SUMMARY OF CURRICULUM



Ecopreneurship
Growing with character

Undergraduate Programme of Physics Education
Faculty of Matematics and Natural Sciences
Universitas Negeri Surabaya
2020

Confirmation Sheet

Summary Curriculum for the Undergraduate Programme of Physics Education (UPPE) has been discussed and approved in the Faculty Meeting which was attended by the Faculty Senate, Dean, Head of Study Programme, and the FMNS Unesa Curriculum Team.

Surabaya, 1 October 2019

Dean of FMNS

Prof. Dr. Madlazim, M.Si

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OBJECTIVES OF THE DEGREE PROGRAMME

1. Vision and Mission of Institution

Based on Rector Decree No. 166/H38/HK.01.23/KL/2009, 21 August 2009, **Vision of Universitas Negeri Surabaya (Unesa)** is **"Excellent in Education, Strong in Science"**

Mission of Unesa:

(1) To conduct education and learning centred on students by using effective instructional approaches, and optimising 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 civilising 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* in Education on Mathematics and Natural Science, Strong* 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.

* "excellent" means to be innovative, competitive, and always trying to improve quality. "strong" means to work systematically, methodically, and objectively, to support the excellence of the studies in mathematics and natural sciences.

Mission of FMNS

(1) To conduct innovative and research-based mathematics and natural science education to produce graduates who are environmentally minded, entrepreneurial in spirit and have global competitiveness.
(2) To conduct researches on mathematics and natural sciences to strengthen both the studies being recognised nationally and internationally and mathematics and natural science education.
(3) To conduct research-based community services to support community welfare.
(4) To build a strong network of collaborations with stakeholders to improve the quality and image of FMNS.
(5) To conduct an autonomous, credible, fair, accountable, and transparent governance for quality assurance and quality improvement in FMNS.

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) Realises a governance system in FMNS that is autonomous, credible, fair, accountable, and transparent for quality assurance and quality improvement.

2. Programme Educational Objective (PEO)

As a consequence of the vision and mission of the institution (i.e. Unesa and FMNS) as well as the mandate of Rector Decree, i.e. SK No. 466/UN38/HK/DT/2016 to change the teaching paradigm into student-centred learning and outcome-centred learning, the Programme Educational Objectives (PEOs) of the Undergraduate Programme of Physics Education (UPPE) focus on producing graduates who are capable of becoming reliable professionals, leaders and agents of change in society with adequate capability to be responsive and adaptive to the challenges met.

The undergraduate programme of Physics Education produces professionals who at the beginning of their careers become Physics educators. However, there are possibility that the graduates of Physics education have ability to be laboratory managers, employees of educational institutions, entrepreneurs, research assistants; have the ability to continue their studies to a higher level of education and have a superior character, environmental insight, and entrepreneurial spirit that able to compete at national and international level. In detail, the PEOs are as follows:

1. Having capability in using pedagogical knowledge and skills to solve problems in work.
2. Having a strong commitment to developing knowledge, whether further study or working formally or informally.
3. Mastering scientific methods to analyse and develop innovations in learning physics and produce scientific work and contribute in their fields.
4. Mastering the fields of physics and learning, can apply their knowledge and expertise in various fields of work and can develop themselves in their career environment.
5. Having capability in communicating orally and or in writing effectively, creatively, innovatively, and collaboratively while working in teams or individually.

The formulated PEOs have extensively considered the inputs from academic staff meeting of the UPPE and the FMNS, alumni, professionals, Physics Society Indonesia (i.e. PSI). The PEOs also have significant relevancies with the Indonesian National Qualification Framework (KKNI).

1. Being able to apply their field of expertise and utilising science and technology in their fields in problem solving and being able to adapt to the situation at hand.
2. 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.

3. Able to take appropriate decisions based on analysis of information and data, and be able to provide guidance in choosing alternative solutions independently and in groups.
4. Be responsible for the work itself and can be given responsibility for the achievement of the work of the organisation.

3. Programme Learning Outcomes (PLO)

Derived from the PEOs, the UPPE has the following Programme Learning Outcomes (PLOs) for its graduates set:

Table 1. PLO of UPPE

ASPECTS	PLO	CODE	
KNOWLEDGE	1. Demonstrate their knowledge of classical physics and modern physics	**KNO-1**	**1**
	2. Formulate a physical system as a physical model by using mathematics	**KNO-2**	**2**
	3. Apply pedagogical knowledge in planning, teaching, and evaluating of physics learning	**KNO-3**	**3**
	4. Apply knowledge in relating to physics education research	**KNO-4**	**4**
SKILL	1. Plan, do, and evaluate of physics learning by using information and communication technology	**SKI-1**	**5**
	2. Design and conduct experiments in learning physics by applying the scientific method	**SKI-2**	**6**
	3. Improve their knowledge and be able to continue their study in a higher degree programme	**SKI-3**	**7**
COMPETENCES	1. Communicate the ideas and research results in verbal as well as written effectively	**COM-1**	**8**
	2. Make a decision based on the data or information in order to fulfil and evaluate the tasks responsibility	**COM-2**	**9**
	3. Work as an individual as well as a team effectively, have an entrepreneur skills, and awareness of environmental issues	**COM-3**	**10**

ATTITUDE AND SOCIAL	1. Demonstrate good scientific manners, critical thinking, and innovation skills in educational, research, and professional fields	**SOC-1**	**11**
	2. Demonstrate the appreciation of religious and cultural values in conducting their tasks as a professional.	**SOC-2**	**12**

4. PEO vs. Indonesian National Qualification Framework (INQF) (Level-6)

Table 2. The relation between PEO and INQF

Objective	Being able to apply their field of expertise and utilizing science and technology in their fields in problem solving and being able to adapt 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 take appropriate decisions based on analysis of information and data, and be able to provide guidance in choosing alternative solutions independently and in groups.	Be responsible for the work itself and can be given responsibility for the achievement of the work of the organization.
PEO-1	S	S	S	M
PEO-2	S	S	S	S
PEO-3	S	S	S	M
PEO-4	S	S	S	S
PEO-5	S	S	S	S

Note: S-Strong; M-Moderate

5. The correlation between the PLOs and the PEOs.

Table 3. Matrix of the Correlation between Programme Education Objectives (PEO) of the Undergraduate Programme of Physics Education (UPPE) and the Programme Learning Outcomes (PLO)

PLO		PEO 1 Having capability in using pedagogical knowledge and skills to solve problems in work.	PEO 2 Having a strong commitment to developing knowledge, whether further study or working formally or informally.	PEO 3 Mastering scientific methods to analyse and develop innovations in learning physics and produce scientific work and contribute in their fields.	PEO 4 Mastering the fields of physics and learning, can apply their knowledge and expertise in various fields of work and can develop themselves in their career environment.	PEO 5 Having capability in communicating orally and or in writing effectively, creatively, innovatively, and collaboratively while working in teams or individually.
1	**KNO 1**	√	√	√	√	√
2	**KNO 2**	√	√	x	√	x
3	**KNO 3**	√	√	x	√	x
4	**KNO 4**	√	√	√	√	√
5	**SKI 1**	√	x	√	√	√
6	**SKI 2**	√	x	√	x	x
7	**SKI 3**	√	√	√	√	√
8	**COM 1**	√	x	√	x	√
9	**COM 2**	√	x	√	√	√
10	**COM 3**	√	x	√	√	√
11	**SOC 1**	√	x	√	√	√
12	**SOC 2**	√	√	√	√	√

* √***-Yes, X-No***

6. Mapping of Subject-Specific Criteria of ASIIN with Programme Learning Outcomes (PLO)

Table 4. The mapping of SSC ASIIN and PLO

ASIIN Subject Specific Criteria for Physics (ASIIN-SSC)		Programme Learning Outcome (PLO)											
		1	2	3	4	5	6	7	8	9	10	11	12
		KNO1	KNO2	KNO3	KNO4	SKI1	SKI2	SKI3	COM1	COM2	COM3	SOC1	SOC2
1	They have sound knowledge of classical physics (mechanics, electrodynamics, thermodynamics, vibrations, waves and optics) and are familiar with the fundamentals of quantum, atomic and 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.		√										
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.	√	√	√									
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.			√	√								
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.			√	√	√							
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 analyse and/or solve them by using natural scientific and mathematical methods.					√	√					√	

ASIIN Subject Specific Criteria for Physics (ASIIN-SSC)		Programme Learning Outcome (PLO)											
		KNO1	KNO2	KNO3	KNO4	SKI1	SKI2	SKI3	COM1	COM2	COM3	SOC1	SOC2
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.						√						
8	They have generally also acquired an overview knowledge in selected other natural science subjects or technical disciplines.											√	√
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 – possibly after appropriate qualification – into their further work.									√	√	√	
10	They are able to continuously and self-reliantly extend and deepen the knowledge acquired in the Bachelor's degree programme. They are familiar with suitable learning strategies (lifelong learning) for this; they are in particular capable of a consecutive Master's degree programme in principle.					√	√	√					
11	They have gained initial experience with regard to generic qualifications (e.g. time man-agreement, study and work techniques, willingness to cooperate, capacity for teamwork, ability to communicate and communication techniques, rules of good scientific practice) in their degree programme, and are able to develop these skills further.							√	√		√		
12	They are familiar with the basic elements of the relevant specialised English.							√	√				
13	They are able to solve a simple scientific problem and to present their results orally (lecture) and in writing (demonstrated in a Bachelor's thesis).								√	√			

7. PROGRAMME STRUCTURE

As mentioned, besides based on the inputs from stakeholders, the improvements of the physics education's curriculum structure were also a result of evaluation on current conditions and future needs of the profession in the field of physics, taking into account both national and global challenges being faced as summarised in Figure 1.

By accommodating those challenges, the structure as well as the course syllabus have been revised and applied within the period of 2015 - 2019. Continuous evaluation of the implementation is conducted annually.

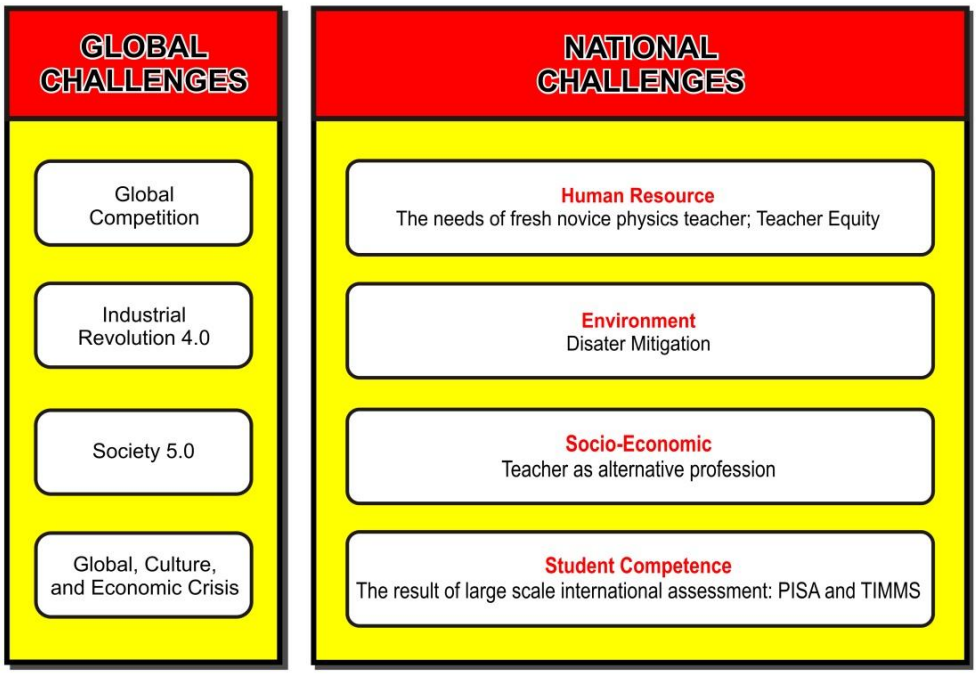


Figure 1. Recognised Challenges in the Field of Physics Education

The curriculum of the UPPE is delivered in 4 phases/years through 3 main structures: basic knowledge, expertise knowledge and synthesis, as illustrated in Figure 2. In this structure, the learning process to gain competence is modelled as a house. Basic knowledge is the foundation of the programme, expertise knowledge as the pillars, and the synthesis of knowledge as the roof which cover all urban and regional planning knowledge.

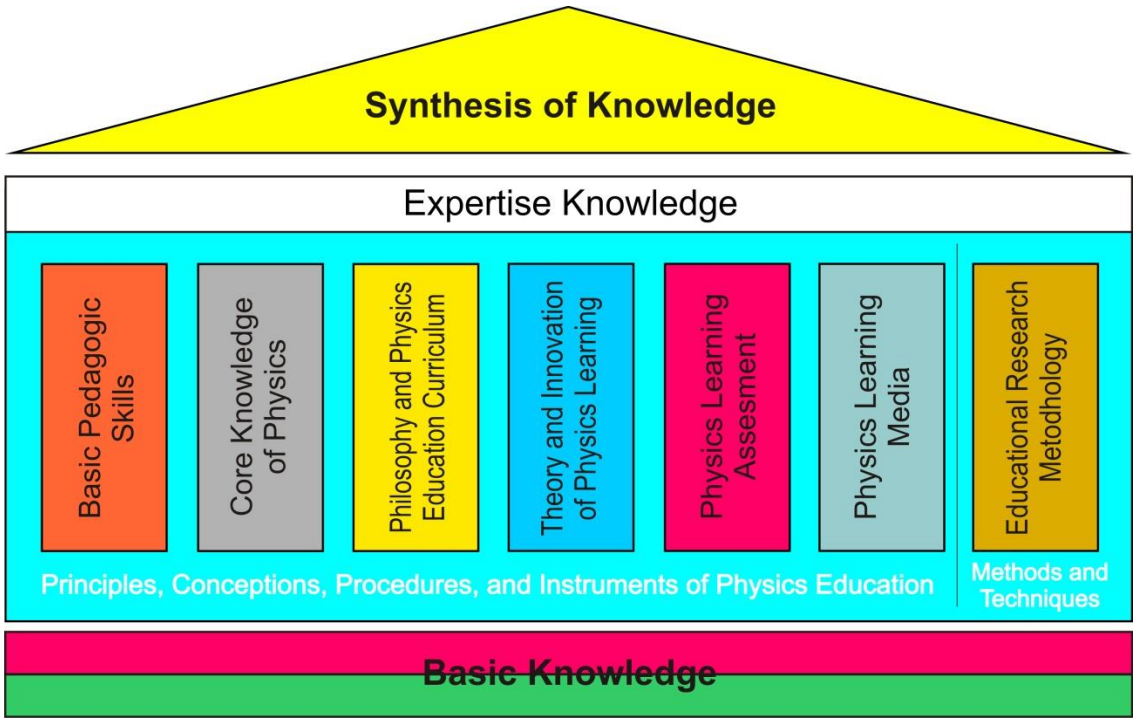


Figure 2. Physics Education's Curriculum Structure

The minimum workload of Undergraduate Programme at Unesa is 144 credit units (CU) which correspond to 5,712 hours[1] or 228.48 ECTS[2], and are generally distributed in 8 regular semesters. On average, the total hour per semester is 714 hours. The normal workload for each regular semester is limited to 793.33 hours, corresponds to 20 CU (32 ECTS).

Note:

[1] *In Unesa, referring to 2019/2020 academic handbook, 1 CU for bachelor degree equals to 170 minutes per week (50' face to face learning, 60' structured learning, and 60' independent learning). In one semester, courses are conducted in 14 weeks (excluding mid- and end-term exam). Thus, 1 CU equals to 39.67 workhours per semester.*

[2] *1 CU equals to 1,586667 or 1.59 ECTS, assuming that 1 ECTS equals to 28.56 workhours per semester.*

Table 5. The mapping of curriculum content into PLO

No	Code	Course Name	CU	PLO											
				1	2	3	4	5	6	7	8	9	10	11	12
				KNO1	KNO2	KNO3	KNO4	SKI1	SKI2	SKI3	COM1	COM2	COM3	SOC1	SOC2
1	0001212008	Pancasila Education	2								√				√
2	0001212009	Indonesian	2								√				√
3	0002213001	Basic Education	3			√	√				√				
4	8420303065	Basic Physics I	3	√									√	√	
5	8420303029	General Biology	3										√	√	
6	8420303106	General Chemistry	3										√	√	
7	8420303117	Basic Mathematics	3		√										
8	8420302188	Physics Measurement System	2						√			√			
9	8420301170	Basic Physics Practicum I	1	√					√		√				
10	842030223x	Religious Education	2												√
11	1000002033	Civic Education	2												√
12	8420303013	English	3								√				
13	8420302232	Digital Literacy	2					√			√				
14	1000002039	Educational Psychology	2				√								
15	8420303066	Basic Physics II	3	√									√	√	
16	8420302107	Natural Resource Conservation	2										√	√	
17	8420303235	Mathematical Physics I	3	√	√								√	√	
18	8420301171	Basic Physics Practicum II	1	√					√		√				
19	8420302236	Learning Theories	2			√	√								
20	8420302233	Physical Education and Fitness	2										√		
21	8420304130	Mechanics	4	√	√								√	√	
22	8420303218	Thermodynamics	3	√	√							√		√	
23	8420302237	Basic Electronics I	2	√										√	
24	8420303238	Mathematical Physics II	3	√	√									√	
25	8420301239	Electronics Practicum I	1	√					√		√				
26	8420302240	Learning Evaluation	2			√		√				√		√	
27	0002212006	Basic Social and Cultural Sciences	2												√
28	8420303115	Electromagnetism	3	√	√									√	
29	8420303076	Modern Physics	3	√	√							√		√	
30	8420302241	Basic Electronics II	2	√										√	

No	Code	Course Name	CU	PLO											
				1	2	3	4	5	6	7	8	9	10	11	12
				KNO1	KNO2	KNO3	KNO4	SKI1	SKI2	SKI3	COM1	COM2	COM3	SOC1	SOC2
31	8420303081	Waves	3	√	√							√			
32	8420302043	Physics Experiment I	2	√					√		√				
33	8420301242	Electronics Practicum II	1	√					√		√				
34	8420303196	Statistics	3				√							√	
35	8420302243	Educational Philosophy	2			√					√				
36	8420302244	Innovative Learning Planning	2	√		√							√		
37	8420302224	Entrepreneurship	2										√	√	
38	8420302247	Statistical Physics	2	√	√									√	
39	8420303069	Quantum Physics	3	√	√									√	
40	8420303077	Physics for School	3			√					√				
41	8420302044	Physics Experiment II	2	√					√		√				
42	8420302250	School Curriculum	2			√					√			√	
43	8420302129	Learning Media	2			√		√					√		
44	8420304249	Research Methodology	4			√	√			√				√	
45	8420302144	Optics	2	√	√							√			
46	8420303080	Solid State Physics	3	√								√		√	
47	8420302108	Physics Laboratory	2	√					√		√				
48	8420302099	Earth and Space Science	2	√										√	
49	8420302184	Seminar	2			√	√				√	√		√	
50	8420302255	Physics Experiment III	2	√					√		√				
51	8420302230	Microteaching	2			√	√	√			√		√		
52	8420301256	Introduction to School I	1										√	√	
53	8420303068	Nuclear Physics	3	√	√			√			√		√		
54	8420301257	Introduction to School II	3										√	√	
55	8420303226	Community Service Programme	3								√	√	√	√	
56	8420306189	Thesis	6			√	√	√		√	√	√		√	
57	8420302262	Astronomy	2	√							√		√		
58	8420302266	Robotics Physics	2							√			√	√	
59	8420302063	Earth Science	2	√							√		√		
60	8420302272	Energy material	2							√			√	√	
61	8420302261	Disaster Mitigation	2	√							√		√		
62	8420302132	Mechanical of technique	2							√				√	

No	Code	Course Name	CU	PLO											
				1	2	3	4	5	6	7	8	9	10	11	12
				KNO1	KNO2	KNO3	KNO4	SKI1	SKI2	SKI3	COM1	COM2	COM3	SOC1	SOC2
63	8420302178	Electrical Circuits	2		√					√				√	
64	8420302073	Advanced Mathematical Physics	2	√	√					√				√	
65	8420302183	History of Physics	2	√						√					
66	8420302268	Physics Argumentation	2			√				√					
67	8420302263	Olympic Physics	2							√	√		√		
68	8420302271	Development of Physics Curriculum	2			√					√			√	
69	8420302254	Physics Local Wisdom	2			√				√					√
70	8420302258	Advanced Innovative Learning	2			√	√	√		√					
71	8420302265	STEAM Learning	2			√		√		√					
72	8420302253	Physics e-learning	2			√		√		√					
73	8420302098	Integrated Science	2			√		√		√					
74	8420302267	School Laboratory Management	2			√			√	√					
75	8420302252	Audio-visual Physics	2			√		√		√					
76	8420302246	Physics of Photography	2			√		√		√					
77	8420302143	Multimedia	2			√		√		√					
78	8420302269	Physics Edutainment	2			√		√		√					
79	8420302259	Physics Communication and Media Analysis	2			√		√		√					
80	8420302264	Measurement and Instruments of Physics Education	2			√		√		√					
81	8420302251	Study of UN, TIMSS, and PISA	2			√		√		√					
82	8420302245	Physics Literacy	2				√	√		√					
83	8420302260	Item Response Theory	2			√		√		√					
84	8420302270	Computer Based Assessment	2			√		√		√					

Note:

[1] *In Unesa, referring to 2019/2020 academic handbook, 1 CU for bachelor degree equals to 3 workhours per week or 170 minutes (50' face to face learning, 60' structured learning, and 60' independent learning). In one semester, courses are conducted in 14 weeks (excluding mid- and end-term exam). Thus, 1 CU equals to 39.67 workhours per semester.*

[2] *1 CU equals to 1,586667 or 1.59 ECTS, assuming that 1 ECTS equals to 28.56 workhours per semester.*

The detailed curriculum structure each semester is shown in tables below.

Table 6. The UPPE Curriculum Structure

1st Semester				2nd Semester			
No	Code	Course Title	CU	No	Code	Course Title	CU
1	0001212008	Pancasila Education (*Pendidikan Pancasila*)	2	1	842030223x	Religious Education (*Pendidikan Agama*)	2
2	0001212009	Indonesian (*Bahasa Indonesia*)	2	2	1000002033	Civic Education (*Pendidikan Kewarganegaraan*)	2
3	0002213001	Basic Education (*Dasar-dasar Pendidikan*)	3	3	8420303013	English (*Bahasa Inggris*)	3
4	8420303065	Basic Physics I (*Fisika Dasar I*)	3	4	8420302232	Digital Literacy (*Literasi Digital*)	2
5	8420303029	General Biology (*Biologi Umum*)	3	5	1000002039	Educational Psychology (*Psikologi Pendidikan*)	2
6	8420303106	General Chemistry (*Kimia Umum*)	3	6	8420303066	Basic Physics II (*Fisika Dasar II*)	3
7	8420303117	Basic Mathematics (*Matematika Dasar*)	3	7	8420302107	Natural Resource Conservation (*Konservasi Sumber Daya Alam*)	2
8	8420302188	Physics Measurement System (*Sistem Pengukuran Fisika*)	2	8	8420303235	Mathematical Physics I (*Fisika Matematik I*)	3
9	8420301170	Basic Physics Practicum I (*Praktikum Fisika Dasar I*)	1	9	8420301171	Basic Physics Practicum II (*Praktikum Fisika Dasar II*)	1
				10	8420302236	Learning Theories (*Teori Belajar*)	2
Total 22 CU (34.98 ECTS)				**Total 22 CU (34.98 ECTS)**			
3th Semester				**4th Semester**			
NO	Code	Course Title	CU	NO	Code	Course Title	CU
1	8420302233	Physical Education and Fitness (*Pend. Jasmani dan Kebugaran*)	2	1	8420303115	Electromagnetism (*Listrik Magnet*)	3
2	8420304130	Mechanics (*Mekanika*)	4	2	8420303076	Modern Physics (*Fisika Modern*)	3
3	8420303218	Thermodynamics (*Termodinamika*)	3	3	8420302241	Basic Electronics II (*Elektronika Dasar II*)	2
4	8420302237	Basic Electronics I (*Elektronika Dasar I*)	2	4	8420303081	Waves (*Gelombang*)	3
5	8420303238	Mathematical Physics II (*Fisika Matematik II*)	3	5	8420302043	Physics Experiment I (*Eksperimen Fisika I*)	2
6	8420301239	Electronics Practicum I (*Praktikum Eldas I*)	1	6	8420301242	Electronics Practicum II (*Praktikum Eldas II*)	1
7	8420302240	Learning Evaluation (*Evaluasi Belajar dan Pembelajaran*)	2	7	8420303196	Statistics (*Statistika*)	3
8	0002212006	Basic Social and Cultural Sciences (*ISBD*)	2	8	8420302243	Educational Philosophy (*Filsafat Pendidikan*)	2
				9	8420302244	Innovative Learning Planning (*Perencanaan Pembelajaran Inovatif*)	2
Total 19 CU (30.21 ECTS)				**Total 21 CU (33.39 ECTS)**			
5th Semester				**6th Semester**			
NO	Code	Course Title	CU	NO	Code	Course Title	CU
1	8420302224	Entrepreneurship (*Kewirausahaan*)	2	1	8420302144	Optics (*Optik*)	2
2	8420302247	Statistical Physics (*Fisika Statistik*)	2	2	8420303080	Solid State Physics (*Fisika Zat Padat*)	3
3	8420303069	Quantum Physics (*Fisika Kuantum*)	3	3	8420302108	Physics Laboratory (*Laboratorium Fisika*)	2
4	8420303077	Physics for School	3	4	8420302099	Earth and Space Science	2

		(*Fisika Sekolah*)				(*IPBA*)	
5	8420302044	Physics Experiment II (Eksperimen Fisika II)	2	5	8420302184	Seminar	2
6	8420302250	School Curriculum (*Kurikulum Sekolah*)	2	6	8420302255	Physics Experiment III (*Eksperimen Fisika III*)	2
7	8420302129	Learning Media (*Media Pembelajaran*)	2	7	8420302230	Microteaching (*Pembelajaran Mikro*)	2
8	8420304249	Research Methodology (*Metodologi Penelitian*)	4	8	8420301256	Introduction to School I (*Pengenalan Lapangan Persekolahan I*)	1
				9		Elective courses*	2
Total 20 CU (31.8 ECTS)				**Total 18 CU (28.62 ECTS)**			
7th Semester				**8th Semester**			
NO	**Code**	**Course Title**	**CU**		**Code**	**Course Title**	**CU**
1	8420303068	Nuclear Physics (*Fisika Inti*)	3	1	8420306189	Thesis (*Skripsi*)	6
2	8420301257	Introduction to School II (*Pengenalan Lapangan Persekolahan II*)	3				
3	8420303226	Community Service Programme (*Kuliah Kerja Nyata*)	3				
4		Elective course*	2				
5		Elective course*	2				
6		Elective course*	2				
7		Elective course*	2				
Total 17 CU (27.03 ECTS)				**Total** 6 CU (9.54 ECTS)			

Table 7. Elective Course of the UPPE*

No	CODE	COURSE TITLE	CU	No	CODE	COURSE TITLE	CU
1	8420302262	Astronomy (Astronomi)	2	15	8420302265	STEAM Learning (Pembelajaran STEAM)	2
2	8420302266	Robotics Physics (Fisika Robotika)	2	16	8420302253	Physics e-learning (E-Learning Fisika)	2
3	8420302063	Earth Science (Fisika Bumi)	2	17	8420302098	Integrated Science (IPA Terpadu)	2
4	8420302272	Energy material (Material Energi)	2	18	8420302267	School Laboratory Management (Manajemen Laboratorium Sekolah)	2
5	8420302261	Disaster Mitigation (Mitigasi Bencana)	2	19	8420302252	Audiovisual Physics (Fisika Audiovisual)	2
6	8420302132	Mechanical of Technique (Mekanika Teknik)	2	20	8420302246	Physics of Photography (Fisika Fotografi)	2
7	8420302178	Electrical Circuits (Rangkaian Listrik)	2	21	8420302143	Multimedia	2
8	8420302073	Advanced Mathematical Physics (Fisika Matematika Lanjut)	2	22	8420302269	Physics Edutainment	2
9	8420302183	History of Physics (Sejarah Fisika)	2	23	8420302259	Physics Communication and Media Analysis (Komunikasi Fisika & Analisis Media)	2
10	8420302268	Physics Argumentation (Argumentasi Fisika)	2	24	8420302264	Measurement and Instruments of Physics Education (Pengukuran & Instrumen Pend Fisika)	2
11	8420302263	Olympic Physics (Fisika Olimpiade)	2	25	8420302251	Study of UN, TIMSS, and PISA (Kajian UN, TIMSS, dan PISA)	2
12	8420302271	Development of Physics Curriculum (Pengembangan Kurikulum Fisika)	2	26	8420302245	Physics Literacy (Literasi Fisika)	2
13	8420302254	Physics Local Wisdom (Kearifan Lokal Fisika)	2	27	8420302260	Item Response Theory (Teori Respon Butir)	2
14	8420302258	Advanced Innovative Learning (Pembelajaran Inovatif Lanjut)	2	28	8420302270	Computer Based Assessment (Penilaian Berbasis Komputer)	2
Total 56 CU (89.04 ECTS)							

Table 8. Summary of credit unit (CU) and ECTS of each semester in the UPPE

No	Semester	CU	ECTS
1	1	22	34.98
2	2	22	34.98
3	3	19	30.21
4	4	21	33.39
5	5	20	31.80
6	6	18	28.62
7	7	17	27.03
8	8	6	9.54
		145	**230.55**

Rule of institution
Requirement for graduation,
Obligatory course = 135 CU (214.65 ECTS)
Selective course = 56 CU (89.04 ECTS) with minimum requirement 9 CU (14.31 ECTS)
Total (minimum) = **145 CU** (credit unit) equal to **230.55 ECTS**

Based on the UPPE curriculum structure is shown in Figure 2, then it is significant to demonstrate the roadmap of courses into PLO. The road-map also demonstrates that the curriculum structure consists of multi-discipline courses designed in 8 semesters in order to achieve the comprehensiveness in the UPPE. The roadmap also describes in different colour-boxes corresponding to the UPPE - programme learning outcome (PLO) in Figure 3 to Figure 14.

Roadmap of PLO-1 (KNO-1)

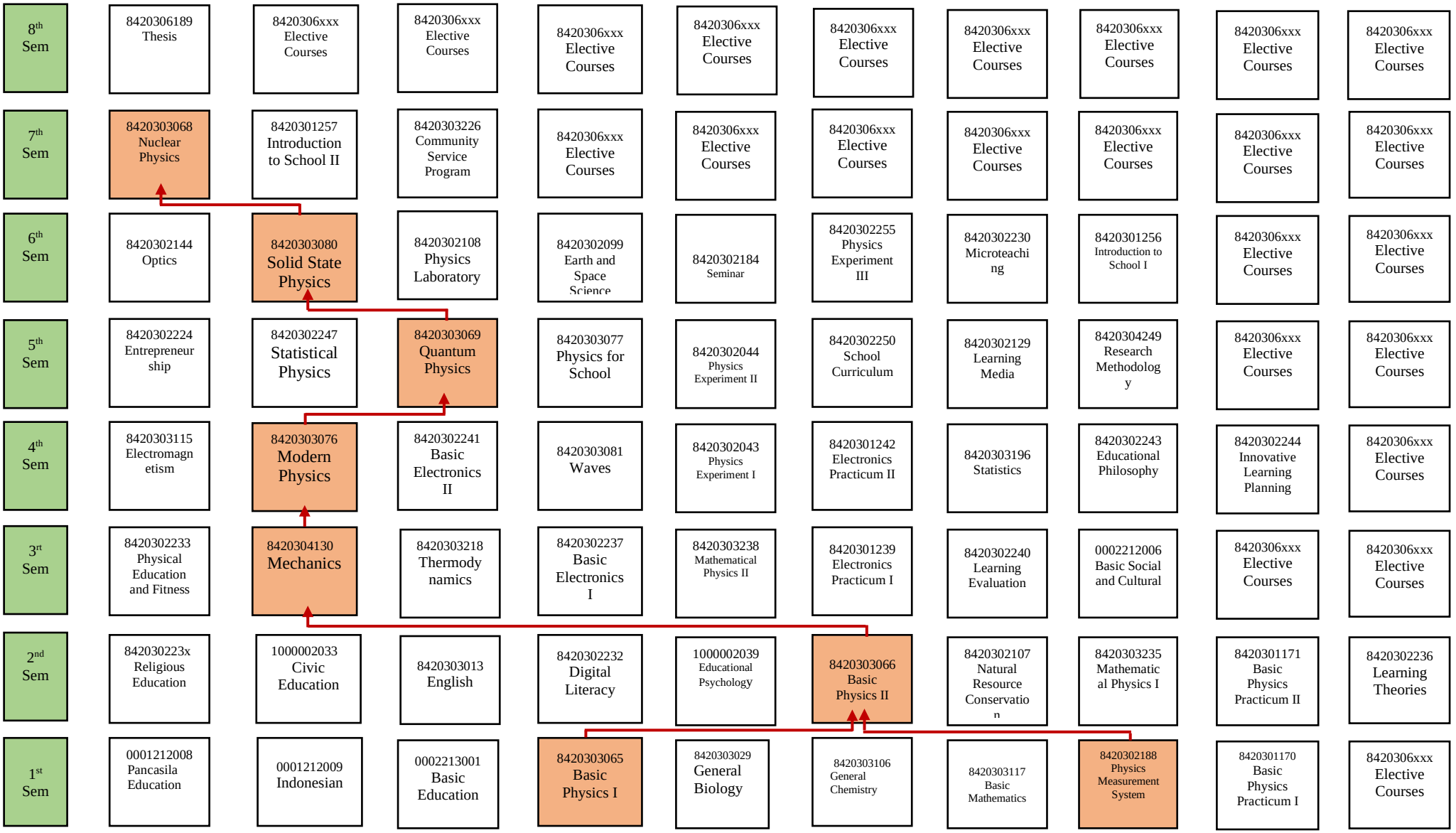


Figure 3. Course roadmap to achieve learning outcomes KNO-1

Roadmap of PLO-2 (KNO-2)

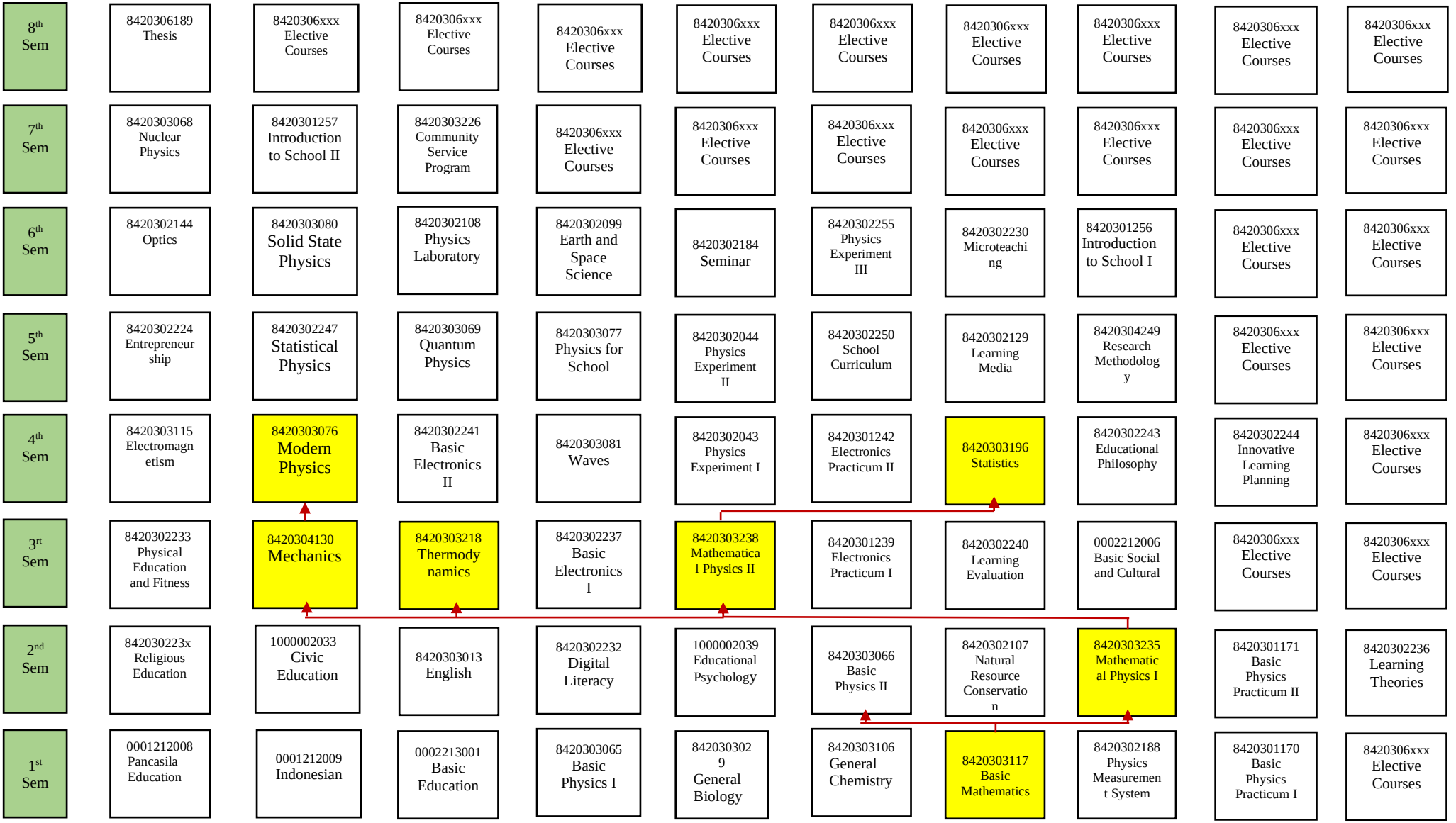


Figure 4. Course roadmap to achieve learning outcomes KNO-2

Roadmap of PLO-3 (KNO-3)

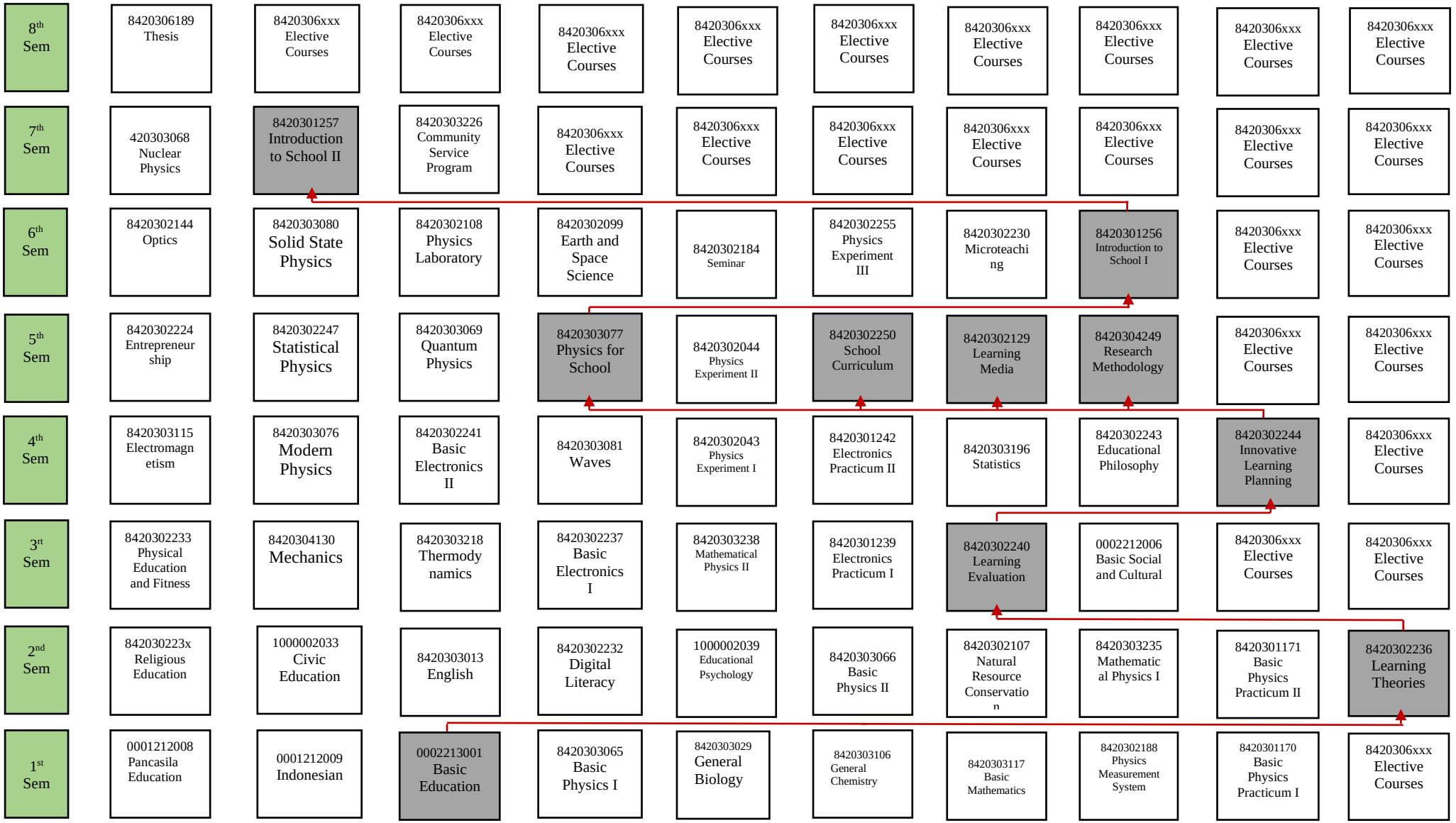


Figure 5. Course roadmap to achieve learning outcomes KNO-3

Roadmap of PLO-4 (KNO-4)

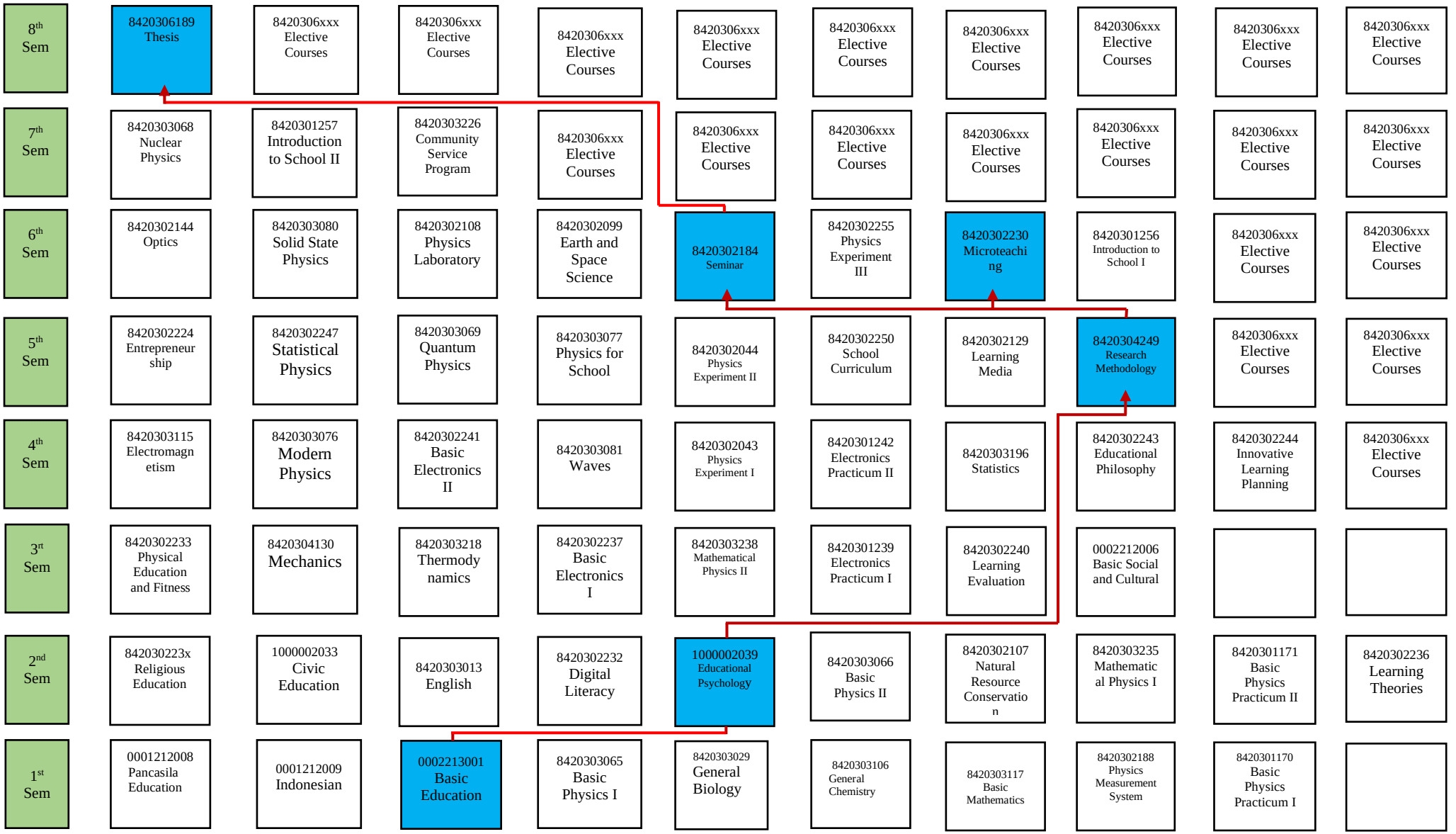


Figure 6. Course roadmap to achieve learning outcomes KNO-4

Roadmap of PLO-5 (SKI-1)

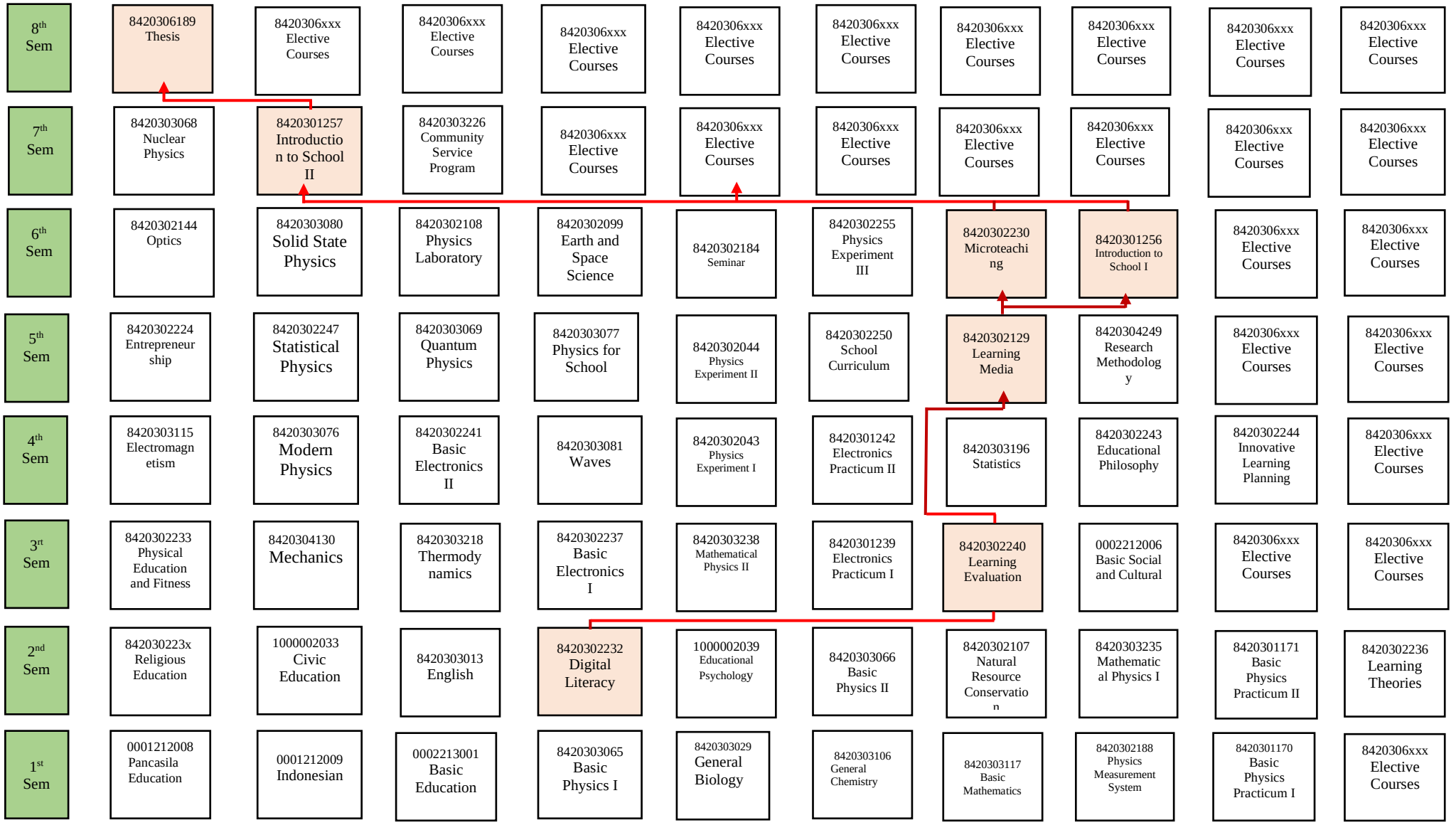


Figure 7. Course roadmap to achieve learning outcomes SKI-1

Roadmap of PLO-6 (SKI-2)

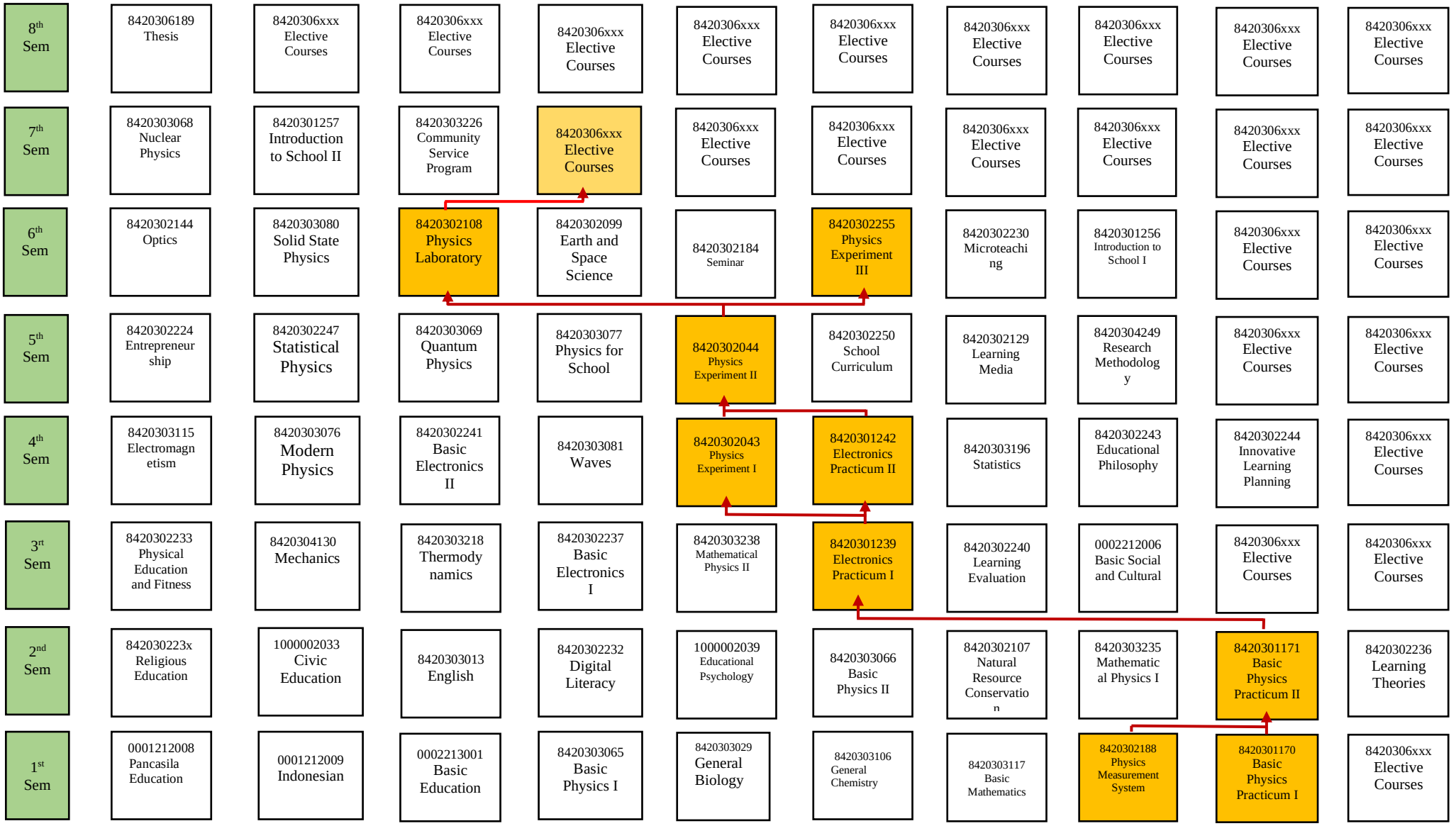


Figure 8. Course roadmap to achieve learning outcomes SKI-2

Roadmap of PLO-7 (SKI-3)

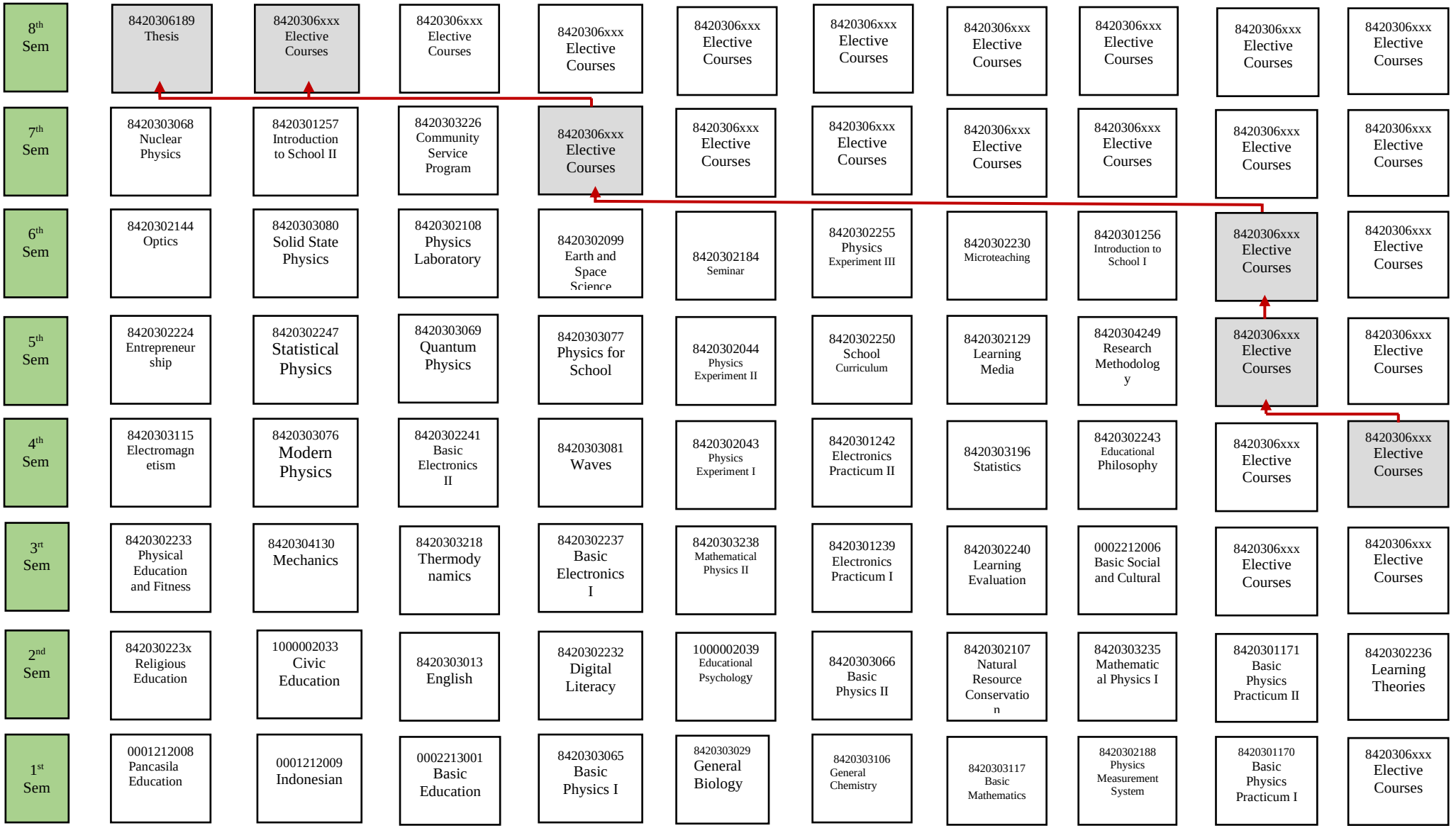


Figure 9. Course roadmap to achieve learning outcomes SKI-3

Roadmap of PLO-8 (COM-1)

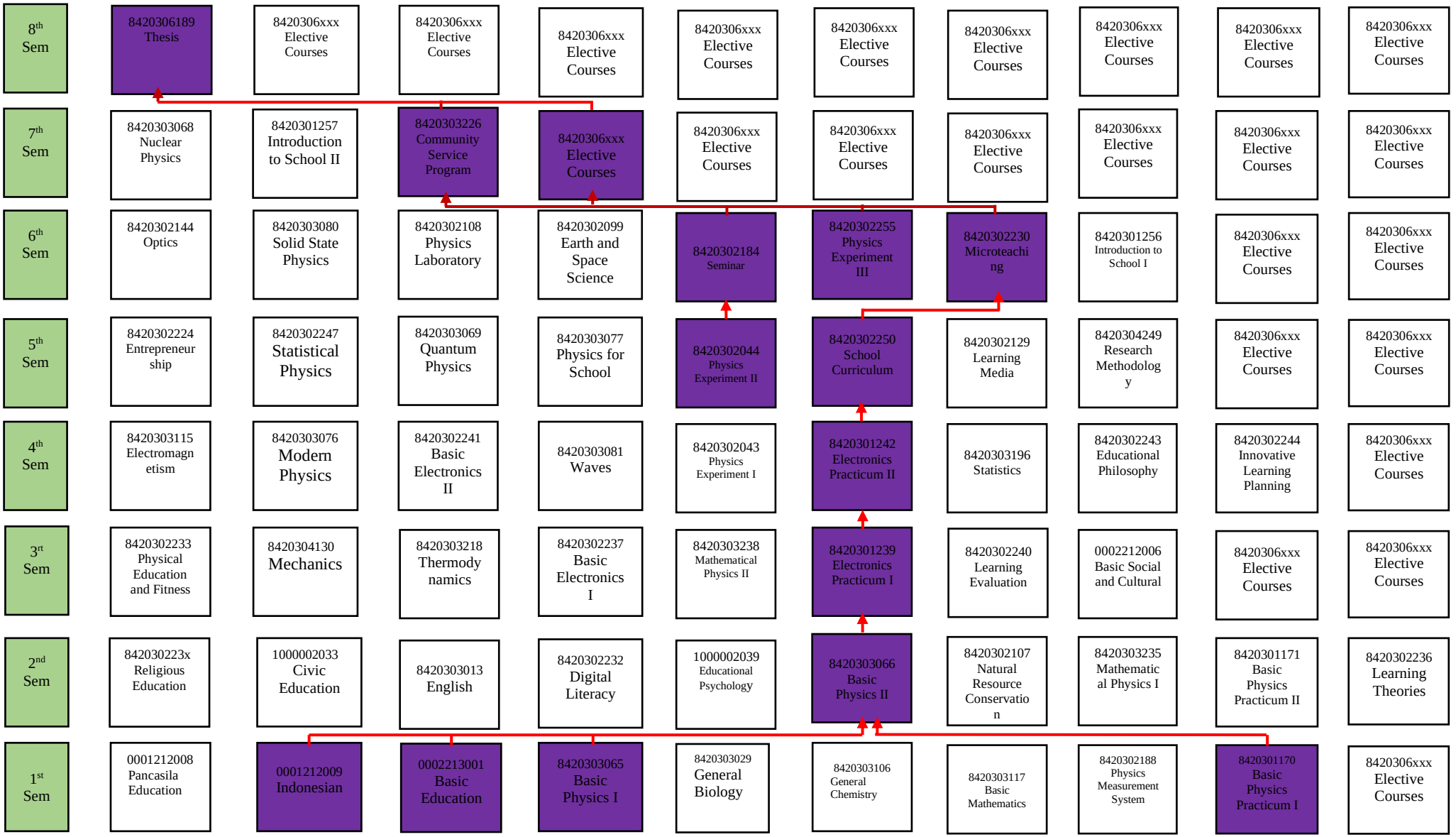


Figure 10. Course roadmap to achieve learning outcomes COM-1

Roadmap of PLO-9 (COM-2)

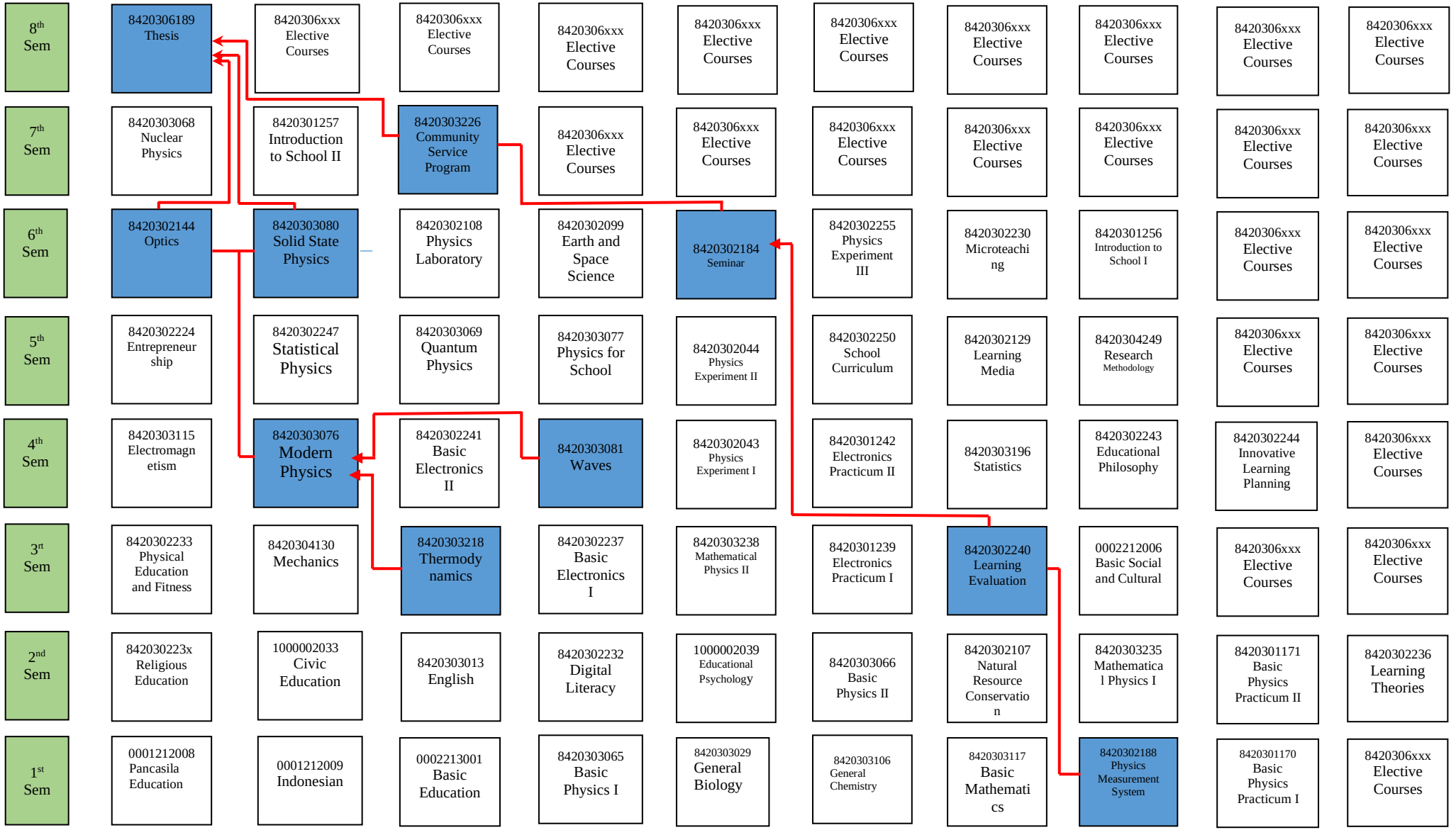


Figure 11. Course roadmap to achieve learning outcomes COM-2

Roadmap of PLO-10 (COM-3)

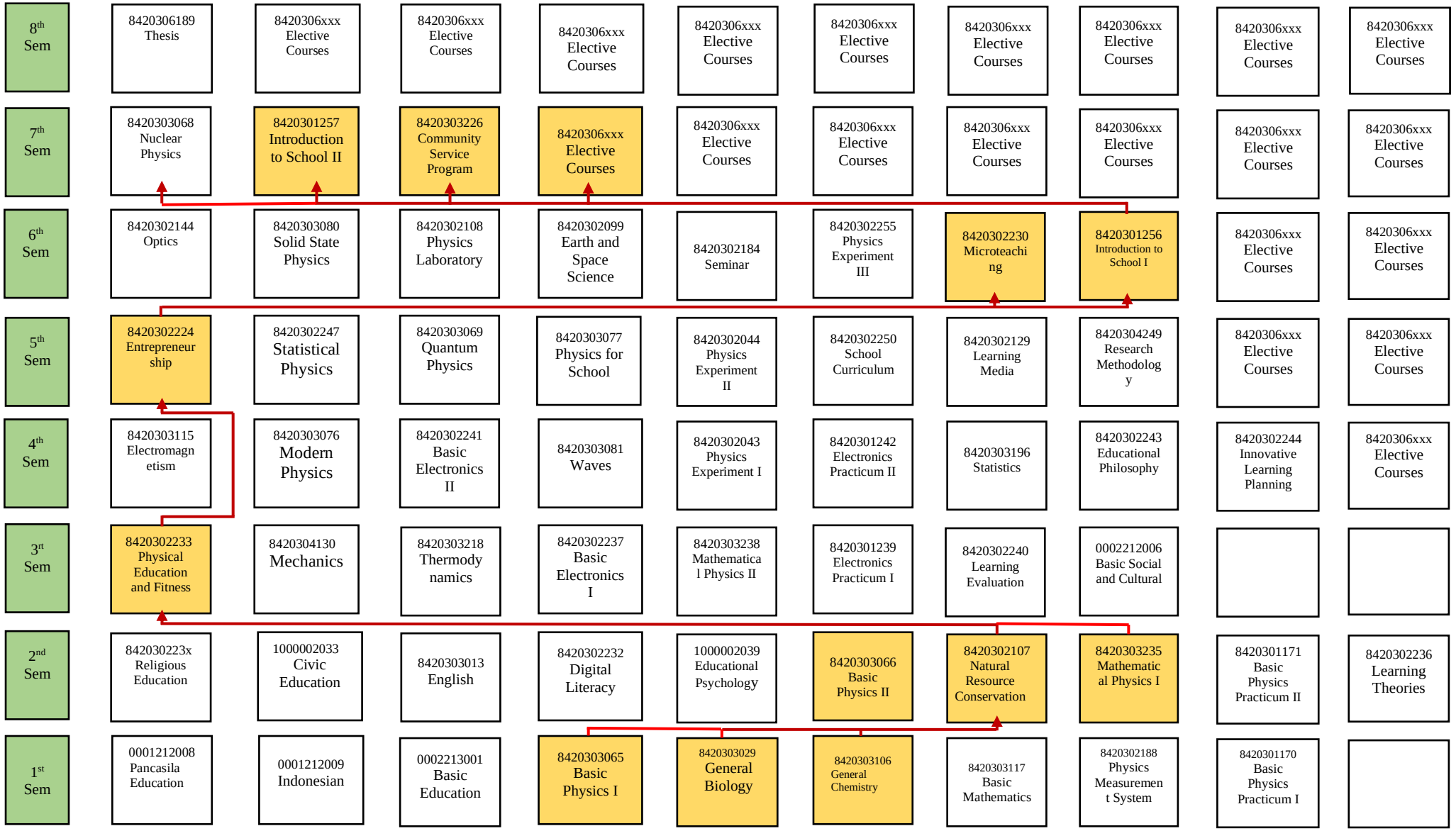


Figure 12. Course roadmap to achieve learning outcomes COM-3

Roadmap of PLO-11 (SOC-1)

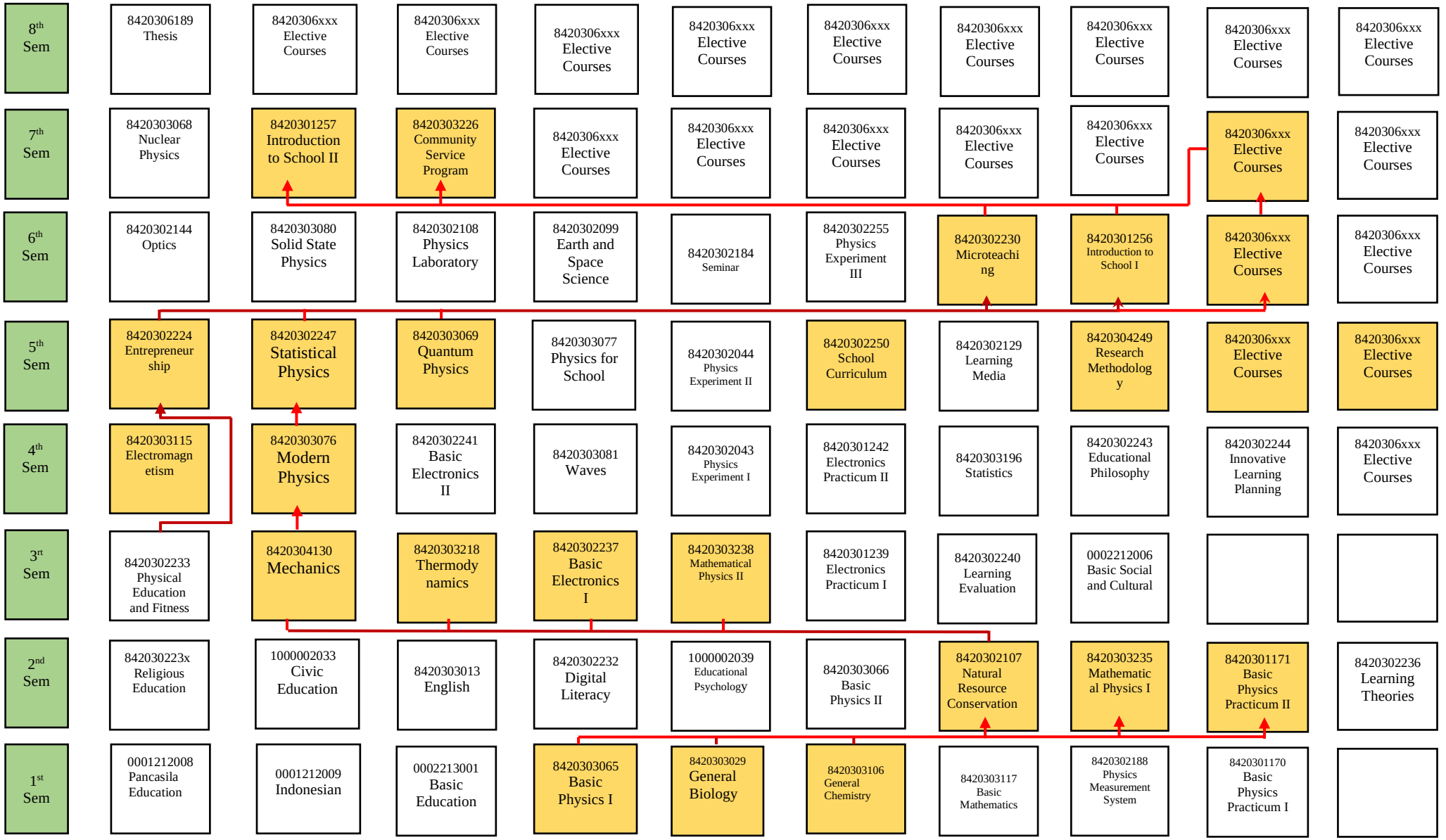


Figure 13. Course roadmap to achieve learning outcomes SOC-1

Roadmap of PLO-12 (SOC-2)

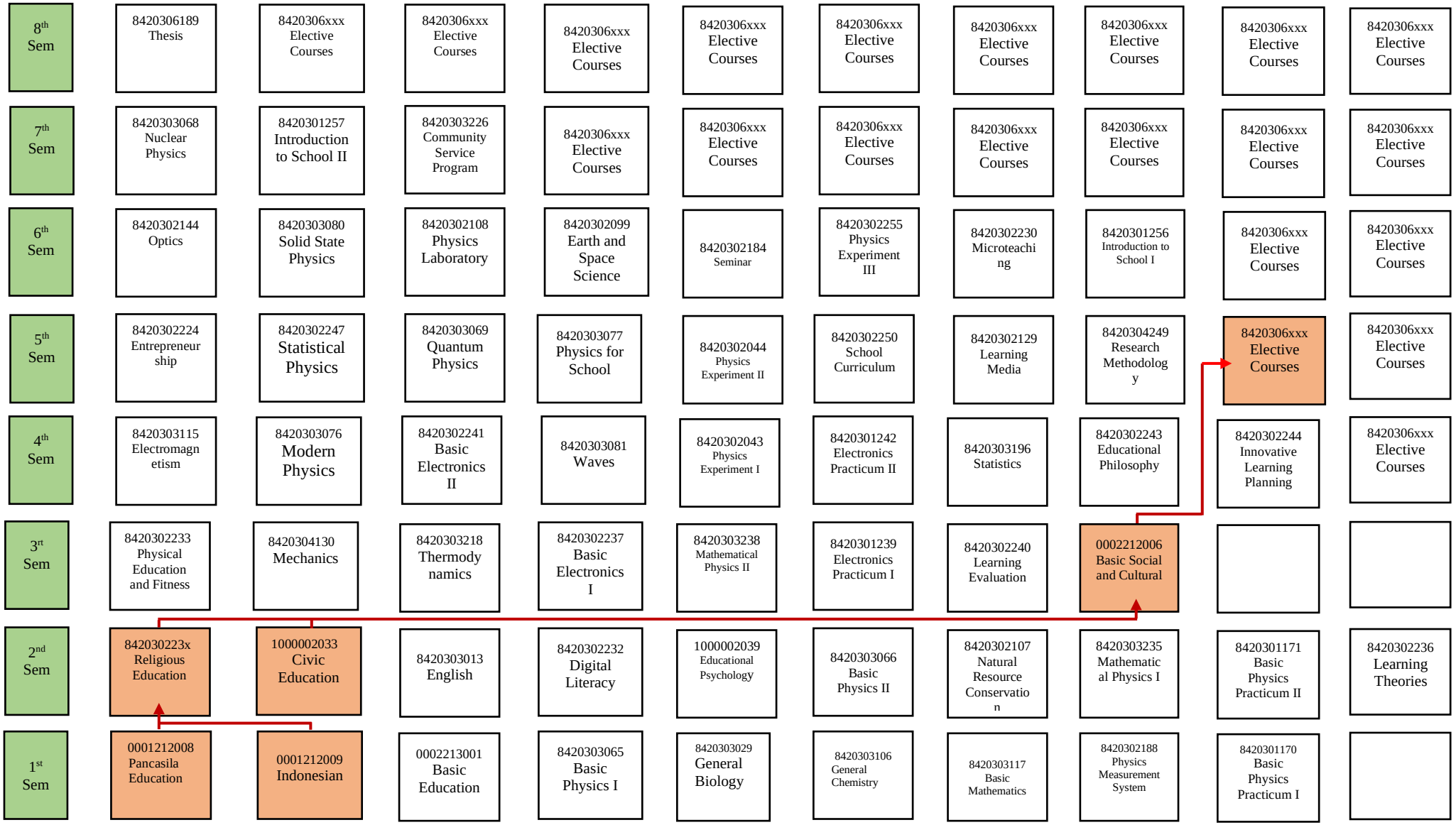


Figure 14. Course roadmap to achieve learning outcomes SOC-2

COURSE DESCRIPTION

No	Name of Course	Description
1	Basic Education	Education Basics studies and equips prospective teachers and / or teachers in positions regarding the basic concepts of education, human nature and its development, educational foundations, education as a system, the national education system, teachers as a profession, educational problems, educational innovation in Indonesia, and education. character both at school and outside the school.
2	Basic Physics 1	The study of quantities, units and measurements, particle kinematics (one, two and three dimensional motion), particle dynamics (Newton's laws and their use, work and energy, linear momentum and collisions), rotational dynamics (rotation of rigid bodies, angular momentum and force moments , rigid body equilibrium), harmonious vibrations, universal laws of gravity, fluid mechanics, mechanical waves (sound waves, superposition and standing waves), thermo physics (temperature, expansion and ideal gases, heat) and the laws of thermodynamics I (kinetic theory of gases) and laws thermodynamics II (heat engine, entropy)
3	Basic Physics 2	The study of Electric field, Gauss law, electric potential, capacitance and dielectric, current and resistance, direct current circuit, magnetic field source magnetic field, Faraday law, inductance, alternating current circuit, electromagnetic waves, geometric optics, light wave interference, diffraction and polarized waves
4	Basic Physics Practicum	This course examines simple physics experiments at the basic level that are correlated with knowledge of physics. In the Basic Physics Practicum course 1, students will study uncertainty in measurement, density of solids, moment of inertia of pulleys, Newton's second law, mathematical pendulum, spring constant, pulley system, viscosity of liquid, sound wave resonance, thermometer detection, heat capacity calorimeter, and the heat of melting ice. Giving practicum is expected to strengthen students' understanding of physical phenomena related to kinematics, dynamics, waves and thermodynamics. After participating in this practicum course, students can understand the limitations of measurement tools and calculate measurement errors that occur, and can understand the concepts of mechanics and thermodynamics through the teaching aids used during the practicum. Students are also expected to see the relationship between theory and practice in general
5	Digital Literacy	This course is a course that develops interests, attitudes and abilities of individuals using digital technology and communication tools to access, manage, integrate, analyze

		and evaluate information, build new knowledge, create, and communicate with others in order to participate effectively.
6	Learning Media	This course is a course that designs and develops teaching and learning process aids in the form of hardware and software, namely anything that can be used to stimulate the thoughts, feelings, attention and abilities or skills of learners so that they can encourage the learning process.
7	Mechanics	This course examines basic concepts (space and vectors), Newtonian mechanics (kinematics and particle dynamics), harmonic vibration, central force field and gravitational field, transformation frame of reference, particle system dynamics and rigid body mechanics, Lagrangian mechanics and Hamilton equations by applying discussion methods, guided discovery, problem solving, and tutorials for discover, understand, and apply mechanical concepts. Duty independently and in groups as well as presentations on study search results as well applied.
8	Basic Electronics 1	Basic Electronics 1 course covers two main subjects, the first material is the basics of electronics including: direct current, alternating current, passive components and the basic principles of measuring and measuring electricity. The second material deals with active components covering the working principle and application of semiconductors, p-n junctions, diodes, bipolar transistors (BJT).
9	Basic Electronics 2	The Basic Electronics 2 course covers the working principles and application of BJT transistors, JFET field effect transistors, op-amp characteristics and circuits, and the basic material of digital electronics.
10	Learning Evaluation	Study of the meaning, purpose, function, and assessment principles, taxonomy of cognitive, affective, and psychomotor learning outcomes, including scientific literacy and HOTs, various approaches, methods, and assessment strategies / techniques, instrument forms, rubrics / assessment guidelines, analysis and interpretation of assessment results, and their use. Online learning is carried out through discussions, assignments, and project assignments related to assessments at school.
11	Innovative Learning 1	Innovative Learning I studies and equips prospective students of physics education about analysing, evaluating and creating about physics learning using innovative learning models (direct instruction, concept attainment models, meaningful learning, SDGs learning, HOTs based learning) to be able to compete and excel in this era. 4.0 and welcoming society 5.0.
12	Innovative Learning 2	Study of learning models which include cooperative learning, scientific approach-oriented learning such as: problem-based learning, inquiry-discussion learning and contextual learning and project-based learning. The

		assessment is carried out through the presentation of concepts, presenting operational examples of each learning model in the form of learning tools, workshops on developing learning tools by students oriented to each learning model and strategy. The study activity ended with an exercise in the implementation of a certain learning model by each student in the peer teaching forum followed by discussion and reflection activities.
13	School Curriculum	Study of the definition of curriculum, development of school curricula, adaptation of the latest curriculum to curriculum implementation in schools, curriculum analysis which includes analysis of tasks and materials, formulation of objectives and indicators of achievement and accommodating inclusive education, essential concepts and learning, misconceptions and coping strategies by utilizing ICT
14	Physics for School	This lecture discusses the depth, breadth, order of delivery, and examples of implementation and plans and simulations of learning from physics learning materials for Senior High School class X, XI, and XII and vocational physics.
15	Physical Mathematics 1	This course examines infinite series, partial differential, ordinary differential equations, and vector analysis through active learning by combining the methods of discussion, questions and answers, also assignment using IT.
16	Physical Mathematics 2	This course examines complex number, Fourier series, special function, series solution for differential equation and partial differential equation through active learning by combining the methods of discussion, questions and answers, also assignment using IT.
17	Thermodynamics	The thermodynamics course discusses the concepts/principles/theories/basic laws of thermodynamics (physics content knowledge) that underlies thermodynamic study materials in depth covering temperature and the zero law of thermodynamics, some simple thermodynamic systems, work, heat and the first law of thermodynamics. , ideal gas, second law of thermodynamics, Carnot cycle and thermodynamic temperature scale, and entropy, and able to communicate scientifically and work effectively both independently and in groups, with assessment in the form of assignments, mid test and final exam
18	Optics	In this courses, various optical systems are discussed fissionally and geometrically, where physical optics will discuss: Huygens principle, interference (wavefront splitting interferometer, amplitude splitter), diffraction (Fresnell, Frounthoufer, single slit and diffraction lattice), polarization and geometric optics discusses Fermat's principle of reflection and refraction, optical tools and the propagation of light in the medium and between mediums

19	Wave	Waves in a medium have more than one dimension: flat waves, water waves, wave equations and their solutions in cartesian coordinates, spherical and cylindrical, reflection and refraction, stationary waves. Transverse mechanical waves, impedance, reflection and transmission, stationary waves, dispersion, polarization, Fourier techniques, modulation. Longitudinal mechanical waves: sound waves in solids and fluids. Electromagnetic waves (EM): Maxwell's system of equations for EM fields in medium, EM waves, medium impedance, wave kinematics and energetics, dispersion linkages, Doppler effect. Propagation on the border of two medium, in waveguide, optical fiber and non-isotropic medium. Coherence, interference, diffraction (Fraunhofer and Fresnel), slit and lattice diffraction patterns, interferometry
20	Electricity and Magnetism	Magnetic Electricity courses include vector analysis, gradients, divergences, curls, Stokes Theorem, electric fields, Coulomb's Law, electric fields, Gauss's Law, electric potential, Electric dipoles, multipole of electric energy, field energy density, Laplace equation and Poisson's equation, terms - boundary conditions, shadow method, variable separation method. dielectric material: polarization vector, polarizing charge, displacement vector D, Gauss's law for D. Electric current: flow of electric charge, continuity equation. Magnetic field: Lorentz force, Biot-Savart law, vector potential, Ampere's law, magnetic dipole moment, switch potential, magnetization, magnetic poles, Ampere's law for H, magnetic materials, hysteresis. Magnetic effects, displacement currents, Maxwell's equations.
21	Modern Physics	The Modern Physics course discusses the concepts/principles/theories / basic laws of Modern Physics (physics content knowledge) which underlies the study material in the Physics curriculum of SMA / SMK in depth which includes Relativity, Particle Properties of Waves, Wave Properties of Particles, Structure Atom, Quantum Mechanics, Hydrogen Atom Quantum Theory, Multiple Electron Atom, Core Structure, Nuclear Transformation, as well as being able to communicate scientifically and work effectively both individually and in groups.
22	Nuclear Physics	Nuclear Physics studies about the history of the discovery and the concept of atomic physics, the nature, and behavior of the atomic nucleus, the stability of the nucleus and the binding energy of the nucleus, the deuteron as the simplest nucleus, the energy levels of the nucleus, various models of the nucleus, the radioactivity of the nucleus, the mechanism of radioactive nucleus decay, calculations. Q-value for various types and conditions of core reactions, building blocks of matter, elementary particle 'families', fundamental

		conservation principles in the world of elementary particles, the birth of mesons, fission and fusion reactions, alternative energy sources based on fusion reactions , nuclear technology, and management of nuclear waste, and radioisotope applications in many areas of life.
23	Statistical Physics	Statistical Physics studies the behaviour of microscopic systems with a large number of forming particles through two approaches, namely the laws of classical statistical distribution (Maxwell-Boltzmann statistics) and quantum statistical distributions (Bose-Einstein statistics and Fermi-Dirac statistics). In the lecture, we will explain the differences between the three laws of statistical distribution and the application of the three types of distribution in some cases of physics, for example ideal gases and true gases, bosons and fermion gases, classical and semi-classical gases, Gibbs paradox, classical and semi-classical gas entropy -classic, monatomic and diatomic gases, specific heat of monatomic and diatomic gases, specific heat of solids according to classical and quantum statistics, and the total partition function in the presence of molecular interactions, as well as introduction to the concept of ensemble (micro-canonical, canonical and large canonical).
24	Quantum Physics	This course examines: 1. The scope of the study of Quantum Physics, 2. The study of quantum concepts (reviews from physical phenomena to theoretical approaches), 3. Formulation of Schrodinger wave mechanics to solve the problem of microscopic particle physics without and in the presence of simple potential fields (an harmonics and harmonics), 4. An overview of the theory of the hydrogen atom related to the complete solution of the Schrodinger equation of radial components and spherical harmonics, 5. Orbital, electron transition, and Pauli's rule 6. Zeeman effect and Stark effect 7. The role of spin-orbit interactions in fine and super fine structure phenomena, Lectures are carried out with the "Student Centred Learning Method" assisted by references, ICT, and academic services. The assessment emphasizes the use of "Performance Assessment and Projects".
25	Earth Science	Earth Physics contains the study of earth science with class discussion topics including understanding the interaction between humans and nature; the role of the earth (land, oceans, atmosphere and biosphere) in human life; the impact of human activities on nature and the environment; several types of earth disasters that often occur in Indonesia and the counter measures thereof; awareness and disaster

		preparedness as part of disaster mitigation education to reduce disaster risk, understanding and applying local wisdom in disaster mitigation education.
26	Research Methodology	The research methodology course discusses the basic concepts of research, literature review in research, research design, population and samples, data collection methods, action research, research stages, proposals and research reports.
27	Educational Philosophy	This educational philosophy course has four main parts, namely: Humans as thinking creatures; The scope of the philosophy of science; A means of scientific thinking, and science; as well as the nature and use of science. The first part discusses the advantages of humans with reason so that they have curiosity and thinking abilities that give birth to knowledge. The second part discusses science as a study of philosophy, the origins of science and the history of the development of science and the relationship between science and philosophy. The third section discusses the basics of knowledge which includes reasoning, logic, as a way to find truth, criteria for truth, sources of knowledge and truth; the basics of science which includes the object of the study of knowledge (ontology) as well as the interpretation of the nature of the objectivity of the relation, the law of causality and order. The fourth section discusses the scientific means of thinking which include language, mathematics and statistics, the role of mathematics in logic and the development of science, besides that it also discusses aspects of logic, namely the role of symbols, scientific systems and theories, scientific explanations and finally discussed the nature and usefulness of science.
28	Physics Edutainment	This course is a course that designs and develops a physics learning process that is designed in such a way that educational and entertainment content can be combined harmoniously to create fun physics learning.
29	Pancasila Education	This course will discuss the concept and essence of Pancasila as the basis and ideology of the state, as well as the nation's outlook on life. This course also examines Pancasila historically, juridically and philosophically and its actualization in the life of the nation and state. Pancasila as a foundation in Political Ethics and Development Paradigm and its implementation in the life of society, nation and state through studies, presentation of concepts, discussions, case studies, and assignments of both individuals and groups.
30	Civic Education	This subject is an introduction to the nature of Civics, which is continued by discussing the rights and obligations of citizens in accordance with the constitution in the context of national identity and national integration, implemented democratically and based on applicable law. Then deepened

		by talking about law enforcement and Human Rights, Gender, Archipelago Insights, followed by National Resilience and ending on Anti-Corruption Education. Lectures are carried out with a system of case study analysis, presentations and discussions, problem solving tasks (problem solving), and reflection.
31	Physical Education and Fitness	This course provides understanding and mastery of the nature, function, and goals of physical education. Provide introduction and experience in carrying out various sports and game activities to be used in order to increase physical activity according to the recommendations of various researches and WHO. In addition, students can experience composing physical education programs for themselves in an effort to improve and maintain physical fitness. Students have experience in measuring the level of physical fitness using various measurement methods. Students have understanding and experience in determining indicators and measuring the ideal body shape based on various methods. As an additional competency, students learn in sports management and competition systems.
32	Entrepreneurship	This course discusses entrepreneurial concepts, definitions of entrepreneurship, types of entrepreneurship, entrepreneurial values and behaviours, various theories about entrepreneurship, ideas and opportunities, creativity, innovation, business planning, entrepreneurial trigger factors, entrepreneurial process models, Entrepreneurial characteristics and functions and entrepreneurial competence. Preparation of business plans and implementation.