



# Summary of Curriculum

## **Undergraduate Program of Physics (UPP)**

**Faculty of Mathematic and Natural Science  
Universitas Negeri Surabaya (UNESA)  
Year 2021**

## 1. THE VISION AND MISSION OF INSTITUTION

### **Vision of Universitas Negeri Surabaya (Unesa):**

*Excellent in Education, Strong in Science*

### **Mission of Unesa:**

- (1) To conduct education and learning centred on students by using effective instructional approaches, and optimizing the use of technology
- (2) To conduct researches in educational sciences, natural sciences, social and cultural sciences, arts, and/or sports, and developments of technologies whose findings are beneficial for the development of sciences and public welfares
- (3) To disseminate science, technology, arts, culture and sports, and research results through community service oriented towards empowering and civilizing society
- (4) To realize Unesa an educational centre, especially for primary and secondary educations as well as a scientific centre based on the noble values of national culture
- (5) To conduct an autonomous, accountable, and transparent high educational governance for a sustainable quality assurance and improvement.

### **Vision and Mission of Faculty**

### **Vision of Faculty of Mathematics and Natural Science (FMNS):**

*Excellent<sup>1</sup> in Education on Mathematics and Natural Science, Strong<sup>2</sup> in Mathematics and Natural Science Studies in 2035.*

### **Extended Vision of FMNS:**

- (1) Excellent in innovation of mathematics and natural science education.
- (2) Strong in mathematics and natural science studies and their applications for strengthening mathematics and natural science education (wider mandate).
- (3) Excellent in global competition.
- (4) Excellent in graduates having environmental-minded and entrepreneurial spirit.

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<sup>1</sup> *Excellent* means to be innovative, competitive, and always trying to improve quality.

<sup>2</sup> *Strong* means to work systematically, methodically, and objectively, to support the excellence of the studies in mathematics and natural sciences.

### **Mission of FMNS**

- (1) Organizing innovative and research-based mathematics and natural sciences education to produce graduates who are environmentally minded, entrepreneurial in spirit and have global competitiveness.
- (2) Carrying out Mathematics and Natural Sciences research in strengthening national and international recognized science and strengthening Mathematics and Natural Sciences education.
- (3) Organizing research-based community service to support community welfare.
- (4) Build a strong collaborative network with stakeholders to improve the quality and image of FMNS.
- (5) Organizing civil service in FMNS that is autonomous, credible, fair, accountable, and transparent for quality assurance and quality improvement.

### **Objectives of FMNS**

- a) Produces graduates in mathematics and natural sciences and education having environmental insight, entrepreneurial spirit, and global competitiveness.
- b) Yields research results in mathematics and natural sciences and education to strengthen the studies of MNS and MNS education.
- c) Implements research results for community services to support community welfare.
- d) Executes strong collaboration with stakeholders to improve the quality and image of FMNS.
- e) Realizes a governance system in FMNS that is autonomous, credible, fair, accountable, and transparent for quality assurance and quality improvement.

(Available on <http://fmipa.unesa.ac.id/visi-dan-misi/> )

## 2. PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

Undergraduate Program of Physics (UPP) at FMNS Unesa focuses on producing graduate who can become professionals in academics, assistant of researcher, practitioner, and entrepreneur (professional accomplishment) who have the following objectives.

1. Produce Bachelor of Physics who are able to use physics knowledge and methodology to solve problems in their work field.
2. Produce Bachelor of Physics who have a strong commitment to developing knowledge, whether by studying in a higher-level degree working in a formal institution and entrepreneurs.
3. Produce Bachelor of Physics who master the scientific method to observe, analyze and understand physical phenomena, and produce scientific work and contribute according to their expertise.
4. Produce Bachelor of Physics who masteries physics that is able to apply their knowledge, expertise in various fields of work, and develop themselves in their career environment.
5. Produce Bachelor of Physics who can communicate orally and/ in writing effectively, creatively, innovatively, and collaboratively, as well as working in teams.

### PEO Vs INQF (KKNI)

Level of Degree Program on Indonesian National Qualification Framework (INQF) Level 6

**Table 1.** The analysis of PEO and INQF

<b>Objectives</b>	They are being able to apply their field of expertise and utilizing science and technology in problem-solving and adapting to the situation at hand.	Mastering theoretical concepts in a particular field of knowledge in general and the theoretical concepts of special sections in that field of knowledge in-depth, as well as being able to formulate procedural problem solving.	Able to make appropriate decisions based on analysis of information and data and be able to guide in choosing alternative solutions independently and in groups.	Be responsible for the work itself and be given responsibility for the achievement of the organisation's work.
<b>PEO-1</b>	S	S	S	M

<b>PEO-2</b>	S	S	S	S
<b>PEO-3</b>	S	S	S	M
<b>PEO-4</b>	S	S	S	S
<b>PEO-5</b>	S	S	S	S

S-Strong, M-Moderate, L-Low

### 3. PROGRAMME LEARNING OUTCOMES (PLOs)

**Table 2.** PLO of Undergraduate Programme of Physics

Competency SSC-ASIN	Component	NO.	Programme Learning Outcomes
<b>Specialist competences</b>	<b>Knowledge</b>	KNO-1	Able to <b>demonstrate</b> knowledge of Classical Physics and Modern Physics
		KNO-2	Able to <b>formulate</b> a physical systems as physical model by using mathematics
		KNO-3	Able to <b>solve problems</b> in physical systems comprehensively by using mathematics and computational tools.
	<b>Skill</b>	SKI-1	Able to <b>analyze</b> a physical system by applying mathematics and computational tools/ICT.
		SKI-2	Able to <b>design and conduct</b> experiments in learning physics by applying the scientific methods.
		SKI-3	Able to <b>improve their knowledge</b> and be able to continue their study in a higher education.
		SKI-4	Able to <b>communicate</b> their ideas and/or research results in academic writing and speaking effectively.
<b>Social and Attitude competences</b>	<b>Social</b>	SOC-1	Able to <b>make a decision</b> based on the data and information in order to fulfil and evaluate their task responsibility.
		SOC-2	Able to <b>work as an individual as well as a team</b> effectively, <b>have entrepreneurship skill</b> and awareness of environmental issues.
	<b>Attitude</b>	ATT-1	Able to <b>demonstrate good scientist's manners</b> , critical thinking and innovation skills in research and professional fields; and willing to do lifelong learning.
		ATT-2	Able to <b>demonstrate the appreciation of religious values, and nationalism as citizens</b> as well as conducting their tasks professionally.

## PLO Vs PEO

**Table 3.** The analysis of competences based on PEO and PLO

Outcomes	Objectives				
	Produce Bachelor of Physics who are able to use physics knowledge and methodology to solve problems in their work field.	Produce Bachelor of Physics who have a strong commitment to developing knowledge, whether by studying in a higher-level degree working in a formal institution and entrepreneurs.	Produce Bachelor of Physics who master the scientific method to observe, analyze and understand physical phenomena, and produce scientific work and contribute according to their expertise.	Produce Bachelor of Physics who masteries physics that is able to apply their knowledge, expertise in various fields of work, and develop themselves in their career environment.	Produce Bachelor of Physics who can communicate orally and/ in writing effectively, creatively, innovatively, and collaboratively, as well as working in teams.
<b>PLO-1</b>	S	S	S	S	S
<b>PLO-2</b>	S	S	S	S	S
<b>PLO-3</b>	S	S	S	S	S
<b>PLO-4</b>	S	S	S	S	S
<b>PLO-5</b>	S	M	S	M	S
<b>PLO-6</b>	S	M	S	S	M
<b>PLO-7</b>	S	S	S	M	S
<b>PLO-8</b>	S	M	S	M	S
<b>PLO-9</b>	S	M	S	M	S
<b>PLO-10</b>	M	M	M	M	S
<b>PLO-11</b>	M	M	M	S	S

S-Strong, M-Moderate, L-Low

**Table 4.** Mapping ASIIN - Subject-Specific Criteria and Programme Learning Outcomes (PLO)

ASIIN Subject Specific Criteria for Physics (ASIIN-SCC)		Programme Learning Outcomes (PLO)										
		1	2	3	4	5	6	7	8	9	10	11
1	They have good knowledge of classical physics (mechanics, electrodynamics, thermodynamics, vibrations, waves and optics) and are familiar with the basics of quantum, atomic and molecular, nuclear, elementary particles and solid-state physics.	√										
2	They are familiar with important mathematical methods used in physics and can use them to solve physics problems.		√									
3	They have a broad understanding of the basic principles of physics, inherent relations and mathematical formulations and, based on this, have obtained suitable methods for theoretical analysis, modeling and simulation of relevant processes.	√	√	√	√							
4	They are able to apply their knowledge to exemplary physics problems and studied several fields in greater depth, thus gaining the first basis for problem solving competencies.			√								
5	They have the basic capacity to understand physical problems. But in general this has not facilitated a deeper understanding of the current research area.	√										
6	They have the ability to classify independently based on physics and some interdisciplinary problems that require a target-oriented and logic-based approach, and to analyze and / or solve them using natural scientific and mathematical methods.			√	√							
7	They are familiar with the basic					√		√		√		

ASIIN Subject Specific Criteria for Physics (ASIIN-SCC)		Programme Learning Outcomes (PLO)																
		1	2	3	4	5	6	7	8	9	10	11						
	principles of experimentation, are able to use modern physics measurement methods, and are in a position to assess the significance of results correctly.																	
8	They are, in general, obtain overview knowledge in natural science subjects or other selected technical disciplines.												√					
9	They are able to apply their knowledge to various fields and act responsibly in their professional activities. They are also able to recognize new trends in their field of study and integrate relevant methodologies - maybe after appropriate qualifications - into their next work.																	
10	They are able to expand and deepen their knowledge continuously and independently to finish the undergraduate program. They are familiar with suitable learning strategies (lifelong learning); they are particularly capable of successive Master's degree programs in principle.																	
11	They have preliminary experience concerning generic qualifications (e.g. work time agreements, study and work techniques, willingness to work together, capacity for teamwork, ability to communicate and communication techniques, rules of good scientific practice) in their degree programs able develop these skills further.																	
12	They master the basic elements of special English that are relevant.																	
13	They are able to solve simple scientific problems and to present their results verbally (lectures) and in writing (indicated in the Bachelor's thesis).																	



## **4. PROGRAMME STRUCTURE**

### **4.1. The Curriculum**

Undergraduate Programme of Physics (UPP) in FMNS Universitas Negeri Surabaya has a Bachelor of Science (Sarjana Sains or S.Si) degree, with expertise in some specific areas or fields in Physics. The expertise covers classical physics, modern physics, applied physics, mathematical physics and physics analysis. The curriculum is developed to achieve the vision, mission, and goals set. It must accommodate the whole educational objectives by taking into account the characteristics of Unesa as a local learning setting that is realized in the learning outcomes of study programs. Besides, the Physics Study Program curriculum must provide a learning experience for students to achieve the expected competencies and self-development, both now and in the future. Therefore, the Physical Study Program curriculum is expected to answer the demands of the needs in the field. Some issues considered in the preparation and development of this curriculum are as follows:

- 1) Indonesian National Qualification Framework (KKNI: Kerangka Kualifikasi Nasional Indonesia) and National Standards for Higher Education.
- 2) 21st-century skills needed, namely critical thinking and problem-solving, creativity and innovation, communication, and collaboration.
- 3) The ASEAN Economic Community since 2015
- 4) Adequate literacy in science, technology and communication, according to the Law of Ministry of Education (Permendikbud No. 23 of 2015) concerning the improvements of manners
- 5) The development of global community dynamics that need to be anticipated for its development to prepare reliable Indonesian human resources, such as the challenges of the ASEAN Free Trade Area (AFTA), the World Trade Organization (WTO), and the Asia Pacific Economic Cooperation (APEC).

Furthermore, the current curriculum adopts a new paradigm of education: out-comes-based education, learner-centred learning, continuous improvement, and international benchmarking and accreditation. The curriculum is periodically updated every five years by following the curriculum's development processes, considering some principles of the curriculum development. This is shown in the following chart.



**Figure 1.** Principles of curriculum development

Students should take 144 credit units (CU) comprising 120 CU as compulsory courses and 24 CU as elective courses to complete the learning program.

**Table 5. Compulsory and elective courses in Physics, Unesa**

CU Compulsory courses	CU	ECTS	Note
CU of compulsory courses	<b>120</b>	<b>190,8</b>	The CU courses are distributed into 49 compulsory courses.
CU of elective courses	<b>24</b>	<b>38,16</b>	There are 56 available credit unit which is distributed into 30 elective courses and students should take at least 24 course unit.
Total	<b>144</b>	<b>228,96</b>	



No	Code	MK	CU	ECTS	PLO (Outcome)										
					1	2	3	4	5	6	7	8	9	10	11
41	4520102239	Physics Experiment III	2	3,18					√		√	√			
42	4510102116	Industrial Management	2	3,18							√	√			
43	4520103137	Nuclear Physics	3	4,77			√	√						√	
44	4520102143	Research methodology	2	3,18							√	√	√	√	
45	4520102203	Statistics	2	3,18			√	√							
46	4520102203	Philosophy of Natural Sciences	2	3,18	√										
47	4520102049	Community Service Program	3	4,77							√	√	√	√	
48	4520102217	PKL	2	3,18					√			√	√		
49	4520106199	Thesis	6	9,54					√	√	√	√	√	√	
50	4520102007	Physical System Analysis	2	3,18	√	√	√	√							
51	4520103210	Thermodynamics of Material	2	3,18					√	√	√				
52	4520103137	Material Characterization Method	2	3,18						√	√	√			
53	4520102250	Sensor	2	3,18				√	√			√	√		
54	4520102197	Microcontroller	2	3,18				√	√			√	√		
55	4520102237	Control System	2	3,18				√	√			√	√		
56	4520102242	Robotics	2	3,18						√			√	√	
57	4520103169	Digital Signal Processing	2	3,18			√	√	√		√	√	√	√	
58	4520102150	Optoelectronics	2	3,18								√		√	
59	4520103037	Electroacoustic	2	3,18								√		√	
60	4520102251	Medical Physics	2	3,18						√		√		√	
61	4520102076	Polymer Physics	2	3,18								√		√	
562	4520103018	Alloy Material	2	3,18					√		√	√	√	√	
63	4520103244	Renewable Energy	2	3,18						√		√	√		
64	4520103130	Material Fabrication Method	3	4,77					√	√		√	√		
65	4520103111	Diffraction Data Analysis	2	3,18						√		√		√	
66	4520103109	Corrosion	2	3,18						√		√	√		
67	4520102067	Metal Physics	2	3,18						√		√	√		
68	4520102098	Ceramics	2	3,18						√		√	√		
69	4520102096	Capita Selecta of Material Physics	2	3,18				√	√		√	√		√	
70	4520102252	Introduction to Geodynamics and Geothermal	2	3,18				√	√	√	√	√	√	√	
71	4520102246	Physics of Tsunamis	2	3,18			√	√		√	√	√	√	√	
72	4520102075	Physical Oceanography	2	3,18			√	√		√	√		√	√	
73	4520102142	Geophysical Measurement Method	2	3,18	√					√	√			√	
74	4520102247	Mitigation of Natural Disasters	2	3,18					√	√	√		√	√	
75	4520102254	Geophysical Fluid Dynamics	2	3,18			√	√		√	√	√	√	√	
76	4520102058	Physics of Volcanoes	2	3,18	√					√	√			√	
77	4520102077	Physics of Seismology	2	3,18			√	√		√	√	√	√	√	
78	4520102248	Physics of Atmosphere	2	3,18			√	√		√	√	√	√	√	

## CU OF COURSES PER YEAR

**Table 7. Courses in 1<sup>st</sup> Year**

1 <sup>st</sup> Semester				2 <sup>nd</sup> Semester			
No	Code	Name of Courses	CU	No	Code	Name of Courses	CU
1	1000002003	Indonesian	2	1	1000002026	Religion	2
2	4520103026	Biology	3/1	2	4520103021	English	3
3	4520104055	Basic Physics I	3	3	4520102203	Philosophy of Natural Sciences	2
4	4520103104	Chemistry	3/1	4	4520104057	Basic Physics II	3
5	4520103118	Basic Mathematics	3/1	5	4520104070	Mathematical Physics I	3
6	1000002018	Pancasila	2	6	4520102227	Literation Digital	2
7	4520101221	Basic Physics Practicum I	1	7	4520102107	KSDA	2
8	4520102196	Physics Measurement System	2	8	1000002033	Civic Education	2
				9	4520101229	Basic Physics Practicum II	1
<b>TOTAL CU</b>			<b>19</b>	<b>TOTAL CU</b>			<b>20</b>
<b>TOTAL ECTS</b>			<b>30,21</b>	<b>TOTAL ECTS</b>			<b>31,80</b>

**Table 8. Courses in 2<sup>nd</sup> Year**

3 <sup>rd</sup> Semester				4 <sup>th</sup> Semester			
No	Code	Name of Courses	CU	No	Code	Name of Courses	CU
1	4520103053	Earth Physics	3	1	4520103042	Basic Electronics II	2
2	4520103041	Basic Electronics I	2	2	4520101231	Basic Electronics Practicum II	1
3	4520101230	Basic Electronics Practicum I	1	3	4520103233	Mathematical Physics III	3
4	4520104127	Mechanics	4	4	4520103074	Modern Physics	2
5	4520104071	Mathematical Physics II	3	5	4520102203	Statistics	2
6	4520103209	Themodinamics	3	6	4520103114	Electromagnetics	2
7	4520104086	Science of Materials	3	7	4520103084	Waves	2
8	1000002011	ISBD	2	8	4520102034	Physics Experiment I	2
9	4520102219	Physical Education and Fitness	2	9	4520102216	Interpreneurships	2
<b>TOTAL CU</b>			<b>23</b>	<b>TOTAL CU</b>			<b>19</b>
<b>TOTAL ECTS</b>			<b>36,57</b>	<b>TOTAL ECTS</b>			<b>30,21</b>

**Table 9. Courses in 3<sup>rd</sup> Year**

5 <sup>th</sup> Semester				6 <sup>th</sup> Semester			
No	Code	Name of Courses	CU	No	Code	Name of Courses	CU
1	4520104065	Quantum Physics	4	1	4520103082	Physics of Solids	3
2	4520102149	Optics	2	2	4520103079	Statistic of Physics	3
3	4520103043	Electronics (Advanced)	2	3	4520102105	Colloquium	2
4	4520102143	Research Methodology	2	4	4520102116	Industrial Management	2
5	4520102035	Physics Experiment II	2	5	4520102239	Physics Experiment III	2
6	452010OS1	Option Odd Semester-	2	6	452010ES-1	Option even semester-1	2

		1					
7	452010OS2	Option Odd Semester-2	2	7	452010ES-2	Option even semester-2	2
8	452010OS3	Option Odd Semester-3	2	8	452010ES-3	Option even semester-3	2
				9	452010ES-4	Option even semester-4	2
<b>TOTAL CU</b>			<b>19</b>	<b>TOTAL CU</b>			<b>20</b>
<b>TOTAL ECTS</b>			<b>30,21</b>	<b>TOTAL ECTS</b>			<b>31,80</b>

**Table 10. Courses in 4<sup>th</sup> Year**

7 <sup>th</sup> Semester				8 <sup>th</sup> Semester			
No	Code	Name of Courses	CU	No	Code	Name of Courses	CU
1	4520103137	Nuclear Physics	3	1	4520106199	Thesis	6
2	4520102217	PKL	3	2	452010ES-5	Option Even Semester-5	2
3	4520102049	Community Service Program	3	3	452010ES-6	Option Even Semester-6	2
4	452010OS-4	Option Odd Semester-4	2				
5	452010OS-5	Option Odd Semester-5	2				
	452010OS-6	Option Odd Semester-6	2				
<b>TOTAL CU</b>			<b>15</b>	<b>TOTAL CU</b>			<b>10</b>
<b>TOTAL ECTS</b>			<b>23,85</b>	<b>TOTAL ECTS</b>			<b>15,90</b>

**Table 11. Optional Courses**

Odd Semester					Even Semester				
No	Course Code		Name of Course	CU	No	Course Code		Name of Course	CU
1	4520102075	452010 OS-1	Physics of Oceanography-1	2	1	4520102248	452010 ES-1	Physics of Atmospherics-1	2
2	4520102237		Control System-1	2	2	4520102076		Physics of Polimer-1	2
3	4520103018		Alloy Material-1	2	3	4520102197		Microcontroller-1	2
4	4520103111	452010 OS-2	Diffraction Data Analysis-2	2	4	4520102150	452010 ES-2	Optoelectronics-2	2
5	4520102007		Analysis of Fisis System-2	2	5	4520102098		Ceramics-2	2
6	4520103169		Digital Signal Processing-2	2	6	4520102058		Physics of Volcanoes-2	2
7	4520102077	452010 OS-3	Physics of Seismology-3	2	7	4520102242	452010 ES-3	Robotics-3	2
8	4520103210		Thermodynamics of Materials-3	2	8	4520102246		Physics of Tsunami-3	2
9	4520102250		Sensor-3	2	9	4520103137		Material Characterization Method-3	2
10	4520102067	452010 OS-4	Physics of Metals-4	2	10	4520103244	452010 ES-4	Energy Materials-4	2
11	4520102252		Introduction to Geodynamics and Geothermal-4	3		4520102247		Mitigation of Natural Disaster-4	2
12	4520103109		Corrosion-4	2	11	4520102245		Medical Materials-5	2
13	4520103130	452010 OS-5	Material Fabrication Methods-5	3	12	4520102096	452010 ES-5	Capita Selektta Material Physics-5	2
14	4520103037		Electroacoustic-5	2	13				
15	4520102142		Geophysical Measuring Method-5	2					
16	4520102254	452010 OS-6	Geophysical Fluids-6	2					
17	4520102251		Medical Instrumentations-6	2					
<b>TOTAL CU</b>				<b>30</b>	<b>TOTAL CU</b>				<b>26</b>
<b>TOTAL ECTS</b>				<b>47,70</b>	<b>TOTAL ECTS</b>				<b>41,34</b>

## Roadmap of PLO-1 (KNO-1)

8 <sup>th</sup> Sem	4520106199 Thesis	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses
7 <sup>th</sup> Sem	4520103137 Nuclear physics	4520102217 PKL	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses
6 <sup>th</sup> Sem	4520103082 Physics of Solids	4520103079 Statistic of Physics	4520102105 Colloquium	4520102116 Industrial Management	4520102239 Physics Experiment III	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses
5 <sup>th</sup> Sem	4520104065 Quantum Physics	4520102149 Optics	4520103043 Electronics (Advanced)	4520102143 Research Methodology	4520102035 Physics Experiment II	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses
4 <sup>th</sup> Sem	4520103042 Basic Electronics II	4520101231 Basic Electronics Practicum II	4520103233 Mathematical Physics III	4520103074 Modern Physics	4520102203 Statistics	4520103114 Electromagnetics	4520103084 Waves	4520102034 Physics Experiment I	4520102216 Interpreneurships
3 <sup>rd</sup> Sem	4520103053 Earth Physics	4520103041 Basic Electronics I	4520101230 Basic Electronics Practicum I	4520104127 Mechanics	4520104071 Mathematical Physics II	4520103209 Thermodynamics	4520104086 Materials Science	1000002011 ISBD	4520102219 Physical Education and Fitness
2 <sup>nd</sup> Sem	1000002026 Religion	4520103021 English	4520102203 Philosophy of Natural Sciences	4520104057 Basic Physics II	4520104070 Mathematical Physics I	4520102227 Literation Digital	4520102107 Conservation of Natural Resources	1000002033 Civic Education	4520101229 Basic Physics Practicum II
1 <sup>st</sup> Sem	1000002003 Indonesian	4520103026 Biology	4520104055 Basic Physics I	4520103104 Chemistry	4520103118 Basic Mathematics	1000002018 Pancasila	4520101221 Basic Physics Practicum I	4520102196 Physics Measurement System	452010xxxx Optional courses

**Figure 2.** Course roadmap to achieve learning outcomes KNO-1

### Roadmap of PLO-2 (KNO-2)

8 <sup>th</sup> Sem	4520106199 Thesis	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses
7 <sup>th</sup> Sem	4520103137 Nuclear physics	4520102217 PKL	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses
6 <sup>th</sup> Sem	4520103082 Physics of Solids	4520103079 Statistic of Physics	4520102105 Colloquium	4520102116 Industrial Management	4520102239 Physics Experiment III	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses
5 <sup>th</sup> Sem	4520104065 Quantum Physics	4520102149 Optics	4520103043 Electronics (Advanced)	4520102143 Research Methodology	4520102035 Physics Experiment II	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses
4 <sup>th</sup> Sem	4520103042 Basic Electronics II	4520101231 Basic Electronics Practicum II	4520103233 Mathematical Physics III	4520103074 Modern Physics	4520102203 Statistics	4520103114 Electromagnetics	4520103084 Waves	4520102034 Physics Experiment I	4520102216 Interpreneurships
3 <sup>rd</sup> Sem	4520103053 Earth Physics	4520103041 Basic Electronics I	4520101230 Basic Electronics Practicum I	4520104127 Mechanics	4520104071 Mathematical Physics II	4520103209 Thermodynamics	4520104086 Materials Science	1000002011 ISBD	4520102219 Physical Education and Fitness
2 <sup>nd</sup> Sem	1000002026 Religion	4520103021 English	4520102203 Philosophy of Natural Sciences	4520104057 Basic Physics II	4520104070 Mathematical Physics I	4520102227 Literation Digital	4520102107 Conservation of Natural Resources	1000002033 Civic Education	4520101229 Basic Physics Practicum II
1 <sup>st</sup> Sem	1000002003 Indonesian	4520103026 Biology	4520104055 Basic Physics I	4520103104 Chemistry	4520103118 Basic Mathematics	1000002018 Pancasila	4520101221 Basic Physics Practicum I	4520102196 Physics Measurement System	452010xxxx Optional courses

**Figure 3.** Course roadmap to achieve learning outcomes KNO-2



### Roadmap of PLO-3 (KNO-3)

8 <sup>th</sup> Sem	4520106199 Thesis	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses
7 <sup>th</sup> Sem	4520103137 Nuclear physics	4520102217 PKL	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses
6 <sup>th</sup> Sem	4520103082 Physics of Solids	4520103079 Statistic of Physics	4520102105 Colloquium	4520102116 Industrial Management	4520102239 Physics Experiment III	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses
5 <sup>th</sup> Sem	4520104065 Quantum Physics	4520102149 Optics	4520103043 Electronics (Advanced)	4520102143 Research Methodology	4520102035 Physics Experiment II	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses
4 <sup>th</sup> Sem	4520103042 Basic Electronics II	4520101231 Basic Electronics Practicum II	4520103233 Mathematical Physics III	4520103074 Modern Physics	4520102203 Statistics	4520103114 Electromagnetics	4520103084 Waves	4520102034 Physics Experiment I	4520102216 Interpreneurships
3 <sup>rd</sup> Sem	4520103053 Earth Physics	4520103041 Basic Electronics I	4520101230 Basic Electronics Practicum I	4520104127 Mechanics	4520104071 Mathematical Physics II	4520103209 Thermodynamics	4520104086 Materials Science	1000002011 ISBD	4520102219 Physical Education and Fitness
2 <sup>nd</sup> Sem	1000002026 Religion	4520103021 English	4520102203 Philosophy of Natural Sciences	4520104057 Basic Physics II	4520104070 Mathematical Physics I	4520102227 Literation Digital	4520102107 Conservation of Natural Resources	1000002033 Civic Education	4520101229 Basic Physics Practicum II
1 <sup>st</sup> Sem	1000002003 Indonesian	4520103026 Biology	4520104055 Basic Physics I	4520103104 Chemistry	4520103118 Basic Mathematics	1000002018 Pancasila	4520101221 Basic Physics Practicum I	4520102196 Physics Measurement System	452010xxxx Optional courses

**Figure 4.** Course roadmap to achieve learning outcomes KNO-3

### Roadmap of PLO-4 (SKI-1)

8 <sup>th</sup> Sem	4520106199 Thesis	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses
7 <sup>th</sup> Sem	4520103137 Nuclear physics	4520102217 PKL	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses
6 <sup>th</sup> Sem	4520103082 Physics of Solids	4520103079 Statistic of Physics	4520102105 Colloquium	4520102116 Industrial Management	4520102239 Physics Experiment III	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses
5 <sup>th</sup> Sem	4520104065 Quantum Physics	4520102149 Optics	4520103043 Electronics (Advanced)	4520102143 Research Methodology	4520102035 Physics Experiment II	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses
4 <sup>th</sup> Sem	4520103042 Basic Electronics II	4520101231 Basic Electronics Practicum II	4520103233 Mathematical Physics III	4520103074 Modern Physics	4520102203 Statistics	4520103114 Electromagnetics	4520103084 Waves	4520102034 Physics Experiment I	4520102216 Interpreneurships
3 <sup>rd</sup> Sem	4520103053 Earth Physics	4520103041 Basic Electronics I	4520101230 Basic Electronics Practicum I	4520104127 Mechanics	4520104071 Mathematical Physics II	4520103209 Thermodynamics	4520104086 Materials Science	1000002011 ISBD	4520102219 Physical Education and Fitness
2 <sup>nd</sup> Sem	1000002026 Religion	4520103021 English	4520102203 Philosophy of Natural Sciences	4520104057 Basic Physics II	4520104070 Mathematical Physics I	4520102227 Literation Digital	4520102107 Conservation of Natural Resources	1000002033 Civic Education	4520101229 Basic Physics Practicum II
1 <sup>st</sup> Sem	1000002003 Indonesian	4520103026 Biology	4520104055 Basic Physics I	4520103104 Chemistry	4520103118 Basic Mathematics	1000002018 Pancasila	4520101221 Basic Physics Practicum I	4520102196 Physics Measurement System	452010xxxx Optional courses

**Figure 5.** Course roadmap to achieve learning outcomes SKI-1

### Roadmap of PLO-5 (SKI-2)

8 <sup>th</sup> Sem	4520106199 Thesis	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses
7 <sup>th</sup> Sem	4520103137 Nuclear physics	4520102217 PKL	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses
6 <sup>th</sup> Sem	4520103082 Physics of Solids	4520103079 Statistic of Physics	4520102105 Colloquium	4520102116 Industrial Management	4520102239 Physics Experiment III	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses
5 <sup>th</sup> Sem	4520104065 Quantum Physics	4520102149 Optics	4520103043 Electronics (Advanced)	4520102143 Research Methodology	4520102035 Physics Experiment II	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses
4 <sup>th</sup> Sem	4520103042 Basic Electronics II	4520101231 Basic Electronics Practicum II	4520103233 Mathematical Physics III	4520103074 Modern Physics	4520102203 Statistics	4520103114 Electromagnetics	4520103084 Waves	4520102034 Physics Experiment I	4520102216 Interpreneurships
3 <sup>rd</sup> Sem	4520103053 Earth Physics	4520103041 Basic Electronics I	4520101230 Basic Electronics Practicum I	4520104127 Mechanics	4520104071 Mathematical Physics II	4520103209 Thermodynamics	4520104086 Materials Science	1000002011 ISBD	4520102219 Physical Education and Fitness
2 <sup>nd</sup> Sem	1000002026 Religion	4520103021 English	4520102203 Philosophy of Natural Sciences	4520104057 Basic Physics II	4520104070 Mathematical Physics I	4520102227 Literation Digital	4520102107 Conservation of Natural Resources	1000002033 Civic Education	4520101229 Basic Physics Practicum II
1 <sup>st</sup> Sem	1000002003 Indonesian	4520103026 Biology	4520104055 Basic Physics I	4520103104 Chemistry	4520103118 Basic Mathematics	1000002018 Pancasila	4520101221 Basic Physics Practicum I	4520102196 Physics Measurement System	452010xxxx Optional courses

**Figure 6.** Course roadmap to achieve learning outcomes SKI-2

### Roadmap of PLO-6 (SKI-3)

8 <sup>th</sup> Sem	4520106199 Thesis	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses
7 <sup>th</sup> Sem	4520103137 Nuclear physics	4520102217 PKL	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses
6 <sup>th</sup> Sem	4520103082 Physics of Solids	4520103079 Statistic of Physics	4520102105 Colloquium	4520102116 Industrial Management	4520102239 Physics Experiment III	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses
5 <sup>th</sup> Sem	4520104065 Quantum Physics	4520102149 Optics	4520103043 Electronics (Advanced)	4520102143 Research Methodology	4520102035 Physics Experiment II	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses
4 <sup>th</sup> Sem	4520103042 Basic Electronics II	4520101231 Basic Electronics Practicum II	4520103233 Mathematical Physics III	4520103074 Modern Physics	4520102203 Statistics	4520103114 Electromagnetics	4520103084 Waves	4520102034 Physics Experiment I	4520102216 Interpreneurships
3 <sup>rd</sup> Sem	4520103053 Earth Physics	4520103041 Basic Electronics I	4520101230 Basic Electronics Practicum I	4520104127 Mechanics	4520104071 Mathematical Physics II	4520103209 Thermodynamics	4520104086 Materials Science	1000002011 ISBD	4520102219 Physical Education and Fitness
2 <sup>nd</sup> Sem	1000002026 Religion	4520103021 English	4520102203 Philosophy of Natural Sciences	4520104057 Basic Physics II	4520104070 Mathematical Physics I	4520102227 Literation Digital	4520102107 Conservation of Natural Resources	1000002033 Civic Education	4520101229 Basic Physics Practicum II
1 <sup>st</sup> Sem	1000002003 Indonesian	4520103026 Biology	4520104055 Basic Physics I	4520103104 Chemistry	4520103118 Basic Mathematics	1000002018 Pancasila	4520101221 Basic Physics Practicum I	4520102196 Physics Measurement System	452010xxxx Optional courses

**Figure 7.** Course roadmap to achieve learning outcomes SKI-3

### Roadmap of PLO-7 (SKI-4)

8 <sup>th</sup> Sem	4520106199 Thesis	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses
7 <sup>th</sup> Sem	4520103137 Nuclear physics	4520102217 PKL	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses
6 <sup>th</sup> Sem	4520103082 Physics of Solids	4520103079 Statistic of Physics	4520102105 Colloquium	4520102116 Industrial Management	4520102239 Physics Experiment III	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses
5 <sup>th</sup> Sem	4520104065 Quantum Physics	4520102149 Optics	4520103043 Electronics (Advanced)	4520102143 Research Methodology	4520102035 Physics Experiment II	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses
4 <sup>th</sup> Sem	4520103042 Basic Electronics II	4520101231 Basic Electronics Practicum II	4520103233 Mathematical Physics III	4520103074 Modern Physics	4520102203 Statistics	4520103114 Electromagnetics	4520103084 Waves	4520102034 Physics Experiment I	4520102216 Interpreneurships
3 <sup>rd</sup> Sem	4520103053 Earth Physics	4520103041 Basic Electronics I	4520101230 Basic Electronics Practicum I	4520104127 Mechanics	4520104071 Mathematical Physics II	4520103209 Thermodynamics	4520104086 Science of Materials	1000002011 ISBD	4520102219 Physical Education and Fitness
2 <sup>nd</sup> Sem	1000002026 Religion	4520103021 English	4520102203 Philosophy of Natural Sciences	4520104057 Basic Physics II	4520104070 Mathematical Physics I	4520102227 Literation Digital	4520102107 Conservation of Natural Resources	1000002033 Civic Education	4520101229 Basic Physics Practicum II
1 <sup>st</sup> Sem	1000002003 Indonesian	4520103026 Biology	4520104055 Basic Physics I	4520103104 Chemistry	4520103118 Basic Mathematics	1000002018 Pancasila	4520101221 Basic Physics Practicum I	4520102196 Physics Measurement System	452010xxxx Optional courses

**Figure 8.** Course roadmap to achieve learning outcomes SKI-4

## Roadmap of PLO-8 (SOC-1)

8 <sup>th</sup> Sem	4520106199 Thesis	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses
7 <sup>th</sup> Sem	4520103137 Nuclear physics	4520102217 PKL	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses
6 <sup>th</sup> Sem	4520103082 Physics of Solids	4520103079 Statistic of Physics	4520102105 Colloquium	4520102116 Industrial Management	4520102239 Physics Experiment III	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses
5 <sup>th</sup> Sem	4520104065 Quantum Physics	4520102149 Optics	4520103043 Electronics (Advanced)	4520102143 Research Methodology	4520102035 Physics Experiment II	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses
4 <sup>th</sup> Sem	4520103042 Basic Electronics II	4520101231 Basic Electronics Practicum II	4520103233 Mathematical Physics 3	4520103074 Modern Physics	4520102203 Statistics	4520103114 Electromagnetics	4520103084 Waves	4520102034 Physics Experiment I	4520102216 Interpreneurships
3 <sup>rd</sup> Sem	4520103053 Earth Physics	4520103041 Basic Electronics I	4520101230 Basic Electronics Practicum I	4520104127 Mechanics	4520104071 Mathematical Physics II	4520103209 Thermodynamics	4520104086 Science of Materials	1000002011 ISBD	4520102219 Physical Education and Fitness
2 <sup>nd</sup> Sem	1000002026 Religion	4520103021 English	4520102203 Philosophy of Natural Sciences	4520104057 Basic Physics II	4520104070 Mathematical Physics I	4520102227 Literation Digital	4520102107 Conservation of Natural Resources	1000002033 Civic Education	4520101229 Basic Physics Practicum II
1 <sup>st</sup> Sem	1000002003 Indonesian	4520103026 Biology	4520104055 Basic Physics I	4520103104 Chemistry	4520103118 Basic Mathematics	1000002018 Pancasila	4520101221 Basic Physics Practicum I	4520102196 Physics Measurement System	452010xxxx Optional courses

**Figure 9.** Course roadmap to achieve learning outcomes SOC-1

### Roadmap of PLO-9 (SOC-2)

8 <sup>th</sup> Sem	4520106199 Thesis	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses
7 <sup>th</sup> Sem	4520103137 Nuclear physics	4520102217 PKL	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses
6 <sup>th</sup> Sem	4520103082 Physics of Solids	4520103079 Statistic of Physics	4520102105 Colloquium	4520102116 Industrial Management	4520102239 Physics Experiment III	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses
5 <sup>th</sup> Sem	4520104065 Quantum Physics	4520102149 Optics	4520103043 Electronics (Advanced)	4520102143 Research Methodology	4520102035 Physics Experiment II	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses
4 <sup>th</sup> Sem	4520103042 Basic Electronics II	4520101231 Basic Electronics Practicum II	4520103233 Mathematical Physics III	4520103074 Modern Physics	4520102203 Statistics	4520103114 Electromagnetics	4520103084 Waves	4520102034 Physics Experiment I	4520102216 Interpreneurships
3 <sup>rd</sup> Sem	4520103053 Earth Physics	4520103041 Basic Electronics I	4520101230 Basic Electronics Practicum I	4520104127 Mechanics	4520104071 Mathematical Physics II	4520103209 Thermodynamics	4520104086 Science of Materials	1000002011 ISBD	4520102219 Physical Education and Fitness
2 <sup>nd</sup> Sem	1000002026 Religion	4520103021 English	4520102203 Philosophy of Natural Sciences	4520104057 Basic Physics II	4520104070 Mathematical Physics I	4520102227 Literation Digital	4520102107 Conservation of Natural Resources	1000002033 Civic Education	4520101229 Basic Physics Practicum II
1 <sup>st</sup> Sem	1000002003 Indonesian	4520103026 Biology	4520104055 Basic Physics I	4520103104 Chemistry	4520103118 Basic Mathematics	1000002018 Pancasila	4520101221 Basic Physics Practicum I	4520102196 Physics Measurement System	452010xxxx Optional courses

Figure 10. Course roadmap to achieve learning outcomes SOC-2

## Roadmap of PLO-10 (ATT-1)

8 <sup>th</sup> Sem	4520106199 Thesis	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses
7 <sup>th</sup> Sem	4520103137 Nuclear physics	4520102217 PKL	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses
6 <sup>th</sup> Sem	4520103082 Physics of Solids	4520103079 Statistic of Physics	4520102105 Colloquium	4520102116 Industrial Management	4520102239 Physics Experiment III	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses
5 <sup>th</sup> Sem	4520104065 Quantum Physics	4520102149 Optics	4520103043 Electronics (Advanced)	4520102143 Research Methodology	4520102035 Physics Experiment II	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses
4 <sup>th</sup> Sem	4520103042 Basic Electronics II	4520101231 Basic Electronics Practicum II	4520103233 Mathematical Physics III	4520103074 Modern Physics	4520102203 Statistics	4520103114 Electromagnetics	4520103084 Waves	4520102034 Physics Experiment I	4520102216 Interpreneurships
3 <sup>rd</sup> Sem	4520103053 Earth Physics	4520103041 Basic Electronics I	4520101230 Basic Electronics Practicum I	4520104127 Mechanics	4520104071 Mathematical Physics II	4520103209 Thermodynamics	4520104086 Science of Materials	1000002011 ISBD	4520102219 Physical Education and Fitness
2 <sup>nd</sup> Sem	1000002026 Religion	4520103021 English	4520102203 Philosophy of Natural Sciences	4520104057 Basic Physics II	4520104070 Mathematical Physics I	4520102227 Literation Digital	4520102107 Conservation of Natural Resources	1000002033 Civic Education	4520101229 Basic Physics Practicum II
1 <sup>st</sup> Sem	1000002003 Indonesian	4520103026 Biology	4520104055 Basic Physics I	4520103104 Chemistry	4520103118 Basic Mathematics	1000002018 Pancasila	4520101221 Basic Physics Practicum I	4520102196 Physics Measurement System	452010xxxx Optional courses

**Figure 11.** Course roadmap to achieve learning outcomes ATT-1



## Roadmap of PLO-11 (ATT-2)

8 <sup>th</sup> Sem	4520106199 Thesis	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses
7 <sup>th</sup> Sem	4520103137 Nuclear physics	4520102217 PKL	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses
6 <sup>th</sup> Sem	4520103082 Physics of Solids	4520103079 Statistic of Physics	4520102105 Colloquium	4520102116 Industrial Management	4520102239 Physics Experiment III	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses
5 <sup>th</sup> Sem	4520104065 Quantum Physics	4520102149 Optics	4520103043 Electronics (Advanced)	4520102143 Research Methodology	4520102035 Physics Experiment II	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses	452010xxxx Optional courses
4 <sup>th</sup> Sem	4520103042 Basic Electronics II	4520101231 Basic Electronics Practicum II	4520103233 Mathematical Physics III	4520103074 Modern Physics	4520102203 Statistics	4520103114 Electromagnetics	4520103084 Waves	4520102034 Physics Experiment I	4520102216 Interpreneurships
3 <sup>rd</sup> Sem	4520103053 Earth Physics	4520103041 Basic Electronics I	4520101230 Basic Electronics Practicum I	4520104127 Mechanics	4520104071 Mathematical Physics II	4520103209 Thermodynamics	4520104086 Science of Materials	1000002011 ISBD	4520102219 Physical Education and Fitness
2 <sup>nd</sup> Sem	1000002026 Religion	4520103021 English	4520102203 Philosophy of Natural Sciences	4520104057 Basic Physics II	4520104070 Mathematical Physics I	4520102227 Literation Digital	4520102107 Conservation of Natural Resources	1000002033 Civic Education	4520101229 Basic Physics Practicum II
1 <sup>st</sup> Sem	1000002003 Indonesian	4520103026 Biology	4520104055 Basic Physics I	4520103104 Chemistry	4520103118 Basic Mathematics	1000002018 Pancasila	4520101221 Basic Physics Practicum I	4520102196 Physics Measurement System	452010xxxx Optional courses

**Figure 12.** Course roadmap to achieve learning outcomes ATT-2