MODUL HANDBOOK

BA PHYSICS – 2025 CURRICULUM

DEPARTEMENT OF PHYSICS
FACULTY OF MATHEMATICS & NATURAL SCIENCES
IPB UNIVERSITY
2025

Foreword

We express our gratitude to the presence of God Almighty for His grace and blessings so that this Module Handbook for the Bachelor's Degree in Physics Study Program can be compiled and published. This book is compiled as a learning guide for students, lecturers, and related parties in order to support the implementation of the educational process in the Bachelor's Degree in Physics Study Program, IPB University.

The Module handbook is designed to reflect the program educational objectives (PEO) and Program Learning Outcomes (PLO) of Bachelor's Degree in Physics Study Program, and is compiled based on the latest curriculum in accordance with the Indonesian National Qualification Framework (KKNI) and higher education quality standards. Each module contains learning objectives, course descriptions, materials to be discussed, teaching methods, and evaluation systems, which are expected to support the achievement of the desired graduate competencies.

We hope that this book can be a useful guideline for lecturers in designing an effective and efficient learning process. For students, this book is expected to help them understand the direction and objectives of each course so that they are more focused in planning their studies.

We would like to express our gratitude to all parties who have contributed to the preparation of this book, including the team of lecturers, administrative staff, and leaders of the Bachelor's Degree in Physics Study Program. We greatly appreciate constructive criticism and suggestions for the improvement and refinement of this book in the future.

Finally, we hope that this book can provide the greatest possible benefits for the advancement of education in the Bachelor's Degree in Physics Study Program, as well as support the achievement of superior and competent graduates in the field of physics.

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Module Handbook – Religion

Module designation	*Religion*
Semester(s) in which the module is taught	*1st and 2nd (odd and even) Semester*
Person responsible for the module	*Dr. Hamzah, M.Si*
Language	*Indonesian*
Relation to curriculum	*Compulsory Courses for undergraduate program in IPB University*
Teaching methods	*Classical lecture using power point and module.* *Independent learning using class.ipb.ac.id.*
Workload (incl. contact hours, self-study hours)	***Total workload is 135 hours per semester,*** *which consists of 100 minutes lectures per week, 120 minutes structured assignments per week, 120 minutes individual study per week, and 170 minutes practicum/recitation per week. Total 16 weeks per semester.*
Credit points	*3 x 1.67 ECTS = 5.01 ECTS*
Required and recommended prerequisites for joining the module	*1. Registered in this course* *2. Minimum 80% attendance in this course*
Module objectives/intended learning outcomes	*1. Able to explain the urgency of Islamic education and apply manners in seeking knowledge. (application).* *2. Able to explain Islamic teachings comprehensively in the fields of Aqidah, Sharia, Morals and Da'wah and be able to correct erroneous understandings of Islamic teachings. (comprehension).* *3. Able to explain the concept of science in Islam and eliminate the dichotomous attitude that opposes science and Islam. (understanding).* *4. Able to explain the relationship between humans and religion in Islam, realize the truth of Islam by being tolerant of other religions.* *5. Able to be honest, disciplined, responsible and anticorruption.* *6. Able to read the Koran properly and diligently worship and carry out various activities according to Islamic rules.*
Content	*Courses that comprehensively discuss the main points of Islamic religious teachings to shape the character and literacy of Muslim scientists as a foundation for the development and implementation of science for the progress of the state and nation. This course consists of material on Islam and Knowledge, Man and Religion, Islamic Faith, Islamic Sharia, Morals and Da'wah. This course also discusses the applicability of Islamic values in everyday life.*
Examination forms	*Written exam*

Study and examination requirements	***Cognitive:*** *Midterm exam, Final exam, Quizzes, Assignments* ***Psychomotor:*** *Practice* ***Affective:*** *Assessed from the element /variables achievement, namely (a) Contributions (attendance, active, role, initiative, language), (b) Being on time, (c) Effort.*
Reading list	*Mandatory Reading;* *Al-Qur'an and Translations, Islamic Religious Education Guidebook compiled by TIM PAI-IPB* *Additional Readings;* *1. Miftah Faridz, 1999. Pokok-pokok ajaran Islam karya Mifta Faridz, Penerbit Pustaka. Jakarta.* *2. Yunahar Ilyas.1999. Kuliah Akhlak. LIPPI 3. Yusuf Qardhawy,1997.Pengantar Kajian Islam (terjmhn.). Pustaka Kautsar. Jakarta.* *3. Hamzah Yaqub,1996. Etika Islam. CV. Diponegoro. Bandung.* *4. Yunahar Ilyas.2002. Kuliah Aqidah Islam. LPDI UMY.* *5. Yusuf Qardhawy.1996. Tauhid dan Fenomena Kemusyrikan (terjmhn). Pustaka Progresif. Surabaya* *6. Shalih bin Fauzan. 1999. Kitab Tauhid I (terjemahan).Darul Haq. Jakarta. Ismail Fauzi. Al-Islam dan Ilmu Pengetahuan.*

Module Handbook – Basic Physics 1

Module designation	*Basic Physics 1*
Semester(s) in which the module is taught	*1th (first) and 2nd (second)*
Person responsible for the module	*Dr. Setyanto Tri Wahyudi*
Language	*English and Indonesian*
Relation to curriculum	*Compulsory Courses for undergraduate program Ba Physics*
Teaching methods	*Classical lecture using power point and module.* *Independent learning using class.ipb.ac.id.*
Workload (incl. contact hours, self-study hours)	***Total workload is 135 hours per semester,*** *which consists of 100 minutes lectures per week, 120 minutes structured assignments per week, 120 minutes individual study per week, and 170 minutes practicum/recitation per week. Total 16 weeks per semester.*
Credit points	*2 SCH x (1.67) = 3.34 ECTS*
Required and recommended prerequisites for joining the module	-

Module objectives/intended learning outcomes	*Upon successful completion of this course, students will be able to:* 1. *Explain the fundamental principles of classical mechanics and thermodynamics, including concepts such as motion, force, energy, momentum, rotation, oscillation, waves, fluids, and thermodynamic laws.* 2. *Analyze and solve problems related to one- and two-dimensional motion, using kinematic equations and graphical representations.* 3. *Apply Newton's laws to determine the dynamics of particles and rigid bodies in linear and rotational motion.* 4. *Solve problems involving work, energy conservation, and power in mechanical systems.* 5. *Analyze linear momentum, impulse, and collisions in various physical contexts.* 6. *Understand rotational kinematics and dynamics, including torque, moment of inertia, and angular momentum.* 7. *Describe elastic properties of materials and apply them in analyzing simple harmonic motion and oscillatory systems.* 8. *Understand the propagation of mechanical waves, including wave parameters, superposition, and resonance.* 9. *Explain the behavior of fluids at rest and in motion using the principles of fluid statics and dynamics (e.g., Pascal's law, Bernoulli's principle).* 10. *Describe the basic concepts of temperature, heat, specific heat capacity, and heat transfer mechanisms.* 11. *Apply the ideal gas law and kinetic theory to explain the behavior of gases.* 12. *Understand and apply the laws of thermodynamics to simple physical systems, including energy conservation and entropy changes.*

Content	*This course provides an introduction to the fundamental concepts and principles in classical physics, focusing on mechanics and thermodynamics. Topics include:* ***Kinematics**: Describing motion in one and two dimensions using equations, vectors, and graphs.* ***Dynamics**: Newton's laws of motion and their applications to particles and rigid bodies.* ***Work and Energy**: The relationship between force and motion, work-energy theorem, and conservation of energy.* ***Momentum**: Linear momentum, impulse, and conservation in collisions.* ***Rotational Motion**: Angular kinematics and dynamics, moment of inertia, torque, and angular momentum.* ***Elasticity and Oscillations**: Elastic deformation, Hooke's Law, simple harmonic motion, damped and driven oscillations.* ***Mechanical Waves**: Wave motion, speed, frequency, wavelength, interference, and standing waves.* ***Fluid Mechanics**: Properties of fluids, pressure, buoyancy, fluid flow, and Bernoulli's equation.* ***Heat and Temperature**: Temperature scales, calorimetry, phase changes, and thermal expansion.* ***Kinetic Theory and Ideal Gases**: Microscopic interpretation of temperature, gas laws, and molecular motion.* ***Thermodynamics**: Zeroth to Second Law, heat engines, entropy, and the conservation of energy in thermal processes.*
Examination forms	*Multiple-choice exam*
Study and examination requirements	*Minimum attendance at lectures is 80% (according to IPB regulation). Final score is evaluated based on midterm exam (20%), end final exam (20%), Quiz (10%), Assignment (20%), and Practicum (30%)*
Reading list	*1. Halliday, D., Resnick, R., & Walker, J. (2010). Fundamentals of Physics (9th ed.). Hoboken, NJ: John Wiley & Sons.* *2. Giancoli, D. C. (2008). Physics for Scientists & Engineers with Modern Physics (4th ed.). Upper Saddle River, NJ: Pearson/Addison-Wesley.* *3. Tipler, P. A., & Mosca, G. (2007). Physics for Scientists and Engineers: Extended Version (6th ed.). New York, NY: W. H. Freeman and Company.* *4. Serway, R. A., & Jewett, J. W. (2004). Physics for Scientists and Engineers with Modern Physics (6th ed.). Belmont, CA: Thomson Brooks/Cole.*

Module Handbook – Statistics and Data Analysis

Module designation	*Statistics and Data Analysis*
Semester(s) in which the module is taught	*1st and 2nd (odd and even) Semester*
Person responsible for the module	*Dr Ir I Made Sumertajaya, M.Si*
Language	*Indonesian (regular class), English (international class)*
Relation to curriculum	*Compulsory Courses for undergraduate program in IPB University*
Teaching methods	*Classical lecture using power point and module.* *Independent learning using class.ipb.ac.id.*
Workload (incl. contact hours, selfstudy hours)	***Total workload is 135 hours per semester,*** *which consists of 100 minutes lectures per week, 120 minutes structured assignments per week, 120 minutes individual study per week, and 170 minutes practicum/recitation per week. Total 16 weeks per semester.*
Credit points	*3 x 1.67 ECTS = 5.01 ECTS*
Requirements according to the examination regulations	1. *Registered in this course* 2. *Minimum 80% attendance in this course*
Recommended prerequisites	-
Module objectives/intended learning outcomes	1. *Students have the ability to generate, present and interpret information general from the data* 2. *Students have the ability to process simple data collection and management generate valid information*
Content	*This course explains the basic concepts of statistics, the understanding of several internal terms statistics (sample, population, data, etc.); various techniques of understanding data (data understanding), which include presentation and summary of data, exploration of the existence of extreme values, exploration of distribution patterns, exploration of comparisons between groups, and exploration of relationships between variables; modeling (modeling), that is includes associations, correlations and recognition of linear regression models; understanding of several collection methods data, data management as well as several techniques of presenting information in the presentation of analysis results, which can be applied to various applied fields, such as Agriculture, Biology, Social, Business, and so on. This course also forms the basis for courses for further statistics courses such as Data Analysis Categorical, Regression Analysis, Experiment Design, Quality Control Statistics, and Time Series Analysis.*
Examination forms	*Written exam*

Study and examination requirements and forms of examination	***Cognitive:*** *Midterm exam, Final exam, Quizzes, Assignments* ***Psychomotor:*** *Practice* ***Affective:*** *Assessed from the element /variables achievement, namely (a) Contributions (attendance, active, role, initiative, language), (b) Being on time, (c) Effort.*
Media employed	*Classical teaching tools with white board and power point presentation*
Reading list	*1. Agresti A, Franklin C, Kingenberg B. 2018. Statistics: the art and science of learning from data.* *2. Pearson – Harlow, England. Anderson DR, Sweeney DJ, Williams TA, Camm JD, Cochran JJ. 2018. Statistics for Bussiness and Economics, 13th ed. Cengage Learning. Boston.* *3. Moore DS, McCabe GP, Craig BA. 2014. Introduction to the Practice of Statistics. WH Freeman and Company – New York, USA*

Module Handbook – Mathematics 1

Module designation	*Mathematics 1*
Semester(s) in which the module is taught	*2nd Semester*
Person responsible for the module	*Prof. Toni Bakhtiar*
Lecturer	*Team Teaching from Department of Mathematic*
Language	*Indonesian*
Relation to curriculum	*Compulsory Courses for undergraduate program Ba Physics*
Type of teaching, contact hours	*Classical lecture using power point and module.* *Independent learning using class.ipb.ac.id.*
Workload	***Total workload is 180 hours per semester,*** *which consists of 150 minutes lectures per week, 180 minutes structured assignments per week, 180 minutes individual study per week, and 170 minutes practicum/recitation per week. Total 16 weeks per semester.*
Credit points	*4 x 1.67 ECTS = 6.68 ECTS*
Requirements according to the examination regulations	*1. Registered in this course* *2. Minimum 80% attendance in this course*
Recommended prerequisites	-
Module objectives/intended learning outcomes	*1. Explain the concept of differentiation, relation between derivative and tangent and rate of change, determine derivative of a function, and solve related rates.* *2. Determine maximum and minimum values of a function, determine increase/decrease interval, determine the concavity interval, find asymptots, sketch the graph. Apply the concept of differentiation in optimization.* *3. Relate the concept of area and the definite integral, explain the relation between derivative and integral, calculate definite and indefinite integrals by substitution rule.* *4. Describe the definition of inverse function, explain the definition of natural logarithmic and exponential functions and their relation, determine the derivative and integral of logarithmic, exponential, and trigonometric functions. .* *5. Determine integral of a function by using integral by parts and determine the integral of rational functions.*

	6. *Apply integral to calculate area between curves, explain the average value theorem and its application.* 7. *Solve first order differential equations by using variable separation technique and its application.*
Content	*This course studies the derivation of a function and its application, integral of a function, transcendental function, technique of integration, application of integral, and introduction to ordinary differential equations.*
Examination forms	*Written exam*
Study and examination requirements and forms of examination	*Cognitive: Midterm exam, Final exam, Quizzes, Assignments* *Psychomotor: Practice Affective: Assessed from the element /variables achievement, namely (a) Contributions (attendance, active, role, initiative, and language), (b) Being on time, (c) Effort.*
Media employed	*Classical teaching tools with white board and power point presentation*
Reading list	1. *Stewart, J. 2001. Kalkulus. Ed. 4. I Nyoman Susila & Hendra Gunawan, penerjemah. Erlangga, Jakarta.* 2. *Kreyzig, E. 1990. Matematika Teknik Lanjutan. Jilid 1. E. Hutahean, dkk, penerjemah. Erlangga, Jakarta.*

Module Handbook – Indonesian Language

Module designation	*Indonesian Language*
Courses, if applicable	*IPB106 Indonesian Language*
Semester(s) in which the module is taught	*Odd/Even Semester*
Person responsible for the module	*Dr. Mukhlas Ansori, MSi*
Lecturer	*Team Teaching*
Language	*Indonesian*
Relation to curriculum	*Compulsory Courses for undergraduate program in IPB University*
Type of teaching, contact hours	*Classical lecture using power point and module.* *Independent learning using class.ipb.ac.id.*
Workload	***Total workload is 90 hours per semester,*** *which consists of 50 minutes lectures per week, 60 minutes structured assignments per week, 60 minutes individual study per week and 170 minutes practicum/recitation per week.. Total 16 weeks per semester.*
Credit points	*2 x 1.67 ECTS = 3.34 ECTS*
Requirements according to the examination regulations	*1. Registered in this course* *2. Minimum 80% attendance in this course*
Recommended prerequisites	-
Module objectives/intended learning outcomes	*1. be able to explain the concept of language, the history of the Indonesian language, the position of the Indonesian language, the functions of the Indonesian language;* *2. able to explain and identify aspects of language, starting from the simple level, namely spelling, vocabulary, sentences, paragraphs, to types of text;* *3. able to correct language errors;* *4. be able to use written and spoken Indonesian in accordance with the rules;* *5. mastering the skills and application of the steps for writing scientific papers which include the pre-writing, writing, and editing stages;* *6. able to carry out simple research and then compile it into a paper in accordance with the field of knowledge; as well as* *7. able to communicate verbally properly and correctly and be able to present research results.*

Content	*This course contains material that enhances a sense of national love in the form of the history of the Indonesian language. Material related to improving language skills in the form of effective sentence writing includes spelling, word choice, and structure. The material for reading and writing skills is in the form of techniques for composing paragraphs, composing texts, selecting readings, critical thinking, and compiling scientific papers. The material for oral language skills is in the form of an oral presentation. Student work in the form of outline paragraphs, paragraphs, types of text, slides, videos, and simple research papers.*
Examination forms	*Written exam*
Study and examination requirements and forms of examination	***Cognitive:*** *Midterm exam, Final exam, Quizzes, Assignments* ***Psychomotor:*** *Practice* ***Affective:*** *Assessed from the element /variables achievement, namely (a) Contributions (attendance, active, role, initiative, language), (b) Being on time, (c) Effort.*

Module Handbook – Chemistry of Science and Technology

Module designation	*Chemistry of Science and Technology*
Semester(s) in which the module is taught	*1st Semester*
Lecturer	*Team Teaching*
Language	*Indonesian*
Relation to curriculum	*Compulsory module for undergraduate program in IPB University*
Type of teaching, contact hours	*Classical lecture using power point, laboratory practice And Independent learning using class.ipb.ac.id.*
Workload	***Total workload is 135 hours per semester,*** *which consists of 100 minutes lectures per week, 120 minutes structured assignments per week, 120 minutes individual study per week, and 170 minutes practicum/recitation per week. Total 16 weeks per semester.*
Credit points	*3 x 1.67 ECTS = 5.01 ECTS*
Requirements according to the examination regulations	1. *Registered in this course* 2. *Minimum 80% attendance in this course*
Recommended prerequisites	-
Module objectives/intended learning outcomes	1. *Be able to understand Chemistry as the Central of Science for science and technology in the fields of agriculture, marine and tropical biosciences* 2. *Be able to apply the concept of chemistry to design the structure, dynamics and rate of change in living systems related to energy exploration for the future.* 3. *Able to communicate and express opinions and ideas logically to solve a problem and respect the opinions of others.* 4. *Able to collaborate and cooperate through group work with due regard to safety, occupational health and environmental aspects*

Content	*This course encourages students to actualize Chemistry as a Central of Science for the foundation of science and technology in the fields of agriculture, marine and tropical biosciences. The theoretical foundation will begin by providing insight into the contribution of chemistry in the field of world technology, its relationship with other sciences, efficiency of atoms for product synthesis, dynamics and rate of change of products and utilization of products for the development of technology for the welfare of living things.*
Examination forms	*Written exam*
Study and examination requirements and forms of examination	***Cognitive:*** *Midterm exam, Final exam, Quizzes, Assignments* ***Psychomotor:*** *Practice* ***Affective:*** *Assessed from the element /variables achievement, namely (a) Contributions (attendance, active, role, initiative, and language), (b) Being on time, (c) Effort.*
Media employed	*Classical teaching tools with white board and power point presentation*
Reading list	*Suchocki J. 2007. Conceptual Chemistry: Understanding Our World of Atoms and Molecules. Ed. Ke-3. San Francisco (US): Pearson Benjamin Cummings.*

Module Handbook – Civic Education

Module designation	*Civic Education*
Semester(s) in which the module is taught	*1st Semester*
Lecturer	*Team Teaching*
Language	*Indonesian and English*
Relation to curriculum	*Compulsory module for undergraduate program in IPB University*
Type of teaching, contact hours	*Type of teaching: Face to face lecture*
Workload	***Total workload is 90 hours per semester,** which consists of 50 minutes lectures per week, 60 minutes structured assignments per week, 60 minutes individual study per week and 170 minutes practicum/recitation per week. Total 16 weeks per semester.*
Credit points	*2 x 1.67 ECTS = 3.34 ECTS*
Requirements according to the examination regulations	*1. Registered in this course* *2. Minimum 80% attendance in this course*
Recommended prerequisites	-
Module objectives/intended learning outcomes	*Student able:* *1. Understand the four basic consensus and the importance of state defense awareness (C2).* *2. Understanding the dynamics of implementing the 1945 Constitution and changes to the constitutional system (C2).* *3. Applying the principles of democratization, regional autonomy, good governance, and anticorruption character as an effort to improve the Indonesian nation's self-image in facing changes in the world order, and management of national resources for the prosperity of the Indonesian nation state (C3)* *4. Identifying problems with the National Security conception approach and increasing national awareness of various threats in order to uphold the existence of the Unitary State of the Republic of Indonesia (C4).*

Content	*The Citizenship Education course provides an understanding of the importance of awareness of defending the country for the next generation of the Indonesian nation in fighting for and maintaining the integrity of the Unitary State of the Republic of Indonesia through the mastery and application of science and technology based on 4 basic consensus, namely the values of Pancasila, the 1945 Constitution of the Republic of Indonesia, Unity in Diversity, and the Unitary State of the Republic of Indonesia. Realizing sustainable national development based on archipelago vision, national resilience and national vigilance in harmony with the principles of democratization, regional autonomy, good governance and anti-corruption character.*
Examination forms	*Written exam*
Study and examination requirements and forms of examination	***Cognitive:*** *Midterm exam, Final exam, Quizzes, Assignments* ***Psychomotor:*** *Practice* ***Affective:*** *Assessed from the element /variables achievement, namely (a) Contributions (attendance, active, role, initiative, and language), (b) Being on time, (c) Effort.*
Media employed	*Classical teaching tools with white board and power point presentation*
Reading list	*1. Rangkuti, P.A.,2016, Membangun Kesadaran Bela Negara, Bogor : (edisi ke2) IPB Press.* *2. Mahmuzar, 2010, Sistem Pemerintahan Indonesia : Sebelum dan Sesudah Amandemen UUD 1945, Jakarta : Nusa Media.* *3. Syakrani,2009, Implementasi Otonomi Daerah dalam Perspektif Good Governance, Jakarta : Pustaka Pelajar.* *4. Pendidikan Kewarganegaraan untuk Perguruan Tinggi, Cet.1, Kemristek Dikti* *5. Pendidikan Anti Korupsi Untuk Perguruan Tinggi, Nanang T.Puspito, Marcella Elwina (edit) Kemendikbud: 2011* *6. Undang-Undang Dasar Negara Kesatuan Republik Indonesia tahun 1945 (yang telah diamandemen)* *7. Undang-Undang No. 12 tahun 2006 tentang Kewarganegaraan Republik Indonesia* *8. Undang-Undang No. 32 tahun 2004 tentang Pemerintahan Daerah* *9. 10. Undang-Undang No. 39 tahun 1999 tentang Hak Asasi Manusia*

Module Handbook – Pancasila

Module designation	*Pancasila*
Semester(s) in which the module is taught	*1st/2nd Semester*
Person responsible for the module	*Team Teaching*
Language	*Indonesian and English*
Relation to curriculum	*Compulsory module for undergraduate program in IPB University*
Type of teaching, contact hours	*Type of teaching: Face to face lecture*
Workload	***Total workload is 90 hours per semester,*** *which consists of 50 minutes lectures per week, 60 minutes structured assignments per week, 60 minutes individual study per week and 170 minutes practicum/recitation per week. Total 16 weeks per semester.*
Credit points	*2 x 1.67 ECTS = 3,34 ECTS*
Requirements according to the examination regulations	*1. Registered in this course* *2. Minimum 80% attendance in this course*
Recommended prerequisites	-
Module objectives/intended learning outcomes	*Students able to:* *build self-awareness as the next generation of the Indonesian nation that carries the mandate and human nature to always practice the values of Pancasila through the ability to interpret the essence of historical values (C2), the position and nature of the Pancasila precepts (C2), being proactive about the actual problems of the nation and state (C3), as well as applying Pancasila values in the mastery and development of science and technology for the development and progress of the Indonesian nation (C4.*
Content	*The Pancasila Education course as a compulsory subject aims to build and foster student attitudes, behavior, mindset, insight, knowledge, and skills that are in accordance with Pancasila values (religious, humanist, nationalist, cooperative, and just) through understanding Pancasila (1) historically, namely the history of the development of Pancasila thought; (2) philosophically, including Pancasila as a philosophical system, ethical system, national view of life, national ideology, the basis of the state; (3) juridically, regarding the position of Pancasila in the laws and regulations, (4) Pancasila as a National Development Paradigm in*

	the Political, Economic, Socio-Cultural, Defense and Security fields, and (5) The millennial generation action program in advancing the nation state of Indonesia (Actualization of the character of Pancasila values) in the form of assignments to make individual papers with the theme Implementation and Development of Pancasila Values which can Improve the Quality of Life in Society, Nation and State, including religious values (Religiosity), family values (humanist), harmony values (nationalist)), social values (cooperating), and justice values.
Examination forms	*Written exam*
Reading list	1. *Abdullah, Rozali, 1984, Pancasila sebagai Dasar Negara dan Pandangan Hidup Bangsa, CV. Rajawali, Jakarta.* 2. *Ali, As'ad Said, 2009, Negara Pancasila Jalan Kemaslahatan Berbangsa, Pustaka LP3ES, Jakarta.* 3. *Anshoriy, HM. Nasruddin, 2008, Bangsa Gagal: Mencari Identitas Kebangsaan, LKiS, Yogyakarta.* 4. *Bakry, Noor Ms., 2010, Pendidikan Pancasila, Pustaka Pelajar, Yogyakarta.* 5. *Kaelan, 2000, Pendidikan Pancasila, Paradigma, Yogyakarta.* 6. *Dodo, Surono dan Endah (ed.), 2010, Konsistensi Nilai-Nilai Pancasila dalam UUD 1945 dan Implementasinya, PSP-Press, Yogyakarta.* 7. *Kaelan, 2012, Problem Epistemologis Empat Pilar Berbangsa dan Bernegara, Paradigma, Yogyakarta.* 8. *Kusuma, A.B., 2004, Lahirnya Undang-Undang Dasar 1945, Badan Penerbit Fakultas Hukum Universitas Indonesia, Jakarta.* 9. *Latif, Yudi, 2011, Negara Paripurna: Historisitas, Rasionalitas dan Aktualitas Pancasila, PT Gramedia Pustaka Utama, Jakarta.* 10. *Nurdin, Encep Syarief, 2002, Konsep-Konsep Dasar Ideologi: Perbandingan Ideologi Besar Dunia, CV Maulana, Bandung.* 11. *Rinjin, Ketut, 2012, Pendidikan Pancasila untuk Perguruan Tinggi, PT. Gramedia Pustaka Utama, Jakarta.* 12. *Zubair, Achmad Charris, 1990, Kuliah Etika, Rajawali Pers, Jakarta.*

Module Handbook – Sociology

Module designation	*Sociology*
Semester(s) in which the module is taught	*Odd/Even Semester*
Lecturer	*Team Teaching from Faculty of Human Ecology*
Language	*Indonesian*
Relation to curriculum	*Compulsory module for undergraduate program in IPB University*
Type of teaching, contact hours	*Classical lecture using power point and module.* *Independent learning using class.ipb.ac.id.*
Workload	***Total workload is 90 hours per semester,*** *which consists of 100 minutes lectures per week, 120 minutes structured assignments per week, and 120 minutes individual study per week. Total 16 weeks per semester.*
Credit points	*2 x 1.67 ECTS = 3.34 ECTS*
Requirements according to the examination regulations	*Registered in this course* *Minimum 80% attendance in this course*
Recommended prerequisites	-
Module objectives/intended learning outcomes	*1. Students are able to describe the definition of the concept of sociology [reflected in the main points]* *2. Students are able to provide examples of social facts based on empirical observations in Indonesia with sociological concepts.* *3. Students are able to analyze social facts and empirical observations in Indonesia with sociological concepts to identify and solve social problems* *4. Students have an attitude of curiosity, critical, inclusive, and concerned about social justice.* *5. Mastering the theoretical concepts of certain fields of knowledge and skills in general and the theoretical concepts of special sections in the fields of knowledge and skills in depth (KKNI for S1)*

Content	*Topics that will be discussed in the course include (1) Understanding Society Sociologically; (2) Social Interaction: Building Cooperation and Functioning Social Conflict; (3) Community Portrait seen through the Lens of Social Structure; (4) Diversity and Existence of Indonesian Culture; (5) Dynamics of Social Institutions; (6) Group Dynamics in a Changing Society (7) Bureaucracy and Corruption Prevention; (8) Power and Authority; (9) Communication knits Social Relations, (10) Patterns of Ecological Adaptation; (11) Ecological Creation and Ecological Modernization (12) Gender, Equality and Social Inclusion and (13) Social Change in the Flow of Globalization*
Examination forms	*Written exam*
Study and examination requirements and forms of examination	***Cognitive:*** *Midterm exam, Final exam, Quizzes, Assignments* ***Psychomotor:*** *Practice* ***Affective:*** *Assessed from the element /variables achievement, namely (a) Contributions (attendance, active, role, initiative, language), (b) Being on time, (c) Effort.*
Media employed	*Classical teaching tools with white board and power point presentation*
Reading lists	*1. Berger PL. 1963. Invitation to Sociology. A Humanistic Perspective. New York: Anchor Books.* *2. Brym RJ. 2009. Sociology as a Life or Death Issue. Canada: Nelson Education.* *3. Charon JM. 1980. The Meaning of Sociology. US: Alfred Publishing Co. Inc. America.* *4. Creswell JW. 2012. Research Design: Pendekatan Kualitatif, Kuantitatif dan Mixed. Yogyakarta: Pustaka Pelajar.* *5. Durkheim E. 1966. The Rules of Sociological Method. Ed ke-8. Terjemahan oleh Sarah A. Solovay and John H. Mueller. New York and CollierMacMillan Limited. London: The Free Press.* *6. Harper CL. 1989. Exploring Social Change. Englewood Cliffs, New Jersey, USA: PrenticeHall Publisher.* *7. Kinseng RA. 2017. Struktugensi: sebuah teori tindakan. Sodality: Jurnal Sosiologi Pedesaan. 5(2): 127137.* *8. Plummer K. 2010. Sociology the Basics. London: Routledge.* *9. Sibeon R. 2004. Rethinking Social Theory. London, Thousand Oaks, New Delhi: SAGE Publications.*

	10. Suseno FM. 1999. Pemikiran Karl Marx Dari Sosialisme Utopis ke Perselisihan Revisionisme. Jakarta: Gramedia Pustaka Utama. *11. Wallace RA, Wolf A. 2006. Contemporary Sociological Theory. Expanding the Classical Tradition. Ed ke-6, Prentice Hall, New Jersey: Pearson.* *12. Weber M. 1974. The Theory of Social and Economic Organization. New York: The Free Press*

Module Handbook – Elementary Biology

Module designation	*Elementary Biology*
Semester(s) in which the module is taught	*1st or 2nd Semester*
Person responsible for the module	
Lecturer	*Team teaching Biology Department*
Language	*Indonesian*
Relation to curriculum	*Compulsory Courses for undergraduate program in IPB University*
Type of teaching, contact hours	*Classical lecture using power point and module. Independent learning using class.ipb.ac.id.*
Workload	***Total workload is 135 hours per semester,*** *which consists of 100 minutes lectures per week, 120 minutes structured assignments per week, 120 minutes individual study per week, and 170 minutes practicum/recitation per week. Total 16 weeks per semester.*
Credit points	*3 x 1.67 ECTS = 5.01 ECTS*
Requirements according to the examination regulations	1. *Registered in this course* 2. *Minimum 80% attendance in this course*
Recommended prerequisites	-
Module objectives/ intended learning outcomes	*Students after taking this course are able to:* 1. *connecting phenomena encountered in life with biology* 2. *understand that it is necessary to manage Indonesia's biodiversity and always be a material consideration for every decision taken to solve problems that will impact the existence of Indonesia's biodiversity* 3. *imitate social attitudes, be able to express opinions and respect the opinions of others about biological knowledge and its application in everyday life* 4. *Developing a sense of love for the motherland after studying Indonesia's biodiversity and its prospects* 5. *Observing and explaining the diversity, structure and biological functions of organisms: monera, protists, fungi, plantae, animalia.* 6. *Observing and explaining the ecology: population, community, ecosystem and bioconservation*

Content	*This course explains the theories and basic principles of biology that form the basis for further courses in the major / department. The lecture begins by explaining the scope of biology and the origins of life, then proceeding to the Midterm Examination, lectures explaining the structure and function of biology at the cellular level, genetics and its application in biotechnology. In the next section until the Final Examination, the lecture explains about biodiversity and biological functions at the level of organisms (monera, protists, fungi, plantae, and animalia), population, community, ecosystem, and conservation biology. Examples and the application of each topic are given to help students understand basic principles and theories.*
Examination forms	*Written exam*
Study and examination requirements and forms of examination	***Cognitive:*** *Midterm exam, Final exam, Quizzes, Assignments* ***Psychomotor:*** *Practice* ***Affective:*** *Assessed from the element /variables achievement, namely (a) Contributions (attendance, active, role, initiative, language), (b) Being on time, (c) Effort.*
Media employed	*Classical teaching tools with white board and power point presentation*
Reading list	*Jane B. Reece, Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, Robert B. Jackson. 2014. Campbell Biology.10th. Pearson Education, Inc.* *Neil A. Campbell, Jane B. Reece. 2008. Biology 8th. Pearson Benjamin Cummings: San Francisco.*

Module Handbook – English

Module designation	*English*
Semester(s) in which the module is taught	*1st Semester*
Person responsible for the module	*Teaching Team*
Language	*Indonesian and English*
Relation to curriculum	*Compulsory Courses for undergraduate program in IPB University*
Type of teaching, contact hours	*Classical lecture using power point and module.* *Independent learning using class.ipb.ac.id.*
Workload	***Total workload is 135 hours per semester,*** *which consists of 100 minutes lectures per week, 120 minutes structured assignments per week, 120 minutes individual study per week, and 170 minutes practicum/recitation per week. Total 16 weeks per semester.*
Credit points	*3 x 1.67 ECTS = 3.34 ECTS*
Requirements according to the examination regulations	*1. Registered in this course* *2. Minimum 80% attendance in this course*
Recommended prerequisites	-

Module objectives/ intended learning outcomes	1. *Students are able to use English to communicate according to the needs of their time* 2. *Students have the ability to analyze English discourse to get the content/meaning contained in the discourse correctly.* 3. *Students are able to choose the form of speech (language functions) according to their communication needs*
Content	*This course is structured to encourage students to be able to use English according to their needs and context. For this reason, grammatical structures, rhetorical models are introduced in constructing ideas, developing vocabulary, and forms of speech according to language functions in their respective contexts.*
Examination forms	*Written exam*
Study and examination requirements and forms of examination	***Cognitive:*** *Written test (Mid Test, Final Test, Assignment, Quiz* ***Psychomotor:*** *Practice* ***Affective:*** *assessed from the element /variables achievement, namely :(a) Contributions (attendance, active, role, initiative, language) , (b) Being on time , (c) Effort.*
Media employed	*Classical teaching tools with white board and power point presentation*
Reading list	1. *Abdulaziz, Helen Taylor, & Alfred D. Stover. 1980. Academic Challenges in Reading. Prentice-Hall, Inc.Englewood Cliffs, N.J.* 2. *Anson M. Chris, Schwegler A. Robert. 2001. The Longman Handbook for Writers and Readers, An Imprint of Addision Wesley Longman, Inc.* 3. *Dobbs, Carrie. 1989. Reading for a Reason. Prentice Hall Regents Englewood Cliffs, N.J.* 4. *Feverstein, Tamar and Miriam S. 1995. Enhancing Reading Comprehension in the Language Learning Clasroom. Alta Book Center Pub. San Fransisco, California.* 5. *Grellet, Francois. 1981. A Practical Guide to Reading Comprehension Exercises. Cambridge University Press.* 6. *Hornby, A.S. 1991. Oxford Advanced Learner's Dictionary. Oxford UP.* 7. *Karen Blanchard et.al. 1997. For Your Information 3. Longman.* 8. *Kranhlee, Karl. 1976. Reading Together: A Reading Activities Text. St. Martin Press.* 9. *Labarca. Angela and James M. Hendrickson. 1984. Our Global Village. Harcourt Brace Jovanovichy, Inc.* 10. *Latulippe, L.D. 1987. Developing Academic Reading Skills. Prentice Hall Regents, Englewood Cliffs, N.J.*

	11. *Maingay, S. 1983. Making Sense of Reading: An Introduction to Reading Skills in English. Australia Nelson.* 12. *Marcelino, M. 1999. Materials for Foundations of Academic Writing Course. AMINEF, Jakarta.* 13. *Mickulecky, Beatrice S. 2004. More Reading Power, Reading for Pleasure, Comprehension Skills, Thinking Skills, Reading Faster. Pearson Education, Inc.* 14. *Oshima, Alice, and Ann Hogue. 1999. Writing Academic English. Longman.* 15. *Praninkas, Jean. 1975. Rapid Review of English Grammar. Prentice Hall.* 16. *Rowland, Black S. and Lisa Rosenthal. 1986. Academic English and Study Skills for International Students. Prentice Hall. N.J.* 17. *Skykes, J.B. 1989. The Concise Oxford Dictionary. Oxford UP.* 18. *The British Council. 1979. Reading and Thinking: Exploring* 19. *Functions. Oxford UP.* 20. *Torres G, Eunice. Smith L. Michael. English for Fisheries Technology. National Bookstore, Inc.* 21. *Valerie Kay. 1985. Biological Sciences "Developing Reading Skill in English". Pergamon Press.* 22. *Woods, Enid Nolan and David Foll. 1986. Penguin Advanced Reading Skills. Penguin Book Ltd. England.* 23. *https://en.wikipedia.org/wiki/Chart* 24. *https://en.wikipedia.org/wiki/Graph* 25. *https://www.ncsu.edu/labwrite/res/tablevsgraph/res- tablevsgraph.html* *http://www.diffen.com/difference/Communism_vs_Fascism* *http://www.diffen.com/difference/DNA_vs_RNA*

Module Handbook – Innovative Agriculture

Module designation	*Innovative Agriculture*
Semester(s) in which the module is taught	*1st Semester*
Person responsible for the module	*Prof. Dr. Ir. Hadi Susilo Arifin, M.S.*
Language	*Indonesian and English*
Relation to curriculum	*Compulsory module for undergraduate program at IPB University*
Type of teaching, contact hours	*Classical lecture using PowerPoint and module.* *Independent learning using class.ipb.ac.id.*
Workload	***Total workload is 90 hours per semester,** which consists of 100 minutes lectures per week, 120 minutes structured assignments per week, and 120 minutes individual study per week. Total 16 weeks per semester.*
Credit points	*2 x 1.67 ECTS = 3.34 ECTS*
Requirements according to the examination regulations	*1. Registered in this course* *2. Minimum 80% attendance in this course*
Recommended prerequisites	-
Module objectives/ intended learning outcomes	*After taking this course, students are able to explain agriculture in a broad sense and the supporting sciences.*
Content	*This course is designed and structured to take IPB University students to the world of agriculture in a broad sense.*
Examination forms	*Written exam*
Study and examination requirements and forms of examination	***Cognitive:** Midterm exam, Final exam, Quizzes, Assignments* ***Psychomotor:** Practice* ***Affective:** Assessed from the element /variables achievement, namely (a) Contributions (attendance, active, role, initiative, and language), (b) Being on time, (c) Effort.*

Media employed	*Classical teaching tools with white board and power point presentation*
Reading list	1. *AHN: Buku PIP Author AHN (Book 1-Soft File)* 2. *KM: Buku Kumpulan Makalah (Book 2-Soft File)* 3. *TGM: Buku Tantangan Generasi Muda (Hard File)*

Module Handbook – Basic Physics 2

Module designation	*Basic Physics 2*
Semester(s) in which the module is taught	*2nd (second)*
Person responsible for the module	*Dr. Setyanto Tri Wahyudi*
Language	*English and Indonesian*
Relation to curriculum	*Compulsory Courses for undergraduate program Ba Physics*
Teaching methods	*Lecture, recitation and practicum.*
Workload (incl. contact hours, self-study hours)	***Total workload is 135 hours per semester,** which consists of 100 minutes lectures per week, 120 minutes structured assignments per week, 120 minutes individual study per week, and 170 minutes practicum/recitation per week. Total 16 weeks per semester.*
Credit points	*3 SCH x (1.67) = 5.01 ECTS*
Required and recommended prerequisites for joining the module	-

Module objectives/intended learning outcomes	*Upon successful completion of this course, students will be able to:* *1. Explain the fundamental concepts of electricity and magnetism, electromagnetic waves, optics, and introductory modern physics.* *2. Analyze electric forces and fields using Coulomb's Law and the concept of electric field lines.* *3. Apply Gauss's Law to determine electric fields in symmetric charge distributions.* *4. Understand and calculate electric potential and potential energy in electrostatic systems.* *5. Analyze the behavior and energy storage of capacitors, including the role of dielectrics.* *6. Solve problems involving direct current (DC) circuits, including Ohm's Law, resistors in series and parallel, and Kirchhoff's rules.* *7. Describe magnetic fields and forces, and calculate magnetic effects using the Biot–Savart Law and Ampère's Law.* *8. Analyze electromagnetic induction, including Faraday's Law and Lenz's Law, and their applications.* *9. Understand and solve problems involving alternating current (AC) circuits, including impedance and resonance.* *10. Explain the generation and properties of electromagnetic waves, and describe their propagation and energy transport.* *11. Understand the principles of geometric optics, including reflection, refraction, and lens/mirror equations.* *12. Analyze interference and diffraction patterns and explain their physical basis in wave optics.* *13. Describe the key ideas of special relativity, including time dilation and length contraction.* *14. Understand the quantum behavior of light and matter, including the photoelectric effect and wave-particle duality.*

Content	*This course is a continuation of Fundamental Physics I and covers key topics in electricity and magnetism, optics, and introductory modern physics. Topics include:* ***Electrostatics**: Electric forces (Coulomb's Law), electric field and electric flux, Gauss's Law, electric potential, potential energy, and equipotential surfaces.* ***Capacitance and Dielectrics**: Capacitance, energy storage in capacitors, series and parallel combinations, and the effect of dielectric materials.* ***Direct Current (DC) Circuits**: Electric current, resistance, electromotive force (EMF), Kirchhoff's rules, and circuit analysis.* ***Magnetostatics**: Magnetic fields, forces on moving charges and current-carrying wires, magnetic fields of currents, and laws of Ampère and Biot–Savart.* ***Electromagnetic Induction**: Faraday's Law, Lenz's Law, induced EMF, motional EMF, and inductance.* ***Alternating Current (AC)**: AC sources, impedance in RLC circuits, power in AC circuits, and resonance.* ***Electromagnetic Waves**: Derivation from Maxwell's equations, wave properties, speed of light, and energy transport.* ***Geometrical Optics**: Reflection, refraction (Snell's Law), mirrors, lenses, ray tracing, and optical instruments.* ***Wave Optics**: Interference (Young's double-slit), diffraction (single-slit, diffraction grating), and polarization.* ***Introduction to Modern Physics**: Special relativity (Einstein's postulates, time dilation, length contraction), and the quantum nature of light (photoelectric effect, Compton scattering, wave-particle duality).*
Examination forms	*Multiple-choice exam*
Study and examination requirements	*Minimum attendance at lectures is 80% (according to IPB regulation). Final score is evaluated based on midterm exam (20%), end final exam (20%), Quiz (10%), Assignment (20%), and Practicum (30%)*
Reading list	*1. Halliday, D., Resnick, R., & Walker, J. (2010). Fundamentals of Physics (9th ed.). Hoboken, NJ: John Wiley & Sons.* *2. Giancoli, D. C. (2008). Physics for Scientists & Engineers with Modern Physics (4th ed.). Upper Saddle River, NJ: Pearson/Addison-Wesley.* *3. Tipler, P. A., & Mosca, G. (2007). Physics for Scientists and Engineers: Extended Version (6th ed.). New York, NY: W. H. Freeman and Company.* *4. Serway, R. A., & Jewett, J. W. (2004). Physics for Scientists and Engineers with Modern Physics (6th ed.). Belmont, CA: Thomson Brooks/Cole.*

Module Handbook – Mathematical Physics

Module designation	*Mathematical Physics*
Semester(s) in which the module is taught	*2nd (second)*
Person responsible for the module	*Prof. Tony Sumaryada*
Language	*Indonesian*
Relation to curriculum	*Compulsory in the second year (3rd semester) bachelor's degree*
Teaching methods	*Lecture and recitation in class. Student activities in class*
Workload (incl. contact hours, self-study hours)	*Total workload is 135 hours per semester, which consists of 100 minutes lectures per week, 120 minutes structured assignments per week, 120 minutes individual study per week, and 170 minutes practicum/recitation per week. Total 16 weeks per semester.*
Credit points	*3 SCH x (1.67) = 5.01 ECTS*
Required and recommended prerequisites for joining the module	-
Module objectives/intended learning outcomes	1. *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.* 2. *Students can understand the concept of complex numbers and be able to demonstrate and use them in solving various physics problems in nature.* 3. *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.* 4. *Students can understand concepts and demonstrate and use partial differentiation methods and techniques in solving physics problems in nature.* 5. *Students understand concepts and can use multiple integration methods and techniques in solving physics problems in nature.* 6. *Students can understand concepts and be able to use vector analysis techniques with various operators to solve physics problems in nature.*
Content	*Partial and total differentials, folding integrals, vector analysis, linear algebra, complex numbers, Calculus of Variation and series.*
Examination forms	*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%).*
Study and examination requirements	*Written Exam*

Reading list	1. *Mary L Boas, "Mathematical Methods in the Physical Sciences.", Academic Press, 3rd edition 2005* 2. *George Arfken, Mathematical Methods for Physicists: A Comprehensive Guide 7th Edition, Academic Press, 2012* 3. *Metode Matematik dalam Fisika, Alatas, Sumaryada, Ahmad, IPB Press 2023*

Module Handbook – Newtonian Mechanics

Module designation	*Newtonian Mechanics*
Semester(s) in which the module is taught	*3rd (third)*
Person responsible for the module	*Dr. Mersi Kurniati*
Language	*Indonesian*
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 135 hours per semester, which consists of 100 minutes lectures per week, 120 minutes structured assignments per week, 120 minutes individual study per week, and 170 minutes practicum/recitation per week. Total 16 weeks per semester*
Credit points	*3 SCH x (1.67) = 5.01 ECTS*
Required and recommended prerequisites for joining the module	*Basic Physics 1*
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 theorem 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. *Arya, A. P., "Introduction to Classical Mechanics," 2nd Ed., Prentice Hall, 1998.* 2. *P.A. Tipler, Fisika untuk Sains dan Teknik, Jilid 1, Penerbit Erlangga, Jakarta. 1991*

Module Handbook – Advanced Mathematical Physics

Module designation	*Advanced Mathematical Physics*
Semester(s) in which the module is taught	*3rd (third)*
Person responsible for the module	*Dr. Faozan*
Language	*Bahasa Indonesia*
Relation to curriculum	*Academic core 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 135 hours per semester,** which consists of 100 minutes lectures per week, 120 minutes structured assignments per week, 120 minutes individual study per week, and 170 minutes practicum/recitation per week. Total 16 weeks per semester.*
Credit points	*3 SCH x (1.67) = 5.01 ECTS*
Required and recommended prerequisites for joining the module	*Mathematical Physics*
Module objectives/intended learning outcomes	*1. Students can express functions in the form of Fourier series and Fourier integrals and apply them to solve physics problems.* *2. Students can solve various forms of first- and second-order linear differential equations using different methods and apply them in solving physics problems.* *3. Students can derive the equations of motion for the dynamics of physical systems based on the principle of variation.* *4. Students can solve problems related to special functions such as factorial, gamma, and beta functions, and apply them in solving physics problems.* *5. Students can describe several physical quantities using tensor notation and apply them in solving physics problems.* *6. Students can solve particular differential equations (Legendre, Bessel, Hermite, and Laguerre differential equations) in series form and apply them in solving physics problems.* *7. Students can solve various forms of multi-variable differential equations (partial differential equations) and apply them in solving physics problems.* *8. Students can solve various forms of real integrals using complex variable representation and apply them in solving physics problems.*

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. (2006). Mathematical methods in the physical sciences. 3rd, New York, Wiley.* 2. *George Arfken, Mathematical Methods for Physicists: A Comprehensive Guide 7th Edition, Academic Press, 2012* 3. *Metode matematik dalam Fisika, Alatas, Sumaryada, Ahmad, IPB Press 2023*

Module Handbook – Analogue Electronics

Module designation	*Analogue Electronics*
Semester(s) in which the module is taught	*3rd (third)*
Person responsible for the module	*Mahfuddin Zuhri, M.Sc*
Language	*Indonesian*
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 135 hours per semester,*** *which consists of 100 minutes lectures per week, 120 minutes structured assignments per week, 120 minutes individual study per week, and 170 minutes practicum/recitation per week. Total 16 weeks per semester.*
Credit points	*3 SCH x (1.67) = 5.01 ECTS*
Required and recommended prerequisites for joining the module	-
Module objectives/intended learning outcomes	*1. Students can understand the basic principles of electricity, sources of electrical energy, loading problems, 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, as well as identify electronic component values based on color codes, numbers, or letters.* *3. Students can analyze and simplify electronic circuits using the laws and theorems of electrical circuits.* *4. Students can analyze the characteristics of RLC circuits in response to DC and AC signals and create simple RLC circuit applications.* *5. Students can design power supplies and simple signal processing circuits using Diodes, Transistors, and Operational Amplifiers (Op-Amps).* *6. Students can create simple analog 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. *Grob's Basic Electronics, Mitchel E. Schultz, Mc-Graw Hill, 11th Edition* 2. *Electronic Circuit Design, An Engineering Approach, Savant, Roden, The Benjamin/Cummings Publishing Company, Inc.* 3. *Prinsip-prinsip Elektronika, Malvino, Erlangga, Jakarta, Erlangga, 1990*.

Module Handbook – Thermodynamics

Module designation	*Thermodynamics*
Semester(s) in which the module is taught	*3rd (third)*
Person responsible for the module	*Dr. Setyanto Tri Wahyudi*
Language	*Indonesian*
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 135 hours per semester,** which consists of 100 minutes lectures per week, 120 minutes structured assignments per week, 120 minutes individual study per week, and 170 minutes practicum/recitation per week. Total 16 weeks per semester.*
Credit points	*3 SCH x (1.67) = 5.01 ECTS*
Required and recommended prerequisites for joining the module	*Basic Physics 1*

Module objectives/intended learning outcomes	1. *Students can explain the zero law of thermodynamics, temperature and its measurement, and calculate temperatures using various measuring instruments and convert between different temperature units.* 2. *Students can explain various simple thermodynamic systems and compare the work done by each system.* 3. *Students can explain and perform calculations related to the first law of thermodynamics, heat transfer, the ideal gas equation, and kinetic theory of gases.* 4. *Students can explain and perform calculations related to the second law of thermodynamics, the Carnot cycle, and its applications to various types of engines (gasoline, diesel, steam, and Stirling).* 5. *Students can explain and perform calculations related to entropy, PV, TS, PT, and PVT diagrams, as well as pure substances.* 6. *Students can use mathematical methods to explain thermodynamic equations such as enthalpy, Helmholtz function, Gibbs function, internal energy, heat capacity, and Tds equations.* 7. *Students can explain open systems, Joule-Thomson expansion and its applications, as well as the Clausius-Clapeyron equation.* 8. *Students can explain the basic principles of statistical mechanics and demonstrate the relationship between statistical mechanics and classical thermodynamics.*
Content	*This course studies temperature, namely the macroscopic thermodynamics, thermal equilibrium and the concept of systems, namely equations of states, differential changes and extension quantities; work namely, quasi-static proces in simple systems; heat and the first law of thermodynami heat-conducting thermal conductivity, Stefan-Boltzmann l gas, ideal gas equation, the second law of thermodynamic entropy principle; enthalpy and energy namely, enthalpy, equation, T ds equation, energy equation; phase changes evaporation, sublimation; Kirchoff's equation; Introductio*
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 – Waves

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 135 hours per semester,** which consists of 100 minutes lectures per week, 120 minutes structured assignments per week, 120 minutes individual study per week, and 170 minutes practicum/recitation per week. Total 16 weeks per semester.*
Credit points	*3 SCH x (1.67) = 5.01 ECTS*
Required and recommended prerequisites for joining the module	*Basic Physics 1*
Module objectives/intended learning outcomes	*1. Students are expected to be able to use mathematical analysis tools to support understanding.* *2. Students are expected to understand the concept of simple harmonic motion.* *3. Students are expected to understand the concept of damped oscillations and forced oscillations.* *4. Students are expected to analyze the concept of coupled oscillatory motion in various systems.* *5. Students are expected to understand the concept of traveling waves.* *6. Students are expected to understand the concept of standing waves.* *7. Students are expected to understand the concepts of wave energy, impedance, and superposition.* *8. Students are expected to understand the concepts of wave reflection and transmission.* *9. Students are expected to understand the concept of sound waves.* *10. Students are expected to understand the properties of electromagnetic waves.*

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. F.S. Crawford,"WAVES", Berkeley Physics course, volume 3, McGraw-Hill Book Company, New York, 1968.* *2. G A Sarojo, "Gelombang dan Optika", Salemba Teknika, 2011.* *3. Pain, H.J. The Physics of Vibrations and Waves, 6th Edition, John Wiley & Sons, 2005* *4. M.O. Tjia,"Gelombang" Dabara Publishers, Solo,1994.* *5. Sutrisno,"Fisika Dasar ;Gelombang dan Optik", Penerbit ITB, Bandung,1976.*

Module Handbook – Electrostatics

Module designation	*Electrostatics*
Semester(s) in which the module is taught	*3rd (third)*
Person responsible for the module	*Prof. Dr. Akhiruddin, M.Si*
Language	*Indonesian*
Relation to curriculum	*Compulsory in the second year (3rd semester) bachelor's degree*
Teaching methods	*100 minutes lectures and 50 minutes structured activities per week.*
Workload (incl. contact hours, self-study hours)	***Total workload is 135 hours per semester,** which consists of 100 minutes lectures per week, 120 minutes structured assignments per week, 120 minutes individual study per week, and 170 minutes practicum/recitation per week. Total 16 weeks per semester.*
Credit points	*3 SCH x (1.67) = 5.01 ECTS*
Required and recommended prerequisites for joining the module	*Basic Physics 2*
Module objectives/intended learning outcomes	*1. Students are expected to understand vector algebra.* *2. Students are expected to understand coordinate systems and coordinate transformations.* *3. Students are expected to understand vector calculus.* *4. Students are expected to understand electrostatic fields.* *5. Students are expected to understand the concept of electric fields in matter.* *6. Students are expected to understand the concept of electrostatic boundary conditions.*
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, Polarization, 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. *Matthew N.O Sadiku, "Element of Electromagnetics", Oxford University Press, New York, 2018.* 2. *David J. Griffiths, INTRODUCTION TO ELECTRODYNAMICS, Fourth Edition, Pearson, 2013.* 3. *Paul A. Tipler, Gene Mosca, PHYSICS FOR SCIENTISTS AND ENGINEERS, Sixth Edition, W. H. Freeman and Company, New York, 2008.*

Module Handbook – Computational Physics

Module designation	*Computational Physics*
Semester(s) in which the module is taught	*3th (third)*
Person responsible for the module	*Dr. Sitti Yani*
Language	*Indonesian*
Relation to curriculum	*Elective course in the fourth year (7th semester) bachelor's degree*
Teaching methods	*100 minutes lectures and 120 minutes structured activities perweek.*
Workload (incl. contact hours, self-study hours)	***Total workload is 90 hours per semester,** which consists of 50 minutes lectures per week, 60 minutes structured assignments per week, 60 minutes individual study per week, and 170 minutes practicum/recitation per week. Total 16 weeks per semester.*
Credit points	*2 SCH x (1.67) = 3.34 ECTS*
Required and recommended prerequisites for joining the module	-

Module objectives/intended learning outcomes	1. *Students are able to explain the fundamental concepts of computational thinking and apply them to physical systems and models.* 2. *Students are able to write Python programs that implement basic computation involving variables, data types, arithmetic operations, and input/output relevant to physical quantities (e.g., velocity, force, energy).* 3. *Students are able to apply control structures and functions in Python to simulate physical phenomena (e.g., motion under gravity, harmonic oscillators).* 4. *Students are able to translate simple physical problems into algorithms, using flowcharts or pseudocode as intermediate representations.* 5. *Students are able to use Python to visualize physical data and simulation results through plots and graphs using libraries such as matplotlib.* 6. *Students are able to develop and apply basic data structures (lists, arrays, dictionaries) to store and manipulate physical parameters and simulation results.* 7. *Students are able to present data and computational results in informative graphical visualizations (such as line graphs, histograms, scatterplots) to support analysis.* 8. *Students are able to Identify patterns and trends in physics data through simple data exploration and estimate relationships between variables using basic correlation or regression approaches.* 9. *Students are able to test, debug, and validate code for correctness in both programming logic and physical interpretation.* 10. *Students are able to develop problem-solving strategies for computational challenges through practical exercises and projects..*
Content	*This course introduces the fundamental principles of computational thinking, algorithm design, and numerical modeling with applications in physics and data science. Students will learn how to formulate algorithms to solve physical problems, represent and manipulate data, and analyze the efficiency and accuracy of computational solutions. The course also provides an introductory exposure to data science, including data handling, basic statistical analysis, and data visualization, all within the context of physical systems and experimental results. Emphasis is placed on problem-solving, logical reasoning, and scientific interpretation of computational outputs.*
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%), end semester exam (30%), and assignment/project (40%)*
Reading list	1. *Thomas H. Cormen et al. Introduction to Algorithms, MIT Press* 2. *Hill, Christian, Learning scientific programming with Python, Cambridge, United Kingdom, Cambridge University Press, 2015*

Module Handbook – Lagrangian-Hamiltonian Mechanics

Module designation	*Lagrangian-Hamiltonian Mechanics*
Semester(s) in which the module is taught	*4^{th} (fourth)*
Person responsible for the module	*Prof. Husin Alatas*
Language	*Indonesian*
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 135 hours per semester,** which consists of 100 minutes lectures per week, 120 minutes structured assignments per week, 120 minutes individual study per week, and 170 minutes practicum/recitation per week. Total 16 weeks per semester.*
Credit points	*3 SCH x (1.67) = 5.01 ECTS*
Required and recommended prerequisites for joining the module	*Newtonian Mechanics*
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. Arya, A. P., "Introduction to Classical Mechanics," 2nd Ed., Prentice Hall, 1998.* *2. Iver H. Brevik, Jacob Linder, Introduction to Lagrangian and Hamiltonian Mechanics, Bookboon, 2016.*

Module Handbook – Digital Electronics

Module designation	*Digital Electronics*
Semester(s) in which the module is taught	*4^{th} (fourth)*
Person responsible for the module	*Mahfuddin Zuhri, M.Sc*
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 structured activities per week.*
Workload (incl. contact hours, self-study hours)	***Total workload is 90 hours per semester,** which consists of 50 minutes lectures per week, 60 minutes structured assignments per week, 60 minutes individual study per week, and 170 minutes practicum/recitation per week. Total 16 weeks per semester.*
Credit points	*2 SCH x (1.67) = 3.34 ETCS*
Required and recommended prerequisites for joining the module	*(FIS2215) Analogue Electronics*
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.* *5. Students are able to create simple programs for PLC using ladder diagrams.*
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. 2017. Digital System, Principles and Applications. 12th Edition New Jersey: Prentice-Hall,Inc.* 2. *Malvino. A.P. 1992. Elektronika Komputer Digital, Pengantar Mikrokomputer. Jakarta: Erlangga*

Module Handbook – Advanced Computational Physics

Module designation	*Advanced Computational Physics*
Semester(s) in which the module is taught	*4th (fourth)*
Person responsible for the module	*Dr. Agus Kartono*
Language	*Indonesian*
Relation to curriculum	*Academic core course in the second year (4th semester) bachelor's degree*
Teaching methods	*50 minutes lectures and 170 minutes structured activities per week.*
Workload (incl. contact hours, self-study hours)	***Total workload is 90 hours per semester,** which consists of 50 minutes lectures per week, 60 minutes structured assignments per week, 60 minutes individual study per week, and 170 minutes practicum/recitation per week. Total 16 weeks per semester.*
Credit points	*2 SCH x (1.67) = 3.34 ECTS*
Required and recommended prerequisites for joining the module	*FIS221D Computational 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. *Computational Physics, 2nd edition, Nicholas J. Giordano, Hisao Nakanishi, Pearson Education Inc, 2006.* 2. *Fisika Komputasi, Heriyanto Syafutra dan Agus Kartono, PT Penerbit IPB Press, 2017.* 3. *S.R. Otto and J.P. Denier, An Introduction to Programming and Numerical Methods in MATLAB. Springer-Verlag London Limited 2005*

Module Handbook – Modern Physics Experiment

Module designation	*Modern Physics Experiment*
Semester(s) in which the module is taught	*4th (Fourth)*
Person responsible for the module	*Prof. Akhiruddin*
Language	*Indonesian*
Relation to curriculum	*Academic core course in the second year (4th semester) bachelor's degree*
Teaching methods	*50 minutes lectures and 170 minutes practicum per week.*
Workload (incl. contact hours, self-study hours)	***Total workload is 90 hours per semester,** which consists of 50 minutes lectures per week, 60 minutes structured assignments per week, 60 minutes individual study per week, and 170 minutes practicum/recitation per week. Total 16 weeks per semester.*
Credit points	*2 SCH x (1.67) = 3.34 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. *Daryl W. Preston, “The Art of Experimental Physics.”, John Wiley & Sons, Inc. 1991.* 2. *Adrian C. Melissinos, Jim Napolitano, “Experiments in Modern Physics.”, Second Edition, Academic Press, 2003.*

Module Handbook – Biophysics

Module designation	*Biophysics*
Semester(s) in which the module is taught	*4th (fourth)*
Person responsible for the module	*Dr. Yessie Widya Sari*
Language	*Indonesian*
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 135 hours per semester,** which consists of 100 minutes lectures per week, 120 minutes structured assignments per week, 120 minutes individual study per week, and 170 minutes practicum/recitation per week. Total 16 weeks per semester.*
Credit points	*3 SCH x (1.67) = 5.01 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. Hoppe W, Lohmann W, Markl H, Ziegler H. 1983. Biophysics. First edition. Heilderberg, Berlin: Springer. https://doi.org/10.1007/978-3-642-68877-5* *2. Lakowicz JR. 2006. Principles of Fluorescence Spectroscopy. Third edition. United State (US): Springer.* *3. Hou HJM, Najafpour MM. Moore GF. Allakhverdiev SI. 2017. Photosynthesis: Structures, Mechanisms, and Applications. Cham, Switzerland: Springer. 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. 2004. Membrane Technology and Applications. Second edition. West Sussex, England: John Wiley & Sons Ltd.* *6. Hall, E.J. 2011. Radiobiology for Radiobiologist. Lippincottt Williams & Wilkins; 7th edition* *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. Joana Madureira, Lillian Barros, Sandra Cabo Verde, Fernanda M. A. Margaça, Celestino Santos-Buelga, 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. 2011. Introduction to Bioelectricity. Di dalam: Yoo HJ, van Hoof C, editor. Bio-Medical CMOS ICs. Integrated Circuits and Systems. Boston: Springer. Halaman 13 - 29. https://doi.org/10.1007/978-1-4419-6597-4_2* *10. Kelly SG. 2012. Mechanical Vibrations: Theory and Applications. United State of America (USA): Global Engineering. ISBN-13: 978-1-4390-6214-2. ISBN-10: 1-4390-6214-5.*

Module Handbook – Electrodynamics

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 135 hours per semester,*** *which consists of 100 minutes lectures per week, 120 minutes structured assignments per week, 120 minutes individual study per week, and 170 minutes practicum/recitation per week. Total 16 weeks per semester.*
Credit points	*3 SCH x (1.67) = 5.01 ECTS*
Required and recommended prerequisites for joining the module	*Basic Physics 2, 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 Jefimenko 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. *David J Griffiths, "Introduction to Electrodynamics", Prentice Hall International, Inc.* 2. *William H Hyat, J A Buck, ,"Elektromagnetika" (Terjemahan Bahasa Indonesia), penerbit Erlangga.* 3. *Edward M Purcell, "Electricity And Magnetism", Berkeley Physics, Course Volume 3, Mc Graw Hill, Inc*

Module Handbook – Material Physics

Module designation	*Material Physics*
Semester(s) in which the module is taught	*4th (fourth)*
Person responsible for the module	*Dr. Mersi Kurniati*
Language	*Bahasa Indonesia*
Relation to curriculum	*In-Depth Course in the third year (4th semester) bachelor's degree*
Teaching methods	*100 minutes lectures per week.*
Workload (incl. contact hours, self-study hours)	***Total workload is 90 hours per semester,** which consists of 100 minutes lectures per week, 120 minutes structured assignments per week, 120 minutes individual study per week. Total 16 weeks per semester.*
Credit points	*2 SCH x (1.67) = 3.34 ECTS*
Required and recommended prerequisites for joining the module	-
Module objectives/intended learning outcomes	*1. Students are given an understanding of atomic arrangement, crystal structure, defects, and how these affect material properties.* *2. Students are given an understanding of energy and material stability, including phase transitions and their behaviour under various conditions.* *3. Students are given an understanding of how the electronic structure of materials determines their electrical conductivity, optical absorption, and magnetic behaviour.* *4. Students are given an understanding of how materials respond to stress and strain, including concepts such as elasticity, plasticity, and fracture.* *5. Students are provided with knowledge of semiconductors, metals and alloys, ceramics, polymers, dielectrics, superconductors, optics, magnetic materials, optical materials, and thin films.* *6. Students are provided with skills in materials synthesis and processing.*

Content	*A Materials Physics course studies the properties, structure, and behaviour of materials, based on the principles of physics and materials science. This course explores how the atomic and molecular arrangement of a material affects its macroscopic characteristics, and how these materials can be designed and utilized for various applications. This course is interdisciplinary, connecting fundamental physics concepts with practical engineering applications. This course contains the following materials: Crystal structure, Diffraction and reciprocal lattices, Order, Disorder, and defects in crystals, Bonding in solids, Phonons, Thermally activated processes, phase diagrams, and phase transitions, Electrons in solids: Electrical and magnetic properties of materials, Optical properties of materials, Mechanical properties of materials, Semiconductors, Metals and alloys, Ceramics, Polymers, Dielectric materials, Superconductors, Magnetic materials, Optical materials, Thin films, Material synthesis and processing*
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 (30%), mid-semester exam (35%), and end-semester exam (35%)*
Reading list	*1. Callister, W.D., Rethwisch, D.G. (2018). Materials Science and Engineering: An Introduction. 10th Ed., John Wiley & Sons, Inc.* *2. Gersten, J.I., Smith, F.W. (2001). The Physics and Chemistry of Materials, John Wiley & Sons, Inc.*

Module Handbook – Quantum Physics

Module designation	*Quantum Physics*
Semester(s) in which the module is taught	*5^{th} (fifth)*
Person responsible for the module	*Dr. rer.nat. Hendradi Hardhienata*
Language	*Indonesian*
Relation to curriculum	*Compulsory course in the fifth year (5^{th} fifth) bachelor's degree*
Teaching methods	*Lecture and recitation, student activities in class*
Workload (incl. contact hours, self-study hours)	*Total workload is 135 hours per semester, which consists of 100 minutes lectures per week, 120 minutes structured assignments per week, 120 minutes individual study per week, and 170 minutes practicum/recitation per week. Total 16 weeks per semester.*
Credit points	*3 SCH x (1.67) = 5.01 ECTS*
Required and recommended prerequisites for joining the module	-

Module objectives/intended learning outcomes	*1. Students can explain the background of quantum physics, the concept of wave-particle duality, and understand the fundamental postulates of quantum physics and the properties of wave functions.* *2. Students can solve one-dimensional quantum mechanics problems such as particles in a box, step potential, and quantum harmonic oscillator, and determine the related wave functions and eigenvalues.* *3. Students can analyze the properties of Hermitian operators, solve eigenvalue equations using Dirac and matrix notation, and determine the eigenvalues and eigenfunctions of angular momentum and spherical harmonics.* *4. Students can determine the energy spectrum of the hydrogen atom by solving the three-dimensional Schrödinger equation, and understand the energy structure and atomic orbitals based on analytical solutions.* *5. Students can explain modern physics phenomena such as blackbody radiation, photoelectric effect, Compton effect, de Broglie waves, and the hydrogen atomic spectrum that cannot be explained by classical physics, and understand the double-slit experiment as evidence of wave-particle duality.* *6. Students can understand the postulates of quantum physics related to wave functions and quantum operators, and analyze wave function properties such as probability, expectation values ($\langle x \rangle$, $\langle p \rangle$), variances (σ_x, σ_p), and position and momentum probability distributions.* *7. Students can determine the solutions of the one-dimensional Schrödinger equation for cases such as free electrons, infinite and finite potential wells including tunneling effects, and calculate the expected energy values and particle existence probabilities.* *8. Students can examine the properties of quantum operators including Hermitian characteristics, solve commutation relations, explain simultaneous observables and degeneracy, and understand and use Dirac notation (bra-ket) in various quantum calculations.* *9. Students can express the Hamiltonian operator of the harmonic oscillator in ladder operator and matrix form, determine the eigenvalues and wave functions for the ground and first excited states, and explain the existence of non-zero ground state energy (zero-point energy).*

	10. *Students can solve the commutation relations between angular momentum operators, determine the eigenvalues of spherical harmonics functions, solve the radial part of the Schrödinger equation for the hydrogen atom, and determine its energy spectrum'.*
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. *David S. Saxon, Elementary quantum mechanics, University of California, Los Angeles* 2. *S. Gasiorowicz. (1995). Quantum Physics. 2nd, John Wiley & Sons.* 3. *Hendradi Hardhienata, Tutorial Mekanika Kuantum Vol. 1,* *IPB University.* 4. *Ahmad A. Kamal, 1000 Solved Problems in Modern Physics Springer-Verlag Berlin Heidelberg 2010*

Module Handbook – Statistical Physics

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	*Lectures and recitations, student activities*
Workload (incl. contact hours, self-study hours)	*Total workload is 135 hours per semester, which consists of 100 minutes lectures per week, 120 minutes structured assignments per week, 120 minutes individual study per week, and 170 minutes practicum/recitation per week. Total 16 weeks per semester*
Credit points	*3 SCH x (1.67) = 5.01 ECTS*
Required and recommended prerequisites for joining the module	-

Module objectives/intended learning outcomes	1. *Students can understand the concept of kinetic theory and how to construct the Maxwell-Boltzmann statistics using pure statistical principles combined with conservation laws in physics, such as the conservation of energy and particle number.* 2. *Students can explain the concept of phase space, determine the phase space volume, and calculate the density of states in phase space.* 3. *Students can understand how to determine the parameters α and β in the Maxwell-Boltzmann distribution function.* 4. *Students can understand how to construct the Bose-Einstein statistics using pure statistical principles combined with conservation laws in physics, such as the conservation of energy and particle number.* 5. *Students can understand how to construct the Fermi-Dirac statistics using pure statistical principles combined with conservation laws in physics, such as the conservation of energy and particle number.* 6. *Students can explain how to derive the density of states of a quantum system and how to obtain it from the density of states of a classical system.* 7. *Students can understand various gas quantities derived from the Maxwell-Boltzmann distribution function.* 8. *Students can understand several applications of Maxwell-Boltzmann statistics in classical ensembles.* 9. *Students can understand several applications of Bose-Einstein statistics in photon and phonon ensembles.* 10. *Students can understand several applications of Fermi-Dirac statistics in fermion ensembles..*
Content	*Maxwell-Boltzmann statistics, Phase room and Canonical Ensemble concept, Determination of Statistical Parameters, Determination of Statistical Parameters, Bose-Einstein 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 – Optics and Photonics

Module designation	*Optics and Photonics*
Semester(s) in which the module is taught	*5th (fifth)*
The person responsible for the module	*Dr. rer.nat. Hendradi Hardhienata*
Language	*Indonesian*
Relation to curriculum	*Compulsory course in the third year (5th fifth semester) of bachelor's degree*
Teaching methods	*Lecture in class and practicum in optics lab.*
Workload (incl. contact hours, self-study hours)	*Total workload is 135 hours per semester, which consists of 100 minutes lectures per week, 120 minutes structured assignments per week, 120 minutes individual study per week, and 170 minutes practicum/recitation per week. Total 16 weeks per semester*
Credit points	*3 SCH x (1.67) = 5.01 ECTS*
Required and recommended prerequisites for joining the module	-

Module objectives/intended learning outcomes	1. *Students can clearly and concisely present the historical development of optics and photonics as branches of science that study the nature and behavior of light. They can describe the contributions of prominent scientists such as Ibn al-Haytham, Isaac Newton, and Albert Einstein in advancing the understanding of light phenomena and the concept of photons as fundamental particles of light. With this deep understanding, students can appreciate the evolution of optics and photonics and their implications for various modern technological applications.* 2. *Students can derive the electromagnetic wave equation as a propagation of electric and magnetic fields, including the transmission of energy through these fields. They can also understand Maxwell's equations as a system of differential equations describing the complex relationship among electric fields, magnetic fields, and electric charges in the context of electromagnetic waves.* 3. *Students can explain the propagation of electromagnetic waves in homogeneous and periodic media using boundary conditions and field continuity. They can also explain how electromagnetic waves undergo diffraction and dispersion when propagating through periodic media, such as crystal lattices, and understand the energy bandgap phenomenon in photonic crystals.* 4. *Students can derive the Fresnel equations using the concept of boundary conditions, enabling them to understand and describe transmission and reflection behavior as functions of refractive index, incidence angle, and light polarization.* 5. *Students can understand dipole radiation formation as a result of light-induced perturbation of electrons, light polarization, and its relation to Huygens' principle, allowing them to understand refraction and reflection phenomena at the microscopic level.* 6. *Students can derive light-matter interaction through a simple oscillator model in semiconductors (Lorentz model) involving restoring forces and in metals (Drude model), as well as derive the refractive index and electric susceptibility from both models.*

	7. *Students can understand plasma oscillations and their relation to reflection and transmission. They can also understand surface propagation of plasma oscillation waves through dispersion relations and phase matching. In addition, students can understand the concept of negative refractive index and its applications in metamaterials.* 8. *Students can understand the formation of high harmonic waves resulting from multi-photon processes involving virtual states, the importance of phase matching, nonlinear polarization, and the applications of nonlinear optics in daily life.* 9. *Students can understand light propagation in optical fibers and its application in current telecommunication systems, including components, architecture, and performance analysis of fiber-optic-based communication networks.* 10. *Students can understand the basic principles of optical-based measurements, especially in relation to experimental investigations, design of optical sensors and transducers, and their latest applications in various fields.*
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. (2016). Optics (5th ed.). Pearson.* 2. *Pedrotti, F. L., Pedrotti, L. M., & Pedrotti, L. S. (2017). Introduction to Optics (3rd ed.).* 3. *Pearson. Saleh, B. E. A., & Teich, M. C. (2007). Fundamentals of Photonics (2nd ed.). Wiley-Interscience.*

Module Handbook – Theory of Relativity

Module designation	*Theory of Relativity*
Semester(s) in which the module is taught	*6^{th} (sixth)*
Person responsible for the module	*Prof. Husin Alatas*
Language	*Indonesian*
Relation to curriculum	*In-depth course in the third year (6^{th} sixth 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 (1.67) = 3.34 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 – Physics Entrepreneurship

Module designation	*Physics Entrepreneurship*
Semester(s) in which the module is taught	*5th (fifth)*
Person responsible for the module	*Dr. Siti Nikmatin*
Language	*Indonesian*
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 90 hours per semester,** which consists of 100 minutes lectures per week, 120 minutes structured assignments per week, and 120 minutes individual study per week. Total 16 weeks per semester.*
Credit points	*2 SCH x (1.67) = 3.34 ECTS*
Required and recommended prerequisites for joining the module	-
Module objectives/intended learning outcomes	*1. Students can explain the basic concepts of technology entrepreneurship (technopreneurship) and identify business opportunities arising from innovations in the field of physics* *2. Students can analyze the feasibility of physics-based business ideas using frameworks such as the Business Model Canvas (BMC) and basic market analysis* *3. Students can design a Minimum Viable Product (MVP) concept for a technology idea based on physics.* *4. Students can develop an economic analysis based on a feasibility study for a physics-based innovative product.* *5. Students can explain the importance and types of Intellectual Property (IP) in protecting technological innovations.* *6. Students can develop a comprehensive business plan and present it (pitch) effectively and persuasively.*
Content	*Students will study economic analysis and develop the ability to:* *Design innovative product ideas that meet market needs; conduct feasibility studies and business modeling; validate market potential; understand and apply concepts of intellectual property, branding, and marketing strategies; and prepare draft documents for patents or copyrights related to deep-tech products based on physics.*
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 (35%), and end semester exam (35%)*
Reading list	*Introduction to economic analysis, 2009, Preston Mc Afee Caltech, tract R Lewis*

Module Handbook – Solid State Physics

Module designation	*Solid State Physics*
Semester(s) in which the module is taught	*6rd (Sixth)*
Person responsible for the module	*Dr. Siti Nikmatin*
Language	*Indonesian*
Relation to curriculum	*Compulsory course in the third year (6th sixth 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 135 hours per semester, which consists of 100 minutes lectures per week, 120 minutes structured assignments per week, 120 minutes individual study per week, and 170 minutes practicum/recitation per week. Total 16 weeks per semester.*
Credit points	*3 SCH x (1.67) = 5.01 ECTS*
Required and recommended prerequisites for joining the module	*Quantum Physics*
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. M. Ali Omar, Elementary Solid-State Physics, 1993 Addison Wesley* *2. N. Ashcroft, D. Mermin. Solid State Physics. New York, Holt, Rinehart and Winston. 1976* *3. P. Yu dan M. Cardona. Fundamentals of Semiconductors. Springer. Fourth Edition. 2010* *4. C Kittel, "Introduction of Solid-State Physics."*

Module Handbook – Advanced Quantum Physics

Module designation	*Advanced Quantum Physics*
Semester(s) in which the module is taught	*6^{th} (sixth)*
Person responsible for the module	*Prof. Dr. Tony Sumaryada*
Language	*Indonesian*
Relation to curriculum	*In depth course in the third year (6^{th} semester) bachelor's degree*
Teaching methods	*Lectures and student activities in class.*
Workload (incl. contact hours, self-study hours)	*Total workload is 90 hours per semester, which consists of 100 minutes lectures per week, 120 minutes structured activities per week, and 120 minutes individual study per week. Total 16 weeks per semester*
Credit points	*2 SCH x (1.67) = 3.34 ECTS*
Required and recommended prerequisites for joining the module	*Quantum Physics*
Module objectives/intended learning outcomes	*1. Students are able to understand quantum phenomena, the formulation of quantum theory in the formalism of Hilbert space, Heisenberg and Schroedinger picture.* *2. Students are able to represent angular momentum and spin operators in matrix representation and formulate and calculate angular momentum summation coefficient (Clebsch-Gordan Coefficient).* *3. Students are able to formulate the problem of quantum systems with time-independent interference fields.* *4. Students are able to formulate quantitative-relativistic equations, Klein-Gordon equation and Dirac equation.* *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 are able to understand the energy level transition mechanisms through time-dependent perturbation theory.* *8. Students are able to understand the method of solving Schrodinger's 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, time-independent and time-dependent perturbation theory, Fermi Golden Rule, Klein-Gordon equations, Dirac equations, real atoms, many-electron atoms, Hartree-Fock approach, and density functional theory approach.*

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. S. Gasiorowicz. (1995). Quantum Physics. 2nd, John Wiley & Sons.* *2. David J. Griffiths. (2005). Introduction to Quantum Mechanics. 2nd, Pearson Education.* *3. J. J. Sakurai, (1994) Modern Quantum Mechanics. Addison-Wesley* *4. G. Auletta, (2019) The Quantum Mechanics Conundrum, Springer*

Module Handbook – Atomic and Molecular Physics

Module designation	*Atomic and Molecular Physics*
Semester(s) in which the module is taught	*6^{th} (Sixth)*
Person responsible for the module	*Dr. Agus Kartono, M.Si.*
Language	*Indonesian*
Relation to curriculum	*In depth course in the third year (6^{th} semester) bachelor's degree*
Teaching methods	*Lectures and student activities in class*
Workload (incl. contact hours, self-study hours)	*Total workload is 90 hours per semester, which consists of 100 minutes lectures per week, 120 minutes structured activities per week, and 120 minutes individual study per week. Total 16 weeks per semester*
Credit points	*2 SCH x (1.67) = 3.34 ECTS*
Required and recommended prerequisites for joining the module	-
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 molecular vibrations energy levels.* *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, interaction of two or more single-electron atoms with magnetic radiation, molecular structure and spectrum of molecules, lasers and their interaction with molecules, applications of atomic and molecular physics.*
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. *Luciano Colombo, "Atomic and Molecular Physics: A primer" University of Cagliari, Italy, IOP Publishing Ltd 2019.* 2. *An Introduction to Atomic-, Molecular- and Quantum-Physics, Wolfgang Demtröder Springer-Verlag Berlin Heidelberg 2006, 2010*

Module Handbook – Nuclear and Particle Physics

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	*Indonesian*
Relation to curriculum	*In depth course in the third year (6^{th} semester) bachelor's degree*
Teaching methods	*Lectures, students project/presentation*
Workload (incl. contact hours, self-study hours)	*Total workload is 90 hours per semester, which consists of 100 minutes lectures per week, 120 minutes structured activities per week, and 120 minutes individual study per week. Total 16 weeks per semester*
Credit points	*2 SCH x (1.67) = 3.34 ECTS*
Required and recommended prerequisites for joining the module	-
Module objectives/intended learning outcomes	*1. Students are able to understand the standard model of elementary particles and the types of fundamental interactions and the principle of symmetry and are able to solve related physical problems.* *2. Students are able to understand the basic physical quantities in nuclear (nuclear properties) include nuclear radius, spin, magnetic dipole moment, energy, nuclear stability.* *3. Students are able to understand the nuclear structures and models and their stability. binding energy, liquid drops model, Fermi model, magic number, nuclear shell model and solve related problems.* *4. Students are able to understand the concept of nuclear reactions (fission, fusion, and decay) and their applications.* *5. Students are able to understand the nuclear utilization for human life in the fields of energy, health, and agriculture, as well as astrophysics.* *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*

Content	*The course subject includes nuclear (core) and subatomic particles and the elementary interactions responsible for their stability (standard model). Nuclear stability and reactions (fission, fusion, decay). This course also equips students to recognize the applications of nuclear and particle physics in everyday life, such as energy problems, health/medical, determination of the age of objects (carbon dating), research and others. An introduction to the state of the art in the field of nuclear and particle physics experiments and nuclear astrophysics is also delivered in this course.*
Examination forms	*Written Exams*
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. Jean-Louis Basdevant, Fundamentals in Nuclear Physics: From Nuclear Structure to Cosmology, Springer; 2005* *2. Das, Ferbel, Introduction to Nuclear and Particle Physics, World Scientific Publishing Company; 2nd edition (December 23, 2003).* *3. Donald Perkins, Introduction to High Energy Physics, Cambridge University Press; 4 edition (April 24, 2000).*

Module Handbook – Nonlinear Physics and Complex System

Module designation	*Nonlinear Physics and Complex System*
Semester(s) in which the module is taught	*5^{th} (fifth)*
Person responsible for the module	*Prof. Husin Alatas*
Language	*Indonesian*
Relation to curriculum	*Compulsory in the third year (5^{th} fifth semester) bachelor's degree*
Teaching methods	*Lecture and student activities.*
Workload (incl. contact hours, self-study hours)	*Total workload is 90 hours per semester, which consists of 100 minutes lectures per week, 120 minutes structured activities per week, and 120 minutes individual study per week. Total 16 weeks per semester.*
Credit points	*2 SCH x (1.67) = 3.34 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. Introduction to the Theory of Complex System, S. Turner et al. Oxford University Press, 2018.* *2. T. Egami, S. J. S. Billinge, Underneath the Bragg Peaks: Structural Analysis of Complex Materials, Pergamon Press, 2003.* *3. A. S. Mikhailov, G. Ertl, Chemical Complexity: Self-Organization Processes in Molecular Systems, Springer Science, 2017.* *4. Nonlinear Dynamics and Chaos, S. Strogatz, CRC Press, USA, 2013*

Module Handbook – Machine Learning Based Physics

Module designation	*Machine Learning Based Physics*
Semester(s) in which the module is taught	*7^{th} (seventh)*
Person responsible for the module	*Dr. rer. nat. Hendradi Hardhienata*
Language	*Indonesian/English (if international student is present)*
Relation to curriculum	*In-depth course in the fourth year (7th 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 90 hours per semester, which consists of 100 minutes lectures per week, 120 minutes structured activities per week, and 120 minutes individual study per week. Total 16 weeks per semester.*
Credit points	*2 SCH x (1.67) = 3.34 ECTS*
Required and recommended prerequisites for joining the module	*Computational Physics*
Module objectives/intended learning outcomes	*1. Students are able to understand the role and significance of machine learning in solving complex problems in physics. 2. Students are able to apply supervised and unsupervised learning techniques to analyze physical data. 3. Students are able to implement regression models, classification algorithms, and clustering methods to explore physical systems. 4. Students are able to preprocess and visualize large-scale physical datasets for machine learning applications. 5. Students are able to use machine learning frameworks (e.g., Scikit-learn, TensorFlow, PyTorch) to model physical phenomena. 6. Students are able to evaluate model performance using metrics such as mean squared error (MSE), R^2, accuracy, and confusion matrix in physics-based experiments. 7. Students are able to integrate machine learning models with simulations of physical systems (e.g., dynamics, thermodynamics, quantum systems). 8. Students are able to perform feature engineering to identify key physical parameters that influence system behavior. 9. Students are able to compare traditional computational physics methods with data-driven machine learning approaches. 10. Students are able to communicate findings from machine learning analysis of physical systems through reports, visualizations, and presentations.*

Content	*Supervised Learning in Physical Systems, Unsupervised Learning for Pattern Recognition in Physics, Feature Engineering in Experimental Physics, Regression Models for Predictive Physical Modeling, Classification of Physical States using ML Algorithms, Clustering Methods for Phase Space Analysis, Neural Networks in Solving Differential Equations in Physics, Deep Learning for Image-Based Physical Measurements, Dimensionality Reduction in High-Dimensional Physical Data, Model Evaluation using MSE, RMSE, R^2, Accuracy, and Confusion Matrix, Time Series Forecasting in Dynamic Physical Systems, Physics-Informed Neural Networks (PINNs), ML Integration with Monte Carlo Simulations, Anomaly Detection in Sensor-Based Physical Experiments, Reinforcement Learning for Control in Physical Systems.*
Examination forms	*Written exam and Project Based Coding*
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. *Physics-Informed Neural Networks: A Deep Learning Framework for Solving Forward and Inverse Problems Involving Nonlinear Partial Differential Equations* *https://doi.org/10.1016/j.jcp.2018.10.045* 2. *Physics-informed Machine Learning https://www.nature.com/articles/s42254-021-003 14-5*

Module Handbook – Nuclear and Radiation Engineering Physics

Module designation	*Nuclear and Radiation Engineering Physics*
Semester(s) in which the module is taught	*6^{th} (sixth)*
Person responsible for the module	*Prof. Dr. Tony Sumaryada*
Language	*Bahasa Indonesia*
Relation to curriculum	*In-Depth Course in the third year (6^{th} semester) bachelor's degree*
Teaching methods	*Lectures in class and student project*
Workload (incl. contact hours, self-study hours)	*Total workload is 90 hours per semester, which consists of 100 minutes lectures per week, 120 minutes structured activities per week, and 120 minutes individual study per week. Total 16 weeks per semester.*
Credit points	*2 SCH x (1.67) = 3.34 ECTS*
Required and recommended prerequisites for joining the module	*Nuclear and Particle Physics*
Module objectives/intended learning outcomes	*1. Students are able to understand wide-spectrum applications of nuclear and radiation physics.* *2. Students are able to understand the nuclear stability and its radiative nature of Isotopes.* *3. Students are able to understand various nuclear reactions and basic reactor theory.* *4. Students are able to understand the basic principle of energy generation in various types of nuclear reactors from 1^{st} generation reactors up to 4^{th} generation reactors.* *5. Students are able to understand the radiation and matter interaction, including ionizing and non-ionizing radiation* *6. Students are able to understand the principle of radiation detection and various types of particle/radiation detectors including the most advanced Lab such as CERN, Super-Kamiokande, etc.* *7. Students are able to understand the basic concept of application of Montecarlo simulation for radiodiagnostic, radiotherapy, EBRT, brachytherapy, PET, etc. Various simulator are introduced such as PHITS, EGSnRC, GEANT, PUffIN* *8. Students are able to simulate the radiation protection for hospitals, nuclear reactors, and cosmic space application. Students are given insights for future research, development and applications of nuclear and radiation physics.*

Content	*This course equips students with the theoretical basis and in-depth insight into the application of nuclear, particle, and radiation physics in various fields. The material covered includes nuclear stability and the phenomenon of particle radiation and electromagnetic waves on various isotopes. This course discusses the basic theory of nuclear reactions, both fission and fusion reactions, along with their utilization in various types of nuclear reactors from generation 1 to 4 Small Modular Reactors, HTGR, Pebble Bed Reactor, Thorium-based Reactor, Fusion Reactor. In addition, students will learn the basic theory of heavy, light and EM particle interactions with matter, particle detectors, muon imaging, and the use of Monte Carlo simulations in applications such as radiotherapy, radiodiagnostics, external beam radiation therapy (EBRT), brachytherapy, and radiation protection. Aspects of radiation protection will also be comprehensively covered, including its application in hospitals, nuclear reactors, and cosmic radiation mitigation for space satellites. To complete the insight, the latest information on nuclear and particle research conducted at world-class facilities such as CERN, Jefferson Lab, and Super-Kamiokande will be presented.*
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 (50%), mid semester exam (25%), and end semester exam (25%)*
Reading list	*1. Hiroshi Sekimoto, (2007). Nuclear Reactor theory, Tokyo Institute of Technology. ISBN978-4-903054-11-7 C3058* *2. Ervin B. Podgorsak. (2010). Radiation Physics for Medical Physicists. Springer Science & Business Media.* *3. Joao Seco, Frank Verhaegen (2013), Monte Carlo Techniques in Radiation Therapy, CRC Press, Taylor and Francis.*

Module Handbook – Astrophysics & Cosmology

Module designation	*Astrophysics & Cosmology*
Semester(s) in which the module is taught	*7^{th} (seventh)*
Person responsible for the module	*Prof. Husin Alatas*
Language	*Indonesian*
Relation to curriculum	*In-depth course in the fourth year (7th semester) bachelor's degree*
Teaching methods	*Lecture and assignment.*
Workload (incl. contact hours, self-study hours)	*Total workload is 90 hours per semester, which consists of 100 minutes lectures per week, 120 minutes structured activities per week, and 120 minutes individual study per week. Total 16 weeks per semester.*
Credit points	*2 SCH x (1.67) = 3.34 ECTS*
Required and recommended prerequisites for joining the module	*Theory of Relativity*
Module objectives/intended learning outcomes	*1. Students are able to understand the importance of studying astrophysics & cosmology.* *2. Students are able to understand the astrophysical concept related to stellar nucleosynthesis, fusion reaction in stars, proton-proton chain, CNO cycles, alpha process, slow and rapid process.* *3. Students understand the Stars classification based on luminosity and temperature (color), Hertzprung-Russel Diagram. Type of supernovas.* *4. Students are able to understand the theory of relativity derived formulation on astrophysics such as Tolman-Oppenheimer-Volkov to understand dynamics of compact stars.* *5. Students are able to understand the formulation of astrophysical concepts related to the exotic stars such as pulsar, magnetar, black-hole etc.* *6. Students are able to understand the formulation of astrophysical concepts related to the star formation and galaxy.* *7. Students are able to understand the existence of black-hole.* *8. Students are able to understand the formulation of cosmological models such as (anti-) de Sitter, Friedmann-Robertson-Walker.* *9. Students are able to understand the related Friedmann equation of expanding universe.* *10. Students are able to understand the cosmological-model-related Friedmann equation of universe.* *11. Students are able to understand the formulation of ΛCDM model.* *12. Students are able to understand the phenomenon of accelerating universe.*

	13. *Students are able to understand the phenomenon of inflationary scenarios in the early universe.*
Content	*Alpher-Bethe-Gamow theory of stellar nucleosynthesis, Primordial nucleosynthesis, Star's fusion process, Tolman-Oppenheimer-Volkov equation; Star formation and Galaxy; Neutron Star; Pulsar; Magnetar; Black-Hole; (Anti-)de Sitter Universe; FRW universe; ΛCDM model; Accelerating Universe; Inflation scenario in early universe.*
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. *Wolfgang Demtröder, Astrophysics, Springer, 2024* 2. *Daniel Baumann, Cosmology, Cambridge University Press, 2022*

Module Handbook – Physics of Material Design

Module designation	*Physics of Material Design*
Semester(s) in which the module is taught	*7th (seventh)*
Person responsible for the module	*Dr. Faozan*
Language	*Indonesian*
Relation to curriculum	*Elective course in the fourth year (7th 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 90 hours per semester, which consists of 100 minutes lectures per week, 120 minutes structured activities per week, and 120 minutes individual study per week. Total 16 weeks per semester.*
Credit points	*2 SCH x (1.67) = 3.34 ECTS*
Required and recommended prerequisites for joining the module	*Quantum Physics*
Module objectives/intended learning outcomes	*1. Students are able to explain fundamental physical principles underlying material behavior, including electronic structure, bonding, crystallography, and thermodynamics.* *2. Students are able to analyze structure–property relationships in materials and predict how atomic-level features influence macroscopic properties such as mechanical strength, electrical conductivity, thermal performance, and optical behavior.* *3. Students are able to utilize computational and theoretical tools, such as density functional theory (DFT), molecular dynamics, or phase diagrams, to design and model materials with targeted properties.* *4. Students are able to evaluate the suitability of materials for specific applications in fields such as electronics, energy, and structural engineering based on their physical properties.* *5. Students are able to design new materials or modify existing ones by applying principles of solid-state physics, quantum mechanics, and materials thermodynamics.* *6. Students are able to interpret experimental data relevant to materials characterization (e.g., XRD, SEM, spectroscopy) and correlate them with theoretical predictions.* *7. Students are able to work in interdisciplinary teams and communicate technical results effectively,*

	integrating knowledge from physics, chemistry, and engineering for innovative material solutions.
Content	*This course examines the physical principles underlying the design and engineering of functional materials through theoretical and computational approaches. Students will learn how material properties can be predicted, modified, and optimized using theoretical physics methods and numerical simulations. Topics include a review of quantum mechanics, electronic structure theory, quantum approximation methods, ab-initio methods, density functional theory (DFT), and the application of machine learning in materials discovery. This course also includes case studies of cutting-edge materials such as 2D materials, battery electrodes, catalysts, solar cell materials, sensor materials, and superconductors. Students are expected to be able to integrate knowledge of physics and computational engineering to design innovative materials in the fields of energy, sensors, and nanotechnology.*
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%), end semester exam (30%), and assignment/project (40%)*
Reading list	*1. David S. Sholl, Janice A. Steckel (2011). Density Functional Theory: A Practical Introduction. John Wiley & Sons.* *2. Ambrish Kumar Srivastava (2025), Computational Studies From Molecules to Materials, CRC Press* *3. J. Leszczynski (2004). Computational Materials Science, Elsevier*

Module Handbook – Quantum Physics Engineering

Module designation	*Quantum Physics Engineering*
Semester(s) in which the module is taught	*7th (seventh)*
Person responsible for the module	*Prof. Husin Alatas*
Language	*Indonesian*
Relation to curriculum	*Elective course in the fourth year (7th semester) bachelor's degree*
Teaching methods	*Lecture and assignment*
Workload (incl. contact hours, self-study hours)	*Total workload is 90 hours per semester, which consists of 100 minutes lectures per week, 120 minutes structured activities per week, and 120 minutes individual study per week. Total 16 weeks per semester.*
Credit points	*2 SCH x (1.67) = 3.34 ECTS*
Required and recommended prerequisites for joining the module	-
Module objectives/intended learning outcomes	1. *Students can explain quantum computing systems and quantum information.* 2. *Students can explain qubit systems and the related linear algebra formulations.* 3. *Students can use quantum gates to perform quantum computations.* 4. *Students can explain and apply the phenomenon of quantum entanglement in quantum information systems.*
Content	This course introduces the fundamental concepts and applications of quantum physics in modern engineering and technology. Topics covered include: Introduction to Quantum Engineering, Qubit Systems, Linear Algebra for Quantum Engineering, Pauli Matrices in Quantum Systems, Quantum Gates, Fundamentals of Quantum Computing, Fundamentals of Quantum Information and Shannon Entropy, Quantum Entanglement Phenomena and Its Applications in Quantum Information Systems. The course primarily focuses on the principles of quantum theory that underpin various engineered systems, including quantum computing and quantum communication technologies.
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%), end semester exam (30%), and assignment/project (40%)*

Reading list	*M. A. Nielsen, I. L. Chuang, Quantum Computation & Quantum Information, Cambridge University Press, UK, 2010*

Module Handbook – Material Characterization Methods

Module designation	*Material Characterization Methods*
Semester(s) in which the module is taught	*5^{th} (fifth)*
Person responsible for the module	*Prof. Irzaman*
Language	*Indonesian*
Relation to curriculum	*Compulsory in the third year (5^{th} fifth semester) bachelor's degree*
Teaching methods	*Lectures and student activities.*
Workload (incl. contact hours, self-study hours)	*Total workload is 90 hours per semester, which consists of 100 minutes lectures per week, 120 minutes structured activities per week, and 120 minutes individual study per week. Total 16 weeks per semester.*
Credit points	*2 SCH x (1.67) = 3.34 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	3. *Fundamentals of measurement and measurement techniques, Standard and specific calibration methods on advanced research instrumentation of material characterization,* 4. *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* 5. *Crystal structure and amorphous material, the principle of diffraction in the material, and the crystal orientation of the material, XRD data processing and analysis,* 6. *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.* 7. *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),* 8. *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* 9. *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* 10. *The basic principles of measuring the properties of electricity and magnetism.* 11. *Measurement data analysis, Brownian motion, potential Zeta, Mie and Rayleigh Scattering* 12. *The basic principles and measurement analysis of PSA, BET* 13. *Overview of gamma radiation with materials Types and basic principles of radiation testing on biomedical materials Processing and analysis of radiation test results data* 14. *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* 2. *Igor A. Kaltashow, Stephen J. Eyles, Mass Spectrometry in Biophysics, Wiley Interscience* 3. *B.D. Milbrath, A.J. Peurrung, M. Bliss, dan W.J. Weber (2018): Radiation detector materials: An Overview. Journal of Materials Research, 23(10)* 4. *Nadezhda L. Aluker, Yana M. Suzdal'tseva, Anna S. Dulepova, dan Maria E. Herrmann (2016): Thermoluminescent Detectors for Surveillance Studies of Radiation Exposure of The Population, Science Evolution, 1(2)* 5. *Paul F. Fewster (2014): A new theory for X-ray diffraction. Acta Crystallographica Section A Foundations and Advances. A70, 257–282* 6. *Basic Knowledge for using the SEM (https://www.jeol.co.jp/en/applications/pdf/sm/sem_atoz_all.pdf)*

Module Handbook – Sensors and Transducer

Module designation	*Sensors and Transducer*
Semester(s) in which the module is taught	*5th (fifth)*
Person responsible for the module	*Dr. Irmansyah, MSi*
Language	*Indonesian*
Relation to curriculum	*Compulsory in the third year (5th fifth semester) bachelor's degree*
Teaching methods	*Lectures and student project*
Workload (incl. contact hours, self-study hours)	*Total workload is 90 hours per semester, which consists of 50 minutes lectures per week, 60 minutes structured activities per week, and 60 minutes individual study per week, and 170 minutes practicum per week. Total 16 weeks per semester.*
Credit points	*2 SCH x (1.67) = 3.34 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 read and interpret data sheets of various sensors. 3. Students can analyze various physical phenomena, which are the concepts of various sensors and actuators. 4. Students are able to read and interpret data sheets of various types of sensors. 5. Students are able to design and assemble simple sensor system instruments.*
Content	*Sensor Terminology, Displacement 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 assignment and presence (76%), mid semester exam (24%), and end semester exam (24%)*
Reading list	*1. Nathan Ida, 2020. Sensors, Actuators and their Interface Multidisciplinary. Institution of Engineering and Technology 2. J. Fraden, "AIP Handbook of Modern Sensors, Physics, Designs and Applications," American Institute of Physics.*

Module Handbook – Physics of Biocomposite

Module designation	Physics of Biocomposite
Semester(s) in which the module is taught	*6th (sixth)*
Person responsible for the module	*Dr. Siti Nikmatin, SSi MSi*
Language	*Indonesian*
Relation to curriculum	*In Depth Course for the fourth year (7th semester) bachelor's degree*
Teaching methods	*Lectures and student projects.*
Workload (incl. contact hours, self-study hours)	*Total workload is 90 hours per semester, which consists of 100 minutes lectures per week, 120 minutes structured activities per week, and 120 minutes individual study per week. Total 16 weeks per semester.*
Credit points	*2 SCH x (1.67) = 3.34 ECTS*
Required and recommended prerequisites for joining the module	
Module objectives/intended learning outcomes	*1. Students are able to Understand the basic concepts and physical principles underlying biocomposite materials.* *2. Students are able to Analyze the mechanical, thermal, and physical properties of biocomposite materials.* *3. Students can Understand the different types of biocomposites and how they are produced and applied.* *4. Students can Apply physics theory in designing and analyzing biocomposites for a wide range of applications.* *5. Students are able to Conduct basic experiments in the testing of biocomposite materials and analyze the results.* *6. Students can Compile systematic and scientific data-based experimental reports.*
Content	*Introduction to Biocomposite Physics, Types of Biocomposites, Matrices and Amplifiers in Biocomposites, Biocomposite Mechanics : Modulus of Elasticity and Tensile Strength, Compressive and Bending Strength, Shear Strength and Matrix-Reinforcing Interactions, Thermal Properties of Biocomposites, Biocomposite Forming and Fabrication Process, Application of Biocomposites in Industry, Biocomposites and the Environment, and Biocomposite Design and Optimization*
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 assignment (50 %), mid semester exam (24%), and end semester exam (24%)*

Reading list	1. *Chawla, K. K. 2013. Composite Materials: Science and Engineering. 3th ed. Springer.* 2. *Liao, K. H.and Tsai, Y. T. 2018. Biocomposites: Design and Applications . Wiley.* 3. *Barber, E. J. 2013. Introduction to Biocomposite Materials . Springer.*

Module Handbook – Int. Based Instrumentation System

Module designation	*Internet Based Instrumentation System*
Semester(s) in which the module is taught	*6th sixth*
Person responsible for the module	*Drs. Mahfuddin Zuhri*
Language	*Indonesian*
Relation to curriculum	*Compulsory in the third year (6th sixth semester) bachelor's degree*
Teaching methods	*Lecture and student's project*
Workload (incl. contact hours, self-study hours)	*Total workload is 90 hours per semester, which consists of 50 minutes lectures per week, 60 minutes structured activities per week, and 60 minutes individual study per week, and 170 minutes practicum per week. Total 16 weeks per semester.*
Credit points	*2 SCH x 1.67 = 3.34 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	*Sudip mIsra, Anandarup Mukherjee. "Introduction to IOT." Cambridge University press, 2021.*

Module Handbook – Nanophysics

Module designation	*Nanophysics*
Semester(s) in which the module is taught	*7th (Seventh)*
The person responsible for the module	*Dr. rer. nat. Hendradi Hardhienata*
Language	*Indonesian*
Relation to curriculum	*Compulsory course in the fourth year (7th semester) of bachelor's degree*
Teaching methods	*100 minutes of lectures 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 (1.67) = 3.34 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 on 1D, 2D, and 3D/0D.* *5. Students are able to understand the phenomenon and characteristics of nanomaterials.* *6. Students are able to understand nanomaterials synthesis methods.* *7. Students are able to understand and explain several examples of nanomaterial structures, especially electronics, energy, and health.*
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, material science, energy, environment, 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. *Edward L. Wolf, Nanophysics and Nanotechnology: An Introduction to Modern Concepts in Nanoscience, Second Edition, 2006 WILEY-VCH Verlag GmbH & Co. KGaA. Online ISBN:9783527618972. DOI:10.1002/9783527618972.* 2. *B S Murty, P Shankar, Baldev Raj, B B Rath, James Murday, Textbook of Nanoscience and Nanotechnology, Springer, 2013, e-ISBN 978-3-642-28030-6, DOI 10.1007/978-3-642-28030-6.* 3. *Klaus D. Sattler (Editor), Handbook of Nanophysics: Principles and Methods, 1st Edition, CRC Press, 2017, ISBN 9781138117853.* 4. *Takaaki Tsusumi, Hiroyuki Hirayama, Martin Vacha, Tomoyasu Taniyama, Nanoscale Physics for Materials Science, CRC Press 2010. ISBN 978-1-4398-0059-1.*

Module Handbook – Physics of Industrial Automation

Module designation	Physics of Industrial Automation
Semester(s) in which the module is taught	*7^{th} (seventh)*
Person responsible for the module	*Drs. Mahfuddin Zuhri, MSi*
Language	*Indonesian*
Relation to curriculum	*In Depth Course for the fourth year (7^{th} semester) bachelor's degree*
Teaching methods	*Lectures and student projects.*
Workload (incl. contact hours, self-study hours)	*Total workload is 90 hours per semester, which consists of 50 minutes lectures per week, 60 minutes structured activities per week, and 60 minutes individual study per week, and 170 minutes practicum per week. Total 16 weeks per semester.*
Credit points	*2 SCH x (1.67) = 3.34 ECTS*
Required and recommended prerequisites for joining the module	*Analog Electronics and Digital analogs*
Module objectives/intended learning outcomes	*1. Students are able to explain the working principle of industrial automation systems.* *2. Students are able to Identify and use sensors, actuators, and control systems.* *3. Students can Designing and programming PLCs for industrial applications.* *4. Students are able to Integrate automation systems using HMI/SCADA.* *5. Students are able to Analyze and solve problems in industrial automation systems.*
Content	*Introduction to Industrial Automation, Sensors and Actuators, Basics of Control Logic, PLC: Basic Architecture and Programming, PLC Special Functions and Instructions, Pneumatic and Hydraulic Systems, HMI (Human Machine Interface), System Supervisory Control and Data Acquisition (SCADA), PLC – HMI – SCADA Integration, Internet of Things (IoT)-Based Automation, Automated System Security, Automation System Analysis and Troubleshooting, Automation Final Project.*
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 assignment (50 %), mid semester exam (24%), and end semester exam (24%).*

Reading list	1. *Mikell P. Groover. 2015. Automation, Production Systems, and Computer-Integrated Manufacturing. Pearson.* 2. *Frank D. Petruzella, 2017. Programmable Logic Controllers. 5th ed. Mc Graw Hill.* 3. *Boldea & Nasar. 2016. Electric Drives and Control. 3rd ed, CRC Press.* 4. *Modul dan Panduan Praktikum Otomatisasi Industri.*

Module Handbook – Biomaterials

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	*Lectures and assignments.*
Workload (incl. contact hours, self-study hours)	*Total workload is 90 hours per semester, which consists of 100 minutes lectures per week, 120 minutes structured activities per week, and 120 minutes individual study per week. Total 16 weeks per semester.*
Credit points	*2 SCH x (1.67) = 3.34 ECTS*
Required and recommended prerequisites for joining the module	*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%)*
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.* *6. Students can understand the definition of polymers, types and characteristics of polymers, as well as sources used for polymer synthesis and their applications of biodegradable polymers in the medical field.* *7. Students can understand the definition of ceramics, types and characteristic properties of ceramics as biomedical materials, the interaction of bioceramics with body tissues, and their applications of ceramic biomaterials, especially in orthopedics and dentistry.* *8. Students can understand the definition, properties, and characteristics of composites as biomedical materials and their applications of composite biomaterials, especially 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* *2. Ratner D.B. Hoffman S.A., Schoen F.J., Lemons J.E., Biomaterial science: an introduction to materials in medicine.*

Module Handbook – Membrane Physics

Module designation	*Membrane Physics*
Semester(s) in which the module is taught	*6^{th} (sixth)*
Person responsible for the module	*Dr. Mersi Kurniati*
Language	*Indonesian*
Relation to curriculum	*in the third year (6th semester) bachelor's degree*
Teaching methods	*Lectures and student assignment*
Workload (incl. contact hours, self-study hours)	*Total workload is 90 hours per semester, which consists of 100 minutes lectures per week, 120 minutes structured activities per week, and 120 minutes individual study per week. Total 16 weeks per semester.*
Credit points	*2 SCH x (1.67) = 3.34 ECTS*
Required and recommended prerequisites for joining the module	-
Module objectives/intended learning outcomes	*1. Students can understand the basic concepts of membrane technology (separation technology).* *2. Students can classify polymers used as membrane materials and explain the factors that determine the properties.* *3. Students can understand synthesis and learn various membrane characterization methods and study the transport phenomena in membranes.* *4. Students can learn about various processes in membranes, understand the phenomena of polarization and membrane fouling.* *5. Students can understand membrane module design and have insight into the development of membrane technology and its applications in various fields.*
Content	*1. Basic principles of membrane technology* *2. Classify polymers of synthetic membrane* *3. Synthesis membrane* *4. Characterization of membrane* *5. Transport phenomena* *6. Processes in membrane* *7. Phenomena of polarization and fouling* *8. Membrane module design* *9. Application of membrane technology*
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 (15%), mid semester exam (30%), and end semester exam (55%).*
Reading list	*1. Baker, R.W, 2004. Membrane Technology and Application. 2nd Edition. John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex PO19 8SQ, England*

	2. *Mulder, M. 1996. Basic Principle of Membrane Technology. 2nd Edition. Dordrecht: Kluwer Academic Publishers*

Module Handbook – Bioinstrumentation

Module designation	*Bioinstrumentation*
Semester(s) in which the module is taught	*6th semester*
Person responsible for the module	*Dr. Erus Rustami*
Language	*Bahasa Indonesia*
Relation to curriculum	*Elective for the third year (6th semester) bachelor's degree*
Teaching methods	*Lectures and student's project*
Workload (incl. contact hours, self-study hours)	*Total workload is 90 hours per semester, which consists of 100 minutes lectures per week, 120 minutes structured activities per week, and 120 minutes individual study per week. Total 16 weeks per semester.*
Credit points	*2 SCH x (1.67) = 3.34 ECTS*
Required and recommended prerequisites for joining the module	-
Module objectives/intended learning outcomes	1. *Students are able to explain and analyze the physics principles underlying the detection and measurement of various biological signals (e.g., bioelectrical, biomechanical, bio-optical, biochemical, and bio-thermal).* 2. *Students are able to apply fundamental electronics concepts (including operational amplifiers, filters, and analog-to-digital conversion) to design and evaluate signal conditioning circuits relevant to biological data acquisition.* 3. *Students are able to identify and differentiate various types of sensors and transducers used in bioinstrumentation, explaining their operating principles and applications in physiological measurement contexts.* 4. *Students are able to understand and articulate the physical foundations behind major medical imaging modalities (such as X-ray, Ultrasound, and Magnetic Resonance Imaging (MRI)), and interpret the information obtained from these imaging techniques.* 5. *Students are able to analyze technical challenges at the interface between electronic and biological systems, including issues of noise, impedance, electrical safety, and considering ethical aspects in medical device development.*
Content	*This Bioinstrumentation course explores the physics principles that underpin modern biological measurement and medical devices. Students will delve into the unique characteristics of biological signals and learn essential electronics concepts like operational*

	amplifiers and filters for effective signal conditioning. The curriculum covers the physics of diverse sensors and transducers used in bioinstrumentation, from bioelectrodes to optical and chemical sensors. Furthermore, the course examines the physical basis of major medical imaging modalities such as X-ray, Ultrasound, and MRI. Finally, students will analyze technical challenges at the electronic-biological interface, including noise, impedance, and electrical safety, while also considering ethical aspects in device development.
Examination forms	*Project presentation and 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 (40%), and semester exam (60%)*
Reading list	1. *Kumar, A and Gupta, R,K., 2022. Bioelectronics: Materials, Technologies, and Emerging Applications. CRC Press* 2. *S.M, Reddy, 2021. Instrumentation in Bioscience. Scientific Publisher* 3. *Najarian, K and Splinter, R. 2012. Biomedical Signal and Image Processing. CRC Press.*

Module Handbook – Radiation Physics

Module designation	*Radiation Physics*
Semester(s) in which the module is taught	*7th semester*
Person responsible for the module	*Dr. Yessie Widya Sari*
Language	*Indonesian*
Relation to curriculum	*Elective for the third year (7th 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 90 hours per semester, which consists of 100 minutes lectures per week, 120 minutes structured activities per week, and 120 minutes individual study per week. Total 16 weeks per semester.*
Credit points	*2 SCH x (1.67) = 3.34 ECTS*
Required and recommended prerequisites for joining the module	-
Module objectives/intended learning outcomes	1. *Students can distinguish the fundamental interaction mechanisms between ionizing radiation (ionization, excitation) and non-ionizing radiation (thermal and photochemical effects) with biological matter.* 2. *Students can quantitatively analyze cellular responses to ionizing radiation using biophysical models (e.g., the Linear-Quadratic Model) and explain damage mechanisms caused by UV radiation.* 3. *Students can compare the biological effects at the tissue and organism levels caused by ionizing radiation (deterministic & stochastic) and non-ionizing radiation (thermal & non-thermal).* 4. *Students can explain the biophysical principles behind medical applications of ionizing radiation (e.g., radiotherapy, PET) and non-ionizing radiation (e.g., laser, MRI, diathermy).* 5. *Students can apply relevant radiation protection principles for ionizing radiation (e.g., ALARA, dosimetry) and non-ionizing radiation (e.g., exposure limits, Maximum Permissible Exposure - MPE).*
Content	*This Radiation physics course explores the interaction mechanisms of ionizing radiation (ionization, excitation) with biological matter, interaction mechanisms of non-ionizing radiation (thermal and photochemical effects) with biological matter, characteristics and impacts of ionizing and non-ionizing radiation*

	interactions. biophysical models (e.g., the Linear-Quadratic Model) in cellular responses to radiation, mechanisms of DNA and tissue damage caused by UV (non-ionizing) radiation, deterministic and stochastic effects of ionizing radiation at the tissue and organism level, thermal and non-thermal effects of non-ionizing radiation, compare patterns of biological effects from both types of radiation based on dose level and mechanisms, working principles of radiotherapy and PET, laser, MRI, and diathermy based on ionizing radiation, basic principles of radiation protection and dosimetry methods for ionizing radiation.
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 (30%), and semester exam (30%)*
Reading list	*Main:* 1. *Hall, E. J., & Giaccia, A. J. (2018). Radiobiology for the Radiologist (8th ed.). Lippincott Williams & Wilkins. (Fokus pada Radiasi Pengion).* 2. *Karol, H. & Zmyslony, M. (Eds.). (2016). Non-Ionizing Radiation: Sources, Exposure, and Health Effects. CRC Press. (Referensi utama untuk Radiasi Non-Pengion).* 3. *Karol, H. & Zmyslony, M. (Eds.). (2016). Non-Ionizing Radiation: Sources, Exposure, and Health Effects. CRC Press. (Referensi utama untuk Radiasi Non-Pengion).* *Supporting* 1. *Niemz, M. H. (2007). Laser-Tissue Interactions: Fundamentals and Applications. Springer.* 2. *Pedoman dari **ICNIRP** (International Commission on Non-Ionizing Radiation Protection) dan **BAPETEN**.*

Module Handbook – Scientific Writing Method Physics

Module designation	*Scientific Writing Method in Physics*
Semester(s) in which the module is taught	*6^{th} (Sixth)*
Person responsible for the module	*Dr. Yessie Widya Sari*
Language	*Indonesian*
Relation to curriculum	*FYP (Final year program) course in the third year (6^{th} 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* *50 minutes of lectures activities per week.*
Workload (incl. contact hours, self-study hours)	*Total workload is 90 hours per semester, which consists of 100 minutes lectures per week, 120 minutes structured activities per week, and 120 minutes individual study per week. Total 16 weeks per semester.*
Credit points	*2 SCH x (1.67) = 3.34 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 estoque 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. *Students are able to understand number writing technique, symbol, term, and scientific nomenclatures.* 6. *Students are able to understand illustration placement techniques.* 7. *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*

Module Handbook – Capstone in Physics I

Module designation	*Capstone in Physics I*
Semester(s) in which the module is taught	*6th (sixth)*
Person responsible for the module	*Dr. Faozan, M.Si*
Language	*Indonesian*
Relation to curriculum	*Compulsory in the third year (6th semester) bachelor's degree*
Teaching methods	*Student individual assignment and regular discussion with advisors.*
Workload (incl. contact hours, self-study hours)	*Total workload is 90 hours per semester, which consists of 340 minutes practicum/capstone project works per week. Total 16 weeks per semester*
Credit points	*2 SCH x (1.67) = 3.34 ECTS*
Required and recommended prerequisites for joining the module	Have completed major courses in semesters 1 - 5
Module objectives/intended learning outcomes	1. *Students are able to conduct scientific literature searching and are able to manage scientific reference resources.* 2. *Students are able to formulate the state of the art of a research topic.* 3. *Students are able to design simple research* 4. *Students are able to formulate simple research hypotheses* 5. *Students are able to master the tools or methods used in research* 6. *Students are able to write research proposals according to scientific writing rules.*
Content	*The course is in the form of project-based learning (PBL) which is the culmination of knowledge and skills from various courses that have been studied from the first to third year. Physics Capstone 1 focuses on exploring problems and research ideas as well as mastery of the tools or methods needed in research. The output of Physics Capstone 1 is a scientific document in the form of literature study results, the state of the art of a research topic, research methods, and research design. The document can be part of the Final Project Proposal that will be presented at the Colloquium course activity. Recording activities related to this course in the form of a log book is mandatory to verify the achievement of learning hours.*
Examination forms	*Project based learning*
Study and examination requirements	*Availability of activity logbook - 15%* *Completeness document assignment - 25%* *Participation (Presence and Activeness) - 10%* *Cooperation - 10%* *Report activity - 30%* *Presentation - 10%*

Reading list	*Main :* *Scientific journal* *Supporters :* *Textbook* *Related resources*

Module Handbook – Thematic-Community Service

Module designation	Thematic-Community Service
Semester(s) in which the module is taught	*7^{th} (sixth)*
Person responsible for the module	*LPPM IPB*
Language	*Indonesian*
Relation to curriculum	*Compulsory in the fourth year (7th semester) bachelor's degree*
Teaching methods	Experiential, project-based, and collaborative learning
Workload (incl. contact hours, self-study hours)	*Total workload is 180 hours per semester, which consists of 680 minutes practicum/community project work per week. Total 16 weeks per semester* .
Credit points	*4 SCH x (1.67) = 6.68 ECTS*
Required and recommended prerequisites for joining the module	Have completed major courses in semesters 1 - 6
Module objectives/intended learning outcomes	*1.* Able to identify, plan, implement, and evaluate community empowerment programs in the broader agricultural and environmental sectors in an integrated manner (multi- and interdisciplinary across professions at IPB); *2.* Demonstrates high levels of care and commitment, skilled in communication, and able to collaborate across professions in addressing current societal issues; *3.* Capable of developing collaborative networks to solve problems and meet the needs arising from the dynamics of current societal life; *4.* Able to provide alternative solutions for development challenges, particularly in the areas of broad-scale agriculture, environment, and community empowerment.
Content	Thematic-Community Service (KKNT) is an educational program where the primary activities take place outside the campus, offering students hands-on learning experiences by immersing them in community life. In this program, students collaborate directly with the community to identify, analyze, and address development challenges. The approach is integrated and interdisciplinary, involving collaboration across various professions at IPB.
Examination forms	*Project based learning*

Study and examination requirements	*Availability of activity logbook* *Completeness document assignment* *Participation (Presence and Activeness)* *Cooperation* *Report activity* *Presentation* *Detail Guideline:* *https://drive.google.com/file/d/1RIr6hZ946Li261pW7CrGf_j-1auYQfMW/view?usp=drive_link*

Module Handbook – Capstone in Physics 2

Module designation	*Capstone in Physics 2*
Semester(s) in which the module is taught	*7/8th (seventh / eighth)*
Person responsible for the module	*Dr. Faozan, M.Si*
Language	*Indonesian*
Relation to curriculum	*Compulsory in the second year (5th semester) bachelor's degree*
Teaching methods	*Student individual assignment and regular discussion with advisors*
Workload (incl. contact hours, self-study hours)	*Total workload is 135 hours per semester, which consists of 510 minutes practicum/ capstone project work per week. Total 16 weeks per semester*
Credit points	*3 SCH x (1.67) = 5.01 ECTS*
Required and recommended prerequisites for joining the module	Have completed major courses in semesters 1 - 6
Module objectives/intended learning outcomes	1. *Students are able to design simple research or projects* 2. *Students are able to master the tools or methods used in research/project and are able to use them to obtain research data.* 3. *Students are able to create research/project data visualizations* 4. *Students are able to analyze research/project data.* 5. *Students are able to write the results of research/projects in the form of scientific papers.* 6. *Students are able to disseminate research/project results in Capstone Festival activities.*
Content	*The course is in the form of project-based learning (PBL) which is the culmination of knowledge and skills from various courses that have been studied from the first to third year of a Bachelor's program. The output of the Physics Capstone Project activity can be in the form of research results, development of a model, prototype tools/devices/materials, and others. The output of the Capstone Project can be part of the Final Project document (Thesis/Final Year Project) presented at the Final Project Seminar activity.*
Examination forms	*Project based learning*
Study and examination requirements	*Availability of activity logbook: 15%* *Completeness document assignment: 20%* *Participation (Presence and Activeness): 10%* *Cooperation: 10%* *Report activity: 20%* *Presentation: 10%* *Poster/Prototype: 15%*

Reading list	*Main :* *Scientific journal* *Supporters :* *Textbook* *Related resources*

Module Handbook – Colloquium

Module designation	*Colloquium*
Semester(s) in which the module is taught	*7/8th (seventh / eighth)*
Person responsible for the module	*Dr. Faozan, M.Si*
Language	*Indonesian*
Relation to curriculum	*Compulsory in the second year (6th semester) bachelor's degree*
Teaching methods	*90 minutes structured activities per week, 90 minutes individual study per week*
Workload (incl. contact hours, self-study hours)	*Total workload is 45 hours per semester, which consists of 170 minutes practicum/attending seminar per week. Total 16 weeks per semester*
Credit points	*1 SCH x (1.67) = 1.67 ECTS*
Required and recommended prerequisites for joining the module	Have completed major courses in semesters 1 - 6
Module objectives/intended learning outcomes	*1. Students are able to compile and present material clearly and effectively.* *2. Able to communicate well in front of an audience, both verbally and visually* *3. Students are able to disseminate the results of research or projects in Final Project Seminar activities* *4. Students have a deep understanding of the topics or themes discussed in the seminar*
Content	*In this course, students make research proposals for the final project and present them in front of supervisors, examiners, and other fellow students. The review of the examiners and feedback from the ongoing discussion will be used to refine the student's research activity plan and final project.*
Examination forms	*Project based learning*
Study and examination requirements	*1. Systematics and writing techniques according to guidelines* *2. Introduction (title, problem formulation, objectives) and research hypothesis* *3. Substance* *4. Presentation of the research plan* *5. Discussion of the research plan (State of the Art, Research Objectives, Research Methods, Foundations of Physics Theory)*
Reading list	*Main :* *Scientific journal* *Supporters :* *Textbook* *Related Resources*

Module Handbook – Seminar

Module designation	*Seminar*
Semester(s) in which the module is taught	*7/8th (seventh / eighth)*
Person responsible for the module	*Dr. Faozan, M.Si*
Language	*Indonesian*
Relation to curriculum	*Compulsory in the second year (8th semester) bachelor's degree*
Teaching methods	*Attending seminar and involved in discussions held by IPB*
Workload (incl. contact hours, self-study hours)	*Total workload is 45 hours per semester, which consists of 170 minutes practicum/project work per week. Total 16 weeks per semester*
Credit points	*1 SCH x (1.67) = 1.67 ECTS*
Required and recommended prerequisites for joining the module	Have completed major courses in semesters 1 - 7
Module objectives/intended learning outcomes	1. *Students are able to compile and present material clearly and effectively.* 2. *Able to communicate well in front of an audience, both verbally and visually* 3. *Students are able to disseminate the results of research or projects in Final Project Seminar activities* 4. *Students have a deep understanding of the topics or themes discussed in the seminar*
Content	*In this lecture, students explained the results of the research they had conducted to test their validity and feasibility scientifically and their suitability with KKNI level 6 and the Learning Outcome Program from the IPB Physics Undergraduate Program in front of supervisors, examiners and other fellow students. Reviews from examiners are used to improve the Final Project.*
Examination forms	*Project based learning*
Study and examination requirements	*Presentation of research results* *Discussion of research results*
Reading list	*Main :* *Scientific journal* *Supporters :* *Textbook* *Related resources*

Module Handbook – Final Year Project I

Module designation	*Final Year Project 1*
Semester(s) in which the module is taught	*7/8th (seventh / eighth)*
Person responsible for the module	*Dr. Faozan, M.Si*
Language	*Indonesian*
Relation to curriculum	*Compulsory in the second year (8th semester) bachelor's degree*
Teaching methods	*Conducting experiment, simulation, discussion with advisors and writing the report*
Workload (incl. contact hours, self-study hours)	*Total workload is 180 hours per semester, which consists of 680 minutes practicum/lab work/final year project work per week. Total 16 weeks per semester*
Credit points	*4 SCH x (1.67) = 6.68 ECTS*
Required and recommended prerequisites for joining the module	Have completed major courses in semesters 1 - 7
Module objectives/intended learning outcomes	1. *Students are able to search scientific literature and to manage scientific reference resources* 2. *Students are able to formulate the state of the art of a research topic* 3. *Students are able to design simple research* 4. *Students are able to formulate simple research hypotheses* 5. *Students master the tools and methods used in research and are able to use them to obtain research data* 6. *Students are able to visualize research data and their tools* 7. *Students are able to analyze research data descriptively or predictively* 8. *Students are able to write research results in the form of scientific papers*
Content	*This course provides testing and assessment of the quality of all final project activities that have been completed by students as reflected in the form of a thesis document (Final Project) in accordance with KKNI level 6 and the Learning Outcomes Program of the IPB Physics Undergraduate Study Program. Testing of students' understanding of the basic concepts of physics related to their Final Project is carried out through a bachelor's exam in front of examiners appointed by the study program and is closed.*
Examination forms	*Project based learning*

Study and examination requirements	*Systematics and writing techniques according to guidelines* *Introduction (title, problem formulation, objectives) and research hypothesis* *Substance* *Data methods and analysis* *Drawing conclusions*
Reading list	*Main :* *Scientific journal* *Supporters :* *Textbook* *related resources*

Module Handbook – Final Year Project II

Module designation	*Final Year Project 2*
Semester(s) in which the module is taught	*7/8th (seventh / eighth)*
Person responsible for the module	*Dr. Faozan, M.Si*
Language	*Indonesian*
Relation to curriculum	*Compulsory in the second year (8th semester) bachelor’s degree*
Teaching methods	*Conducting discussion with advisors and writing the report*
Workload (incl. contact hours, self-study hours)	*Total workload is 90 hours per semester, which consists of 340 minutes practicum/project work per week. Total 16 weeks per semester.*
Credit points	*4 SCH x (1.67) = 6.68 ECTS*
Required and recommended prerequisites for joining the module	Have completed major courses in semesters 1 - 7
Module objectives/intended learning outcomes	*Students are able to demonstrate mastery of the fundamentals of theoretical physics that underlie research, including mechanics, electromagnetism, thermodynamics, and modern physics.*
Content	*This course provides testing and assessment of the quality of all final project activities that have been completed by students as reflected in the form of a thesis document (Final Project) in accordance with KKNI level 6 and the Learning Outcomes Program of the IPB Physics Undergraduate Study Program. Testing of students' understanding of the basic concepts of physics related to their Final Project is carried out through a bachelor's exam in front of examiners appointed by the study program and is closed.*
Examination forms	*Project based learning*
Study and examination requirements	*Systematics and writing techniques according to guidelines* *Introduction (title, problem formulation, objectives) and research hypothesis* *Substance* *Data methods and analysis* *Drawing conclusions*
Reading list	*Main :* *Scientific journal* *Supporters :* *Textbook* *related resources*

Module Handbook – Enrichment Courses

Module designation	*Enrichment Course*
Semester(s) in which the module is taught	*4^{th} (fourth), 6^{th} (sixth), and 7^{th} (seventh)*
Person responsible for the module	*Dr. Faozan, M.Si*
Language	*Indonesian / English*
Relation to curriculum	*Enrichment course in the third and fourth year (4^{th}, 6^{th}, and 7^{th} semester) bachelor's degree*
Teaching methods	*EC by course and EC by activities (program)* *Detail guideline: https://drive.google.com/file/d/1cf-drKdy-wdPW2MOs2Uc5VAR1k2XhTxF/view?usp=drive_link*
Workload (incl. contact hours, self-study hours)	*The total workload is 855 hours.*
Credit points	*19 SCH x (1.67) = 31.73 ECTS*
Required and recommended prerequisites for joining the module	-

Module objectives/intended learning outcomes	1. *able to apply logical, critical, systematic and innovative thinking in the context of developing or implementing science and technology that pays attention to and applies humanities values in accordance with his/her field of expertise;* 2. *able to demonstrate independent, quality and measurable performance;* 3. *able to examine the implications of the development or implementation of science and technology that pay attention to and apply humanities values in accordance with their expertise based on scientific principles, procedures and ethics in order to produce solutions, ideas, designs or art criticism;* 4. *able to make appropriate decisions in the context of solving problems in the field his expertise, based on the results of information and data analysis;* 5. *able to maintain and develop work networks with supervisors, colleagues, and peers both inside and outside the institution;* 6. *able to carry out self-evaluation processes for work groups under his/her responsibility answer, and be able to manage learning independently; and* 7. *able to document, store, secure, and retrieve data to ensure validity and prevent plagiarism.* 8. *Development of a growth mindset and orientation toward future practices;* 9. *Data literacy, the ability to read, analyze, and utilize data and information (big data) in the digital world;* 10. *Technology literacy, the ability to understand how machines work and the application of technology (coding, artificial intelligence, and engineering principles);* 11. *Human literacy, the ability to understand humanities, communication, and design;* 12. *21st-century skills fostering HOTS (Higher Order Thinking Skills), including Communication, Collaboration, Critical Thinking, Creative Thinking, Computational Logic, Compassion, and Civic Responsibility;* 13. *Understanding the era of Industry 4.0 and its developments;* 14. *Comprehension of knowledge to be practiced for the common good at local, national, and global levels;* 15. *Achievement of learning outcomes and other additional competencies.*

Content	*EC/SC Multi-Activity program aims to provide a multi-activity and multi-channel learning space within the framework of flexibility and personalized learning for students. Additionally, this learning space has the following objectives and benefits:* *1. To develop insights and hone critical and creative thinking skills in working across disciplines and with students from diverse backgrounds to solve complex problems;* *2. To provide opportunities for cultivating leadership, soft skills, and character while innovating and collaborating with various parties to enhance the quality of learning;* *3. To strengthen Life-Based Learning to produce outstanding graduates who are agile and adaptive to change by accommodating growth mindset, hard skills, soft skills, character, life skills, networking, and experience;* *4. To encourage students to gain learning experiences by taking credits outside their study programs and/or institutions;* *5. To support transdisciplinary learning as a collective approach, utilizing knowledge, expertise, and analytical capabilities to understand larger and more complex systems;* *6. To internalize professional attitudes and work culture required for the business world, industry, and/or workforce;* *7. To encourage study programs to implement student-centered learning, prioritizing team-based projects and/or case methods, along with related assessments.*
Examination forms	*Project based learning*
Study and examination requirements	*Availability of activity logbook* *Completeness document assignment* *Participation (Presence and Activeness)* *Cooperation* *Report activity* *Presentation* *Detail guideline: https://drive.google.com/file/d/1cf-drKdy-wdPW2MOs2Uc5VAR1k2XhTxF/view?usp=drive_link*