Ministry of Education, Culture, Research, and Technology
Universitas Negeri Yogyakarta
Faculty of Mathematics and Natural Sciences

CURRICULUM OF BACHELOR IN PHYSICS PROGRAM

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CURRICULUM OF
BACHELOR IN PHYSICS PROGRAM

Dean's Address, Faculty of Mathematics and Natural Sciences Universitas Negeri Yogyakarta

All praise be to Allah SWT the Almighty, for His blessing, mercy and guidance in the completion of this curriculum. This publication is made to provide academic guidance for the lecturers and students of the Faculty of Mathematics and Natural Sciences, Universitas Negeri Yogyakarta.

The curriculum is the reference for academicians in the Bachelor of Education in Physics Program, Faculty of Mathematics and Natural Sciences, Universitas Negeri Yogyakarta in conducting academic activities. For lecturers, it can be used as guidance to help them complete their duty in teaching the courses and supervising theses. For academic staff, administration staff and other staff, it can be used as a reference to provide the best service in completing the academic administration tasks. For the students of the Faculty of Mathematics and Natural Sciences, it can be used as guidance to pursue their Bachelor of Education in Physics Program degree in Universitas Negeri Yogyakarta, so it can help them manage and apply the best strategies to complete the study.

Finally, the Faculty of Mathematics and Natural Sciences of Universitas Negeri Yogyakarta would like to show gratitude to the curriculum development team, and all the parties giving suggestions and feedbacks. It is expected that this curriculum can help the implementation of academic activities which fulfill the quality standard of higher education.

Yogyakarta, August 19, 2022
Dean,

Prof. Dr. Ariswan, M.Si.
NIP. 195909141988031003

ACKNOWLEDGEMENT
HEAD OF BACHELOR IN PHYSICS PROGRAM

We express our gratitude to Allah SWT, the One God, who bestows blessings and guidance, enabling us to complete the Outcome Based Education (OBE) Physics Curriculum. This curriculum has been meticulously designed and thoroughly researched to ensure that our students possess skills and knowledge relevant to the increasingly complex demands of the workforce.

The OBE-based Physics Curriculum allows students to gain a deep understanding of the fundamental principles of physics, develop strong experimental, analytical, and problem-solving skills, and adapt quickly to technological and industrial developments. We believe that this curriculum will provide a solid foundation for our students to pursue successful careers in physics and related fields.

We hope that this curriculum will help create a new generation of high-quality physicists who contribute to the advancement of science and technology. We extend our gratitude to all parties involved in the development of this curriculum, and we hope that our students will enjoy an engaging and beneficial learning experience in the Physics Program."

Yogyakarta, December 20, 2022
Coord. of Bachelor Physics Program

Dr. Supardi, S.Si., M.Si.

BACHELOR PROGRAM IDENTITY

Bachelor Program	: Physics
Establishment Permit	: Keputusan Dirjen DIKTI no: 240/DIKTI/Kep. 1997
Acreditation	: Unggul
Certificate of Acreditation	: 12810/SK/BAN-PT/AK-ISK/S/XII/2021
Coordinator of BP Program	: Dr. Supardi, S.Si., M.Si
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INTRODUCTION

A. Bacground

Universitas Negeri Yogyakarta, as one of the leading higher education institutions and Teacher Training Institutes (LPTK) in Indonesia, sets its vision: To become an excellent, creative, and innovative educational university based on piety, independence, and intellectuality by the year 2025. This vision clearly demonstrates UNY's strong commitment to producing graduates who are excellent, creative, and innovative in line with various demands of future changes. Various efforts are made to produce graduates who are pious, independent, and intellectual so that they are capable of living and succeeding in the future.

In today's world, we are faced with various massive and disruptive changes in various fields. The rapid pace of development in science and technology, along with waves of digital technology, artificial intelligence, virtual reality, nanotechnology, and the Internet of Things accompanying the unfolding of the Fourth Industrial Revolution (Schwab, 2016) and Society 5.0 (Keidanren, 2019), will shape the future development landscape. Additionally, the growth from the millennial generation towards Generation Z, alpha, and beyond serves as a catalyst accelerating the pace of change. Various studies (Trilling & Fadel, 2009; OECD, 2011; WEF, 2016) fundamentally agree that these changes bring consequences for the characteristics of future human resources. The characteristics of future human resources entail comprehensive individuals with proficient expertise, noble character, creative and innovative problem-solving abilities, as well as critical and futuristic thinking skills.

In the context of education, including higher education as the main vehicle for preparing human resources, the changing demands of future human resources entail the consequence of the necessity for adjustment and change in orientation to produce graduates who have high adaptability to various demands of these changes. This awareness is what drives the Faculty of Mathematics and Natural Sciences to always take steps to change and improve the implementation of education through a "main design" in the form of a curriculum. The curriculum serves as a guide for a learning program, thus its existence requires dynamic design, implementation, and evaluation in accordance with the development of the times, the needs of science and technology, as well as the competencies required by society and users of university graduates.

The development of the curriculum within the scope of the Faculty of Mathematics and Natural Sciences in 2019 as an improvement from the 2014 Curriculum is a form of continuous improvement in line with various regulations set forth. Law Number 12 of 2012 concerning Higher Education asserts that the curriculum of Higher Education is developed by each university with reference to the National Standards of Higher Education for each Study Program, which includes the development of intellectual intelligence, noble character, and skills. Thus, the development of the curriculum within the scope of the Faculty of Mathematics and Natural Sciences is intended to develop graduates to have comprehensive intelligence.

Curriculum is a set of plans and arrangements regarding the objectives, content, and teaching materials as well as the methods used as guidelines for organizing learning activities to achieve higher education goals (Minister of Education and Culture Regulation No. 3 of 2020).

At the operational level, the objectives are formulated in terms of graduate learning outcomes (graduate competency standards), the content and teaching materials are formulated in the curriculum structure (content standards), and the methods used as guidelines for organizing learning activities to achieve higher education goals are realized in the learning process (process standards) and assessment (assessment standards). Therefore, in line with this policy, curriculum formulation within the scope of the Faculty of Mathematics and Natural Sciences includes aspects of Graduate Profiles and Graduate Learning Outcomes, Curriculum Structure, Learning Processes, and Assessment.

Higher Education Curriculum is the mandate of institutions that must always be updated in accordance with the development of needs and science and technology incorporated into learning outcomes. Higher education institutions as producers of educated human resources need to measure their graduates, whether the graduates produced have abilities equivalent to the abilities or learning outcomes formulated in the qualification levels of the Indonesian National Qualifications Framework (KKNI) as stipulated in Presidential Regulation No. 8 of 2012 concerning the Indonesian National Qualifications Framework (KKNI). Nationally, Bachelor/Applied Bachelor Program graduates, for example, must have at least the ability equivalent to the learning outcomes formulated at level 6 KKNI, Master/Applied Master equivalent to level 8, and Doctorate/Applied Doctorate equivalent to level 9. The description of learning outcomes in KKNI contains four elements, namely attitude and values, work skills, mastery of knowledge, and authority and responsibility. Meanwhile, in SN-Dikti (National Higher Education Standards), CPL (Learning Outcomes) is formulated in terms of attitudes, general skills, specific skills, and knowledge. Attitude and general skills have been detailed and listed in the SN-Dikti annex, while specific skills and knowledge must be formulated by similar study program forums which are the characteristics of graduates of that study program. Based on these CPLs, the development of a study program curriculum can be developed.

Correlation between the development and implementation of higher education curriculum with the SN-Dikti through a study on each element of the curriculum implementation as a continuous improvement process is a manifestation of the implementation of the Internal Quality Assurance System (SPMI) as well as the External Quality Assurance System (SPME). In connection with international accreditation, the curriculum that has been developed based on SN-Dikti actually utilizes the Outcome-Based Education (OBE) approach through three main stages, namely:

1. Outcome-Based Curriculum (OBC), curriculum development based on the profile and Graduate Learning Outcomes (CPL).
2. Outcome-Based Learning and Teaching (OBLT), implementation of learning activities (forms and methods of learning) which will be conducted referring to and in accordance with CPL.
3. Outcome-Based Assessment and Evaluation (OBAE), assessment and evaluation approach carried out on the achievement of CPL in order to improve the quality of continuous learning.

Based on the formulation above, it can be asserted that curriculum development within the scope of the Faculty of Mathematics and Natural Sciences (MIPA) is carried out in line with the demands of the times, the development of knowledge and technology, as well as the competencies needed by society and the users of university graduates. In addition, the curriculum within the scope of the Faculty of Mathematics and Natural Sciences is developed in accordance with various regulations, especially the Higher Education System, National Higher Education Standards, KKNI, and OBE.

B. Curriculum Development Foundation

Curriculum of bachelor in science program is developed with reference to various foundations including philosophical, sociological, psychological, technological, and juridical foundations, with the following explanations:

1. Philosophical Foundation. Curriculum development requires philosophy as a reference or basis for thinking. Ontologically, curriculum development is part of the essence of education as a whole, which serves as a support and tool to achieve educational goals. The national education goals are derived from the worldview of living in society, nationhood, and statehood, namely Pancasila, the 1945 Constitution of the Republic of Indonesia, the Unitary State of the Republic of Indonesia, and Bhinneka Tunggal Ika, adapted to dynamic times. The developed curriculum should facilitate the development of students' potential to become faithful and devout individuals to God Almighty, morally upright, healthy, knowledgeable, skilled, creative, independent, and responsible citizens. The learning process is encouraged to educate students to have a strong national character so that they can become Indonesian individuals who embody their Indonesian identity, possess intelligent character, and actively contribute to creating a world that is orderly, just, safe, and peaceful. Additionally, learning needs to align with values derived from local cultures to contribute to the preservation and development of culture while guiding change.

   Epistemologically, curriculum development aims to interpret the essence of knowledge (knowledge sources, methods of seeking knowledge, validity of knowledge, and boundaries of knowledge). Curriculum development will provide a scientific basis of thinking to students according to the nature of reasoning, both deductive and inductive. The curriculum is developed to produce graduates who are sensitive, capable, and able to respond to the future demands of the Indonesian nation amidst international society. Students are required to have initiative, ways of thinking, attitudes, and proactive actions in developing dignity and national character.

   Axiologically, curriculum development needs to place basic values that have been agreed upon at UNY as references. These values are values of piety, independence, intelligence, and usefulness to society and the Indonesian nation.

   Philosophical studies of the curriculum will address issues: (1) how educational goals should be formulated, (2) what educational content or materials should be presented to learners, (3) what teaching methods should be used to achieve goals, and (4) what roles educators and learners should play. In this regard, the development of the curriculum within the scope of the science faculty is based on four philosophic foundations: realism, idealism, pragmatism, and reconstructionism.

   Realism emphasizes that reality is physical or material. The goal of education is to equip students with a learning system based on performance, competence, and measurable educational outcomes. Lecturers must bring the reality of the physical world (contextual) into the classroom. Students regularly and continuously learn specific skills to become experts in a field of work. Students need to be prepared with specific skills to fill job vacancies or adapt appropriately to their lives. Students are brought into the realities of the workplace.

Idealism interprets truth as plural, subjective, and not absolute. Developing students' character holistically and self-awareness is the primary goal of education. Therefore, the curriculum is designed to produce whole human beings that encompass various aspects holistically. Students are more involved in the thinking process so they can grasp the basic ideas and concepts given by lecturers. Teaching strategies should develop students' abilities holistically, including thinking skills, emotional intelligence, dialogical ability, and logical thinking. Therefore, the teaching methods used in idealistic education require active participation from learners, resembling Socratic teaching by delivering lessons indirectly. Learning is done by stimulating students with questions so that they actively think in search of truth.

Pragmatism interprets truth as physical reality. Everything in nature and life is subject to change. Education is not preparation for life but life itself. Education manifested in the curriculum should provide integrated experiences structured in an "experiential continuum" throughout life. Learning should provide experiences to students that reflect real-world situations and work environments. Learning activities are conducted "hands-on," where students gain practical, authentic, and contextual experiences consistent with real-life practices in society. Problem-solving methods, experimentation, and project models are suitable learning methods applied with the hope of making students more resilient and creative and developing their problem-solving abilities in real life.

Reconstructionism views truth as temporary. People seek truth by continuously critiquing ongoing practices in society. Reconstructionist curriculum allows students to become agents of change by planning, researching, critiquing, and promoting changes or innovations to improve human life. Reconstructionist curriculum can develop critical thinking skills, criticality towards practices of injustice and imbalance. Lecturers provide students with opportunities to use time, both inside and outside the campus, thereby giving them opportunities to learn from real social environments and also apply their learning to society to solve existing societal problems.

The development of the curriculum within the scope of the science faculty combines these four philosophical foundations eclectically and incorporatively, as presented in the following Table 1

Table 1. Basic Philosophy of Curriculum Development

Desired Education	Basic philosophy	Educational Approach	Psychological Approach	Learning approaches	Lecturer's Role
Develop skills in areas of expertise	Realism	Competency-Based Education	Behavioristic	Skill training,	Instructor, facilitator
Develop thinking, feeling, morals	Idealism	Development of generic abilities	Humanistic & cognitivistic	Socratesian, metacognitive, value clarification	
Develop problem solving abilities	Pragmatism	Production-Based Training	Cognitivistic & experimental learning	Learning by doing, project method, contextual learning	
Develop critical thinking skills	Reconstructionism	Social reconstruction, preparing humans as agents of change	Critical education	Project method, socoal thematic, social problem solving	

Based on Table 1, it can be summarized that philosophically, curriculum development within the scope of the Faculty of Mathematics and Natural Sciences is oriented towards producing graduates who have strong expertise in their respective fields, possess character, are capable of problem-solving, and think critically.

1. Sociological foundationan

   The sociological foundation in curriculum development at the Faculty of Mathematics and Natural Sciences is carried out by taking sociology assumptions as the starting point in development. Students come from society, receive education within the scope of society, and are directed to be able to engage in community life. Therefore, the life of society and culture with all its characteristics are the foundation and starting point in implementing education.

   Education is the process of preparing students to become the expected society, a process of socialization, as well as a process of enculturation or cultural development. Education is expected to produce individuals who are not unfamiliar with society, becoming individuals of higher quality, understanding, and capable of building their society. The objectives, content, and process of education must be adjusted to the conditions, characteristics, and development of society. The curriculum must be able to facilitate students to collaborate, interact, adapt to life in society, and enhance their dignity and honor as cultured beings.

   The learning process needs to adapt to the dynamics of society as well as the development of science and technology. Changes occurring at the local, regional, and global levels pose challenges in education development. The demands of increasingly complex changes need to be anticipated by developing a curriculum according to these change demands. The curriculum needs to be developed to prepare students to respond to the challenges and demands of society. The curriculum needs to formulate strategies so that learning can anticipate the development of society and be relevant to current issues, making learning or the education process more meaningful.

2. Psychological Foundations

Education is related to human behavior. In its process, education fosters interaction between learners and both physical and social environments. Through education, a change in student behavior towards maturity is expected, encompassing physical, mental, emotional, moral, intellectual, and social maturity. The curriculum, as a means to achieve educational goals, is expected to serve as a tool for developing and optimizing students' potential and instilling new insights and competencies for entering the future.

Curriculum development of FMIPA UNY is based on psychological assumptions, including studies on what and how learners develop (developmental psychology) and how learners learn (learning psychology). Through these studies, teaching is conducted in accordance with the characteristics of students, including adjustments in terms of the abilities to be achieved, the material to be delivered, the delivery or learning process, and adjustments in terms of learning evaluation.

Students are adults. They have unique learning characteristics that differ from children. Therefore, understanding the characteristics of adult learning is necessary to choose appropriate and effective learning strategies. Adult learning (Andragogy) is conducted by stimulating students to engage in the process of searching for and discovering the knowledge they need in life.

3. Technological Foundation

Development of science and technology has significant implications for educational advancement. Educational activities require support from the advancements in science and technology, including methods and equipment such as computers, television, software, and so on. Considering that education is an effort to prepare students for the future as agents of change in society, curriculum development should be based on the progress of science and technology.

The development of science and technology impacts curriculum development, including development of learning content, utilization of teaching strategies and media, and implementation of evaluation systems. Thus, curriculum development is designed to equip students with problem-solving skills as consequence of development in science and technology. On the other hand, the progress of science and technology is also utilized to address educational issues.

3. Juridical Foundation

The curriculum within scope of FMIPA UNY was developed with following juridical foundations:

a. Law Number 12 of 2012 concerning Higher Education
b. Government Regulation Number 4 of 2014 concerning "Implementation of Higher Education and the Management of Higher Education".
c. Government Regulation Number 13 of 2015 concerning "Second Amendment to Government Regulation Number 19 of 2005, regarding National Education Standards".
d. Presidential Regulation of the Republic of Indonesia Number 8 of 2012 concerning "Indonesian National Qualifications Framework".
e. Minister of Education and Culture Regulation of Republic of Indonesia No. 73 of 2013 concerning "Implementation of Indonesian National Qualifications Framework in Higher Education"

f. Minister of Education and Culture Regulation of Republic of Indonesia No. 81 of 2014 concerning "Diplomas, Competency Certificates, and Professional Certificates in Higher Education".
g. Minister of Education and Culture Regulation Number 50 of 2014 concerning "Quality Assurance System of Higher Education".
h. Minister of Research, Technology, and Higher Education Regulation Number 35 of 2017 concerning "Statute of Yogyakarta State University".
i. Minister of Education, Culture, Research, and Technology Regulation Number 3 of 2020 concerning "National Standards for Higher Education".
j. Guidelines for the Preparation of Higher Education Curricula in Industry 4.0 Era to Support Independent Learning-Campus Independence, published by the Directorate of Learning and Student Affairs, Ministry of Education and Culture and Research Technology.

C. VISION, MISSION AND OBJECTIVES OF UNIVERSITAS NEGERI YOGYAKARTA

UNY was founded in 1999 based on President Decree of Republic Indonesia number 93 of 1999. Before transforming to a university, UNY was called IKIP Yogyakarta which was founded in 1963. Since April 2022, UNY has got "Excellent" accreditation by BANPT.

1. Vision

"In 2025, UNY becomes a excellent, creative, innovative and sustainable educational university based on devotion, independence and intelligence.".

2. Mision

1) providing education through academic, vocational and professional pathways which are excellent, creative and sustainable innovative;
2) carry out research and development in the fields of science and technology, social humanities, sports and health, and arts and culture that are superior, creative and sustainable innovative;
3) organize excellent, creative and innovative community service activities for the empowerment and welfare of the community;
4) organize and build sustainable networks level. national and international; And
5) carry out transparent and accountable institutional governance, services and quality assurance.

3. Objectives

a. Produce graduates who are excellent, creative, innovative, devout, independent and intelligent;
b. produce discoveries, development, and dissemination of science, technology, arts and/or sports that improve the welfare of individuals and society, support regional and national development, and contribute to solving global problems;
c. carrying out community service and empowerment activities that encourage the development of human, community and natural potential to realize community welfare;;
d. produce networks involving society, academics, industry and media at national and international levels;
e. produce transparent and accountable university governance in implementing higher education autonomy.

D. VISION, MISION, AND OBJECTIVES OF FMIPA UNY

Vision, mission, and objectives of Faculty of Mathematics and Natural Sciences UNY are explained in following:

1. Vision

   "In 2025, to become a distinguished faculty in the Southeast Asian region, characterized by a scientific attitude, critical, creative, and innovative grounded in piety, independence, and scholarship".

2. Mision

   1) Conducting STEM education in both educational and non-educational fields to produce outstanding graduates with scientific attitudes, critical, creative, and innovative, competitive at the regional level, prioritizing piety, independence, and scholarship.
   2) Organizing STEM research activities to discover, develop, and disseminate knowledge and technology that benefit individuals and society, support regional and national development, and contribute to solving regional and global problems.
   3) Conducting community service and empowerment activities in the field of STEM to encourage the development of human potential, society, and nature, and to achieve community welfare.
   4) Establishing good and clean governance of FMIPA UNY, as well as building networks and partnerships in implementing university autonomy.

3. Objectives

   1) Producing human resources (graduates) with academic and professional excellence in STEM and STEM Education fields. Competitive at the regional level, devout, independent, and scholarly, upholding the values of Pancasila.
   2) Producing STEM research and education that support the development of science and technology benefiting individuals and society, supporting regional and national development, and contributing to solving regional and global problems.
   3) Realizing community service and empowerment activities in STEM fields that encourage the development of human potential, society, and nature, and to achieve community welfare.
   4) Enhancing the capacity of FMIPA to achieve effective and efficient governance of STEM education in implementing university autonomy.

E. CURRICULUM DEVELOPMENT STAGES

The curriculum development process begins with needs analysis (market signal) through curriculum evaluation, which includes measuring the achievement of the current curriculum's CPL (Curriculum Program Learning) through tracer studies, input from users, graduates, alumni, and experts in the field. Curriculum evaluation also involves examining the developments in science and technology in relevant fields, market needs, as well as the vision and values developed by each institution (scientific version). The stages of needs analysis (market signal) and studies conducted by the study program according to its disciplinary field (scientific vision) produce Graduate Profiles. Next, from these graduate profiles, Learning Outcomes (CPL), study materials, courses along with credit weights, and curriculum structures are formulated. The next stage is the formulation of learning and assessment strategies. Schematically, these stages are presented in Figure 2.

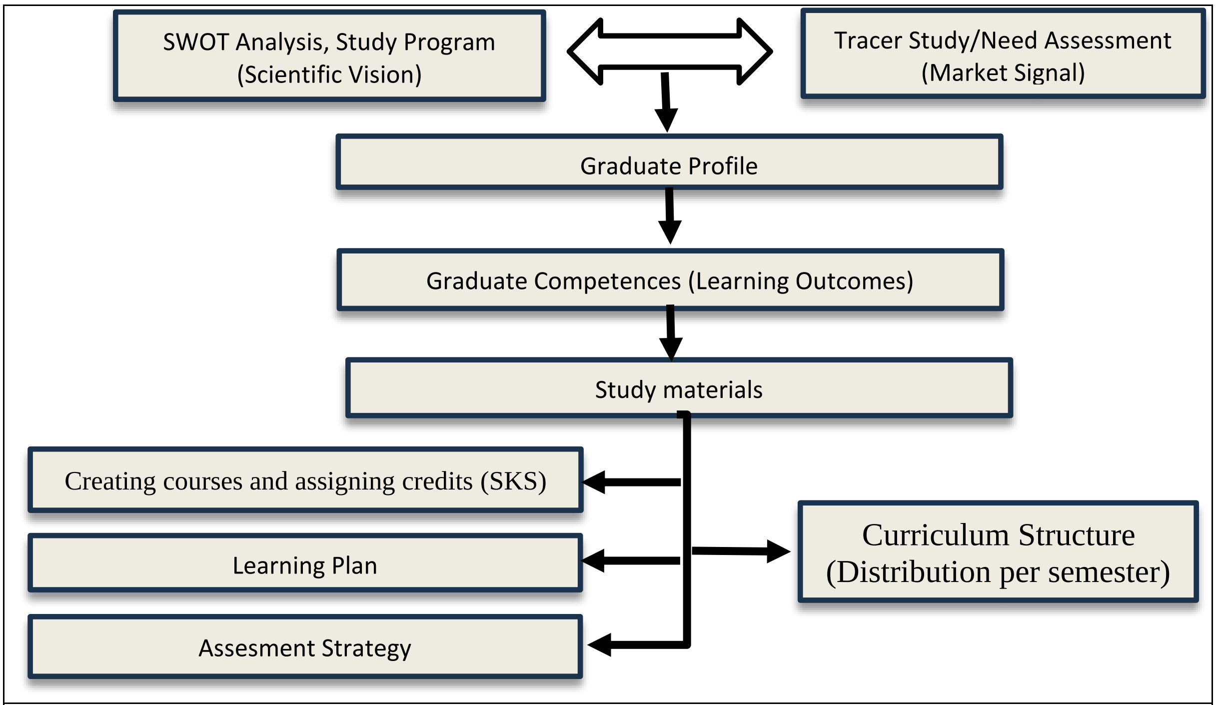

Figure 1. Curriculum Development Stages

In detail, the stages of curriculum development as depicted in Figure 2 can be elaborated as follows:

1) Determination of Graduate Profile
   The graduate profile refers to the roles that graduates can perform in specific fields of expertise or work areas after completing their studies. The profile can be established based on studies of the needs of the job market required by the government and business or industry, as well as the needs in developing science and technology. Ideally, the graduate profile of study programs should be developed by similar study program groups, so that there is an acceptable agreement and reference nationally. Graduates of the study program need to have the abilities stated in the profile, which are expressed in CPL formulations.
2) Formulation of Learning Outcomes or Graduate Learning Achievements (CPL)
   CPL is formulated with reference to the qualifications framework (KKNI) and SN-Dikti. CPL consists of attitudes, general skills, specific skills, and knowledge. Attitude and general skills refer to SN-Dikti as the minimum standard, which can be supplemented by study programs to characterize their graduates. Meanwhile, specific skills and knowledge are formulated with reference to KKNI descriptors according to the educational level. CPL formulations are recommended to include abilities needed in the era of Industry 4.0, such as: data literacy, technology literacy, human literacy, 21st-century skills (Communication, Collaboration, Critical thinking, Creative thinking, Computational logic, Compassion, and Civic responsibility), understanding of the Industry 4.0 era and its developments, and understanding of knowledge to be practiced for the common good locally, nationally, and globally.
3) Determination of Study Materials and Learning Content
   Each CPL item of the study program contains study materials to be used to form courses. These study materials can consist of one or more branches of knowledge and their sub-branches, or a set of knowledge that has been integrated into a new knowledge agreed upon by similar study program forums as a characteristic of the study program's field of knowledge. The study materials are then detailed into learning content. The breadth and

depth of the learning content refer to CPL.

4) Formation of Courses and Determination of Credit Units (SKS)
   The determination of courses for the current curriculum is done by evaluating each course with reference to the CPL of the study program that has been established beforehand. The evaluation is conducted by assessing the extent to which each course (learning materials, task forms, exam questions, and assessments) is related to the formulated CPL. The formation of new courses is based on several CPL items assigned to them. The amount of credit units (SKS) of a course is interpreted as the time required by students to acquire the abilities formulated in a course. The determining factors for estimating the amount of credit units include: the level of ability to be achieved; the depth and breadth of the learning content to be mastered; and the learning methods/strategies chosen to achieve those abilities.ecara rinci, tahapan pengembangan kurikulum sebagaimana Gambar 1 di atas dapat diuraikansecara rinci sebagai berikut.
5) Course Organization in Curriculum Structure
   The organization of courses within the curriculum structure needs to be done carefully and systematically to ensure that students' learning stages are appropriate, guaranteeing efficient and effective learning to achieve Program Learning Outcomes (PLO). The organization of courses within the curriculum structure consists of horizontal and vertical organization. Horizontal course organization within a semester is intended to expand students' discourse and skills in a broader context. Meanwhile, vertical course organization across semesters is intended to provide mastery of skills according to the level of learning difficulty to achieve the PLO of the program that has been determined.
6) Design of Learning Processes
   Learning is the process of interaction between students, instructors, and learning resources in a learning environment. The characteristics of the learning process are interactive, holistic, integrative, scientific, contextual, thematic, effective, collaborative, and student-centered (SN-Dikti Article 11). Being student-centered means that graduate learning outcomes are achieved through a learning process that prioritizes the development of creativity, capacity, personality, and student needs, as well as developing independence in seeking and discovering knowledge.
7) Learning Assessment Strategies
   Assessment is one or more processes of identifying, collecting, and preparing data and evidence to evaluate the process and results of student learning in order to fulfill Graduate Learning Outcomes. Assessment of student learning processes and outcomes includes assessment principles; assessment techniques and instruments; assessment mechanisms and procedures; assessment implementation; assessment reporting; and student graduation.

Instruments used for process assessment can be rubrics, and for outcome assessment, portfolios or design works can be used. Assessment should ideally cover important indicators related to honesty, discipline, communication, decisiveness, and confidence that students should possess.

BACHELOR IN PHYSICS CURRICULUM

A. RATIONALE

Bachelor in Physics Program UNY was established in 1997 based on the Letter of the Directorate General of Higher Education No. 1259/DT/T/97, dated May 29, 1997, regarding the permission to open non-education study programs within the environment of FPMIPA IKIP Yogyakarta. With the Presidential Decree of the Republic of Indonesia Number 93 of 1999 dated August 31, 1999, regarding the change of status from IKIP Yogyakarta to Yogyakarta State University (UNY), FPMIPA changed to the Faculty of Mathematics and Natural Sciences (FMIPA), and the Department of Physics Education officially had a Physics study program.

The curriculum development of Bachelor in Physics is based on several reasons and considerations:

1) Industry Needs. The industry and job market are becoming increasingly complex and rapidly evolving. The demand for workers with skills, understanding, and deep knowledge of physics is growing. In this regard, the development of the Physics study program curriculum aims to produce graduates with relevant skills and knowledge to meet the needs of the industry.
2) Advances in Science. Science and technology are continually advancing rapidly. As a Physics Study Program, it is necessary to keep pace with these developments to produce graduates with accurate and in-depth understanding of current physics concepts. The development of the Physics study program curriculum is based on the renewal and development of ongoing physics concepts.
3) National and International Education Standards. The development of the Physics study program curriculum is also based on national and international education standards. The curriculum must align with national and international education standards to ensure that Physics study program graduates meet requirements and possess the skills and knowledge needed worldwide.
4) Skills and Competencies of Graduates. Curriculum development in the Physics study program is based on the skills and competencies of graduates. The curriculum must ensure that graduates have strong experimental, analytical, and problem-solving skills and are able to adapt quickly to technological and industrial developments. Curriculum development should provide a strong foundation for students to develop successful careers in physics and related fields.

B. SCIENTIFIC VISION AND OBJECTIVES

1. Scientific Vision

Bachelor in Physics' scientific vision is to develop applied physics science that supports local potential related to sustainable environments.

2. Objectives

The Objectives of Bachelor in Physics UNY are based on the formulation of the vision and mission held by Bachelor of Physics. The preparation of the Program Educational Objectives (PEOs) of the Bachelor Program is based on two related regulations, namely Law Number 14 of 2005 concerning Teachers and Lecturers and Presidential Regulation of the Republic of Indonesia No. 8/2012 concerning the Indonesian National Qualifications Framework (KKNI). KKNI is a framework for the qualification hierarchy of Indonesian human resources that juxtaposes, equates, and integrates the education sector with the training and work experience sectors in a scheme of recognizing work capabilities adapted to the structure in various job sectors. KKNI is the embodiment of the quality and national identity of Indonesia related to the national education system, the national work training system, and the national assessment system for equivalence of national learning outcomes, which Indonesia has to produce qualified and productive national human resources. According to KKNI, the bachelor's degree qualification level S1 of the Physics Study Program is included in level 6. Based on the vision and mission of the Physics Study Program, the vision and mission of FMIPA, the vision and mission of Yogyakarta State University, the Indonesian National Qualifications Framework (KKNI), the National Higher Education Standards (SN Dikti), and several related regulations, the Physics Study Program formulates 4 (four) PEOs, namely:

Table 1. Program Educational Objectives (PEOs) Prodi Fisika UNY

No.	Program Objectives Description
PEO 1	Graduates are capable of exhibiting personal characters, academic attitude, and scientific integrity
PEO 2	Graduates are capable of having knowledge in the field of physics
PEO 3	Graduates are capable of performing design skills in the field of physics
PEO 4	Graduates are capable of applying the knowledge of physics to their life and the community

Table 2. Suitability Matrix of PEO with Mission Statements of University, Faculty, and Study Program

PEO		University Mission			Faculty Mission			Bachelor Program Mission			
No.	**Description**	**Tawqa**	**Independent**	**Scholarly**	**Excellent**	**Creative**	**Inovative**	**Organizing Education**	**Conducting Research**	**Engaging Community Service**	**Building Network**
PEO1	Graduates are capable of exhibiting personal characters, academic attitude, and scientific integrity	v	v	v	v	v	v	v	v	v	V
PEO2	Graduates are capable of having knowledge in the field of physics			v	v			v	V		
PEO3	Graduates are capable of performing design skills in the field of physics		v	v	v	v	v	v	v	v	
PEO4	Graduates are capable		v	v	v	v	v			v	v

	of applying the knowledge of physics to their life and the community										

Table 3. Relationship between PO and KKNI Refers to KKNI Level 6

The 6th level of Indonesian Qualification Framework (KKNI level 6)	Program Educational Objectives			
	PEO-1	PEO-2	PEO-3	PEO-4
Capable of applying physics and is adaptable to various situations faced during solving a problem		v	v	v
Mastering the concepts of classical and modern physics and capable of formulating physics problem solving procedures.		v	v	
Capable of taking strategic decisions based on information and data analysis and provides direction in choosing several alternative solutions.			v	
Responsible for her/his own job and can be assigned responsibility of the attainment of organization's performances.	v			

C. GRADUATE PROFILE

In line with the vision and mission of the Physics Department at Yogyakarta State University, which aims to create graduates who are excellent, critical, creative, and innovative, dedicated to serving the community, and capable of collaborating with others, there are three occupation profiles held by Physics graduates, namely: (1) academia, ready to pursue further studies, (2) research assistant, prepared to assist in conducting research, and (3) practitioner, capable of applying Physics knowledge in current technological fields.

Table 4. Relationship between the graduate profile of the Physics study program and PLO

Graduate Profile	Program Learning Outcome							
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
Academia	v	v	v	v	v	v	v	v
Research assistant	v	v	v	v	v	v	v	v
Practitioner	v	v	v	v	v	v	v	v

Mapping the PLO of Bachelor in Physics UNY with ASIIN Subject Specific Criteria (SSC)-13 is described in table 5

Table 5. Mapping PLO with SSC-13

No.	SSC-13	Program Learning Outcome							
		1	2	3	4	5	6	7	8
1	They have sound knowledge of classical physics (mechanics, electrodynamics, thermodynamics, oscillations, waves and optics) and are familiar with the fundamentals of quantum, atomic and		v						

	molecular, nuclear, elementary particle and solid state physics.								
2	They are familiar with important mathematical methods used in physics and can use these to solve physics problems.			v					
3	They have an extensive understanding of the fundamental principles of physics, their inherent relation and mathematical formulation and, based on this, have acquired methods suitable for theoretical analysis, modelling and simulation of relevant processes.		v	v		v			
4	They have applied their knowledge to physics problems in an exemplary manner and studied some areas in greater depth, thereby acquiring a first basis for problem solving competence.					v			
5	They have a basic capacity to comprehend physics problems. This will in general however not yet facilitate a deeper understanding of current research areas.					v			
6	They are therefore in a position to independently classify physics-based and to some extent also interdisciplinary problems that require a target-oriented and logic-based approach, and to analyze and/or solve them by using natural scientific and mathematical methods.				v	v			
7	They are familiar with basic principles of experimentation, are able to use modern physics measurement methods, and are in a position to assess the significance of results correctly.			v					
8	They have generally also acquired an overview knowledge in selected other natural science subjects or technical disciplines.						v		
9	They are able to apply their knowledge to different fields and act responsibly in their professional activity. They are moreover able to recognize new trends in their subject area and integrate the relevant methodology – if necessarily after appropriate qualification – into their further work.	v			v				v

10	They are able to continuously and independently extend and deepen the knowledge acquired in the Bachelor's degree program. They are familiar with suitable learning strategies (lifelong learning) for this; they are in particular qualified for a consecutive Master's degree program in principle.				v				v
11	They have gained initial experience with regard to generic qualifications (e.g. time management, study and work techniques, willingness to cooperate, capacity for teamwork, communication and presentation skills, communication and presentation techniques, programming skills) in their degree program, and are able to develop these skills further	v						v	v
12	They are familiar with the basic elements of the relevant specialized English							v	
13	They are able to solve a simple scientific problem and to present their results orally (talk/presentation) and in writing (demonstrated in a Bachelor's thesis)				v			v	
14	They know the rules of good scientific practice	v							

D. Program Learning Outcomes (PLOs)

Bachelor in Physics' PLOs are based on inputs from alumni, stakeholders, and considerations of current era developments. Table 5 illustrates the Physics Study Program Learning Outcomes, while Table 6 presents the relationship between Program Educational Objectives (PEO) and PLO.

Table 5. Bachelor in Physics' PLOs

No.	Program Learning Outcome
PLO1	To show personal characters based on social ethics and academic responsibility
PLO2	To master the concepts of classical and modern physics
PLO3	To be able to use mathematical, computational, and experimental methods in understanding physical concepts
PLO4	To use operational knowledge of physics to carry out research in applied physics
PLO5	To analyze physical phenomena using mathematical, computational, and experimental methods to obtain mathematical or empirical models of the phenomena
PLO6	To be able to use instrumentation skills to solve physical problems
PLO7	To be able to communicate and disseminate the knowledge and research in the field of physics

PLO8	To be able to collaborate in scientific and social community

Tabel 6. Relationship between PEOs and PLOs

Program Objective	Program Learning Outcome							
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
PEO1	v							
PEO2		v	v	v				
PEO3					v	v		
PEO4							v	v

E. Graduates Learning Outcomes in Accordance with KKNI

The graduates learning outcomes (CPL) of Bachelor in Physics UNY are based on the formulated graduate profiles. This formulation is made considering inputs from alumni, stakeholders, and current technological developments. Meanwhile, in accordance with KKNI level 6 as the standard for bachelor's degree KKNI, 37 CPLs for the Physics Study Program have been established as presented in Table 7

Table 7. Graduates Learning Outcomes (CPL) on KKNI Curriculum

No CPL	
Attitude	
A.1	Fear Allah the Almighty and demonstrate religious attitudes
A.2	Uphold the value of humanity in carrying out duties based on religion, morals, and ethics
A.3	Contribute to the improvement of community, national, and state life quality as well as a sense of responsibility to the country and nation
A.4	Act as proud and patriotic citizens, having nationalism and a sense of responsibility to the country and nation
A.5	Appreciate cultural diversity, views, religions, and beliefs as well as the opinions or original findings of others
A.6	Collaborate and have social sensitivity and concern for society and the environment
A.7	Obey the law and discipline in community and state life
A.8	Internalize academic values, norms, and ethics
A.9	Demonstrate responsibility for work in the field of physics independently
A.10	Internalize the spirit of independence, struggle, and entrepreneurship
Mastering of Knowledge	
K.1	Mastering theoretical concepts and fundamental principles of classical and modern physics
K.2	Mastering mathematical, computational, and instrumental methods and their applications in physics
K.3	Mastering knowledge of physics-based technology and its applications

Specific Skills	
S.1	Able to formulate physical phenomena and problems through analysis based on the results of observation and experimentation
S.2	Able to produce mathematical models or physical models that are consistent with hypotheses or forecasts of the impact of the phenomena under discussion
S.3	Able to analyze various alternative solutions to physical problems and draw conclusions for appropriate decision making
S.4	Able to predict the potential application of physical behavior in technology
S.5	Able to disseminate the results of studies on issues and physical behavior of simple phenomena; in the form of reports or papers according to standardized scientific rules
General Skills	
G.1	Able to apply logical, critical, systematic, and innovative thinking in the development and implementation of physics and technology
G.2	Able to communicate ideas, thought outcomes, or research findings in the field of physics and its applications through various scientific media
G.3.	Capable of making accurate decisions in the context of problem-solving in the field of physics and its applications, based on analysis of information and data.
G.4	Capable of developing and maintaining a network of work relationships with mentors, colleagues, peers within and outside their own institution.
G.5	Capable of taking responsibility for group work achievements, supervising and evaluating the completion of tasks assigned to subordinates.
G.6	Able to examine the implications of physics development or implementation based on scientific principles, procedures, and ethics to generate solutions.
Additional Skills	
Ad.1	Capable of developing potential in the business and industry world.
Ad.2	Capable of developing insights and skills beyond the field of physics, such as: health, humanities, economics, and engineering.

Outcomes-Based Education (OBE) Graduate Learning Achievement (CPL)

Table 8 presents the correlation of CPL based on KKNI established by the Physics Study Program of UNY with ASIIN PLO. The KKNI CPL established by the Program is derived through inputs from alumni and stakeholders, taking into account current era developments.

CPL in KKNI		**Program Learning Outcome**	
A.1	Fear Allah the Almighty and demonstrate religious attitudes	PLO 1	*To show personal characters based on social ethics and academic responsibility*
A.2	Uphold the value of humanity in carrying out duties based on religion, morals, and ethics		
A.3	Contribute to the improvement of community, national, and state life quality as well as a sense of responsibility to the country and nation		
A.4	Act as proud and patriotic citizens, having nationalism and a sense of responsibility to the country and nation		

A.5	Appreciate cultural diversity, views, religions, and beliefs as well as the opinions or original findings of others		
A.6	Collaborate and have social sensitivity and concern for society and the environment		
A.7	Obey the law and discipline in community and state life		
A.8	Internalize academic values, norms, and ethics		
A.9	Demonstrate responsibility for work in the field of physics independently		
A.10	Internalize the spirit of independence, struggle, and entrepreneurship		
G.1	Able to apply logical, critical, systematic, and innovative thinking in the development and		

	implementation of physics and technology		
K.1	Mastering theoretical concepts and fundamental principles of classical and modern physics	PLO 2	*To master the concepts of classical and modern physics*
K.2	Mastering mathematical, computational, and instrumental methods and their applications in physics	PLO 3	*To be able to use mathematical, computational, and experimental methods in understanding physical concepts*
S.1	Able to formulate physical phenomena and problems through analysis based on the results of observation and experimentation	PLO 4	*To use operational knowledge of physics to carry out research in applied physics*
S.3	Able to analyze various alternative solutions to physical problems and draw conclusions for appropriate decision making		
G.6	Able to examine the implications of physics development or implementation based on scientific principles, procedures, and ethics to generate solutions.		
S.2	Able to produce mathematical models or physical models that are consistent with hypotheses or forecasts	PLO 5	*To analyze physical phenomena using*

	of the impact of the phenomena under discussion		*mathematical, computational, and experimental methods to obtain mathematical or empirical models of the phenomena*
S.4	Able to predict the potential application of physical behavior in technology		
G.3	Capable of making accurate decisions in the context of problem-solving in the field of physics and its applications, based on analysis of information and data.		
K.2	Mastering mathematical, computational, and instrumental methods and their applications in physics	PLO 6	*To be able to use instrumentation skills to solve physical problems*
K.3	Mastering knowledge of physics-based technology and its applications		
S.5	Able to disseminate the results of studies on issues and physical behavior of simple phenomena; in the form of reports or papers according to standardized scientific rules	PLO 7	*To be able to communicate and disseminate the knowledge and research in the field of physics*
G.2	Able to communicate ideas, thought outcomes, or research findings in the field of physics and its applications through various scientific media		
G.4	Capable of developing and maintaining a	PLO	*To be able to*

	network of work relationships with mentors, colleagues, peers within and outside their own institution.	8	*collaborate in scientific and social community*
G.5	Capable of taking responsibility for group work achievements, supervising and evaluating the completion of tasks assigned to subordinates.		
Ad. 1	Capable of developing insights and skills beyond the field of physics, such as: health, humanities, economics, and engineering.		
Ad. 2	Capable of developing insights and skills beyond the field of physics, such as: health, humanities, economics, and engineering.		

In Table 9, the relationship between program objectives and PLO is presented, while Table 10 expresses the correlation matrix between PO and PLO.

Table 9. Elaboration of PEOs into PLOs

PEO	Program Learning Outcomes	
PEO1	PLO1	To show personal characters based on social ethics and academic responsibility
PEO2	PLO2	To master the concepts of classical and modern physics
	PLO3	To be able to use mathematical, computational, and experimental methods in understanding physical concepts
	PLO4	To use operational knowledge of physics to carry out research in applied physics
PEO3	PLO5	To analyze physical phenomena using mathematical, computational, and experimental methods to obtain mathematical or empirical models of the phenomena
	PLO6	To be able to use instrumentational skills to solve physical problems
PEO4	PLO7	To be able to communicate and disseminate the knowledge and research in the field of physics
	PLO8	To be able to collaborate in scientific and social community

Table 10. Matrix of the relationship between PEO and PLO

Program Objective	Program Learning Outcome							
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
PEO1	v							
PEO2		v	v	v				
PEO3					v	v		
PEO4							v	v

F. STUDY MATERIAL

The subject matter related to the science of the Physics Study Program includes basic physics concepts such as mechanics, thermodynamics, electricity and magnetism, optics, modern physics, and other related fields. In addition, the subject matter also includes experimental, analytical, and problem-solving skills, as well as the application of technology and innovation in physics. Based on this subject matter, the formation of courses in the Physics Study Program can be carried out by considering several factors: (1) considering important basic physics concepts to be learned by students at the undergraduate level, (2) adjusting the course content to the latest technological advancements and innovations in the field of physics, (3) developing students' skills in applying physics concepts and problem-solving through laboratory work and related assignments, (4) maintaining a balance between theory and practice in the courses, (5) providing elective courses that allow students to take courses that align with their interests.

G. CURRICULUM STRUCTURE AND COURSE DISTRIBUTION

G.1 General Structure

To obtain a Bachelor in Science degree (S.Si) Universitas Negeri Yogyakarta, students are required to take courses totaling a minimum of 146 credits within a maximum period of 6 years (12 semesters), choosing one of three available study patterns: 5-1-2 pattern, 6-0-2 pattern, and 6-1-1 pattern. The details are presented in Table 11.

Table 11. Study Patterns of Physics Program

No	Course Group	Credits Load (SKS)		
		Pattern 5-1-2	Pattern 6-0-2	Pattern 6-1-1
1	University Courses	16	16	16
2	Faculty Courses	4	4	4
3	Core Courses (Main)	71	71	71
4	Elective Courses (Advanced)	9	19	23
5	Courses Outside	18	0	12
6	Off-Campus Courses (including Community Service, Internship, and Final Project)	28	36	20
Total SKS		**146**	**146**	**146**

G.2 Courses and Credits Load

Tables 12 to 16 present a list of courses that can be taken by students of Bachelor in Physics, consisting of university courses, faculty courses, program-specific courses, mandatory field courses, and elective courses (advanced).

Tabel 12. List of University Courses

No	Kode	Mata Kuliah	Rincian SKS				Semester	
			T	P	L	Jml	Gs	Gn
1	MKU6201	Islamic Education*	2			2	v	

2	MKU6202	Catholic Education*	2			2	v	
3	MKU6203	Christian Education*	2			2	v	
4	MKU6204	Hindu Education*	2			2	v	
5	MKU6205	Buddhist Education*	2			2	v	
6	MKU6206	Confucian Education*	2			2	v	
7	MKU6207	Civic Education	2			2	v	
8	MKU6208	Pancasila Education	2			2		v
9	MKU6209	Bahasa Indonesia	2			2		v
10	MKU6211	English	2			2		v
11	MKU6212	Digital Transformation	2			2	v	
12	MKU6213	Creativity, Innovation, and Entrepreneurship	2			2	v	
13	MKU6216	Social Literacy and Humanity	2			2	v	
Jumlah			**16**			**16**		

* chosen according to their respective religions

Tabel 13. List of Faculty Courses

No	Kode	Mata Kuliah	Rincian SKS				Semester	
			T	P	L	Jml	Gs	Gn
1	FMI6201	Studies of Mathematics and Natural Sciences	2			2	v	
2	FMI6202	Statistics	2			2	v	
Jumlah			**4**			**4**		

Tabel 14. List of Compulsory Courses

No	Kode	Mata Kuliah	Rincian SKS				Semester	
			T	P	L	Jml	Gs	Gn
1	FSK6303	Multivariable Calculus for Physics	3			3	v	
2	FSK6304	Differential Equations for Physics	3			3		v
3	FSK6305	Linear Algebra for Physics	3			3	v	
4	FSK6407	Computational Physics	3	1		4	v	
5	FSK6209	Physical Measurement and Analysis	2			2	v	
6	FSK6309	Electrical Circuit Analysis	2	1		3	v	
7	FSK6411	Analog Electronics	3	1		4		v
8	FSK6312	Digital System	2	1		3	v	
9	FSK6313	Sensors	2	1		3		v
10	FSK6414	Mechanics	3	1		4	v	
11	FSK6215	Analytical Mechanics	2			2		v
12	FSK6316	Vibrations and Waves	2	1		3		v
13	FSK6317	Thermodynamics	2	1		3		v

14	FSK6218	Statistical Physics	2			2	v	
15	FSK6419	Electromagnetism	3	1		4	v	
16	FSK6321	Optics	2	1		3		v
17	FSK6222	Special Relativity	2			2	v	
18	FSK6324	Quantum Physics	3			3	v	
19	FSK6225	Atomic Physics	2			2		v
20	FSK6226	Nuclear Physics	2			2		v
21	FSK6227	Solid State Physics	2			2		v
22	FSK6228	Basic Colloidal Physics	2			2		v
23	FSK6229	Fluid Mechanics	2			2		v
24	FSK6330	Research Methodology in Physics	2	1		3	v	
25	FSK6231	Advanced Experimental Physics		2		2		v
26	FSK6232	Physics Laboratory Assistance		2		2	v	
		Jumlah	**56**	**15**		**71**		

Tabel 15. List of Compulsory Field Courses (Off-Campus)

No	Kode	Mata Kuliah	Rincian SKS				Semester	
			T	P	L	Jml	Gs	Gn
1	MKL6603	Internship			6	6	v	
2	MKL6604	Community Service			6	6	v	
3	TAM6801	Undergraduate Thesis	8			8		v
Jumlah			**8**		**12**	**20**		

Tabel 16. List of Elective Courses (Advanced)

No	Kode	Mata Kuliah	Rincian SKS				Semeste r	
			T	P	L	Jml	Gs	G n
1	FSK6340	Measurement System	3			3	v	
2	FSK6341	Microcontroller	2	1		3	v	
3	FSK6342	Electronic Amplifier and Filter	2	1		3		v
4	FSK6343	Outomation	3			3		v
5	FSK6344	Antenna	3			3	v	
6	FSK6345	Modulation	3			3		v
7	FSK6346	System and Signal	3			3	v	
8	FSK6247	Crystallography	2			2	v	
9	FSK6348	Semiconductor	3			3	v	
10	FSK6249	Semiconductor Fabrication and Characterization	2			2		v
11	FSK6250	Thin Film	2			2		v
12	FSK6251	Nano Physics	2			2	v	
13	FSK6252	Nanomaterials Characterization	2			2		v
14	FSK6353	Soft Condensed Matter	3			3		v

15	FSK6254	Chemical Physics	2			2	v	
16	FSK6255	Advanced Colloidal Physics	2			2	v	
17	FSK6256	Light Scattering Technology	2			2	v	
18	FSK6257	Surfactant Technology	2			2		v
19	FSK6358	Liquid Crystal	3			3	v	
20	FSK6359	Monte Carlo Methods in Physics	3			3		v
21	FSK6260	Laser	2			2	v	
22	FSK6261	Photonics	2			2		v
23	FSK6362	Atomic and Molecular Spectroscopy	3			3	v	
24	FSK6363	Biomedical Physics	3			3		v
25	FSK6364	Reactor Physics	3			3	v	
26	FSK6265	Reactor Kinematics Experiment		2		2		v
27	FSK6366	Fisika Radiasi	3			3		v
28	FSK6267	Radiobiology and Radiation Protection	2			2	v	
29	FSK6268	Earth and Space Physics	2			2	v	
30	FSK6269	Physical Geology	2			2		v
31	FSK6270	Seismology	2			2	v	
32	FSK6371	Geophysical Survey Methods	2	1		3		v
33	FSK6272	Meteorology and Climatology	2			2	v	
34	FSK6273	Astronomy	2			2		v
35	FSK6274	Physics of Natural Hazards	2			2	v	
36	FSK6297	Philosophy of Physics	2			2		v
37	FSK6201	Elementary Physics*	2			2	v	
38	FSK6301	General Physics*	3			3	v	
Jumlah			**88**	**5**		**93**		

* Offered to students other than physics and physics education

G.3 Courses outside the Bachelor in Physics

Students of Physics undergraduate program who choose the 5-1-2 or 6-1-1 pattern can take credits outside the physics program within the UNY campus environment according to their desired interests and additional competencies, after consulting with their academic advisor. The number of credits taken is 18 credits for the 5-1-2 pattern and 12 credits for the 6-1-1 pattern. Credits for courses outside the program can also be taken from Physics Education program, with course options as presented in Table 17.

Table 17. List of courses outsite Physics Study Program (Physics Education)

No	Code	Name of Courses	SKS in detail				Semester	
			T	P	L	Ttl	Odd	Even

1	PFI6201	Curriculum and Learning Physics	2			2	v	
2	PFI6202	Physics Learning Strategies	2			2	v	
3	PFI6203	Physics Learning Media	2			2	v	
4	PFI6204	Physics Learning Assessment	2			2	v	
5	PFI6206	Physics Laboratory Management	2			2		V
6	PFI6210	Computer-Based Media	2			2	v	
7	PFI6311	Audio-Visual Media	2	1		3	v	
8	PFI6312	Photography	2	1		3		v
9	PFI6213	Professional Development for Physics Teachers School	2			2	v	
10	PFI6214	Physics Studies	2			2	v	
11	PFI6315	Study of Physics Education Research Results	2	1		3		v
12	PFI6216	Learning Strategies and Management	2			2		v
13	PFI6217	Theory and Measurement Techniques	2			2	v	
14	PFI6218	Item Response Theory	1	1		2		v
15	PFI6319	Educational Research Data Analysis	2	1		3		v
16	PFI6220	Selected Topics in Physics Education	2			2		v

G.4 Courses Distribution per Semester

Table 18 presents distribution of courses assosiated with PLO.

Table 18. Courses distribution per semester

Code	Course	Credit Units			PLO							
		Total	Lecture	Labwork	1	2	3	4	5	6	7	8
Semester 1												
MKU6201	Islamic Education	2	2	-	v							
MKU6207	Civic Education	2	2	-	v							
MKU6212	Digital Transformation	2	2	-			v					
FMI6201	Studies of Mathematics and Natural Sciences	2	2	-	v							

FMI6202	Statistics	2	2	-			v					
FSK6303	Multivariable Calculus for Physics	3	3	-			v					
FSK6209	Physical Measurement and Analysis	2	2	-			v					
FSK6309	Electrical Circuit Analysis	3	2	1						v		
FSK6414	Mechanics	4	3	1		v			v			
semester 2												
MKU6208	Pancasila Education	2	2	-	v							
MKU6209	Bahasa Indonesia	2	2	-							v	
MKU6211	English	2	2	-							v	
FSK6304	Differential Equations for Physics	3	3	-			v					
FSK6411	Analog Electronics	4	3	1						v		
FSK6215	Analytical Mechanics	2	2	-		v			v			
FSK6316	Vibrations and Waves	3	2	1		v			v			
FSK6317	Thermodynamics	3	2	1		v			v			
semester 3												
MKU6213	Creativity, Innovation, and Entrepreneurship	2	2	-								v
MKU6216	Social Literacy and Humanity	2	2	-								v
FSK6305	Linear Algebra for Physics	3	3	-			v					
FSK6312	Digital System	3	2	1						v		
FSK6218	Statistical Physics	2	2	-		v			v			
FSK6419	Electromagnetics	4	3	1		v			v			

FSK6222	Special Relativity	2	2	-		v			v			
FSK6324	Quantum Physics	3	3	-		v			v			
semester 4												
FSK6407	Computational Physics	4	3	1			v					
FSK6313	Sensor	3	2	1						v		
FSK6321	Optics	3	2	1		v			v			
FSK6225	Atomic Physics	2	2	-		v			v			
FSK6226	Nuclear Physics	2	2	-		v			v			
FSK6227	Solid State Physics	2	2	-		v			v			
FSK6228	Basic Colloidal Physics	2	2	-		v			v			
FSK6229	Fluid Mechanics	2	2	-		v			v			
FSK6231	Advanced Experimental Physics	2	-	2		v			v			
semester 5												
FSK6330	Research Methodology in Physics	3	2	1				v			v	
FSK6232	Physics Laboratory Assistance	2	-	2							v	
FSK6340	Measurement System*	3	3	-			v					
FSK6341	Microcontroller*	3	2	1					v			
FSK6344	Antenna*	3	3	-					v			
FSK6346	System and Signal*	3	3	-		v			v			
FSK6247	Crystallography*	2	2	-		v			v			
FSK6348	Semiconductor*	3	3	-		v			v			
FSK6251	Nano Physics*	2	2	-		v			v			
FSK6254	Chemical Physics*	2	2	-		v			v			

FSK6255	Advanced Colloidal Physics*	2	2	-		v			v			
FSK6256	Light Scattering Technology*	2	2	-		v			v			
FSK6358	Liquid Crystal*	3	3	-		v			v			
FSK6260	Laser*	2	2	-		v			v			
FSK6362	Atomic and Molecular Spectroscopy*	3	3	-		v			v			
FSK6364	Reactor Physics*	3	3	-		v			v			
FSK6267	Radiobiology and Radiation Protection*	2	2	-		v			v			
FSK6268	Earth and Space Physics*	2	2	-		v			v			
FSK6270	Seismology*	2	2	-		v			v			
FSK6272	Meteorology and Climatology*	2	2	-		v			v			
FSK6274	Physics of Natural Hazards*	2	2	-		v			v			
semester 6												
FSK6342	Electronic Amplifier and Filter*	3	2	1						v		
FSK6343	Automation*	3	3	-						v		
FSK6345	Modulation*	3	3	-						v		
FSK6249	Semiconductor Fabrication and Characterization*	2	2	-		v			v			
FSK6250	Thin Film*	2	2	-		v			v			
FSK6252	Nanomaterials Characterization*	2	2	-		v			v			

FSK6353	Soft Condensed Matter*	3	3	-		v			v			
FSK6257	Surfactant Technology*	2	2	-		v			v			
FSK6359	Monte Carlo Methods in Physics*	3	3	-			v					
FSK6261	Photonics*	2	2	-		v			v			
FSK6363	Biomedical Physics*	3	3	-		v			v			
FSK6265	Reactor Kinematics Experiment*	2	-	2		v			v			
FSK6366	Radiation Physics*	3	3	-		v			v			
FSK6269	Physical Geology*	2	2	-		v			v			
FSK6371	Geophysical Survey Methods*	3	2	1		v			v			
FSK6273	Astronomy*	2	2	-		v			v			
FSK6297	Philosophy of Physics*	2	2	-		v					v	
semester 7												
PKL6603	Internship	6	-	6								v
MKU6614	Community Service	6	-	6								v
semester 8												
FSK6801	Undergraduate Thesis	8	8	-				v				v

H. LEARNING PROCESS

Learning process in Physics Study Program is carried out with reference to the National Higher Education Standards, which include the characteristics of learning process, planning of learning process, implementation of learning process, and student learning load. Characteristics of the learning process include interactive, holistic, integrative, scientific, contextual, thematic, effective, collaborative, and student-centered nature. Planning of the learning process is prepared for each course and presented in the semester learning plan (RPS) developed by lecturers independently or together in a group of expertise.

Implementation of learning process takes place in the form of interaction between lecturers, students, and learning resources in a specific learning environment. It can be carried out using various learning methods: group discussions, simulations, case studies, collaborative learning, cooperative learning, project-based learning, problem-based learning, or other effective learning methods, which can effectively facilitate the achievement of learning outcomes. Each course may use one or a combination of several learning methods and is accommodated in a form of learning such as (1) lectures, (2) responses and tutorials, (3) seminars, (4) laboratory work or field practice, (5) internships, (6) research, (7) humanitarian projects, (8) entrepreneurship, (9) student exchanges, and/or (10) other forms of community service. These forms of learning accommodate students' interests and potentials to develop themselves as part of the freedom of learning to achieve desired learning outcomes. Learning in Physics Study Program has utilized technological advancements. Several courses have developed online lectures that can be used fully or in blended learning and can be accessed through the Learning Management System (BeSmart UNY) on the website http://besmart.uny.ac.id/v2/ . Students are also required to be able to utilize technology through various available applications. Assignments can be done by utilizing existing technology applications such as social media and YouTube.

The student learning load is stated in terms of credit units per semester (sks). One credit unit of lecture activity is equivalent to 170 (one hundred seventy minutes: 50 minutes face-to-face, 60 minutes structured tasks, and 60 minutes self-study) learning activities per week per semester. Each course must have a minimum weight of 1 (one) credit unit. A semester is the unit of time for effective learning activities for 16 (sixteen) weeks. Further explanations regarding the allocation of learning time are regulated through the UNY Rector Regulation Number 1 of 2019 concerning UNY Academic Regulations Article 7.

Learning process is aimed at fulfilling the competency achievements of the study program in accordance with PLO and Course Learning Outcomes (CLO). These competency achievements require the implementation of a learning process with a system centered on students (student learning center). Learning emphasizes strengthening personality, social, pedagogical, and professional competencies. Learning can be conducted through face-to-face/meetings, including e-learning structured assignments, independent tasks, and other equivalent activities, seminars, practices, research, and community service. Learning can also be done through blended learning or full e-learning models. The total number of learning sessions per semester is 16 times. Students are required to attend lectures at least 75% of the scheduled face-to-face sessions.

Implementation of learning fundamentally involves three stages: introductory, core activities/presentation, and conclusion. Regarding the principle of comprehensive learning, learning activities facilitate students to acquire learning experiences and mastery according to the predetermined competency achievements. Therefore, contextual approaches, lesson study models, and future my action plan (FMAP), with activities that encourage students to be active, innovative, creative, inspirational, and create an enjoyable atmosphere, become continuously developed learning processes. Character perspectives, national values, and entrepreneurial spirit are inseparable parts of building learning meaning. Through the developed learning process, the success of students is determined not only based on hard skills, intellectual abilities (GPA), but also soft skills by considering cognitive abilities, character, personality, and morality.

I. ASSESSMENT

Assessment system in Physics Study Program follows the Regulation of Rector of Universitas Negeri Yogyakarta Number 1 Year 2019 regarding Academic Regulations in Article 21. Determination of academic abilities of Physics students includes knowledge, skills, and attitudes/character reflecting student competencies. Assessment of learning outcomes utilizes various approaches according to the competencies that students must master. The final grade for a course uses a scale from 0 (zero) to 100 (one hundred) with a passing grade of 56 (fifty-six). The final grade is converted into standard letter grades A, A-, B+, B, B-, C+, C, D, and E with set weights as presented at Table 19:

Table 19. Conversion of numeric values to letters

Final Score	Conversion	
Scale 100	Letter	Weight
86 – 100	A	4.00
81 – 85	A-	3.67
76 – 80	B+	3.33
71 – 75	B	3.00
66 – 70	B-	2.67
61 – 65	C+	2.33
56 – 60	C	2.00
41 – 55	D	1.00
0 – 40	E	0.00

The course grade is cumulative result of participation in class activities, completion of assignments/reports, and exam scores that reflect students' mastery of competencies. Calculation of Semester Grade Point Average (GPA) is determined by: transferring letter grades into numerical grades/weights, multiplying them by the number of credit hours (SKS) of the course, and dividing the total by the number of credit hours taken by the student in that specific semester.

J. COURSES DESCRIPTION

FSK6303 Multivariable Calculus for (3 SKS)

In this course, students are expected to master the basic mathematical concepts used in theoretical analysis in the field of physics. The topics covered include: concept of functions, infinite series, limits, derivatives, partial derivatives, integrals, and multiple integrals.

Main reference:
Stewart, J., *Calculus 7th edition*, 2012, Cengage Learning.

FSK6209 Physical Measurement and Analysis (2 SKS)

In this course, students are expected to master the basic concepts of physics measurement. The topics covered include: measurement uncertainty, uncertainty reporting, uncertainty propagation, random and systematic errors, statistical analysis of random uncertainty, normal distribution.

Main reference:
Taylor, J.R., 1997, *An Introduction to Error Analysis 2nd edition*, University Science Books

FSK6309 Electrical Circuit Analysis (3 SKS; 2 SKS Theory, 1 SKS Labwork)

This course explores the concepts of Ohm's Law, series and parallel circuits, Kirchhoff's Laws I and II, equivalent circuits (Thevenin and Norton), circuit analysis (mesh, loop, superposition methods), transient phenomena, series and parallel circuits of R-C, R-L, and R-L-C. It is expected, students will be able to analyze AC and DC circuit diagrams and translate circuit diagrams into circuits with actual electronic components, as well as measure circuit parameters (voltage and current).

Main reference:
Alexander, C.K. & Sadiku, M.N.O., 2016, *Fundamentals of Electrics Circuits 6th edition*, McGraw-Hill.

FSK6414 Mechanics (4 SKS; 3 SKS Theory, 1 SKS Labwork)

This course covers the analysis of motion through the vector mechanics (Newtonian) approach. The material covered includes: Newton's laws of motion, projectile motion and charged particles, momentum and angular momentum, energy. It is expected that through this course, students will be able to analyze motion using the Newtonian mechanics approach.

Main Reference:
Grant R. Fowles, 1985, Analytical Mechanics, Belmont, CA

FSK6304 Differential Equations for Physics (3 SKS)

In this course, students are expected to master the mathematical methods used in theoretical analysis in the field of physics. The topics covered include: Ordinary Differential Equations, Laplace Transform, Fourier analysis, Partial Differential Equations, Series Solutions for Differential Equations (Legendre, Bessel, Hermite, and Laguerre functions).

Main reference:
Boas, M.L., 2005, *Mathematical Methods in the Physical Sciences 3rd edition*, Wiley.

FSK6411 Analog Electronics (4 SKS; 3 SKS Theory, 1 SKS Labwork)

This course covers the concept of p-n junctions; Transistors (characteristics, Common-Base, Common-Collector, Common-Emitter configurations, biasing techniques, low-frequency small-signal amplifiers, high-frequency amplifiers, bipolar and FET) and Op-amps (inverting, non-inverting, summing). It is expected that through this course, students will be able to analyze the characteristics of active components (diodes, transistors, and op-amps) and design functional analog circuits (rectifiers, amplifiers, and oscillators).

Main reference:
Boylestad, R. & Nashelsky, L., 2012, *Electronics Devices and Circuit Theory 11th edition*, Pearson

FSK6215 Analytical Mechanics (2 SKS)

This course covers motion analysis through scalar mechanics approaches (Lagrangian and Hamiltonian). The topics studied include: virtual work, Lagrangian mechanics, calculus of variations, central forces, Hamiltonian mechanics, and rigid body dynamics.

Main Reference:
Grant R. Fowles, 1985, Analytical Mechanics, Belmont, CA

FSK6316 Analytical Mechanics (3 SKS; 2 SKS Theory, 1 SKS Labwork)

This course covers the phenomena of vibrations and waves, with an emphasis on mechanical waves. The topics studied include: simple harmonic motion, damped oscillations, forced oscillations, coupled oscillations, traveling waves, standing waves (stationary), interference, diffraction, and wave dispersion. It is expected that through this course, students will be able to understand that vibrations are manifestations of energy exchange between components in a system and that waves are propagating vibrations.

Main reference:
King, G.C., 2009, *Vibrations and Waves*, Wiley

FSK6317 Thermodynamics (3 SKS; 2 SKS Theory, 1 SKS Labwork)
This course covers heat dynamics and the relationship between heat and energy. The topics studied include: temperature and zeroth law of thermodynamics, state equations, work in thermodynamics, first law of thermodynamics, ideal gases, second law of thermodynamics, Carnot cycle, entropy, thermodynamic potential, and Clausius-Clapeyron equation. It is expected that through this course, students will be able to analyze heat dynamics in the physical systems they encounter.

Main reference:
Zemansky M.W. & Dittman, R.H., 1997, *Heat and Thermodynamics 7th edition*. McGraw-Hill.

FSK6305 Linear Algebra for Physics (3 SKS)
In this course, students are expected to master the mathematical methods used in theoretical analysis in the field of physics. The material studied includes: linear algebra and matrices, series solutions for differential equations, complex numbers and functions, vector analysis, tensor analysis.

Main reference:
Boas, M.L., 2005, *Mathematical Methods in the Physical Sciences 3rd edition*, Wiley.

FSK6407 Computational Physics (4 SKS; 3 SKS Theory, 1 SKS Labwork)
After completing this course, students are expected to master the numerical methods used in physics. The material covered includes: numerical derivatives, numerical integrals, differential equations, linear and non-linear equations, random processes, Fourier transformations.

Main reference:
Newman, M., 2012, *Computational Physics*, CreateSpace

FSK6312 Digital System (3 SKS; 2 SKS Theory, 1 SKS Labwork)
This course covers number systems and code systems, Boolean algebra, digital circuit design, combinational circuits, flip-flops, counters, registers, multiplexers-demultiplexers, and applications of digital circuits. It is expected that through this course, students will be able to analyze and design (up to implementation)

digital circuits (comparators, adders, counters, controllers, registers).

Main reference:
Tocci, R.J., Widmer, N.S., & Moss, G.L., 2016, *Digital System: Principles and Applications 12th edition*, Pearson

FSK6213 SENSOR (2 SKS)
This course examines static and dynamic characteristics of sensors; primary sensors (temperature, pressure, fluid flow, position-velocity-acceleration, magnetic field, humidity, light intensity). It is expected that through this course, students will be able to understand the working principles of sensors and be capable of designing and creating instruments to measure physical quantities.

Main reference:
Bentley, J.P., 2004, *Principles of Measurement System 4th edition*, Pearson.

Main reference:
Taylor, J.R., 2005, *Classical Mechanics*, University Science Books

FSK6215 Analytical Mechanics (2 SKS)
This course studies the analysis of motion through the scalar mechanics approach (Lagrangian and Hamiltonian). The topics covered include virtual work, Lagrangian mechanics, calculus of variations, central forces, Hamiltonian mechanics, and rigid body dynamics.

Main reference:
Hand, L.N. & Finch J.D., 1998, *Analytical Mechanics*, Cambridge University Press

FSK6316 Vibrations and Waves (3 SKS; 2 SKS Theory, 1 SKS Labwork)
This course studies the phenomena of vibration and waves, with an emphasis on mechanical waves. The material covered includes: simple harmonic motion, damped oscillations, forced oscillations, coupled oscillations, traveling waves, standing waves (stationary), interference, diffraction, and wave dispersion. It is expected that through this course, students will be able to understand that vibration is a manifestation of energy exchange between components in a system, and that waves are vibrations that propagate.

Main reference:
King, G.C., 2009, *Vibrations and Waves*, Wiley

FSK6317 Thermodynamics (3 SKS; 2 SKS Theory, 1 SKS Labwork)
This course covers the study of heat dynamics and the relationship between heat and energy. The topics include: temperature and the zeroth law of thermodynamics, equations of state, work in thermodynamics, the first law of thermodynamics, ideal gases, the second law of thermodynamics, Carnot cycle, entropy, thermodynamic potentials, and the Clausius-Clapeyron equation. It is

expected that through this course, students will be able to analyze heat dynamics in the faced physical systems.

Main reference:
Zemansky M.W. & Dittman, R.H., 1997, *Heat and Thermodynamics 7th edition*. McGraw-Hill.

FSK6218 Statistical Physics (2 SKS)

This course discusses the thermodynamic properties of systems through statistical analysis of the constituent particles of the system. The topics covered include: kinetic theory of gases, transport phenomena, statistical thermodynamics (Maxwell-Boltzmann, Bose-Einstein, and Fermi-Dirac statistics), and their application to ideal gases and solids. It is expected that through this course, students will be able to analyze the thermodynamic properties of systems based on the dynamics of the constituent particles of the system.

Main reference:
Sears, S.W. & Salinger, G.L., 1975, *Thermodynamics, Kinetic Theory and StatisticalThermodynamics 3rd edition*, Addison-Wesley.

FSK6419 Electromagnetism (4 SKS; 3 SKS Theory, 1 SKS Labwork)

This course examines the phenomena of static electricity and static magnetism. The topics covered include: electric fields and potentials, techniques for determining electric potential, work and energy in electrostatics, conductor concepts, electric fields in materials, magnetic fields and potentials, and magnetic fields in materials. It is expected that through this course, students will be able to understand physical concepts and analyze physical problems in the fields of electrostatics and magnetostatics.

Main reference:
Griffiths, D.J., 2013, *Introduction to Electrodynamics 4th edition*, Pearson.

FSK6321 Optics (3 SKS; 2 SKS Theory, 1 SKS Labwork)

This course consists of two parts, namely geometric optics and physical optics. The topics covered include: Single Surface Refraction, Lenses, Image Formation, Errors in Optical Systems, Light Propagation in Non-Homogeneous Media, Light Polarization, Light Propagation in Media: Refraction and Reflection, Fresnel Equations, Dispersion, Optical Anisotropy, Interference and Diffraction. It is expected that through this course, students will be able to describe images by tracing rays and apply Maxwell's equations in optical cases.

Main reference:
Marchenko, O.M., Kazantzsev, S., & Windholz, L., 2003, *Demonstrational Optics*, Springer.

FSK6222 Special Relativity (2 SKS)

This course explores the basic concepts of the special theory of relativity developed by Einstein. The topics covered include: a review of Newtonian physics, the basic principles of special relativity, the physics of 4-position vectors, relativistic kinematics, relativistic acceleration, relativistic paradoxes, relativistic mass and momentum, relativistic forces, electromagnetic fields, relativistic angular momentum, and Lorentz covariant transformations. It is expected that through this course, students will be able to understand the basic concepts of special relativity and apply them to relativistic problems.

Main reference:
Tsamparlis, M., 2010, *Special Relativity*, Springer.

FSK6324 Quantum Physics (3 SKS)

This course discusses the basic concepts of quantum physics. The topics covered include: Particle aspects of radiation (blackbody radiation, photoelectric effect, Compton effect, pair production, Bremsstrahlung), Wave aspects of particles (de Broglie hypothesis, Davisson-Germer experiment, classical vs quantum views of particles and waves, particle-wave duality), Heisenberg uncertainty principle, probabilistic interpretation, Quantization rules, Wave packets, Schrödinger equation (wave functions at boundaries, particles in potential wells, simple harmonic oscillators, energy barriers), Mathematical apparatus of quantum mechanics: vector spaces and Hilbert spaces, Dirac notation, operators, discrete and continuous basis representations, matrix mechanics vs wave mechanics, Postulates of quantum mechanics, Quantum mechanics in 1D: potential wells and barriers, harmonic oscillators, Quantum mechanics in 3D: problems in Cartesian coordinates, problems in spherical coordinates, Methods for solving stationary state problems: time-independent perturbation theory, variational methods, WKB method (Wentzel-Kramers-Brillouin), Time-dependent perturbation theory.

Main reference:
Zettili, N., 2009, *Quantum Mechanics: Concepts and Applications 2nd edition*, Wiley.

FSK6225 Atomic Physics (2 SKS)

This course covers topics such as hydrogen atoms, helium atoms, LS coupling, hyperfine structure, fundamentals of laser spectroscopy, laser cooling and trapping, magnetic trapping, Bose-Einstein Condensate (BEC), and atom interferometry. Through this course, students are expected to understand the basic concepts of atoms and apply them to physical problems related to atoms.

Main reference:
Foot, C.J., 2005, *Atomic Physics*, Oxford University Press.

FSK6226 Nuclear Physics (2 SKS)

This course explains the basic concepts of atomic nuclei. The topics covered include: physical quantities for nuclei, nucleon-nucleon forces, nuclear models, radioactive decay and detection, alpha, beta, and gamma decay, nuclear reactions, neutrons, nuclear fission, and fusion. It is expected that through this course, students will be able to understand the concepts of atomic nuclei and their applications in the nuclear field.

Main reference:
Krane, K.S., 1988, *Introductory Nuclear Physics*, John-Wiley & Sons

FSK6227 Solid State Physics (2 SKS)

This course explains the physical properties of solid substances. Topics covered include: crystal structure, crystal diffraction, lattice vibrations, metal theory (free electron model and energy bands), semiconductors, dielectrics and optical properties of materials, magnetism of materials, superconductors, and defects in materials.

Main reference:
Omar, M.A., 1975, *Elementary Solid State Physics: Principles and Applications*, Addison-Wesley.

FSK6228 Basic Colloidal Physics (2 SKS)

This course covers the characteristics of particles and colloidal solutions, methods for characterizing colloidal particles both in dissolved conditions and in the air, and examines several important techniques in the characterization of colloidal particles in terms of their size and charge.

Main reference:
Heimen & Rajagopalan, R., 1997, *Principles of Colloid and Surface Chemistry 3rd edition*, Marcel Dekker.

FSK6229 Fluid Mechanics (2 SKS)

This course explains the physical concepts of fluid flow. The topics covered include: static fluids, the Bernoulli equation, Reynolds Transport Theorem, similarity and dimensional analysis, flow in closed conduits. It is expected that through this course, students will be able to understand the physical concepts of fluid flow and apply them to problems related to fluid flow.

Main reference:
Elger, D.F., Lebrey, B.A., Crowe, T.C., & Roberson, J.A., 2016, *Engineering Fluid Mechanics* 11th *edition*, Wiley.

FIS6342 Amplifier and Electronics Filter (3 SKS; 2 SKS Theory, 1 SKS Labwork)

In this course, students are expected to be able to analyze electronic amplifier and filter circuit diagrams and implement them in the form of electronic amplifier and filter circuits. The studied material includes: Common-Emitter, Common-Base, and Common Collector amplifiers, Differential amplifiers, Instrumentation amplifiers, High-pass, low-pass, and band-pass filters.

Main reference:
Les Thede, 2004, *Practical Analog and Digital Filter Design*, Artech House.

FSK6251 Nano Physics (2 SKS)

This course covers nanometer dimensions, size effects on material properties, synthesis of nanostructured materials, characterization of nanostructured materials, quantum dots, nanowires, carbon nanotubes, and nanocomposite materials.

Main reference:
Wolf, E.L., 2006, *Nanophysics and Nanotechnology 2nd edition*, Wiley-VCH.

FSK6353 Soft Condensed Matter (3 SKS)

Condensed matter physics is a branch of physics in which humans endeavor to study systems that consist of numerous particles, such that interactions among these particles give rise to collective phenomena. These collective phenomena certainly do not occur when the physical system under study consists of only one or a few particles. Soft condensed matter encompasses various phases, including solid, liquid, gas, and exotic phases such as superconductors, Bose-Einstein condensates, glass, plasma, and liquid crystals. This course will also discuss various phase transitions encapsulated within the concept of phase transitions.

Main reference:
Sander, L.M., 2009, *Advanced Condensed Matter Physics*, Cambridge University Press.

K. SEMESTER LEARNING PLAN FORMAT

The Semester Learning Plan (RPS) or its equivalent term is a learning program document designed to produce graduates who have competencies in accordance with the established CPL. The RPS must include at least: (a) the name of the study program, name and code of the course, semester, credit hours, name of the lecturer; (b) graduate learning outcomes assigned to the course; planned final abilities at each stage of learning to meet the graduate learning outcomes; study materials related to the abilities to be achieved; learning methods; time provided to achieve the abilities at each stage of learning; student learning experiences manifested in task descriptions to be completed by students during one semester; assessment criteria, indicators, and weights; and a list of references used.

The RPS format for the Physics Study Program refers to the format specified by UNY as follows.

MINISTRY OF EDUCATION, CULTURE, RESEARCH AND TECHNOLOGY
UNIVERSITAS NEGERI YOGYAKARTA
FACULTY OF MATHEMATICS AND NATURAL SCIENCES
BACHELOR IN PHYSICS

SEMESTER LEARNING PLAN (RPS)

Study Program	:	
Course Nama/Code	:	
Number of SKS	:	
Academic Year	:	
Semester	:	
Prerequisite Course	:	
Lecturer	:	1. 2.
Language Used	:	

A. COURSE DESCRIPTION

....
(Provide a description of the course you are teaching)

B. GRADUATE LEARNING OUTCOMES (CPL) DAN COURSE LEARNING OUTCOMES (CPMK)

No.	**Course Learning Outcomes** (CPMK)	**Graduate Learning Outcomes** (CPL)
1	Identify which Study Program Learning Outcome (CPL Prodi) is supported by Course Learning Outcomes (CPMK) of the taught subjects.	Describe the CPMK from the course you are teaching
2		
...		

C. Course Activities:

Week #	CPMK	Study Material	Learning Method	Learning Experience	Assesement Indicator	**Evaluation Methods**	Time	Referen
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Filled meeting on-	Filled with taught CPMK	Filled with the taught material	The learning method used is filled in	Describe students' learning activities	Outline assessment indicators related to the measured abilities	Choose the assessment technique used.	Fill in the allocated time	Write d the books/jou used a referen
1			1.					
2			2.					

D. Evaluation Components:

No.	Evaluation Methods	Percentage of Weighted Evaluation	Description
1.	Cognitive		Accumulation of maximum assessment weight
	a. Presence		
	b. Quiz		
	c. Assignment		
	d. Midterm		
	e. Final Axam		
2.	Participatory		"Accumulation of minimum assessment weight 50%
	a. Case Study		
	b. Team Based Project		
TOTAL		100	

E. REFERENCES

1.
2.
3.

Approved by
Coordinator of Bachelor in Physics

Yogyakarta, ...
Lecture

Name
NIP.

Name
NIP

Attachment.
(Assignments and results of this student's work must be uploaded to the Siakad system)

Participatory Learning Activity Assignment
Case Study

Course Name :
Course Code :
Semester :
Lecturer :
Meeting # :

A. CPMK (Participatory Case Study Learning)
Description of CPMK established in participatory case study learning
B. Sub-CPMK
(Outline specific Sub-CPMK implemented)

C. Objectives
(Outline the objectives of the case study learning conducted)

D. Case Study Title
(Contains a description of the case study with case selection to be done purposefully. Cases can be determined by the lecturer and/or students under the guidance of the lecturer, with problem objects that can include individuals, environments, processes, communities or social units, products, and so on)

E. Learning Activity Mechanisms
(Contains the steps of the case study learning to be implemented, such as case study execution provisions, report creation mechanisms, presentation designs, and others)

F. Assessment
(Contains descriptions of attitude, cognitive, and skill assessments)

ASSIGNMENT
PARTICIPATORY LEARNING ACTIVITY
TEAM-BASED PROJECT

Course Name :
Course Code :
Semester :
Lecturer :
Meeting # :

A. CPMK
(Description of CPMK established in participatory case study learning)

B. Sub-CPMK
(Specifically describe the implemented Sub-CPMK) Objectives (Describe the objectives of the case study learning conducted)

C. Objectives
(Outline the objectives of the project-based learning conducted)

D. Title of Project-Based Learning
(contains a description of project-based learning that will be implemented, referring to the problems to be solved and resulting in a discovery or product. The project to be implemented addresses real issues and encourages students to conduct in-depth investigation)

E. Learning Activity Mechanism
(includes the steps of project-based learning to be implemented, including group formation, problem identification by the lecturer and students, activity planning, scheduling, activity supervision, assessment of the resulting product, evaluation, and more. The activity concludes with a presentation of the work done in class)

F. Assessment
(includes a description of attitude, cognitive, and skill assessments during the learning activies)