Curriculum Summary of UPC

Undergraduate Program of Chemistry (UPC)
Faculty of Mathematics & Natural Sciences
Universitas Negeri Surabaya
2026

PROGRAMME AT A GLANCE

The following table provides a concise overview of the key characteristics of the Undergraduate Chemistry Program (UPC), Faculty of Mathematics and Natural Sciences, Universitas Negeri Surabaya.

Item	Programme Information
Programme Name	Undergraduate Chemistry Program (UPC)
Institution	Universitas Negeri Surabaya (UNESA)
Faculty	Faculty of Mathematics and Natural Sciences (FMNS)
Academic Degree Awarded	Sarjana Sains (S.Si.) / Bachelor of Science (B.Sc.)
Qualification Level	Indonesian Qualifications Framework (IQF/KKNI) Level 6
Programme Establishment	1998
Legal Establishment	Decree of the Director General of Higher Education No. 191/DIKTI/KEP/1998, dated 10 June 1998
Standard Duration of Study	4 years / 8 semesters
Minimum Study Load	144 Credit Units (CU)
ECTS Equivalent	Approximately 229 ECTS
Compulsory Courses	124 CU
Elective Courses Required for Graduation	20 CU
Programme Educational Objectives (PEOs)	5 PEOs
Program Learning Outcomes (PLOs)	10 PLOs
Curriculum Approach	Outcome-Based Education (OBE), student-centered learning, constructive alignment, progressive competency development, and continuous quality improvement
Main Disciplinary Areas	Analytical Chemistry, Inorganic Chemistry, Organic Chemistry, Physical Chemistry, Biochemistry, instrumental analysis, and interdisciplinary/emerging areas of chemistry
Main Learning Components	Theoretical courses, laboratory and practical activities, research-based learning, internship/experiential learning, elective specialization, scientific communication, and Final Project
Distinctive Programme Focus	Development and application of chemistry based on natural resource potential and eco-preneurship with international recognition
Research Component	Progressive research training culminating in the Final Project
Professional/Experiential Component	Internship and other experiential learning activities integrated into the curriculum

Final Academic Requirement	Final Project Proposal Seminar and Final Project

OBJECTIVE OF THE DEGREE PROGRAM

The objectives of the Undergraduate Chemistry Program are formulated within the framework of the vision, mission, and strategic goals of the University, Faculty, and Study Program. This hierarchical alignment ensures that the educational direction of the program is consistent with the broader institutional commitment to academic excellence, scientific advancement, societal contribution, innovation, and sustainable development.

At the university level, the vision and mission provide the overarching direction for education, research, community engagement, and institutional development. These principles are further translated at the faculty level into academic and scientific priorities relevant to the disciplines represented within the faculty. At the study program level, the institutional vision and mission are operationalized into specific educational objectives that reflect the characteristics of the chemistry discipline, developments in science and technology, stakeholder expectations, and the competencies required of graduates.

The alignment among the University, Faculty, and Study Program is intended to ensure coherence between institutional aspirations, curriculum design, Program Learning Outcomes, teaching and learning processes, research activities, and graduate competencies. Through this alignment, the Undergraduate Chemistry Program aims to educate graduates who possess strong disciplinary knowledge and laboratory competence, are capable of scientific and critical thinking, demonstrate professional and ethical responsibility, and can contribute effectively to academia, industry, society, and sustainable development. The relationship between the vision and mission of the University, Faculty, and Undergraduate Chemistry Program, which forms the basis for the objectives of the degree program, is presented in the following sections.

The Undergraduate Programme of Chemistry, Faculty of Mathematics and Natural Sciences (FMNS), Universitas Negeri Surabaya (UNESA), was established in 1998 as part of the expansion of academic programmes in chemistry. The programme was formally authorized by the Government of Indonesia through the Decree of the Director General of Higher Education No. 191/DIKTI/KEP/1998 dated 10 June 1998 and officially commenced its academic operations on 6 October 1998. Following the institutional transformation of IKIP Surabaya into Universitas Negeri Surabaya, as stipulated in Presidential Decree of the Republic of Indonesia No. 93 of 1999 dated 4 August 1999, the Chemistry Study Programme has continued to operate under the Faculty of Mathematics and Natural Sciences of UNESA. The Undergraduate Programme in Chemistry is guided by the vision and mission of Universitas Negeri Surabaya and the Faculty of Mathematics and Natural Sciences. Its strategic focus is the advancement of chemistry through natural resource potential and eco-preneurship, with international recognition.

1. The Vision and Mission of the Institution

In 2022, UNESA officially changed its institutional status from a Public Service Agency (BLU) to a State University with Legal Entity (PTNBH) status. Following this transition, UNESA established new institutional vision and missions as a State University with Legal Entity status**.**

Vision of Universitas Negeri Surabaya

Become a strong, adaptive, and innovative educational university based on entrepreneurship.

Mission of Universitas Negeri Surabaya

1. Organizing education in the field of education and non-education that has a tough, adaptive, and innovative character based on entrepreneurship.
2. Organizing research and improving the quality of innovation in the field of education and non-education based on entrepreneurship.
3. Organizing community service and disseminating innovation in the field of education and non-education based on entrepreneurship for the welfare of society.
4. Organizing the Tridharma activities of higher education through a multi-campus system in a synergistic, integrated, harmonious, and sustainable manner by paying attention to the advantages of UNESA.
5. Organizing effective, efficient, transparent, and accountable governance that guarantees quality in a sustainable manner
6. Organizing productive national and international cooperation in creating, developing, and disseminating innovation in the field of education and non-education based on entrepreneurship.

2. The Vision and Mission of the Faculty of Mathematics and Natural Sciences (FMNS)

Vision of the Faculty

"A resilient, adaptive, innovative, and collaborative Faculty of Mathematics and Natural Sciences based on edu-ecopreneurship and gaining international recognition"

Mission of the Faculty

1. Organizing research-based education in the field of MIPA education and non-education that is adaptive, innovative, collaborative, and characterized by eduecopreneurship.
2. Organizing research and improving the quality of innovation in the field of MIPA education and non-education through global collaboration.
3. Organizing community service and disseminating innovation in the field of MIPA education and non-education for community empowerment.
4. Organizing effective, efficient, transparent, and accountable governance in FMIPA.
5. Establishing productive national and international cooperation to create, develop, and disseminate innovation in the field of MIPA education and non-education.

3. The Vision and Mission of the Undergraduate Programme in Chemistry (UPC)

Vision of the Programme

Learn chemistry based on natural resource potential and eco-preneurship and gain international recognition.

Mission of the Programme

1. Organizing academic education in the field of chemistry based on environmentally friendly natural resource research results.

2. Developing innovative basic and applied research in chemistry to develop natural resources through global collaboration.
3. Developing research results to gain international recognition.
4. Organizing community service and disseminating innovations in the field of chemistry and its applications for community empowerment.

Objectives of the Programme

1. Producing chemistry graduates with an entrepreneurial spirit in the development of environmentally conscious natural resources (green-technopreneurship).
2. Producing graduates who have the capability to continue to develop and learn throughout life, so that they are able to adapt to changes and developments in science and technology.
3. Creating a humanistic, cultured, productive, efficient and transparent academic atmosphere to support the implementation of the Tridharma of higher education.
4. The realization of the development of chemical science and its applications through research is relevant to the development of science and technology, especially in the development of environmentally conscious natural resources to meet the needs of society.
5. The realization of a center for information and services in the field of chemistry plays a role in overcoming problems in society.

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 uality Control, Early Researcher, 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 inthe field of green-technopreneurship. Details of the PEO for Graduates of the undergraduate program of Chemistry can be seen in table 1.

Table 1. PEO of Study Program

PEO Number	Statement
PEO 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).
PEO 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 decisionmakers, and have the ability to lead in relevant field workgroups.
PEO 3	Able to develop and apply chemistry concepts along with the progress of science and technology as well as humanities values.
PEO 4	Able to demonstrate good communication in collaborative work, honest, and be responsible for his expertise in the field of chemistry and have an eco-entrepreneurial character (ecopreneurship).

PEO Number	Statement
PEO 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 Qualification Framework (IQF) and the National Higher Education Standards (SN Dikti). Table 2 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 (IQF).

Table 2. The Relationship between PEO and the 6th Level of IQF

	IQF 1	IQF 2	IQF 3	IQF 4
	Capable of apply science, technology, and artwithin 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 1	S	S	M	M
PEO 2	S	M	S	S
PEO 3	S	S	M	M
PEO 4	M	M	S	S
PEO 5	S	S	M	S

Note: Strong (S) : indicates a direct and substantial alignment in which the competency represented by the IQF descriptor is explicitly and significantly addressed by the PEO. Moderate (M) : indicates a relevant and meaningful alignment in which competency is supported by the PEO but is not its primary or dominant focus.

The distribution of strong and moderate relationships confirms that the PEOs collectively provide comprehensive coverage of the IQF Level 6 descriptors and support the intended qualification profile of graduates of the Undergraduate Chemistry Program.

PROGRAM LEARNING OUTCOMES (PLO)

Originating from PEO, the Program Learning Outcomes (PLOs) of the Undergraduate Chemistry program. The formulation of the PLOs also considers the program's scientific vision, established graduate profiles, workforce demands, and input from alumni, academic experts, and the professional organization, the Indonesian Chemical Society (HKI). The PLO formulation also adheres to the national higher education regulatory framework, including the Republic of Indonesia Law Number 12 of 2012 concerning Higher Education, Presidential Regulation Number 8 of 2012 concerning the Indonesian Qualifications Framework (KKNI), Law Number 14 of 2005 concerning Teachers and Lecturers, and the Regulation of the Minister of Higher

Education, Science, and Technology Number 39 of 2025 concerning Higher Education Quality Assurance. As part of its commitment to continuous quality improvement, UPC periodically evaluates and revitalizes the curriculum, considering PLO achievement, stakeholder feedback, scientific and technological advancements, and evolving societal and workforce needs. The results of these evaluations form the basis for developing and implementing the Transformative Curriculum for the 2024–2028 period. Through a continuous process of evaluation and refinement, the curriculum is expected to remain relevant and adaptive, and to ensure the achievement of established graduate competencies. PLO of Undergraduate Programme of Chemistry :

1) Demonstrate religious, national and cultural values, as well as academic ethics in carrying out their duties.
2) Demonstrate a resilient, collaborative, adaptive, innovative, inclusive, lifelong learning, and entrepreneurial character.
3) Develop logical, critical, systematic and creative thinking in carrying out specific work in the field of expertise and in accordance with the work competency standards in the relevant field.
4) Engage in continuous self-development and collaboration.
5) 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.
6) Master the basic principles and knowledge of how to operate instruments for the analysis and characterization of chemical compounds, as well as utilizing information and communication technology (ICT) for more specific chemical molecule modeling.
7) Mastering the principles of occupational health and safety, managing laboratories and using equipment as well as how to operate chemical equipment
8) Able to design an activity to solve problems by applying capabilities in the field of chemistry.
9) Mastering the basics of scientific methods, designing and implementing research, compiling scientific reports and communicating them both orally and in writing by utilizing information and communication technology.
10) Able to be responsible and carry out self-evaluation of work groups under him/her.

The Program Learning Outcomes (PLOs) of the Undergraduate Chemistry Program have been formulated to ensure close alignment with the Subject-Specific Criteria (SSC) of ASIIN for degree programs in chemistry. The alignment reflects the extent to which the program addresses the core competences expected of chemistry graduates, including a sound foundation in chemical knowledge, the ability to apply scientific principles and methods, practical laboratory competence, analytical and problem-solving skills, research capability, communication skills, professional responsibility, and lifelong learning. The PLOs are mapped against the relevant SSC-ASIIN competences to demonstrate that the intended graduate profile and qualification objectives are consistent with internationally recognized expectations for chemistry education. While the wording of individual PLOs may reflect national higher education regulations and institutional

characteristics, their substance is designed to cover the essential knowledge, skills, and professional competences defined in the SSC-ASIIN framework.

This alignment provides evidence that the curriculum not only complies with national requirements but also supports the development of internationally comparable competencies. The degree of correspondence between the Program Learning Outcomes and the SSC-ASIIN competences is presented in the following mapping table.

Table 3. Correlation between Competency SSC ASIIN and PLO

Competency SSC-ASIIN	Aspects	PLO	Description of PLO
Social Competences	**Attitude 1 (ATT 1)**	PLO 1	Demonstrate religious, national, and cultural values and uphold academic ethics in carrying out their responsibilities.
	Attitude 2 (ATT 2)	PLO 2	Demonstrate resilience, collaboration, adaptability, innovation, inclusivity, a commitment to lifelong learning, and an entrepreneurial mindset.
	General Skills 1 (GS 1)	PLO 3	Develops logical, critical, systematic, and creative thinking to specialized work in their field of expertise, in accordance with the work competency standards in the relevant field.
	General Skills 2 (GS 2)	PLO 4	Engages in continuous self-development and collaboration
	General Skills 3 (GS 3)	PLO 10	Able to be responsible and carry out self-evaluation of work groups under him/her.
Specialist Competences	**Knowledge 1 (KN 1)**	PLO 5	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.
	Knowledge 2 (KN 2)	PLO 6	Master the basic principles and knowledge of how to operate instruments for the analysis and characterization of chemical compounds, as well as utilizing information and communication technology (ICT) for more specific chemical molecule modeling.
	Special Skills 2 (SS 2)	PLO 8	Able to design an activity to solve problems by applying capabilities in the field of chemistry.

Competency SSC-ASIIN	Aspects	PLO	Description of PLO
	Special Skills 3 (SS 3)	PLO 9	Mastering the basics of scientific methods, designing and implementing research, compiling scientific reports, and communicating them both orally and in writing by utilizing information and communication technology.

The Program Learning Outcomes (PLOs) of the Undergraduate Chemistry Program have been benchmarked against the learning outcomes and graduate competencies of comparable chemistry programs at selected international universities. This benchmarking process is conducted to ensure that the intended competencies of graduates are aligned with internationally recognized academic standards and current developments in chemistry education.

The comparison focuses on key areas of graduate competence, including fundamental and advanced chemical knowledge, laboratory and analytical skills, scientific inquiry and research competence, critical and problem-solving abilities, communication and teamwork, professional and ethical responsibility, as well as lifelong learning. Although differences may exist in terminology, curriculum structure, and institutional context, the underlying competencies show a high degree of correspondence with those emphasized by international chemistry programs.

This alignment demonstrates that the Program Learning Outcomes are not only responsive to national higher education requirements but are also comparable to international standards and practices. The benchmarking results are used as a reference for curriculum review, quality enhancement, and continuous improvement of the study program. The comparison of the Program Learning Outcomes with those of selected international universities is presented in the following table.

Table 4. Alignment of Program Learning Outcomes (PLOs) of study program to other universities (international)

UNESA B.Sc. Chemistry	Universiti Sains Malaysia (USM) B.Sc. Chemistry with Honours	Universiti Putra Malaysia (UPM) Bachelor of Science in Chemistry with Honours
PLO 1 Demonstrate religious, national, and cultural values and uphold academic ethics in carrying out their responsibilities.	**Partial** PO11 – Ethics and Professionalism: positive values, ethics, accountability, and professionalism. It aligns with academic ethics, but does not explicitly include UNESA's religious, national, and cultural values.	**Direct** P6 – Professionalism, Values, Attitudes and Ethics. It aligns with ethics and professional values, while UNESA more explicitly incorporates religious, national, and cultural values.

UNESA B.Sc. Chemistry	Universiti Sains Malaysia (USM) B.Sc. Chemistry with Honours	Universiti Putra Malaysia (UPM) Bachelor of Science in Chemistry with Honours
PLO 2 Demonstrate resilience, collaboration, adaptability, innovation, inclusivity, a commitment to lifelong learning, and an entrepreneurial mindset.	**Direct** PO4 – Interpersonal Skills; PO8 – Leadership, Autonomy and Responsibility; PO9 – Personal Skills; and PO10 – Entrepreneurial Skills. Together these cover collaboration, lifelong learning, responsibility, and entrepreneurship.	**Direct** P5 – Social Skills and Responsibility; P7 – Lifelong Learning and Information Management; P8 – Management and Entrepreneurial Skills; and P9 – Leadership Skills. These collectively align with collaboration, lifelong learning, entrepreneurship, and responsibility.
PLO 3 Apply logical, critical, systematic, and creative thinking to specialized work in their field of expertise, in accordance with relevant occupational competency standards.	**Direct** PO2 – Cognitive Skills: critical thinking and providing practical solutions to chemistry-related issues.	**Direct** P3 – Thinking and Scientific Skills, which aligns with logical, critical, systematic, and scientific thinking.
PLO 4 Engage in continuous self-development and work collaboratively.	**Direct** PO4 – Interpersonal Skills and PO9 – Personal Skills, including collaboration and independent acquisition of new knowledge and skills.	**Direct** P5 – Social Skills and Responsibility and P7 – Lifelong Learning and Information Management, aligning with collaboration and continuous self-development.
PLO 5 Demonstrate mastery of concepts related to structure, dynamics, and energy, as well as the fundamental principles of separation, analysis, synthesis, and characterization of small-molecule compounds and their applications.	**Direct** PO1 – Knowledge: application of fundamental chemistry knowledge to chemistry-related practice.	**Direct** P1 – Knowledge, covering mastery and application of chemistry knowledge.

UNESA B.Sc. Chemistry	Universiti Sains Malaysia (USM) B.Sc. Chemistry with Honours	Universiti Putra Malaysia (UPM) Bachelor of Science in Chemistry with Honours
PLO 6 Demonstrate mastery of the fundamental principles and practical knowledge needed to operate instruments for the analysis and characterization of chemical compounds, and use information and communication technology (ICT) for specialized molecular modeling.	**Direct** PO3 – Practical Skills: use of laboratory apparatus and analytical instruments; PO6 – Digital Skills. Specialized molecular modelling is not explicitly stated.	**Partial** P2 – Technical/Practical/Psychomotor Skills and P7 – Lifelong Learning and Information Management. Instrumentation and information skills are represented, but specialized molecular modelling is not explicitly stated.
PLO 7 Demonstrate mastery of occupational health and safety principles and laboratory management, including the proper use and operation of laboratory equipment and chemical instruments.	**Partial** PO3 – Practical Skills: safe handling of chemicals and proficient use of laboratory apparatus and analytical instruments. Laboratory management is not explicitly stated as a separate outcome.	**Partial** P2 – Technical/Practical/Psychomotor Skills, supported by P5/P6 responsibility and ethics. Practical and safety-related competence is represented, but laboratory management is not explicit as a separate outcome.
PLO 8 Design activities to solve problems by applying knowledge and skills in chemistry.	**Direct** PO2 – Cognitive Skills: application of chemistry knowledge and critical thinking to provide practical solutions to chemistry-related issues.	**Direct** P3 – Thinking and Scientific Skills, aligning with scientific reasoning and chemistry-based problem solving.
PLO 9 Demonstrate mastery of the fundamentals of the scientific method; design and conduct research; prepare scientific reports; and communicate findings orally and in writing using information and communication technology.	**Partial** PO2 supports scientific problem solving; PO5 covers communication; PO6 covers digital skills. Research and project work are present in the curriculum, although the PLO wording is less explicit than UNESA PLO 9.	**Direct** P3 – Thinking and Scientific Skills; P4 – Communication Skills; and P7 – Lifelong Learning and Information Management. These align with scientific inquiry, reporting, communication, and information use.

UNESA B.Sc. Chemistry	Universiti Sains Malaysia (USM) B.Sc. Chemistry with Honours	Universiti Putra Malaysia (UPM) Bachelor of Science in Chemistry with Honours
PLO 10 Assume responsibility for teams under their supervision and evaluate their own performance in that supervisory role.	**Direct** PO8 – Leadership, Autonomy and Responsibility, supported by PO4 – Interpersonal Skills. These align with responsibility and leadership in team settings.	**Partial** P9 – Leadership Skills and P5 – Social Skills and Responsibility. Leadership and responsibility are aligned, although explicit supervision and evaluation of supervisory performance are more specific in UNESA.

Note: Alignment is based on substantive similarity between published programme outcomes. 'Direct' indicates close equivalence; 'Partial' indicates related but not fully equivalent coverage.

The Program Learning Outcomes (PLOs) of the Undergraduate Chemistry Program are formulated in close alignment with the Program Educational Objectives (PEOs) and the competency requirements stipulated in the Indonesian Qualifications Framework (IQF). This alignment ensures that the competencies acquired by students upon graduation provide a solid foundation for achieving the broader professional, academic, and societal objectives expected of graduates in their subsequent careers.

The PLOs describe the knowledge, skills, attitudes, and professional competencies that students are expected to demonstrate upon completion of the study program, whereas the PEOs represent the broader achievements expected from graduates several years after graduation. In this context, the PLOs serve as measurable educational outcomes that support the achievement of the PEOs. At the same time, both the PLOs and PEOs are developed with reference to the qualification descriptors of the IQF at the undergraduate level, thereby ensuring conformity with national standards of higher education and graduate qualifications.

The correlation among PLOs, PEOs, and the IQF demonstrates a coherent progression from national qualification requirements to program-level educational objectives and measurable graduate competencies. This alignment also supports constructive curriculum design, appropriate teaching and learning strategies, and systematic assessment of student achievement. The mapping presented below illustrates how each PLO contributes to the achievement of the PEOs and corresponds to the relevant competency dimensions of the Indonesian Qualifications Framework. This correlation serves as an important basis for curriculum evaluation, quality assurance, and continuous improvement of the Undergraduate Chemistry Program.

Table 5. Correlation between the PLO, PEO and IQF

PLO	Programme Educational Objectives (PEO)					Indonesian Qualification Framework (IQF)			
	PEO 1	PEO 2	PEO 3	PEO 4	PEO 5	IQF 1	IQF 2	IQF 3	IQF 4
PLO 1	-	-	√	√	-	-	-	√	√
PLO 2	√	√	√	√	√	√	√	√	√
PLO 3	√	√	√	√	√	√	√	√	√
PLO 4	-	√	√	√	√	√	√	√	√

PLO	Programme Educational Objectives (PEO)					Indonesian Qualification Framework (IQF)			
	PEO 1	PEO 2	PEO 3	PEO 4	PEO 5	IQF 1	IQF 2	IQF 3	IQF 4
PLO 5	√	-	√	-	√	√	√	√	-
PLO 6	√	√	√	√	√	√	√	√	√
PLO 7	√	-	√	√	√	√	√	√	√
PLO 8	√	√	√	√	√	√	√	√	√
PLO 9	√	√	√	√	√	√	√	√	√
PLO 10	-	√	-	√	√	-	-	√	√

Note: A check mark (√) indicates a substantive alignment between the respective Program Learning Outcome (PLO) and the corresponding Program Educational Objective (PEO) or IQF Level 6 descriptor. A dash (–) indicates that the PLO is not directly or primarily aligned with the corresponding PEO or IQF descriptor. The mapping illustrates how the PLOs collectively support the achievement of the PEOs and ensure comprehensive coverage of the IQF Level 6 qualification requirements.

The mapping demonstrates that the Program Learning Outcomes collectively provide comprehensive support for the achievement of all Program Educational Objectives and the competency descriptors of IQF Level 6. Some PLOs contribute broadly across several PEOs and IQF dimensions, while others address more specific aspects of graduate competence. This complementary distribution ensures that disciplinary knowledge, scientific and analytical skills, professional responsibility, communication, collaboration, lifelong learning, and leadership are systematically incorporated into the graduate qualification profile.

PROGRAM STRUCTURE

1. The Curriculum

The Undergraduate Chemistry Program (UPC) at the Faculty of Mathematics and Natural Sciences (FMNS), Universitas Negeri Surabaya (UNESA), leads to the academic degree of *Sarjana Sains* (S.Si.), internationally referred to as a Bachelor of Science (B.Sc.). The program is designed as a four-year undergraduate degree program comprising eight semesters.

The curriculum of the Undergraduate Chemistry Program is developed and periodically reviewed to ensure its relevance to the Program Educational Objectives (PEOs), Program Learning Outcomes (PLOs), the Indonesian National Qualifications Framework (IQF/KKNI), the National Standards for Higher Education, developments in chemistry and related sciences, professional requirements, technological advancement, stakeholder expectations, and current as well as future national and global challenges. Input from students, lecturers, alumni, employers, professional associations, and other relevant stakeholders is considered in the curriculum development and review process.

In addition, the curriculum is designed to respond to the competencies required in the twenty-first century, including critical and analytical thinking, problem solving, creativity, communication, collaboration, digital literacy, adaptability, and lifelong learning. Contemporary educational paradigms, particularly Outcome-Based Education (OBE), student-centered learning, constructive alignment, continuous quality improvement, and international benchmarking, are incorporated into curriculum design, implementation, assessment, and evaluation. This approach is intended to ensure that the curriculum not only provides a strong theoretical foundation in chemistry but also develops scientific reasoning, laboratory competence, research capability,

professional responsibility, and transferable skills that enable graduates to respond to developments in science, technology, industry, and society.

The curriculum development process is guided by five main principles: relevance, flexibility, continuity, efficiency, and effectiveness. Relevance ensures that curriculum content is responsive to scientific developments, professional needs, stakeholder expectations, and societal challenges. Flexibility enables the curriculum to accommodate students' academic interests, emerging areas of chemistry, experiential learning, and changing educational needs. Continuity ensures systematic and progressive development of competencies across semesters. Efficiency concerns the appropriate use of learning time and educational resources, whereas effectiveness refers to the extent to which the curriculum enables students to achieve the intended Program Learning Outcomes.

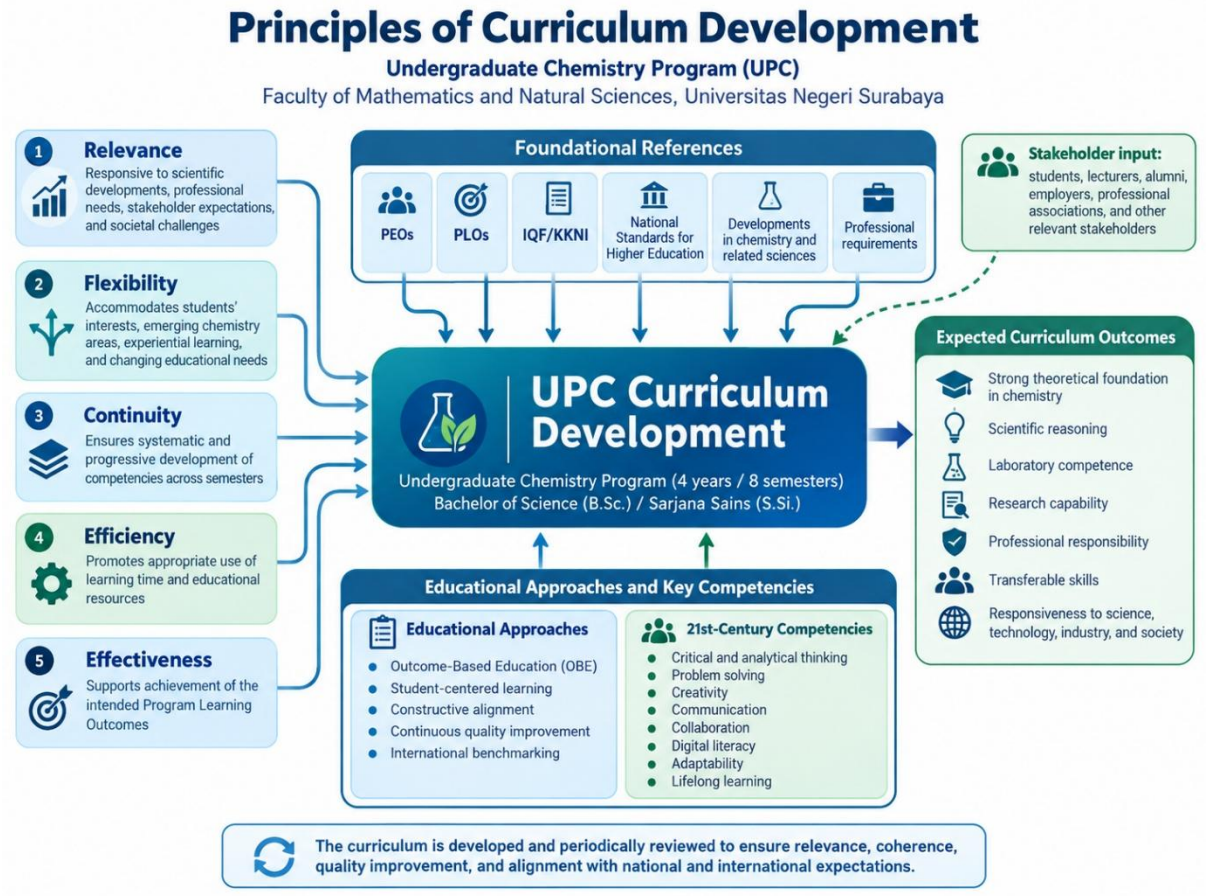


Figure 1. Principles of curriculum development

The curriculum is structured progressively throughout the four-year period to enable students to develop competencies from fundamental scientific knowledge to advanced disciplinary knowledge, professional application, research, and integration of competencies. As illustrated in Figure 2, the first year emphasizes fundamental concepts in chemistry, mathematics, natural sciences, and supporting competencies. The second year strengthens students' knowledge of the core areas of chemistry and develops laboratory and analytical competencies. The third year focuses on advanced chemical concepts, instrumental and analytical skills, research-oriented learning, professional competencies, and opportunities for specialization. The fourth year represents the integrative and capstone stage, in which students deepen selected areas of chemistry

and demonstrate the integration of knowledge, research skills, scientific communication, and problem-solving abilities through advanced learning activities and the undergraduate final project.

This progressive structure ensures that prerequisite knowledge and skills acquired during the earlier stages of study provide the foundation for increasingly complex learning activities in subsequent semesters. It also enables the PLOs to be introduced, reinforced, integrated, and ultimately demonstrated at an appropriate level by the completion of the program.

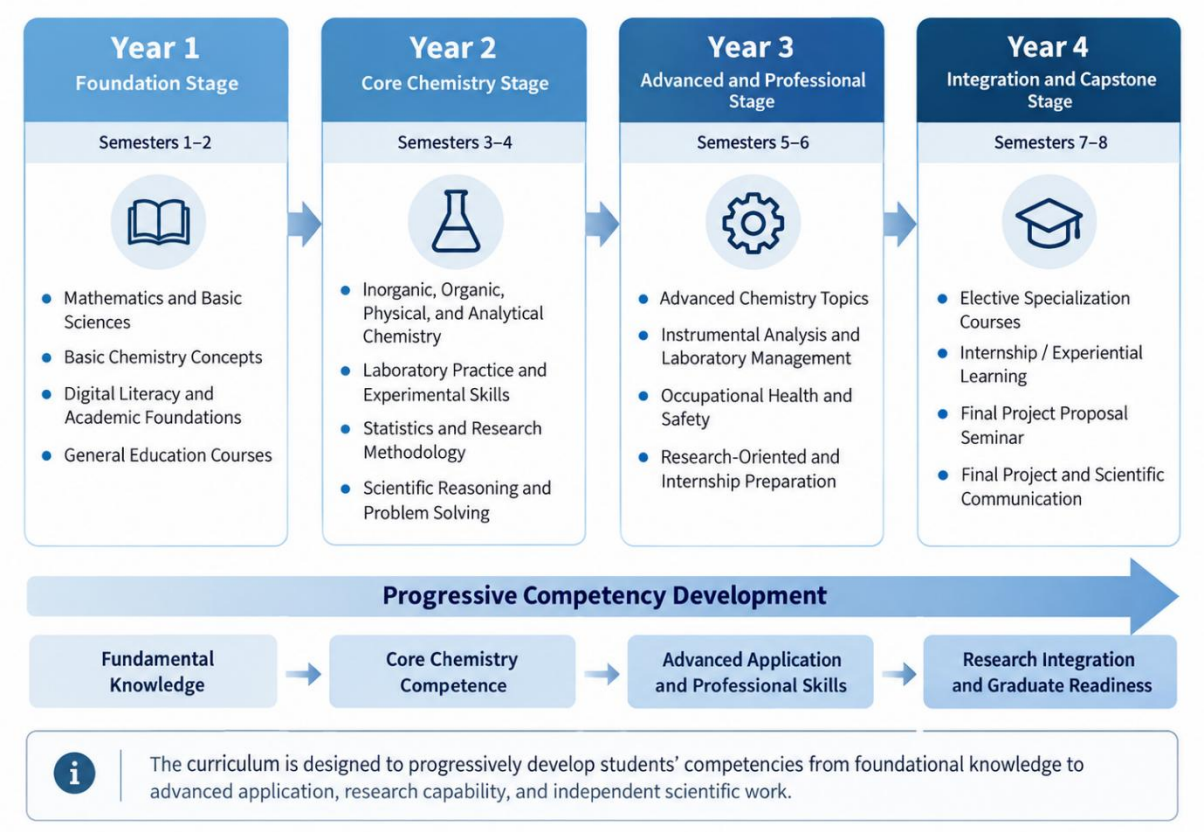


Figure 2. Model of curriculum structure of undergraduate programme in Chemistry

The disciplinary content of the curriculum covers fundamental sciences and the major areas of chemistry, including analytical, inorganic, organic, physical, and biochemical chemistry, together with relevant interdisciplinary and emerging fields. Core theoretical learning is integrated with laboratory activities, instrumental analysis, scientific problem solving, research-based learning, and professional experiences. This structure supports the chemistry-specific competencies expected by the ASIIN Subject-Specific Criteria, particularly sound disciplinary knowledge, scientific and methodological competence, safe and independent laboratory practice, analytical and problem-solving skills, and the ability to communicate scientific results. The ASIIN criteria emphasize that the intended learning outcomes should be demonstrably linked to the contribution of individual modules within the curriculum. ASIIN

Practical and laboratory activities constitute an integral part of the curriculum. They are designed to enable students to apply theoretical principles, perform chemical experiments safely and independently, use laboratory equipment and analytical instruments appropriately, analyze and interpret experimental data, and apply scientific methods to chemical problems. Particular emphasis is placed on occupational health and safety, laboratory management, responsible

handling and disposal of chemicals, good laboratory practices, and environmental responsibility. This is already reflected in the current curriculum through laboratory, instrumentation, occupational safety, calibration, analytical, and research-related courses.

Research competence is developed progressively across the curriculum rather than being confined to the final semester. Students are introduced to scientific methodology, research design, data collection, data analysis and interpretation, scientific communication, and research dissemination through a sequence of research-oriented courses. These competencies culminate in the Final Project, in which students are expected to formulate a scientific problem, design and conduct an investigation, analyze and critically interpret data, draw scientifically sound conclusions, and communicate their findings in written and oral forms. This progression strengthens the relationship between the curriculum and PLOs related to scientific inquiry, problem solving, research, communication, and professional responsibility.

The curriculum also provides opportunities for experiential learning beyond conventional classroom settings through internships, research placements, student mobility, entrepreneurship, community-based learning, and other relevant learning activities. Such experiences enable students to apply chemical knowledge and transferable skills in academic, industrial, environmental, societal, and interdisciplinary contexts. Where learning activities are conducted outside the study program or institution, their academic relevance and credit recognition are determined in accordance with the intended learning outcomes and applicable university regulations.

Curriculum implementation is monitored and evaluated regularly as part of the internal quality assurance and continuous improvement system. Evidence from student learning outcomes, PLO achievement, student feedback, lecturer evaluation, alumni and employer feedback, stakeholder consultation, developments in chemistry, and implementation of the curriculum is considered in the review process. The results are used to identify areas for improvement and, where necessary, to revise learning content, teaching and learning strategies, assessment methods, student workload, course sequencing, or curriculum structure. This establishes a continuous improvement cycle linking curriculum planning, implementation, assessment, evaluation, and improvement.

Based on The Decree of the Rector of Universitas Negeri Surabaya Number 736/HK/KM/2023 and in accordance with the Regulation of the Minister of Higher Education, Science and Technology of the Republic of Indonesia Number 39 of 2025 concerning Quality Assurance in Higher Education, as amended by Regulation Number 10 of 2026, the undergraduate program comprises a minimum study load of 144 credit units (CU) and is designed to be completed within eight semesters. Under the current national regulation, one CU represents 45 hours of student learning workload per semester; therefore, 144 CU corresponds to approximately 6,480 hours of total student workload.

Student workload encompasses the time required to achieve the intended learning outcomes through various forms of learning, including lectures, tutorials, seminars, laboratory and practical work, projects, research, internships, final projects, guided learning activities, structured assignments, and independent study. This workload-based approach is consistent with the principle that academic credits should represent the overall learning effort required to achieve specified learning outcomes rather than contact hours alone.

For international comparability, the national credit system is converted into the European Credit Transfer and Accumulation System (ECTS). The 144 CU required for completion of the Undergraduate Chemistry Program correspond to approximately 229 ECTS. Based on a total

workload of 6,480 hours, one ECTS corresponds to approximately 28.30 hours of student workload, resulting in a conversion factor of approximately 1 CU = 1.59 ECTS. This conversion is consistent with the ECTS principle, under which one ECTS credit generally represents approximately 25–30 hours of total student workload. European Education Area

To complete the Undergraduate Chemistry Program, students are required to obtain a minimum of 144 CU, comprising 125 CU of compulsory courses and 19 CU of elective courses. The compulsory component ensures that all students acquire the fundamental scientific knowledge, core chemistry competencies, laboratory and instrumental skills, research capabilities, and professional competencies required of chemistry graduates. The elective component allows students to broaden or deepen their knowledge according to their academic interests, intended professional orientation, research interests, and emerging developments in chemistry and related fields.

The distribution of courses and workload across the eight semesters is designed to support the progressive achievement of the PLOs within the standard period of study. The relationship between courses and PLOs is demonstrated through the Course–PLO Mapping, while the progressive development of competencies across the curriculum is illustrated through the PLO Roadmap. Together with the curriculum structure, module descriptions, teaching and learning strategies, and assessment methods, these mappings provide evidence of constructive alignment between the intended graduate competencies, curriculum content, learning activities, and assessment. This is particularly relevant to ASIIN, which places the intended learning outcomes and the contribution of individual modules to their achievement at the center of programme evaluation.

The appropriateness of the student workload, the distribution of courses, the achievement of the PLOs, and the effectiveness of curriculum implementation are periodically evaluated through the program's internal quality assurance mechanisms and stakeholder feedback. The results of these evaluations serve as evidence for continuous curriculum improvement. The detailed curriculum structure, including compulsory and elective courses, credit units, ECTS credits, and their distribution across semesters, is presented in the following tables.

Table 6. Compulsory and Elective Courses in UPC

CU Courses	CU	ECTS	Note (related to the distribution in curriculum)
CU of compulsory courses	124	197.16	Number of courses that must be taken by students for graduation, and there are 53 compulsory courses that provided
CU of elective course	20	31.8	The number of elective courses provided is 60 credits
Total	144	228.96	

Table 7. UNESA Compulsory Courses

No.	Code	Course Name	CU
1.	4720103006	General Biology	3
2.	4720103030	General Physics	3
3.	4720103074	Basic Chemistry	3
4.	4720103133	Basic Mathematics	2
5.	4720103095	Quantum Chemistry	3
6.	4720103180	Basic of Analytical Chemistry	3
7.	1000002018	Pancasila	2
8.	4720102005	Digital Literacy	2
9.	4720103047	Basics of Chemical Separations	2
10.	4720102131	Conservation of Natural Resources and Environment	2
11.	4720103067	Basic of Inorganic Chemistry	3
12.	4720103094	Thermodynamics of Chemistry	3
13.	4720103117	Monofunctional Organic Compounds	3
14.	1000002033	Citizenship Education	2
15.	1000002026	Religious Education	2
16.	1000002003	Indonesian	2
17.	4720102009	English	2
18.	4720102179	Physical Education and Fitness	2
19.	4720102158	Practicum of Organic Chemistry	2
20.	4720103116	Polyfunctional Organic Compounds	3
21.	4720103169	Basic Statistics	2
22.	4720102018	Structure and Function of Biomolecules	2
23.	4720103091	Chemical Kinetics	3

No.	Code	Course Name	CU
24.	4720102053	Spectroscopic and Chromatographic Methods	3
25.	4720102064	Coordination Chemistry	2
26.	4720103123	Surface Chemistry	2
27.	4720102220	Chemistry of the Elements	3
28.	4720103015	Metabolism and Genetic Information Flow	3
29.	4720103142	Research Methodology	3
30.	4720101157	Practicum of Inorganic Chemistry	2
31.	4720102024	Philosophy of Science	2
32.	4720102174	Entrepreneurship	2
33.	4720103148	Elucidation of Organic Molecular Structure	2
34.	4720101156	Practicum of Biochemistry	2
35.	4720103144	Laboratory Organization	2
36.	4720103107	Environmental Chemistry	2
37.	4720102054	Electrochemical Analysis	2
38.	4720102245	Research Planning	2
39.	4720102246	Research Program Evaluation	2
40.	4720102247	Methodology and Implementation of Chemical Research	2
41.	4720102248	Analysis and Interpretation of Chemical Research Data	2
42.	4720102249	Dissemination of Chemical Research Findings	2
43.	4720102210	Internship Program Planning	2
44.	4720103206	Internship Program Evaluation	2
45.	4720102211	Occupational Health and Safety	2
46.	4720102203	Management and Quality Control	2
47.	4720102204	Instrument Calibration and Analytical Method Validation	2

No.	Code	Course Name	CU
48.	4720103201	Instrumental Analysis	2
49.	4720103212	Internship Program Implementation	4
50.	4720102250	Sampling Techniques and Sample Preparation	2
51.	4720102251	Processing and Interpretation of Chemical Analysis Data	2
52.	4720102159	Final Project Proposal Seminar	2
53.	4720106167	Final Project	4
Total			**124**

Table 8. Elective Courses in Study Program Curriculum

No.	Code	Course Name	CU
1	4720102182	Halal Food Products	2
2	4720102082	Pharmaceutical Chemistry	2
3	4720102108	Materials Chemistry	2
4	4720102129	Solid-state Chemistry	2
5	4720102106	Cosmetics	2
6	4720102072	Natural Product Chemistry	2
7	4720102172	Research Technique of Biochemistry	2
8	4720102127	Organic Polymer Chemistry	2
9	4720102225	AI-Driven Chemical Discovery	2
10	4720102010	Bioinorganic	2
11	4720102173	Toxicology	2
12	4720102071	Mechanism of Inorganic Reaction	2
13	4720102119	Mechanism of Organic Reaction	2
14	4720102242	Fundamentals of Green Chemistry	2
15	4720102244	Chemistry-based Economy Circular	2
16	4720102243	Biomedical Chemistry	2
17	4720102103	Radiochemistry	2
18	4720102101	Industrial Chemistry	2
19	4720102104	Computational Chemistry	2
20	4720102122	Food Chemistry	2
21	4720102143	Microbiology	2
22	4720102151	Career Development	2
23	4720103165	Organic Synthesis	2

No.	Code	Course Name	CU
24	4720102183	Nanomaterial and Nanoscience	2
25	4720102020	Biotechnology product development	2
26	4720102241	Aroma and Flavour Chemistry	2
27	4720102162	Organometallic Chemistry	2
28	4720120222	Phytochemistry	2
29	4720102253	Nutraceutical Chemistry	2
30	4720102252	Introduction of Forensic Chemistry	2
Total			**60**

The Course–Program Learning Outcomes (PLO) mapping is developed to demonstrate the systematic alignment between the curriculum structure and the intended qualification objectives of the Undergraduate Chemistry Program. Each course is mapped to relevant PLOs based on its learning content, teaching and learning activities, expected competencies, and assessment methods, following the principle of constructive alignment.

The mapping ensures that the curriculum is coherent, progressive, and comprehensive, allowing students to gradually develop the knowledge, practical and analytical skills, scientific reasoning, professional attitudes, communication abilities, collaborative competencies, and lifelong learning capacities required of chemistry graduates. The distribution of PLOs across the curriculum also provides evidence that the intended learning outcomes are introduced, developed, reinforced, and assessed through appropriate courses and learning experiences throughout the study period.

Furthermore, the Course–PLO matrix serves as an important instrument for monitoring the achievement of the Program Learning Outcomes and evaluating curriculum effectiveness. The results of this mapping are periodically reviewed as part of the program's internal quality assurance and continuous improvement process to ensure that the curriculum remains consistent with the qualification objectives, developments in the field of chemistry, stakeholder expectations, and the requirements of international accreditation.

Table 9. Mapping of Course and Program Learning Outcome (PLO)

No.	Code	Course	CU	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
Compulsory Course													
1	4720103006	General Biology	3					√				√	
2	4720103030	General Physics	3					√				√	
3	4720103074	Basic Chemistry	3					√		√			
4	4720103133	Basic Mathematics	2			√		√					
5	4720103095	Quantum Chemistry	3					√	√				
6	4720103180	Basic of Analytical Chemistry	3			√		√		√	√		
7	1000002018	Pancasila	2	√		√							
8	4720102005	Digital Literacy	2			√						√	
9	4720103047	Basics of Chemical Separations	2			√		√			√		
10	4720102131	Conservation of Natural Resources and Environment	2	√	√	√					√		
11	4720103067	Basic of Inorganic Chemistry	3			√		√					
12	4720103094	Thermodynamics of Chemistry	3			√		√					
13	4720103117	Monofunctional Organic Compounds	3			√		√					
14	1000002033	Citizenship Education	2	√		√							
15	1000002026	Religious Education	2	√		√							
16	1000002003	Indonesian	2	√								√	
17	4720102009	English	2				√					√	
18	4720102179	Physical Education and Fitness	2		√		√						
19	4720102158	Practicum of Organic Chemistry	2						√	√	√	√	

No.	Code	Course	CU	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
20	4720103116	Polyfunctional Organic Compounds	3			√		√					
21	4720103169	Basic Statistics	2			√						√	
22	4720102018	Structure and Function of Biomolecules	2			√		√					
23	4720103091	Chemical Kinetics	3			√		√				√	
24	4720102053	Spectroscopic and Chromatographic Methods	3					√	√			√	
25	4720102064	Coordination Chemistry	2			√		√					
26	4720103123	Surface Chemistry	2					√				√	
27	4720102220	Chemistry of the Elements	3			√		√				√	
28	4720103015	Metabolism and Genetic Information Flow	3			√		√					
29	4720103142	Research Methodology	3			√						√	
30	4720101157	Practicum of Inorganic Chemistry	2					√	√	√	√		
31	4720102024	Philosophy of Science	2			√	√					√	
32	4720102174	Entrepreneurship	2		√		√						
33	4720103148	Elucidation of Organic Molecular Structure	2			√		√	√				
34	4720101156	Practicum of Biochemistry	2					√	√	√			
35	4720103144	Laboratory Organization	2		√					√		√	√
36	4720103107	Environmental Chemistry	2			√		√	√			√	
37	4720102054	Electrochemical Analysis	2			√		√	√				
38	4720102245	Research Planning	2			√					√	√	
39	4720102246	Research Program Evaluation	2			√						√	√

No.	Code	Course	CU	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
40	4720102247	Methodology and Implementation of Chemical Research	2							√	√	√	
41	4720102248	Analysis and Interpretation of Chemical Research Data	2			√			√			√	
42	4720102249	Dissemination of Chemical Research Findings	2				√					√	
43	4720102210	Internship Program Planning	2		√						√		
44	4720103206	Internship Program Evaluation	2				√						√
45	4720102211	Occupational Health and Safety	2	√						√			
46	4720102203	Management and Quality Control	2			√				√			√
47	4720102204	Instrument Calibration and Analytical Method Validation	2			√			√	√			
48	4720103201	Instrumental Analysis	2					√	√			√	
49	4720103212	Internship Program Implementation	4		√		√		√	√			
50	4720102250	Sampling Techniques and Sample Preparation	2					√		√	√		
51	4720102251	Processing and Interpretation of Chemical Analysis Data	2			√			√			√	
52	4720102159	Final Project Proposal Seminar	2	√		√						√	
53	4720106167	Final Project	4			√		√			√	√	
Total			**124**										
Elective Course													
1	4720102151	Career Development	2		√		√					√	

No.	Code	Course	CU	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
2	4720102104	Computational Chemistry	2					√	√				
3	4720102122	Food Chemistry	2			√		√			√		
4	4720102101	Industrial Chemistry	2		√						√	√	
5	4720102143	Microbiology	2					√		√			
6	4720102106	Cosmetics	2		√			√			√		
7	4720102182	Halal Food Products	2	√				√			√		
8	4720102108	Materials Chemistry	2			√		√					
9	4720102072	Natural Product Chemistry	2			√	√	√					
10	4720102082	Pharmaceutical Chemistry	2			√		√					
11	4720102172	Research Technique of Biochemistry	2			√	√	√					
12	4720102129	Solid-state Chemistry	2			√		√					
13	4720102020	Biotechnology product development	2		√	√		√				√	
14	4720102183	Nanomaterial and Nanoscience	2					√	√				
15	4720103165	Organic Synthesis	2			√		√					
16	4720120222	Phytochemistry	2					√	√				
17	4720102225	AI-Driven Chemical Discovery	2			√			√		√		
18	4720102243	Biomedical Chemistry	2			√		√					
19	4720102244	Chemistry-based Economy Circular	2		√	√					√		
20	4720102241	Aroma and Flavour Chemistry	2					√			√		
21	4720102242	Fundamentals of Green Chemistry	2		√			√			√		
22	4720102071	Mechanism of Inorganic Reaction	2			√		√					

No.	Code	Course	CU	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
23	4720102127	Organic Polymer Chemistry	2			√		√				√	
24	4720102103	Radiochemistry	2					√		√			
25	4720102173	Toxicology	2			√		√		√			
26	4720102010	Bioinorganic	2			√		√					
27	4720102162	Organometallic Chemistry	2			√		√					
28	4720102252	Introduction of Forensic Chemistry	2	√				√	√				
29	4720102119	Mechanism of Organic Reaction	2			√		√					
30	4720102253	Nutraceutical Chemistry	2					√			√		
Total			**60**										

Table 10. Curriculum Structure of Study Program in each semester

1st Semester					2nd Semester				
	Code	**Course Name**	**CU**	**ECTS**		**Code**	**Course Name**	**CU**	**ECTS**
1	4720103006	General Biology	3	4.77	1	4720102005	Digital Literacy	2	3.18
2	4720103030	General Physics	3	4.77	2	4720103047	Basics of Chemical Separations	2	3.18
3	4720103074	Basic Chemistry	3	4.77	3	4720102131	Conservation of Natural Resources and Environment	2	3.18
4	4720103133	Basic Mathematics	2	3.18	4	4720103067	Basic Theory of Inorganic	3	4.77
5	4720103095	Quantum Chemistry	3	4.77	5	4720103094	Thermodynamics of Chemistry	3	4.77
6	4720103180	Basic of Analytical Chemistry	3	4.77	6	4720103117	Monofunction Organic Compounds	3	4.77
7	1000002018	Pancasila	2	3.18	7	1000002033	Citizenship Education	2	3.18
8					8	1000002026	Religion Education	2	3.18
TOTAL			**19**	**30.21**	**TOTAL**			**19**	**30.21**

3rd Semester					4th Semester				
	Code	**Course Name**	**CU**	**ECTS**		**Code**	**Course Name**	**CU**	**ECTS**
1	1000002003	Indonesian	2	3.18	1	4720103123	Surface Chemistry	2	3.18
2	4720102009	English	2	3.18	2	4720102220	Chemistry of the Elements	3	4.77
3	4720102179	Physical Education and Fitness	2	3.18	3	4720103015	Metabolism and Pathways of Genetics Information	3	4.77
4	4720102158	Practicum of Organic Chemistry	2	3.18	4	4720103142	Research Methodology	3	4.77
5	4720103116	Polyfunction Organic Compound	3	4.77	5	4720101157	Practicum of Inorganic Chemistry	2	3.18
6	4720103169	Basic Statistics	2	3.18	6	4720102024	Philosophy of Science	2	3.18
7	4720102018	Structure and Function of Biomolecule	2	3.18	7	4720102174	Entrepreneurship	2	3.18
8	4720103091	Chemical Kinetics	3	4.77	8	4720103148	Elucidation of Organic Molecular Structure	2	3.18
9	4720102053	Spectroscopy and Chromatography Method	3	4.77	9	4720101156	Practicum of Biochemistry	2	3.18
10	4720102064	Coordination Chemistry	2	3.18	10		Elective Courses*	2	3.18
TOTAL			**23**	**36.57**	**TOTAL**			**23**	36.58

5th Semester					6th Semester				
	Code	**Course Name**	**CU**	**ECTS**		**Code**	**Course Name**	**CU**	**ECTS**
1	4720103144	Laboratory Organization	2	3.18	1	4720102210	Internship Program Planning	2	3.18

5th Semester					6th Semester				
	Code	**Course Name**	**CU**	**ECTS**		**Code**	**Course Name**	**CU**	**ECTS**
2	4720103107	Environmental Chemistry	3	4.77	2	4720103206	Internship Program Evaluation	2	3.18
3	4720102054	Electrochemistry Analysis	2	3.18	3	4720102211	Occupational Health and Safety	2	3.18
4	4720102245	Research Planning	2	3.18	4	4720102203	Management and Quality Control	2	3.18
5	4720102246	Research Program Evaluation	2	3.18	5	4720102204	Instrument Calibration and Analytical Method Validation	2	3.18
6	4720102247	Methodology and Implementation of Chemical Research	2	3.18	6	4720103201	Instrumental Analysis	2	3.18
7	4720102248	Analysis and Interpretation of Chemical Research Data	2	3.18	7	4720103212	Internship Program Implementation	4	6.36
8	4720102249	Dissemination of Chemical Research Findings	2	3.18	8	4720102250	Sampling Techniques and Sample Preparation	2	3.18
9		Elective courses *	6	9.54	9	4720102251	Processing and Interpretation of Chemical Analysis Data	2	3.18
					10		Elective courses *	4	6.36
TOTAL			**23**	**36.57**	**TOTAL**			**24**	38.16

7th Semester					8th Semester				
	Code	**Course Name**	**CU**	**ECTS**		**Code**	**Course Name**	**CU**	**ECTS**
1	4720102159	Final Project Proposal Seminar	2	3.18	1	4720106167	Final Project	4	6.36
2		Elective courses *	6	9.54	2		Elective Courses*	2	3.18
TOTAL			**8**	**12.72**	**TOTAL**			**6**	9.54

Table 11. SSC-based Objective-Module Matrix

No.	Subject Specific Criteria (SSC)	PLO										Corresponding Modules
		1	2	3	4	5	6	7	8	9	10	
		ATT1	ATT2	GS 1	GS 2	KN 1	KN 2	KN 3	SS 1	SS 2	GS 3	
Specialist competences												
1	have gained chemistry-relevant **fundamental knowledge of mathematics and the natural sciences**,			√		√						Basic Mathematics; General Physics; General Biology; Basic Statistics; Basic Chemistry.
2	have sound knowledge of the **core subjects of chemistry** including inorganic, organic and physical chemistry, as well as of analytical chemistry,					√						Basic Chemistry; Basic of Inorganic Chemistry; Chemistry of the Elements; Monofunctional Organic Compounds; Thermodynamics of Chemistry; Chemical Kinetics; Basic of Analytical Chemistry; Spectroscopic and Chromatographic Methods; Electrochemical Analysis.

No.	Subject Specific Criteria (SSC)	PLO										Corresponding Modules
		1	2	3	4	5	6	7	8	9	10	
		ATT1	ATT2	GS 1	GS 2	KN 1	KN 2	KN 3	SS 1	SS 2	GS 3	
3	have gained knowledge in one or several other **special areas** in the natural sciences or humanities,	√	√		√							Conservation of Natural Resources and Environment; Structure and Function of Biomolecules; Metabolism and Genetic Information Flow; Philosophy of Science; Pancasila; Entrepreneurship.
4	are able to carry out **practical chemistry work** and have learnt how to handle chemicals independently and safely in lab practicals,						√	√		√		Practicum of Organic Chemistry; Practicum of Inorganic Chemistry; Practicum of Biochemistry; Occupational Health and Safety; Instrumental Analysis; Internship Program Implementation; Final Project.

No.	Subject Specific Criteria (SSC)	PLO										Corresponding Modules
		1	2	3	4	5	6	7	8	9	10	
		ATT1	ATT2	GS 1	GS 2	KN 1	KN 2	KN 3	SS 1	SS 2	GS 3	
5	have knowledge of **safety and environmental issues** and the legal fundamentals,	√						√				Conservation of Natural Resources and Environment; Environmental Chemistry; Occupational Health and Safety; Laboratory Organization; Fundamental of Green Chemistry; Toxicology.
6	have gained **methodological competence** in chemistry and are able to apply this in other contents, and			√					√	√		Basic Statistics; Research Methodology; Methodology and Implementation of Chemical Research; Analysis and Interpretation of Chemical Research Data; Dissemination of Chemical Research Findings; Final Project.

No.	Subject Specific Criteria (SSC)	PLO										Corresponding Modules
		1	2	3	4	5	6	7	8	9	10	
		ATT1	ATT2	GS 1	GS 2	KN 1	KN 2	KN 3	SS 1	SS 2	GS 3	
7	have **interdisciplinary** knowledge and skills, such as in economics, ethics or philosophy.	√	√	√								Pancasila; Citizenship Education; Philosophy of Science; Entrepreneurship; Industrial Chemistry; Conservation of Natural Resources and Environment; Chemistry-based Economy Circular.
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,	√		√					√	√		Basic Statistics; Instrumental Analysis; Analysis and Interpretation of Chemical Research Data; Processing and Interpretation of Chemical Analysis Data; Research Methodology; Final Project.

No.	Subject Specific Criteria (SSC)	PLO										Corresponding Modules
		1	2	3	4	5	6	7	8	9	10	
		ATT1	ATT2	GS 1	GS 2	KN 1	KN 2	KN 3	SS 1	SS 2	GS 3	
9	**solve problems** of a scientific/application-oriented nature independently, and to present the results, as well as			√					√	√		Research Methodology; Research Planning; Methodology and Implementation of Chemical Research; Dissemination of Chemical Research Findings; Internship Program Implementation; Final Project.
10	pursue **lifelong learning**.		√		√							Digital Literacy; English; Philosophy of Science; Internship Program Implementation; Final Project.
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	√	√		√					√		Indonesian; English; Digital Literacy; Dissemination of Chemical Research Findings; Final Project Proposal Seminar; Final Project; Internship Program Implementation.

No.	Subject Specific Criteria (SSC)	PLO										Corresponding Modules
		1	2	3	4	5	6	7	8	9	10	
		ATT1	ATT2	GS 1	GS 2	KN 1	KN 2	KN 3	SS 1	SS 2	GS 3	
12	are aware of social and ethical **responsibility** in their actions and are familiar with the professional ethical principles and standards of chemistry,	√									√	Pancasila; Citizenship Education; Philosophy of Science; Occupational Health and Safety; Laboratory Organization; Career Development; Internship Program Implementation.
13	are able to work both alone and as a member of international, mixed-gender groups		√		√						√	Practicum of Organic Chemistry; Practicum of Inorganic Chemistry; Practicum of Biochemistry; Research Planning; Internship Program Planning; Internship Program Implementation; Final Project.

No.	Subject Specific Criteria (SSC)	PLO										Corresponding Modules
		1	2	3	4	5	6	7	8	9	10	
		ATT1	ATT2	GS 1	GS 2	KN 1	KN 2	KN 3	SS 1	SS 2	GS 3	
14	are familiar with the basic principles for conduction of projects and able to develop appropriate leadership responsibility			√					√	√	√	Research Planning; Research Program Evaluation; Internship Program Planning; Internship Program Evaluation; Internship Program Implementation; Management and Quality Control; Entrepreneurship; Final Project.
15	are prepared for entry to professional life in an industrial or academic environment, through adequate practical relevance of the degree programme		√	√	√	√	√	√	√	√	√	Career Development; Industrial Chemistry; Laboratory Organization; Occupational Health and Safety; Management and Quality Control; Instrumental Analysis; Internship Program Implementation; Final Project.

ROADMAP PLO

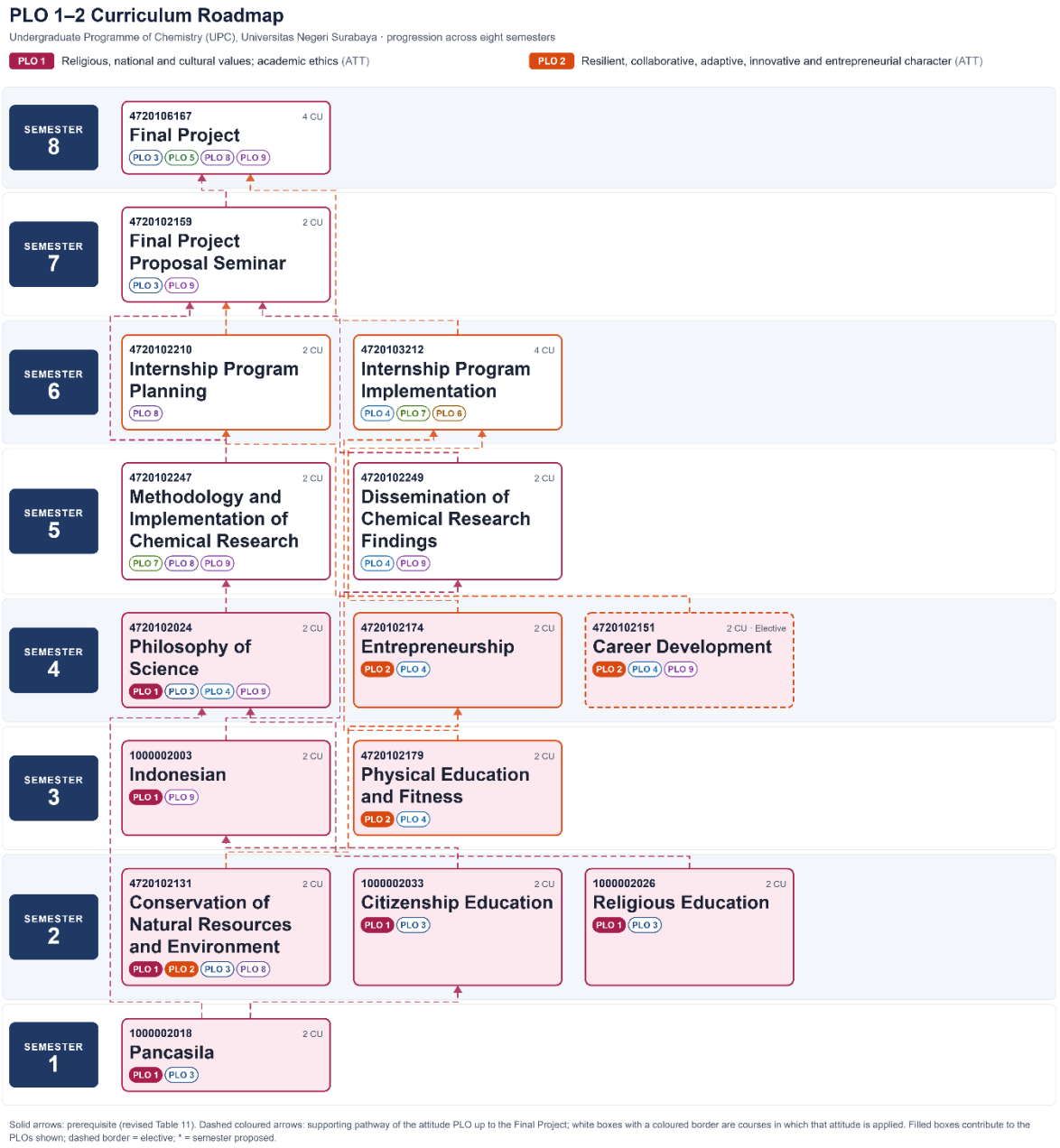


Figure 3. Course roadmap supporting the attitude aspect (PLO1/ ATT1 & PLO2/ATT2). (for a better resolution it can be accessed at this site)



Figure 4. Course roadmap supporting the General Skill (GS) aspect (PLO 3/GS1, PLO 4/GS2 & PLO 10/GS3) (for a better resolution it can be accessed at this site)



Figure 5. Course roadmap supporting the Knowledge (KN) aspect (PLO 5/KN1, PLO 6/KN2 & PLO 7/KN3) (for a better resolution it can be accessed at this site)

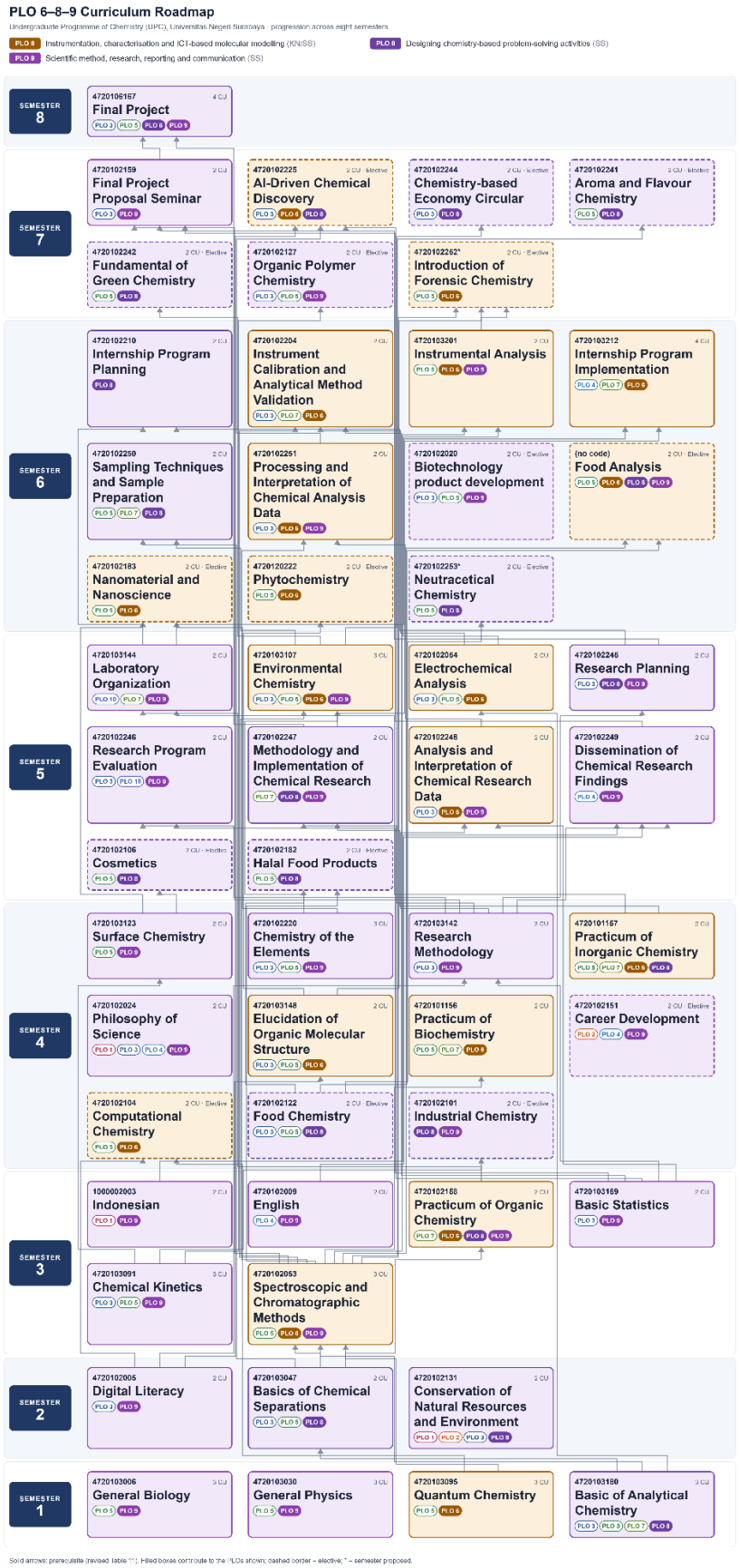


Figure 6. Course roadmap supporting the Special Skill (SS) aspect (PLO 6/SS1, PLO 8/SS2 & PLO 9/SS3) (for a better resolution it can be accessed at this site)

The PLO Roadmap illustrates the progressive development of the Program Learning Outcomes throughout the Undergraduate Chemistry Program by showing the sequence and interconnection of courses from the first to the eighth semester. The roadmap provides a visual representation of how individual modules contribute to the development of specific competency domains and how knowledge and skills acquired in earlier semesters provide the foundation for more advanced learning experiences in subsequent semesters.

For clarity, the PLOs are grouped according to the main competency domains used in the curriculum: **Attitudes (ATT), General Skills (GS), Knowledge (KN), and Specific Skills (SS)**. The ATT roadmap represents the development of **PLO 1 and PLO 2**; the GS roadmap represents **PLO 3, PLO 4, and PLO 10**; the KN roadmap represents **PLO 5, PLO 6, and PLO 7**; and the SS roadmap represents **PLO 6, PLO 8, and PLO 9**. Some PLOs may appear in more than one competency domain because their intended competencies are developed through both disciplinary knowledge and practical or professional application.

The coloured course boxes indicate the PLOs to which each course primarily contributes. Courses represented by a combination of colours contribute simultaneously to more than one PLO. The arrows indicate the progression and academic relationship among courses, showing how competencies developed in earlier courses are reinforced, integrated, and applied in more advanced courses. Therefore, the roadmap should be interpreted as a **competency-development pathway rather than merely a prerequisite structure**.

The roadmap demonstrates that competency development begins with fundamental and supporting courses in the early semesters and progressively moves toward core chemistry courses, laboratory and analytical activities, research-oriented learning, professional and internship experiences, and final-project activities. This progression ensures that students have repeated and increasingly complex opportunities to develop and integrate disciplinary knowledge, practical skills, scientific reasoning, research competence, communication, collaboration, professional responsibility, and independent problem solving throughout the study period.

At the advanced stages of the curriculum, competencies acquired from different courses converge through research, internship, analytical, and final-project activities. These integrative learning experiences provide opportunities for students to demonstrate the graduate competencies represented by the PLOs at a level appropriate for a Bachelor of Science in Chemistry. Accordingly, the PLO Roadmap provides evidence of curriculum coherence, vertical and horizontal integration of learning, and constructive alignment between courses and the intended graduate competencies.

Notes:

1. **ATT** = Attitudes; **GS** = General Skills; **KN** = Knowledge; **SS** = Specific Skills.
2. Each color represents the contribution of a course to a particular PLO, as indicated in the legend of each roadmap.
3. A combination of colors indicates that a course contributes to more than one PLO.
4. Arrows represent the progression and academic connection between courses, indicating how competencies developed in earlier courses support more advanced learning in subsequent semesters.
5. The roadmap represents the **developmental pathway of competencies across the curriculum** and should not be interpreted solely as a formal prerequisite structure.

6. The contribution of each course to the PLOs is further detailed in the **Course–PLO Mapping Matrix**, while evidence of PLO achievement is obtained through the corresponding course learning outcomes and assessment activities.