DEPARTMENT OF PHYSICS
Faculty of Mathematics and Natural Sciences

2020 CURRICULUM – UNDERGRADUATE

Courses	Requirement (credits)
Common Core Course (CCC)	33
Fundamental Course (FC)	3
Academic Core Course (ACC)	36
In-depth Course (IC)	30
Enrichment Course (EC)	21
Final Project (FYP), Capstones (CS), Thematic-Community Service Program (KKNT), Internship	21
Total	144

Course Code	Course Name	Credits (Class-Lab)	Course Category
Semester 1			
IPB110	Religion	3(2-1)	CCC
FIS1104	Physics for Science and Engineering	3(2-1)	CCC
IPB110C	Innovative Agriculture	2(2-0)	CCC
MAT1102	Mathematics and Logical Thinking	3(2-1)	CCC
IPB1106	Indonesian	2(1-1)	CCC
IPB110G	Sports and Arts	1(0-1)	CCC
EKO1101	Economy	2(2-0)	CCC
KPM1131	Sociology	2(2-0)	CCC
Subtotal Credit		18	
Semester 2			
KIM1104	Chemistry for Science and Engineering	3(2-1)	CCC
IPB110D	Pancasila	1(1-0)	CCC
IPB110E	Civic Education	1(1-0)	CCC
BIO1102	Elementary Biology	3(2-1)	CCC
IPB110F	English	2(1-1)	CCC
MAT1104	Calculus 1	3(2-1)	FC
STA1111	Statistics and Data Analysis	3(3-0)	CCC
KOM1102	Computational Thinking	2(2-0)	CCC
Subtotal Credit		18	
Semester 3			
FIS1201	Newtonian Mechanics	3(2-1)	ACC
FIS1203	Mathematical Physics	3(2-1)	ACC
FIS1205	Analogue Electronics	2(1-1)	ACC

FIS1207	Thermodynamics	3(2-1)	ACC
FIS1209	Waves	3(2-1)	ACC
FIS120B	Electrostatics	3(2-1)	ACC
Subtotal Credit		17	
Semester 4			
FIS1202	Langrangian-Hamiltonian Mechanics	3(2-1)	ACC
FIS1206	Advanced Mathematical Physics	3(2-1)	ACC
FIS1208	Digital Electronics	2(1-1)	ACC
FIS1204	Computational Physics	2(1-1)	ACC
FIS1282	Advanced Experimental Physics	2(1-1)	IC
FIS1292	Biophysics	2(1-1)	IC
FIS120C	Electrodynamics	3(2-1)	ACC
Subtotal Credit		17	
Semester 5			
FIS1301	Quantum Physics	3(2-1)	ACC
FIS1303	Statistical Physics	3(2-1)	ACC
FIS1381	Optics and Photonics	2(2-0)	IC
FIS1385	Internet Based Instrumentation Systems	2(1-1)	IC
FIS1371	Complex Systems	2(2-0)	IC
FIS1393	Biomaterials	2(2-0)	IC
FIS1383	Material Characterization Methods	2(1-1)	IC
FIS1387	Sensors and Transducers	2(1-1)	IC
Subtotal Credit		18	
Semester 6			
FIS1372	Solid State Physics	3(2-1)	IC
FIS1374	Theory of Relativity	2(2-0)	IC
FIS137A	Advanced Quantum Physics	3(2-1)	IC
FIS137C	Atomic and Molecular Physics	2(2-0)	IC
FIS1386	Nanophysics	2(2-0)	IC
FIS137E	Nuclear and Particle Physics	2(2-0)	IC
FIS1358	Capstone in Physics 1	4(0-4)	CAP/FYP
FIS135A	Scientific Writing Method in Physics	1(1-0)	CAP/FYP
	Enrichment Course	3	EC
Subtotal Credit		22	
Semester 7			
IPB400	Thematic-Community Service Program	4(0-4)	CAP/FYP/KKNT
	Enrichment Course	18	EC
FIS1461	Colloquium	1(0-1)	CAP/FYP
Subtotal Credit		23	
Semester 8			
FIS1452	Capstone in Physics 2	4(0-4)	CAP/FYP
FIS1462	Seminar	1(0-1)	CAP/FYP
FIS1464	Final Year Project	6(0-6)	CAP/FYP
Subtotal Credit		11	

Curriculum Structure

Semester	CCC	FC	ACC	IPC	EC	CAP/FYP/KKNT
1	18					
2	15	3				
3	17					
4	13	4				
5	6	12				
6	14	3	5			
7	18	5				
8	11					
Credits per category	33	3	36	30	21	21
Percentage (%)	23	2	25	20	15	15
IPB standard						
Credits per category	32 - 36		36	28 – 29	21 – 22	21 – 22
Percentage (%)	22-25		25	20	15	15

Course Description

1	FIS1201	Newtonian Mechanics	3(2-1)
	Prerequisite: FIS1104 This course is a deepening of the Basic Physics 1 (PPKU) course which discusses about vector algebra, newton's mechanics, oscillations, general motion in three dimensions, systems non-inertial framework, gravity and central field, special theory of relativity		
2	FIS1203	Mathematical Physics	3(2-1)
	Prerequisite: MAT103 This course is a basic physics course that equips students with an understanding of mathematical methods and techniques (mathematical analysis tools) needed to understand and solve problems related to physical phenomena in nature. The analytical tools include solving series, complex numbers, linear algebra, matrices, prices and eigenfunctions, folding integrals and vector analysis. Mastery of these materials is very important to support other basic physics subjects such as waves, thermodynamics, mechanics, electromagnetics and other advanced courses.		
3	FIS1205	Analogue Electronics	2(1-1)
	Prerequisite: FIS1104		

	This course is given with the aim of equipping students with the basic skills of analog instrumentation. The topics in this course include: Basic Electrical Principles, Semiconductors, Semiconductor Diode Circuits, Power Supply Circuits, Bipolar Connection Transistors (BJT), BJT Amplifiers, Field Effect Transistors (FET), FET Amplifiers, Power Amplifiers, Signal Processors with Operational ICs Amplifier (Op-Amp), and Oscillator.		
4	FIS1207	Thermodynamics	3(2-1)
	Prerequisite: FIS1104 This course provides a foundation for the application of (classical) physics in various fields, as well as a bridge to study Statistical Physics (Mechanics) related to the interaction of particle systems in the microscopic (quantum) realm. The material provided includes basic concepts of thermodynamics, kinetic theory of gases, equations of state, first and second laws of thermodynamics, entropy, thermodynamic potentials, Maxwell's relations. Application on a simple system.		
5	FIS1209	Waves	3(2-1)
	Prerequisite: FIS1203 This course is an in-depth study to understand the concept of waves with material coverage including free oscillations of simple systems; free oscillation of a system with many degrees of freedom; forced oscillation; traveling waves; reflection, Impedance, modulation, Fourier analysis, two and three dimensional wave motion, polarization, Interference and diffraction, Electromagnetic waves		
6	FIS120B	Electrostatics	3(2-1)
	Prerequisite: FIS1104 This course is a basic physics course that provides knowledge, understanding and analytical skills regarding fundamental concepts in nature related to electrostatic phenomena. Concepts of charge, Coulomb interaction, vector field (electric field), scalar field (potential field), continuous charge distribution in various geometric shapes, dipoles, as well as various applications of electrostatic concepts are discussed in this course.		
7	FIS1202	Langrangian-Hamiltonian Mechanics	3(2-1)
	Prerequisite: FIS1201 This course is an advanced compulsory subject with prerequisites for Newtonian Mechanics which equips students with analytical tools and methods for solving more complex physical problems. In this course, attention is focused on the representation of Newtonian mechanics in the Lagrange and Hamilton formulations. The topics in this course include the motion of particle systems, rigid body motion, gravitational potential and force, Hamiltonian and Lagrangian dynamics equations, inertial tensor and		

	coordinate transformation, coupled oscillation, wire vibration, fluid motion and relativistic mechanics.		
8	FIS1206	Advanced Mathematical Physics	3(2-1)
	Prerequisite: FIS1203 This course is a basic physics course that equips students with an understanding of mathematical methods and techniques (mathematical analysis tools) needed to understand and solve problems related to physical phenomena in nature. The analytical tools include Fourier Series and Transformations, Ordinary Differential Equations, Calculus of Variations, Tensor Analysis, Special Functions, Series Solutions of Differential Equations (Legendre, Bessel, Hermite, Laguerre). Partial Differential Equations and Functions of Complex Variables.		
9	FIS1208	Digital Electronics	2(1-1)
	Prerequisite: FIS1205 This course is given with the aim of equipping students with basic digital instrumentation skills. This course discusses the basic concepts of digital systems such as number systems, Boolean algebra, Combination Circuits, Karnaugh Map, Characteristics of TTL and CMOS ICs, Decoder-Encoder, Multiplexers and Demultiplexers, Sequential Circuits such as Flip-Flops, Registers and Counters, Memory, Introduction to Systems Microcomputer.		
10	FIS1204	Computational Physics	2(1-1)
	Prerequisite: FIS1203 This course discusses programming and numerical methods for solving various problems in physics, including solving the roots of a linear and nonlinear equation to obtain the eigenvalues of a wave function, solving ordinary differential equations using the Euler and Runge-Kutta methods to explain harmonic motion. simple and damped, solving partial differential equations using finite difference and finite element methods to explain heat propagation, solving linear and nonlinear regression from experimental data sets to obtain interpolation and extrapolation equations.		
11	FIS1282	Advanced Experimental Physics	2(1-1)
	Prerequisite: FIS1104 This course contains several topics of fundamental experimental material that build advanced quantum theory and physics that underlie advanced technology. The experimental topics in this course are atomic spectrum, black body radiation, proprietary oil drops, e/m ratio, photoelectric effect, Frank-Hertz experiment, radioactive count, laws of thermal radiation, electron spin resonance, Hall effect, light`s speed, and laser characteristics.		
12	FIS1292	Biophysics	2(1-1)

	This course is given to equip all students with general graduate competencies related to the expertise program they are engaged in. In particular, it provides an understanding of the concepts and methods of physics in discussing biological phenomena and phenomena. The subject matter includes cell biophysics, forces at the nanometer scale, the structure and physical properties of biomolecules, biological thermodynamics, photobiophysics, radiation biophysics, as well as the electrical and magnetic properties of cells. The presentation of this course does not require a strong mathematical background so that it is hoped that all students can digest and understand it well.		
13	FIS120C	Electrodynamics	3(2-1)
	Prerequisites: FIS120B This course is a basic physics course that equips students with an understanding of classical electrodynamic phenomena based on the four Maxwell equations. Extending the concept of electrostatics to an accelerated charge, describing Maxwell's Equations in both differential and integral forms, laws of conservation, electromagnetic waves and their propagation in materials, concepts of potential and fields, electromagnetic radiation, electrodynamics' relation to relativity, vector calculus and curved coordinates, and the Helmholtz`s theorem		
14	FIS1301	Quantum Physics	3(2-1)
	Prerequisite: FIS1202 This course provides an adequate foundation for development towards Theoretical Physics, Biophysics and Applied Physics. The material that will be given is wave-particle dualism, wave function, one-dimensional potential and the SchrÖdinger equation to determine eigenvalues, operator methods in quantum mechanics, general structure of quantum mechanics, momentum angles, the SchrÖdinger equation for the hydrogen atom, perturbation theory, and many-particle systems.		
15	FIS1303	Statistical Physics	3(2-1)
	Prerequisite: FIS1207 This course equips students with statistical principles for general cases in physics as well as very specific ones such as the behavior of phonon gases and electron gases. For cases with a very large number of components, such as the behavior of molecules in a gas, it is certainly not possible to apply it exactly. Statistical physics is formulated to describe the macroscopic properties of gas particles without having to calculate in detail the individual motions of the gas molecules. The three particle distribution models studied are; Maxwell-Boltzmann Statistics, Bose-Einstein Statistics, and Fermi-Dirac Statistics. Statistical concepts for temperature, entropy, canonical, microcanonical and grand canonical ensembles and their applications are studied in this course.		

16	FIS1381	Optics and Photonics	2(2-0)
	Prerequisite: FIS1209 This course is an advanced physics course that equips students to understand the characteristics of light and the interaction of light with matter and its current applications. Understand that light is an electromagnetic wave, dipole formation and dipole radiation in materials as a result of interaction with light, Huygens principle and Fermat principle, geometric derivation of Snell's law, Fresnel equation, photonic crystals, waveguides, wave propagation in optical fiber, plasmon propagation on the surface, virus detection using plasmons, metamaterials, introduction to nonlinear optics, quantum theory of light, photoelectric effect, interferometry/gravity wave detection by LIGO, and state of the art photovoltaic cells (Perovskite solar cells).		
17	FIS1385	Internet Based Instrumentation Systems	2(1-1)
	Prerequisite: FIS1208 This course discusses internet-based measurement and instrumentation systems. This course discusses the Basic Principles of Control Systems, Microcontrollers, Small Board Computers, Network Operating Systems, Network Basic Principles, Network Application Services, Network Programming Basics, Application Programming Interfaces, Introduction to IoT Security, Introduction to Big Data, and IoT Hackathon.		
18	FIS1371	Complex Systems	2(2-0)
	Prerequisite: FIS302 This course covers the application of physical principles in describing complex systems. Lectures cover the definition of complex systems, nonlinear interactions, formulation of continuous and discrete system dynamics, agent-based modeling, fractal geometry, thermodynamic description and statistical physics of complex systems, complexities in biological, environmental, and socio-economic systems.		
19	FIS1393	Biomaterials	2(2-0)
	This course is given to equip students with insight into the definition of biomaterials, types and characteristics of biomaterials, the body's response to biomaterials, and trends in biomaterial research. This course covers material biocompatibility, drug delivery, biosensors, metal biomaterials, polymer biomaterials, and ceramic biomaterials.		
20	FIS1383	Material Characterization Methods	2(1-1)
	This course is given in semester 7 with the aim of equipping final year students with knowledge and understanding of measurement instruments, characterization, and analysis of test results. The main topics of this course include: measurement basics, measuring instrument calibration techniques,		

	radiation testing of biomedical materials, atomic spectroscopy (AAS, AES, and XRD), molecular spectroscopy (UV-Vis, FTIR, fluorescence, and thermoluminescence), material characterization using microscopes (optical and electron microscopes), electroanalytical chemistry (potentiometry, voltammetry), thermal measurement methods (DTA, DSC), and nanomaterial analysis (PSA).		
21	FIS1387	Sensors and Transducers	2(1-1)
	This course is given to equip students to be able to explain the concept of sensor working mechanism related to material response to detected physical/chemical parameters. The topics that will be delivered in this course include Terminology, Classification and Characteristics of Sensors, Temperature Sensors, Optical Sensors, Fiber Optic Sensors, Resistive, Capacitive and Magnetic Sensors, Mechanical Sensors, Acoustic Sensors, Radiation Sensors, Chemical Sensors and Biosensors.		
22	FIS1372	Solid State Physics	3(2-1)
	Prerequisite : FIS1301 This course is an advanced physics course that equips students to understand physical phenomena related to solids as a basis for studying advanced materials. Studying lattices+bases as forming crystal systems, symmetry, crystals, x-ray diffraction, Miller's index, dispersion relations, thermal and electric conductivity of phonons and electrons (metals), heat capacity of Dulong Petit, Einstein, Debye, phonon scattering, DC and AC Drude model, Hall Effect, Quantum Hall Effect, Wiedeman franz's law, phonon DOS, electron DOS, Fermi level, k sphere, Fermi-Dirac distribution, thermoelectric effect of solids, fermi surface, dipole/vd waals bond, Lenard-Jones potential, bond ions, Madelung constant, covalent bonding, molecular orbital theory, bonding and antibonding, orbital hybridization, orbital mixing, homo lumo, electronic band structure, direct and indirect transition, fg bloch, bloch waves, Kronig-Penney model, nearly free electron model.		
23	FIS1374	Theory of Relativity	2(2-0)
	Prerequisite: FIS1206 This course covers the special and general theories of relativity. The discussion of special relativity theory includes a review of the principles of Galileo's relativity and Newton's dynamics, postulates of special relativity, Lorentz transformations, the principle of space-time equivalence, space-time diagrams, the physical consequences of the postulates of special relativity, relativistic mechanics and the formulation of the covariance of Maxwell's theory. The discussion of general relativity theory includes the formulation of manifold space, non-Euclidian geometry, Riemann geometry, tensor calculus, covariance derivatives, parallel transport, Einstein field		

	equations, Schwarzschild geometry, static black holes, Friedman-Robertson-Walker geometry and an introduction to cosmology.		
24	FIS137A	Advanced Quantum Physics	3(2-1)
	Prerequisite: FIS1301 This course provides an adequate foundation for development towards Theoretical Physics, Biophysics and Applied Physics. The material that will be given is the theory of independent disturbance time, time dependent perturbation theory, interaction of electrons with GEM, real atoms, molecules, atomic radiation, collision theory, and absorption of radiation in materials		
25	FIS137C	Atomic and Molecular Physics	2(2-0)
	Prerequisite: FIS1301 This course will introduce quantum physics to atomic and molecular fundamentals. The material will be divided into three parts: the first part provides a historical perspective that leads to contemporary views of atomic and molecular physics, as well as outlining the principles of non-relativistic quantum mechanics. The second part includes a description of atomic physics and its interactions with radiation, while the third part deals with molecular physics and its interactions with radiation. The molecular energy spectrum includes rotational, vibrational and electronic modes. Introduction to LCAO orbital quantum theory, hybridization of molecular bonds and types of molecular bonds (pi and sigma bonding).		
26	FIS1386	Nanophysics	2(2-0)
	Prerequisite: FIS303 This course is an advanced physics course that equips students with an understanding of physics at the nanoscale which can have different characteristics from physics at the macro scale. Quantum theory of nanomaterials, analogy of particles in a potential box, subwavelength optics, dependence of absorption and emission on nanoparticle size. Nanomaterial synthesis method, top down vs bottom up, nanostructure (grating, meta-structure), anoparticles, Kubo levels, characterization of nanomaterials, carbon quantum dots and carbon nanotubes, fabrication of carbon quantum dots both conventionally and green synthesis, synthesis of nanoparticles via laser ablation , the role of nanotechnology in medicine, advanced materials, sensors, biosensors, biology, ecology, and renewable energy.		
27	FIS137E	Nuclear and Particle Physics	2(2-0)
	Prerequisite : FIS303 This course is a basic physics course that equips students with an understanding of the basic structure of matter, including nuclear and subatomic particles and the basic interactions that are responsible for their		

	stability (standard model). This course discusses the static and dynamic quantities of nuclear, nuclear models, such as the liquid drop model (Bethe-Weizsäcker), the Fermi model, and the Shell model. Discuss the reactions of fission, fusion, and nuclear decay. Basic principles and technology of nuclear detection, nuclear astrophysics. Various applications of nuclear and particle physics in everyday life such as energy issues, health, agriculture, determining the age of objects (carbon dating), physics research and others.		
28	FIS1358	Capstone in Physics 1	4(0-4)
	This course is the culmination of knowledge and skills from various subjects that have been studied from the first to the third year of a Bachelor's program. The output of the Physics Capstone Design is a document related to the final project implementation plan, which can be in the form of a literature study search result document, design design: model, innovation of a tool (devices/systems) or materials (materials), etc. The document can be part of the Final Project Proposal which will be presented at the Colloquium course. Recording of activities related to this course can be done since semester 3.		
29	FIS135A	Scientific Writing Method in Physics	1(1-0)
	This course provides direction to students how to write a scientific work in the form of publications, reports, theses, etc. by following/complying with all matters related to technical writing, literature search, and prevention of plagiarism. Ethics and rules of scientific writing, paraphrasing techniques, the use of reference managers (endnote, mendeley, bibtex, etc.) as well as language checking software (grammarly) and plagiarism checking both paid and free will also be presented in this lecture.		
30	FIS1461	Colloquium	1(0-1)
	In this course, students make research proposals for their final assignments and present them in front of their supervisors, examiners, and other fellow students. Examiners' reviews and feedback from ongoing discussions will be used to refine research activity plans and students' final assignments.		
31	FIS1452	Capstone in Physics 2	4(0-4)
	This course is the culmination of knowledge and skills from various subjects that have been studied from the first to the third year of a Bachelor's program. The outputs of the Physics Capstone Project activities can be in the form of developing a model, prototype tools/devices/materials, coding programs and others. The output of the Capstone Project can be part of the Final Year Project document that is presented at the Final Project Seminar. The results of competitions/competitions participated by students such as PIMNAS and other competitions can also be calculated by taking into account the documentation of the time spent in accordance with the weight of the credits of this course. Recording of activities related to this course can be done since semester 3.		

32	FIS1462	Seminar	1(0-1)
	In this lecture, students explain the results of the research they have done to test their scientific validity and feasibility and their suitability with the KKNI level 6 and the Learning Outcome Program of the Physics Undergraduate Program of IPB in front of supervisors, examiners and other fellow students. Reviews from examiners are used to complete the Final Project.		
33	FIS1464	Final Year Project	6(0-6)
	This course provides testing and assessment of the quality of all final project activities that have been passed 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 Physics Undergraduate Study Program of IPB. The testing of students' understanding of the basic concepts of physics related to the Final Project is carried out through an undergraduate trial in front of examiners appointed by the study program.		