Module Handbook

Module name	Introduction to Particle Physics
Module level, if applicable	Bachelor of Science
Code, if applicable	18H02134303
Subtitle, if applicable	-
Course, if applicable	-
Semester(s) in which the module is taught	6th (Even)
Person responsible for the module	Bansawang BJ
Lecturer	Bansawang BJ
Language	Indonesian Language [Bahasa Indonesia]
Relation to Curriculum	This course is an elective course and is offered in the 6th semester.
Type of teaching, contact hours	Teaching methods: [group discussion], [~~simulation~~], [case study], [collaborative learning], [~~project-based learning~~], [problem-based learning]. Teaching forms: [lecture], [tutorial], [seminar], [~~practicum~~], [~~research~~], [~~internship~~], [~~community service~~] CH : 08.00 - 16.00
Workload	For this course, students are required to meet a minimum of 136 hours in one semester, which consists of: - 40 hours for lectures, - 48 hours for structured assignments, - 48 hours for private study
Credit points	3 credit points (equivalent to 5.1 ECTS)
Requirements according to the examination regulations	Students have participated in at least 80% of the learning activities (Academic Regulations, Chapter VII)
Recommended prerequisites	Mathematical Physics 2 and Quantum Physics
Module objectives/intended learning outcomes	After completing this module, **Intended Learning Outcomes** ● **ILO 3**: Students will be able to use the basic principles of physics in technology application. ● **ILO 6**: Students will be able to use the mathematical method to solve the physical-related problem. **Course Learning Objectives:**

	After completing this course, students are expected to explain the categorization of fundamental interaction types and particle charges, the quark structure of hadrons and baryons, as well as Dirac particle spinors and antiparticles, and have the ability to apply Feynman diagrams for both spin-0 (spinless) particles and spin-½ particles in particle scattering processes. **Sub-CLO** Students are able to: **ILO 3 ⇒ CLO 1:** Students are able to explain the types of fundamental interactions and their characteristics such as interaction range, strength, and interaction constants. **ILO 6 ⇒ CLO 2**: Students are able to explain the classification of particle charges based on their electric charges and hadronic charges. **ILO 3 ⇒ CLO 3**: Students are able to explain the types of quarks and quark arrangements for hadrons and baryons, as well as the color factors of quarks. **ILO 3 ⇒ CLO 4**: Students are able to explain the nature of symmetry in physics and calculate the generator components of the SU(2) group for isospin and the SU(3) group. **ILO 6 ⇒ CLO 5**: Students are able to derive the Dirac equation with current density and charge density, as well as its solution, for free particle spinors and anti-particle spinors. **ILO 6 ⇒ CLO 6**: Students are able to apply Feynman diagram rules for spinless particles in calculating transition probability rates and transition amplitudes. **ILO 6 ⇒ CLO 7**: Students are able to apply Feynman diagram rules for quantum electrodynamics in calculating scattering cross-sections and Lorentz invariant phase space (dLips).
Content	Students will learn about: 1. Types of fundamental interactions and their properties: types of interactions, interaction range, strength and interaction constants, phenomena of interaction classification. 2. Particle charge classification: Poincaré depiction of particles, electric charge, hadronic charge. 3. Quarks and color: types of quarks, quark arrangement for hadrons, quark arrangement for baryons, color factors. 4. Symmetry and groups: group definition, symmetry in physics, Group SU(2) for isospin, isospin for antiparticles, Group SU(3). 5. Dirac equation and its solutions: covariant form of the Dirac equation, Dirac matrices, conservation laws of current density and charge density, free particle spinors, spinors for antiparticles, Dirac particle spin and helicity operator. 6. Particle scattering and interaction: kinematics of interaction processes, concept of interaction, scattering matrix (S-Matrix).

	7. Electrodynamics for spin-0 particles: spinless "electron" (structureless particle) in the electromagnetic field A^{μ}, Feynman diagram rules for spinless particles, transition probability rate, Fermi's golden rule, transition amplitude for positron-photon scattering, scattering between spinless "electron" and muon. 8. Electrodynamics for spin-½ particles: Feynman diagram rules for quantum electrodynamics, scattering cross-section, Lorentz invariant phase space, and electron interaction with the electromagnetic field A^{μ}.
Forms of Assessment	Assessment techniques: [~~observation~~], [participation], [~~performance~~], [written test], [~~oral test~~] Assessment forms: [~~quiz~~], [midterm exam], [final term exam], [assignment], [~~report~~], [~~presentation~~] Assignment = 30%, Mid exam = 35%; Final exam = 35% CLO 1 => ILO 3: 10% (Mid term exam: written test) CLO 2 => ILO 6: 10% (Mid term exam: written test) CLO 3 => ILO 3: 15% (Mid term exam: written test) CLO 4 => ILO 3: 10% (Assignment: participation) CLO 5 => ILO 6: 10% (Assignment: participation) CLO 6 => ILO 6: 25% (Assignment: participation, Final exam: written test) CLO 7 => ILO 6: 10% (Assignment: participation, Final exam: written test)
Study and examination requirements and forms of examination	**Study and examination requirements:** ● Students must attend 15 minutes before the class starts. ● Students must switch off all electronic devices. ● Students must inform the lecturer if they will not attend the class due to sickness, etc. ● Students must submit all class assignments before the deadline. ● Students must attend the exam to get the final grade. **Form of examination:** Written Exam
Media employed	LED, Whiteboard, Textbook, Learning Management System (SIKOLA)
Reading list	1. F. Halzen and A. D. Martin, *Quarks and Leptons*, John Wiley & Sons, 1984. 2. Fayyazuddin and Riazuddin, *A Modern Introduction to Particle Physics*, World Scientific Publishing, Singapore, 2000 3. J. D. Bjorken and S.D. Drell, *Relativistic Quantum Mechanics*, McGraw-Hill, 1964.