wave Energy, impedance and wave superposition, Reflection, transmission, interference and diffraction and polarization of electromagnetic waves, including GEM properties, and their applications.*

Examination forms	*Written exam*
Study and examination requirements	*Minimum attendance at lectures is 80% (according to IPB regulation). Final score is evaluated based on assignment and presence (40%), mid semester exam (30%), and end semester exam (30%)*
Reading list	1. *Pain, H.J. The Physics of Vibrations and Waves, 6th Edition, Wiley& Sons, 2005* 2. *King, G.C, Vibrations and Waves 1st Edition, Wiley, 2009.* 3. *Vistnes, A.I, Physics of Oscillations and Waves: With use of Matlab and Python, 1st Edition, springer, 2018.*