Summary of Curriculum

Undergraduate Program in Chemistry
Faculty of Mathematics and Natural Science
Universitas Negeri Surabaya

2021

A. OBJECTIVES OF THE DEGREE PROGRAMME

The Vision and Mission of Institution

Vision of Universitas Negeri Surabaya:

Excellent in Education, Strong in Science

Mission of Universitas Negeri Surabaya:

1. To conduct education and learning centered 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 center, especially for primary and secondary educations as well as a scientific center 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.

The Vision and Mission of Faculty

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

Excellent in Educational Mathematics and Natural Science, Strong in Mathematics and Natural Science Studies

Extended Vision of Faculty of Mathematics and Natural Science (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 recognized 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

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

The Vision of Undergraduate Program of Chemistry (UPC):

"Becomes an excellent and competitive Study Program at the national level in the field of research-based chemistry in the development of natural resources with an environmental perpective".

The Missions of Undergraduate Program of Chemistry (UPC):

1. Organizing academic education in the field of chemistry based on natural resource research results resources with an environmental perspective.
2. Develop innovative and applied basic research in the field of chemistry to develop natural resources with an environmental perspective

3. Dedicating an expertise in the field of chemistry and its application to empower the community
4. Build and expand a network of good cooperation with various institutions / government agencies and the private sector and stakeholders for the continued development of chemistry study program.
5. Creating a chemistry study program system management that are credible, transparent, accountable, responsible and fair.

B. PROGRAM EDUCATIONAL OBJECTIVES (PEO)

The Chemistry graduates are prepared to achieve Programme Educational Objectives (PEOs) that is to have accomplishment in their early career as a practitioner; research assistant; and entrepreneur who have basic knowledge of chemical concepts and instrumentation, exhibit laboratory technical skills to solve chemistry problem and demonstrate self-development in a sustainable manner, as well as work in the field of green-technopreneurship..

Details of the PEO for Graduates of the undergraduate program of Chemistry are as follows

1. Able to master the fundamental knowledge of chemistry, the basic principles of chemical instruments, laboratory organizations, Occupational Health and Safety, scientific methods, digital literacy to solve a problem in their profession/workplace (professional).
2. Able to improve higher-order thinking skills by analyzing, evaluating data, and being creative; communicating ideas, able to take the right initiatives, be good decision-makers, and have the ability to lead in relevant field workgroups.
3. Able to develop and apply chemistry concepts along with the progress of science and technology as well as humanities values.
4. Able to demonstrate good communication in a collaborative work, honest, and be responsible for his expertise in the field of chemistry and have an eco-entrepreneurial character (ecopreneurship)
5. Able to develop themselves and always update the development of chemistry, as well as lifelong learning through formal or non-formal education.

The formulated PEO has broadly considered input from the meeting of the Indonesian Chemical Association (IPR) division of chemistry, alumni, professionals (principals and teachers). The PEO also has significant relevance to the Indonesian National Qualification Framework (INQF) and the National Higher Education Standards (SN Dikti). Table 1 indicates the correlation between the objectives of the

undergraduate program in Chemistry and the 6th level (the level for bachelor education) of the Indonesian National Qualification Framework (INQF).

Table 1. Correlation Between PEO and INQF

PEO vs INQF	Capable of apply science, technology, and art within his/her expertise and adaptable to various situations faced during solving a problem	Mastering in-depth general and specific theoretical concepts of certain knowledge and capable of formulating problem-solving procedure	Capable of taking strategic decision based on information and data analysis as well as providing direction in choosing several alternative solutions	Responsible for his/her own jobs and can be assigned to take responsibility of the attainment of organization's performances
PEO 01	S	S	S	NS
PEO 02	S	S	S	NS
PEO 03	NS	S	S	NS
PEO 04	NS	NS	S	S
PEO 05	NS	S	S	NS

S-Strong, NS-Not Strong

C. PROGRAM LEARNING OUTCOMES (PLO)

Originating from PEO, UPC has the following Learning Outcomes Programs (PLOs) for established graduates. UPC sets the program learning outcomes for the graduates as presented in Table 2.

Table 2. PLO of Undergraduate Program in Chemistry

ASPECTS	PLO	CODE
KNOWLEDGE	1. Able to master the concepts of structure, dynamics and energy, as well as the basic principles of separation, analysis, synthesis, and characterization of micromolecular compounds and their applications	**KNO-1**
	2. Able to master the basic principles and knowledge of how to operationalize instruments for the analysis and characterization of compounds, as well as utilizing ICT for modeling more specific molecules	**KNO-2**
SKIL	3. Able to master the principles of Occupational Health and Safety, manage laboratories and use their equipment, and operate instrumental of chemistry	**SKI-1**
	4. Able to design an activity to solve problems by implementing capabilities in the field of chemistry that refers to ecopreunership	**SKI-2**

ASPECTS	PLO	CODE
COMPETENCIES	5. Able to apply logical, critical, systematic and innovative thinking in the context of the development or implementation of science and technology by observe and applying the value of humanities in accordance with the field of chemistry in solving problems	**COM-1**
	6. Able to master the basics of the scientific method, designing and conducting research, compiling scientific reports and communicating them both verbally and in writing by utilizing information and communication technology	**COM-2**
ATTITUDE AND SOCIAL	7. Able to build teamwork and have entrepreneurial skills that are environmental perspective, and make the right, honest and responsible decisions in solving problems of chemistry and have social sensitivity as a obligation of citizens and religious communities	**SOC-1**
	8. Able to adapt to various developments in chemistry, continue to develop and learn throughout long-life education, both formal and nonformal	**SOC-2**

These goals strongly support the Indonesian National Qualification Framework (INQF) for undergraduate education and are consistent with the institution's mission. Their consistency with the mission of Unesa and FMNS is realized by producing graduates who have strong abilities to understand and master chemical knowledge and issues related to chemistry. This capability enables graduates to become professionals who take the primary role as quality control, researchers, lecturers, and entrepreneurs in national and global development. Table 3 shows the correlation between PLOs and PEOs.

Table 3. Matrix of the Correlation between Objectives of the Undergraduate Program in Chemistry and the Program Learning Outcomes

	PEO 01	PEO 02	PEO 03	PEO 04	PEO 05
KNO-1	S	NS	S	NS	NS
KNO-2	S	NS	S	NS	NS
SKI-1	S	NS	S	NS	NS
SKI-2	NS	S	S	NS	NS

	PEO 01	PEO 02	PEO 03	PEO 04	PEO 05
COM-1	NS	S	S	NS	NS
COM-2	S	S	NS	NS	NS
SOC-1	NS	NS	S	S	NS
SOC-2	NS	NS	S	NS	S

S-Strong, NS-Not Strong

Table 4. Correlation between Subject-Specific Criteria (SSC) of Chemistry with PLO

Subject Specific Criteria (SSC)	**PLO**							
	1	2	3	4	5	6	7	8
Specialist competences								
1. have gained chemistry-relevant **fundamental knowledge of mathematics and the natural sciences**,	√							
2. have sound knowledge of the **core subjects of chemistry** including inorganic, organic and physical chemistry, as well as of analytical chemistry,	√	√						
3. have gained knowledge in one or several other **special areas** in the natural sciences or humanities,					√			
4. are able to carry out **practical chemistry work** and have learnt how to handle chemicals independently and safely in lab practicals,		√	√					
5. have knowledge of **safety and environmental issues** and the legal fundamentals,			√					
6. have gained **methodological competence** in chemistry and are able to apply this in other contents, and						√		
7. have **interdisciplinary** knowledge and skills, such as in economics, ethics or philosophy.				√				
8. obtain, **interpret and evaluate data** of scientific and technical relevance, and to draw sound conclusions, which take into account scientific, technological and ethical findings,						√		
9. **solve problems** of a scientific/application-oriented nature independently, and to present the results, as well as						√		
10. pursue **lifelong learning**.								√
Social competences								
11. are able to **communicate** with colleagues working in the field as well as with the broader public, about chemistry-related contents and problems, also in a foreign language and on an intercultural basis,				√		√		
12. are aware of social and ethical **responsibility** in their actions and are familiar with the professional ethical principles and standards of chemistry,							√	

Subject Specific Criteria (SSC)	PLO							
	1	2	3	4	5	6	7	8
13. are able to work both alone and as a member of international, mixed-gender **groups**,							√	
14. are familiar with the basic principles for conduction of **projects** and able to **develop appropriate leadership responsibility**							√	
15. are prepared for entry to professional life in an industrial or academic environment, through adequate **practical relevance** of the degree programme								√

D. PROGRAMME STRUCTURE

The undergraduate program in UPC FMNS Universitas Negeri Surabaya has a degree of Bachelor of Science (B.Sc.) or Sarjana Sains (S.Si.) in Bahasa Indonesia As mentioned, in addition to being based on input from stakeholders, the improvement of the UPC curriculum structure is also the result of an evaluation of the current conditions and future needs of the profession in chemistry, taking into account national and global challenges. By accommodating challenges Accordingly, the structure and syllabus of the course have been revised and applied in the period 2013 - 2018. Evaluations of ongoing implementation are carried out every year. The curriculum of the Chemistry Study Program is expected to be able to answer thedemands 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, creative and innovative, communication, and collaboration.
3. The ASEAN Economic Community since 2015
4. The importance of literacy, 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 Word Trade Organization (WTO), and the Asia Pacific Economic Cooperation (APEC).

Furthermore, the current curriculum adopts new paradigm of education, which are out-comes based education, learner-centered learning, continuous improvement, and international benchmarking and accreditation. The curriculum is periodically updated

every five years by following the development processes of the curriculum considering some principles of the curriculum development. This is shown in the following chart.

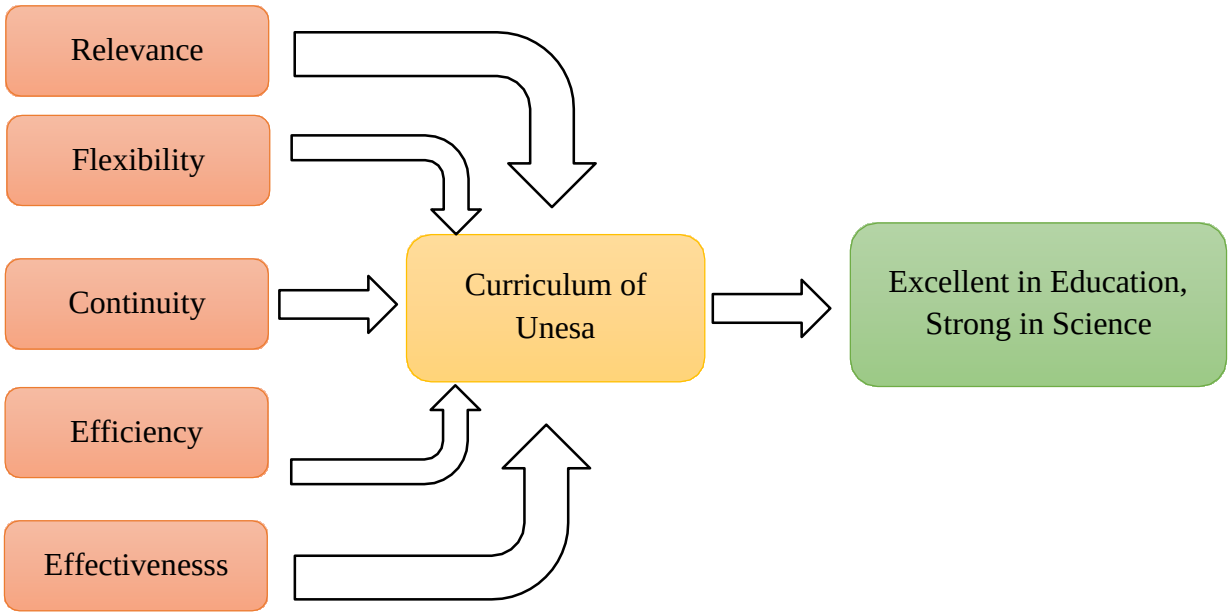


Figure 1. Principles of curriculum development

The UPC curriculum is delivered in 4 years through 4 main structures: fundamental concepts, strong foundation of fundamental concept, advance concept and final projects, as illustrated in Figure 2. In this structure, the learning process to gain competency is modeled in the course flow. Fundamental concepts is the foundation of the program, strong foundation of fundamental concept, advance concept as pillars and final projects as a roofthat includes all knowledge in the chemistry field.

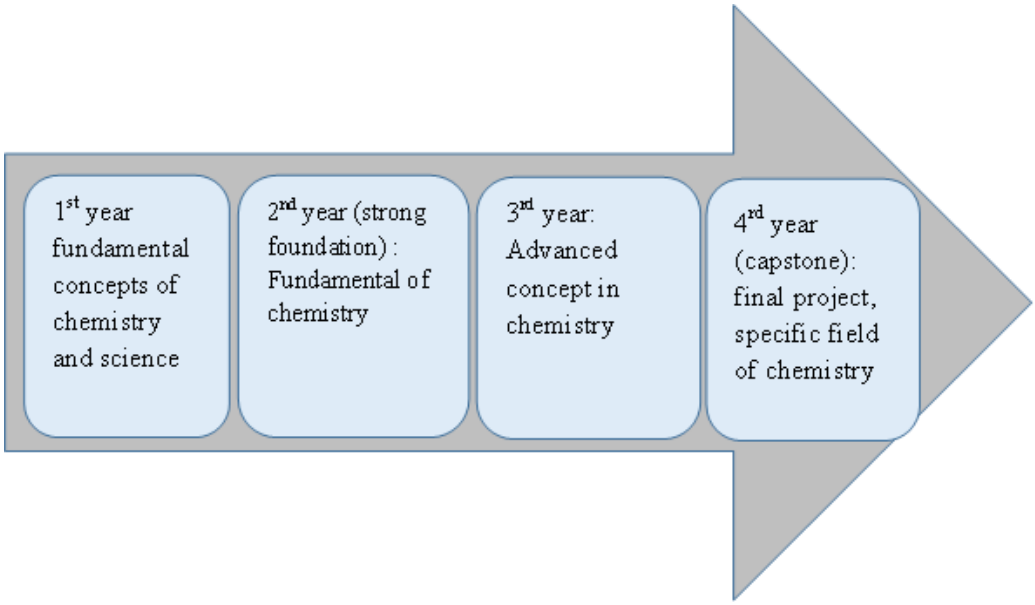


Figure 2. Model of curriculum structure of undergraduate program in Chemistry

To complete the learning program, students should take 146 credit units (CU) comprising 132 CU as a compulsory courses and 40 CU as an elective course.

Table 5. Compulsory and elective courses in undergraduate program in Chemistry, Universitas Negeri Surabaya

CU compulsary courses	CU	Note
CU of compulsory courses	132	Number of courses that must be taken by students for graduation
CU of elective courses	14	The number of elective courses provided is 40 credits
Total	**146**	

Table 6. Mapping of The Courses That Support The Learning Outcomes

MK	Code	Course Title	CU	KNO-01	KNO-02	SKI-01	SKI-02	COM-01	COM-02	SOC-01	SOC-02	ECTS
MK-01		Digital Literacy	2					X				3.18
MK-02	0001212009	Bahasa Indonesia	2						X			3.18
MK-03	0002213005	English	3						X		X	4.77
MK-04	3074213012	General Biology	3						X			4.77
MK-05	3074213013	General Physics	3						X			4.77
MK-06	3074213014	Basic Chemistry 1	3	X		X						4.77
MK-07	3074213015	Basic Mathematics	3						X			4.77
MK-08	0001212008	Pancasila	2					X				3.18
MK-09	3074212017	English for Chemistry	2						X		X	3.18
MK-10	3074212018	Qualitative Analytical Chemistry	2	X		X	X					3.18
MK-11	3074213019	Basic Chemistry 2	3	X		X						4.77
MK-12	3074213020	Quantum Chemistry	3	X							X	4.77
MK-13	3074212021	Conservation of Natural Resources and Environment	2				X	X	X	X		3.18
MK-14	3074213022	Mathematics for Chemistry	3	X								4.77
MK-15	0001212001	Religion Education	2					X				3.18
MK-16	0001212007	Citizenship Education	2					X				3.18
MK-17	3074212025	Philosophy of Science	2					X	X		X	3.18
MK-18	1000002010	Basic Social and Cultural Science	2					X				3.18

MK	Code	Course Title	CU	KNO-01	KNO-02	SKI-01	SKI-02	COM-01	COM-02	SOC-01	SOC-02	ECTS
MK-19	3074212032	Literature of Chemistry	2						X			3.18
MK-20	3074213028	Quantitative Analytical Chemistry	3	X		X		X				4.77
MK-21	3074213023	Laboratory Organization	3			X			X	X		4.77
MK-22	3074213031	Monofunction Organic Compounds	3	X				X				4.77
MK-23	3074213029	Basic Theory of Inorganic Chemistry	3	X				X				4.77
MK-24	3074213030	Thermodynamics of Chemistry	3	X				X			X	4.77
MK-25	3074212033	Basics of Chemical Separations	3	X			X	X				4.77
MK-26	3074212036	Nuclear Chemistry and Radiochemistry	2	X								3.18
MK-27	3074212034	Coordination Chemistry	2	X				X				3.18
MK-28	3074213035	Chemical Kinetics	3	X				X	X		X	4.77
MK-29	3074212038	Practicum of Organic Chemistry	2		X	X	X		X	X		3.18
MK-30	3074213037	Polyfunction Organic Compound	3	X				X				4.77
MK-31	3074213039	Basic Statistics	3						X		X	4.77
MK-32	3074212050	Electrochemistry Analysis	2	X	X			X				3.18
MK-33	3074212041	Spectroscopy and Chromatography Method	3	X	X				X			4.77
MK-34	0002212008	Entrepreneurship	2							X	X	3.18
MK-35	3074213046	Surface Chemistry	3						X	X		4.77
MK-36	3074212042	Main Elements of Inorganic Chemistry	2	X				X				3.18
MK-37	3074213047	Research Methodology	3					X	X			4.77
MK-38	3074213047	Practicum of Biochemistry	1	X	X	X				X		1.59
MK-39	3074212040	Structure and Function of Biomolecule	2	X				X		X		3.18
MK-40	3074112063	Pharmaceutical Chemistry	2	X				X				3.18
MK-41	3074212043	Industrial Chemistry	2				X		X	X		3.18
MK-42	3074213052	Transition Elements of Inorganic Chemistry	3	X				X	X			4.77
MK-43	0002213009	Community Service	3							X	X	4.77
MK-44	3074213049	Metabolism and Pathways of Genetics Information	3	X				X		X		4.77
MK-45	3074211048	Practicum of Inorganic Chemistry	1	X	X	X	X			X		1.59
MK-46	3074212054	Seminar	2					X	X	X		3.18

MK	Code	Course Title	CU	KNO-01	KNO-02	SKI-01	SKI-02	COM-01	COM-02	SOC-01	SOC-02	ECTS
MK-47	3074113075	Food Chemistry	2	X			X	X		X		3.18
MK-48	3074112065	Career Development	2						X	X	X	3.18
MK-49	3074213044	Environmental Chemistry	3	X	X			X	X	X		4.77
MK-50	3074216060	Thesis	6	X	X		X	X			X	9.54
MK-51	3074112066	Food Analysis	2	X	X		X	X	X			3.18
MK-52	3074112074	Electro Chemistry	2	X	X							3.18
MK-53	3074112062	Stereochemistry	2	X				X				3.18
MK-54	3074212056	Mechanism of Organic Reaction	2	X				X				3.18
MK-55	3074112061	Computational Chemistry	2	X	X				X			3.18
MK-56	3074112070	Cosmetics	2	X			X			X		3.18
MK-57	3074213058	Molecular Structure Elucidation	2	X				X				3.18
MK-58	3074211051	Practicum of Analytical Instrument	1	X	X				X			1.59
MK-59	3074213055	Organic Synthesis	2	X				X				3.18
MK-60	3074112071	Material Chemistry	2	X				X				3.18
MK-61	3074112073	Solid-state Chemistry	2	X				X				3.18
MK-62	3074112072	Microbiology	2	X	X	X		X				3.18
MK-63	3074212056	Mechanism of Inorganic Reaction	2	X				X				3.18
MK-64	0002213010	Internship	3		X	X				X	X	4.77
MK-65	3074112080	Bioinorganic	2	X				X				3.18
MK-66	3074112067	Evaluation of Nutritional Value of Food	2	X				X				3.18
MK-67	3074112068	Capita Selecta	2	X							X	3.18
MK-68	3074112069	Natural Product Chemistry	2	X				X			X	3.18
MK-69	3074112064	Organometallic Chemistry	2	X				X				3.18
MK-70	3074112076	Research Technique of Biochemistry	2	X				X			X	3.18
MK-71	3074112077	Toxicology	2	X		X		X				3.18
MK-72	3074112078	Biotechnology	2	X				X	X			3.18
MK-73	3074112079	Organic Polymer Chemistry	2	X				X	X			3.18

The detailed curriculum structure is shown below.

Table 7. Curriculum Structure for Common First Year (TPB) Stage

1st Semester					2nd Semester				
	Code	**Course Name**	**CU**	**ECTS**		**Code**	**Course Name**	**CU**	**ECTS**
1		Digital Literacy	2	3.18	1	3074212017	English for Chemistry	2	3.18
2	0001212009	Bahasa Indonesia	2	3.18	2	3074212018	Qualitative Chemical Analysis	2	3.18
3	0002213005	English	3	4.77	3	3074213019	Basic Chemistry 2	3	4.77
4	3074213012	General Biology	3	4.77	4	3074213020	Quantum Chemistry	3	4.77
5	3074213013	General Physics	3	4.77	5	3074212021	Conservation of Natural Resources and Environment	2	3.18
6	3074213014	Basic Chemistry 1	3	4.77	6	3074213022	Mathematics for Chemistry	3	4.77
7	3074213015	Basic Mathematics	3	4.77	7	0001212007	Citizenship Education	2	3.18
8	0001212008	Pancasila	2	3.18	8	0001212001	Religion Education	2	3.18
TOTAL			21	33.4	TOTAL			19	30.2

Table 8. Curriculum Structure for Bachelor

3rd Semester					4th Semester				
	Code	**Course Name**	**CU**	**ECTS**		**Code**	**Course Name**	**CU**	**ECTS**
1	3074213023	Laboratory Organization	3	4.77	1	3074212033	Basics of Chemical Separations	2	3.18
2	3074212025	Philosophy of Science	2	3.18	2	3074212034	Coordination Chemistry	3	4.77
3	0002212006	Basic Social and Cultural Science	2	3.18	3	3074213035	Chemical Kinetics	2	3.18
4	3074213028	Quantitattive Chemical Analysis	3	4.77	4	3074212036	Nuclear Chemistry and Radiochemistry	3	4.77
5	3074213029	Basic Theory of Inorganic	3	4.77	5	3074213037	Polyfunction Organic Compound	2	3.18
6	3074213030	Thermodynamics of Chemistry	3	4.77	6	3074212038	Practicum of Organic Chemistry	3	4.77
7	3074213031	Monofunction Organic Compounds	3	4.77	7	3074213039	Basic Statistics	2	3.18
8	0002212008	Entrepreneurship	2	3.18	8	3074212032	Literature of Chemistry	2	3.18
TOTAL			21	33.4	9	Elective Course		2	3.18
					TOTAL			21	33.4

5th Semester					6th Semester				
	Code	**Course Name**	**CU**	**ECTS**		**Code**	**Course Name**	**CU**	**ECTS**
1	3074212040	Structure and Function of Biomolecule	3	4.77	1	3074212043	Industrial Chemistry	2	3.18
2	3074212041	Spectroscopy and Chromatographic Methods	2	3.18	2	3074211048	Practicum of Inorganic Chemistry	1	1.59
3	3074212042	Main Elements of Chemistry	2	3.18	3	3074213049	Metabolism and Pathways of Genetics Information	3	4.77
4	3074212045	Mechanism of Organic Reaction	2	3.18	4	3074211051	Practicum of Analytical Instrument	1	1.59
5	3074213046	Surface Chemistry	2	3.18	5	3074213052	Transition Elements of Chemistry	3	4.77
6	3074213047	Research Methodology	3	4.77	7	3074213055	Organic Synthetic	3	4.77

5th Semester					6th Semester				
	Code	**Course Name**	**CU**	**ECTS**		**Code**	**Course Name**	**CU**	**ECTS**
7	3074212050	Electrochemistry Analysis	2	3.18	8	3074213058	Molecular Structure Elucidation	3	4.77
8	3074211053	Practicum of Biochemistry	1	1.59	9	Elective Course		4	6.36
9	Elective Course		2	3.18	TOTAL			20	31.8
TOTAL			19	30.2					

7th Semester					8th Semester				
	Code	**Course Name**	**CU**	**ECTS**		**Code**	**Course Name**	**CU**	**ECTS**
1	3074213044	Enviromental Chemistry	3	4.77	1	3074216060	Thesis	6	9.54
2	3074212056	Mechanism of Inorganic Reaction	2	3.18	2	Elective Course		2	3.18
3	0002213009	Community Service	3	4.77	TOTAL			8	12.7
4	0002213010	Internship	3	4.77					
5	3074212054	Seminar	2	3.18					
6	Elective Course		4	6.36					
TOTAL			17	27					

Table 9. List of Elective Course

Elective Course Odd Semester						Elective Course Even Semester					
	Code	**Course Name**	**CU**	**ECTS**	**Sem**		**Code**	**Course Name**	**CU**	**ECTS**	**Sem**
1	3074112061	Computational Chemistry	2	3.18	5	1	3074112062	Stereochemistry	2	3.18	4
2	3074112063	Pharmaceutical Chemistry	2	3.18	5	2	3074112074	Electrochemistry	2	3.18	4
3	3074112069	Natural Product Chemistry	2	3.18	5	3	3074112065	Career Development	2	3.18	6
4	3074112070	Cosmetics	2	3.18	5	4	3074112071	Material Chemistry	2	3.18	6
5	3074112064	Organometallic Compound	2	3.18	7	5	3074112072	Microbiology	2	3.18	6
6	3074112066	Food Analysis	2	3.18	7	6	3074112073	Solid State Chemistry	2	3.18	6
7	3074112067	Evaluation of Nutritional Value of Food	2	3.18	7	7	3074113075	Food Chemistry	2	3.18	6
8	3074112068	Capita Selecta	2	3.18	7	8	3074112078	Biotechnology	2	3.18	8
9	3074112076	Research Technique of Biochemistry	2	3.18	7	9	3074112079	Organic Polymer Chemistry	2	3.18	8
10	3074112077	Toxicology	2	3.18	7						
11	3074112080	Bio-inorganic	2	3.18	7						

The relationship between one course and other courses within the framework of UPC curriculum structure is shown below. 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 chemistry education. The roadmap also describes in different coloured boxes corresponding to the UPC's PLO in Table 8. In the common first year, students are obliged to attend courses to provide a good foundation of natural science and basic education to acquire scientific thought towards the planning, development and evaluation of chemistry learning. For FMS students, four introductory courses are given, namely: (i) Basic Chemistry, (ii) General Physics, (iii) General Biology, and (iv) Basic Mathematics. Meanwhile, with regards to the development of interpersonal capability, there are 7 supporting courses with a total of 14 credit units which are given to students, such as Religion, Bahasa Indonesia, Citizenship Education, Cultural Social Science Association, Physical Education and Sports, and Digital Literacy. Starting from the third semester, the students begin to learn about spatial and non-spatial basic elements and principles of learning chemistry. Students are further encouraged to apply their knowledge in a series of student projects that are oriented on laboratory. Further studies for more specific and / or supportive subjects can be fulfilled through elective courses provided internally at UPC. This will give students the opportunity to sharpen their knowledge according to their specific interests. In addition, internships in a company as practice-based learning are also well integrated into the program structure. The study program concluded by taking a final project that worth 6 CU. The course roadmap to achieving the whole learning outcomes are shown in Figure 3-6.

Roadmap KNO1 & KNO 2

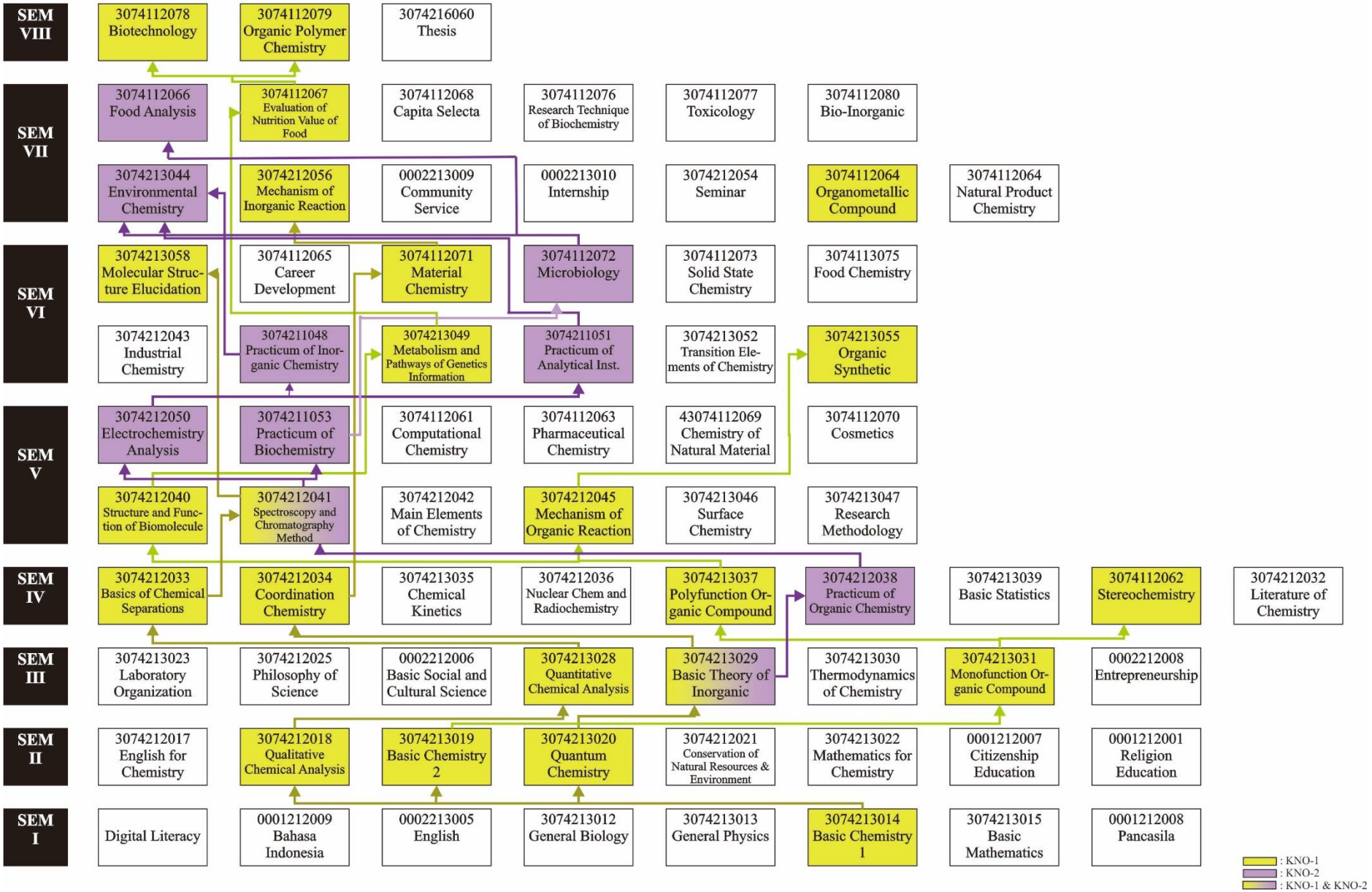


Figure 3. Course Roadmap for Achieving Learning Outcomes (Knowledge)

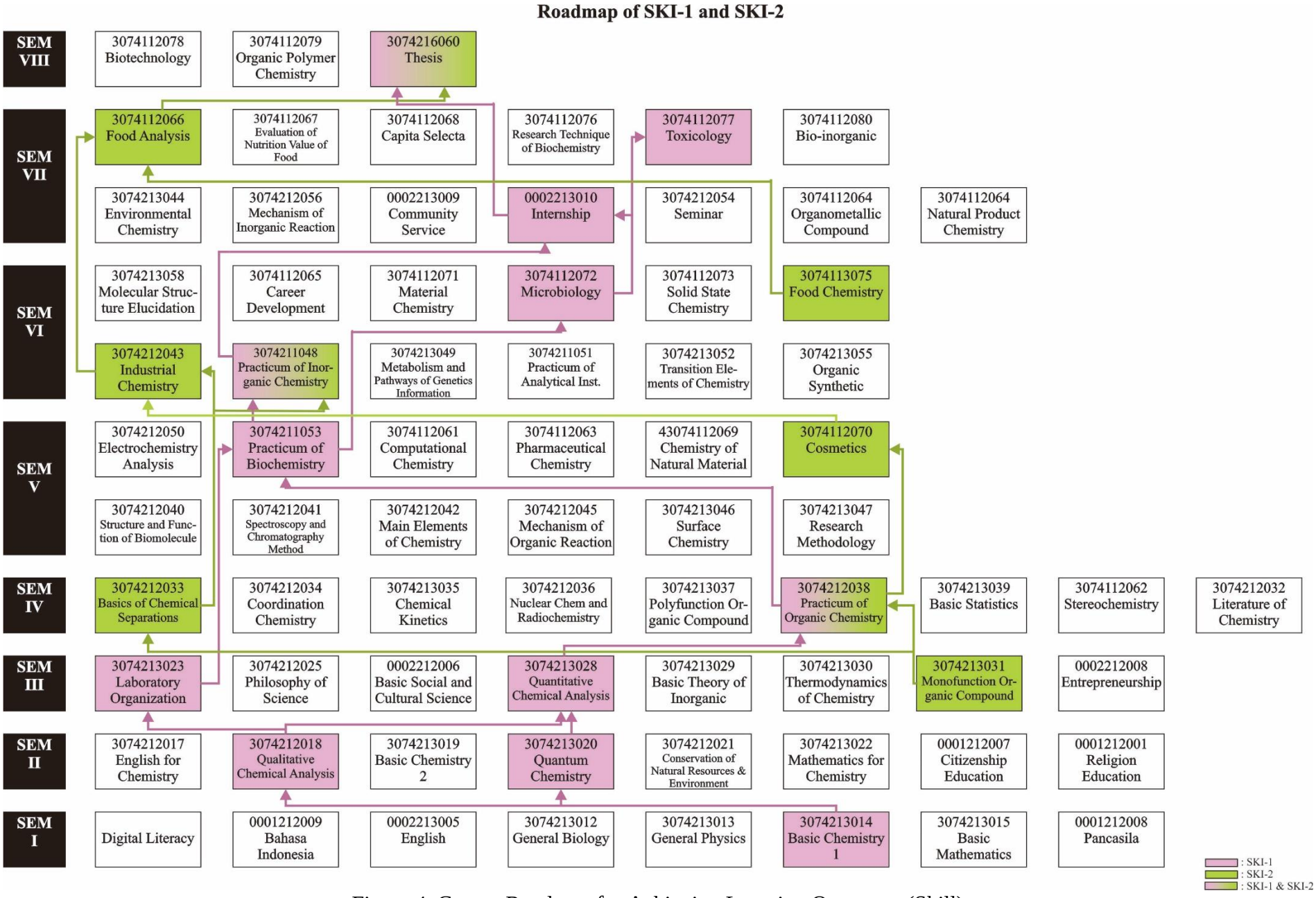


Figure 4. Course Roadmap for Achieving Learning Outcomes (Skill)

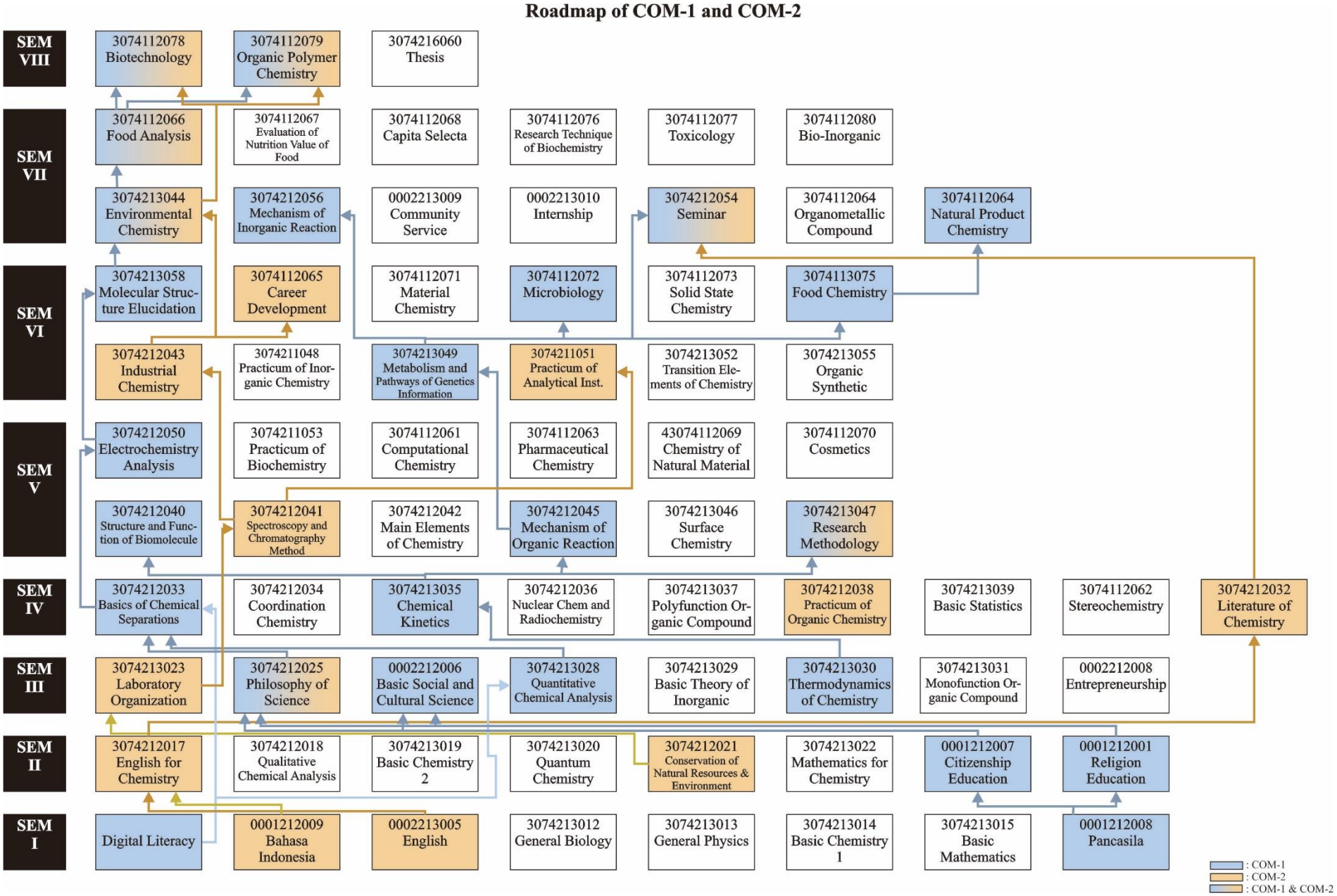


Figure 5. Course Roadmap for Achieving Learning Outcomes (Competencies)

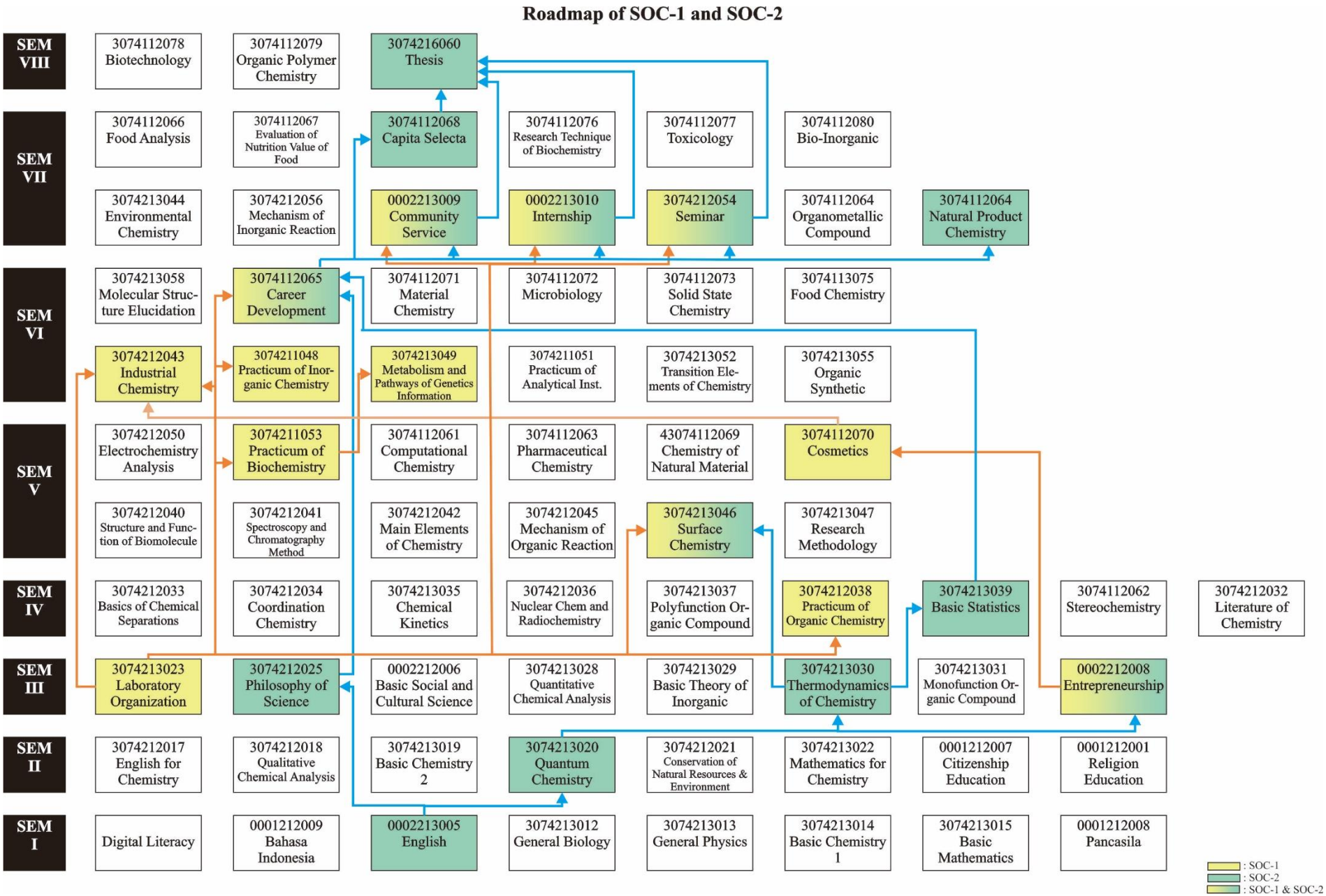


Figure 6. Course Roadmap for Achieving Learning Outcomes (Attitude and Social)

Knowledge aspects related to mastering the concepts of structure, dynamics and energy, as well as the basic principles of separation, analysis, synthesis and characterization of micromolecular compounds and their applications and mastering basic principles and knowledge of how to operationalize instruments for the analysis and characterization of chemical compounds, as well as utilizing ICT for modeling more specific chemical molecules Figure 1 shows the Course Roadmap for Achieving Learning Outcomes (Knowledge).

Skill aspects related to mastering the principles of Work Safety and Security, manage laboratories and use their equipment and how to operate chemical instruments and being able to design an activity to solve problems by implementing the ability of the chemical field that refers to ecopreneurship. Figure 4 shows the Course Roadmap for Achieving Learning Outcomes (Skill).

Competencies Aspect related to applying logical, critical, systematic and innovative thinking in the context of the development or implementation of science and technology by paying attention and applying the value of the humanities in accordance with the field of chemistry in solving problems and mastering the basics of the scientific method, designing and conducting research, compiling scientific reports and communicating them both verbally and in writing by utilizing information and communication technology. Figure 5 shows the Course Roadmap for Achieving Learning Outcomes (Competencies).

Attitude and Social aspects related to building a teamwork and have entrepreneurial skills that are environmental perspective and related to adapting various developments in chemistry, continue to develop and learn throughout life to continue education, both formal and informal. Figure 6 shows the Course Roadmap for Achieving Learning Outcomes (Attitude and Social).