**S t u d y p r o g r a m m e**

***Part A) of the study programme ****

**L e a r n i n g o u t c o m e s**

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|---|---|
| **Faculty offering the field of study:** | **Faculty of Chemistry** |
| **Field of study:** | **chemistry** |
| **Level of study:** | **second-cycle studies** |
| **Level of the Polish Qualifications Framework:** | **level 7** |
| **Degree profile:** | **general academic** |
| **Professional degree awarded to the graduate:** | **magister** |
| **Allocation of the field of study within academic or artistic discipline(s), to which learning outcomes for a given field of study refer:** | **Discipline: Chemical Sciences (100%)**<br><br>**Major discipline: Chemical Sciences** |

| **Symbol** | **Upon completion the graduate achieves the learning outcomes specified below:** |
|---|---|
| | **KNOWLEDGE (the graduate knows and understands)** |
| K_W01 | The graduate has in-depth knowledge of main branches of chemistry, its development and significance to the progress in sciences and natural sciences as well as to the cognition and understanding of the world and human development. |
| K_W02 | The graduate has in-depth knowledge of a selected branch of chemistry. |
| K_W03 | The graduate has knowledge of synthesis and characteristics of inorganic and organic compounds, catalysts, adsorbents, carbon materials, natural and organometallic compounds, polymers, nanomaterials, and their practical use. |
| K_W04 | The graduate knows and understands processes occurring in an atomic nucleus. The graduate knows mathematical systems to the extent allowing to understand the kinetics of nuclear transformations; knows mechanisms and effects of the influence of ionising radiation on the matter. The graduate knows benefits and risks connected with the presence of radioisotopes in the natural environment, industry, medicine, and power industry. |
| K_W05 | The graduate knows how to find a relation between a chemical compound and the technological process by which it is obtained, to control its quality, and manage waste. The graduate has sufficient knowledge enabling them to start and develop business activity involving chemical production and processing. |
| K_W06 | The graduate has theoretical and practical knowledge of modern methods of bioactive substances synthesis and identification. |
| K_W07 | The graduate knows terms which allow to determine the symmetry of a molecule and the crystallographic system and uses the results to obtain information about a substance tested. |
| K_W08 | The graduate knows theoretical fundamentals of quantum chemistry computational methods and is familiar with at least one software package for the electron structure computation as well as properties and reactivity of atoms and molecules. The graduate knows correlations between the results obtained by theoretical computations and various experimental techniques. |
| K_W09 | The graduate knows the rules of proper experiment planning and verification of results' reliability. The graduate has knowledge of statistical methods required for analysing experimental data. |
| K_W10 | The graduate knows theoretical principles of chemical apparatus operation, both for scientific and industrial purposes |

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|---|---|
| K_W11 | The graduate has general knowledge of transition metals chemistry, its development trends and recent findings. |
| K_W12 | The graduate knows and understands theoretical fundamentals of various analytical methods and their application in the interpretation of measurement results. |
| K_W13 | The graduate knows advanced techniques applied in chemical processes. |
| K_W14 | The graduate has sufficient knowledge of occupational health and safety regulations that allows to work on their own and perform unsupervised research or measurement-related work. |
| **SKILLS (the graduate is capable of)** | |
| K_U01 | The graduate is able to use and capitalise on in-depth knowledge covering main branches of chemistry and use it creatively within the range of their specialisation. |
| K_U02 | The graduate is able to enumerate ways in which humans use radioactive materials, to perform radiation intensity measurement as well as to interpret the results obtained. |
| K_U03 | The graduate applies chemical knowledge to assess the possibility of carrying out a technological process, considering the selection of raw materials, production control and monitoring, waste disposal, and material balance calculations. |
| K_U04 | The graduate is able to determine synthesis and transformation conditions of a natural compound, to select the method of its release from a natural source, carry out its analysis and quality assessment. |
| K_U05 | The graduate is able to deal with Polish and international standards in order to determine certain physical and chemical properties of chemical substances. |
| K_U06 | The graduate is able to prepare a workstation and plan the synthesis process of a specific compound or chemical product. |
| K_U07 | The graduate is able to assess the quality of water on the basis of analytical processes carried out and is able to analyse phenomena occurring in the environment as well as in technological processes. |
| K_U08 | The graduate is able to find information in scientific journals and popular science magazines as well as chemical databases published in both Polish and English. The graduate is able to specify scientific problems in chemistry, to search for solutions, to present the results of their work in the form of written reports both in Polish and in a foreign language as well as an individually prepared project. |
| K_U09 | The graduate recognises the symmetry of a molecule and crystal lattice, is able to apply experimental techniques to identify substances and determine crystal lattice parameters. |
| K_U10 | The graduate is able to determine properties of molecules with the use of theoretical methods such as spectroscopy, and to examine chemical reaction pathways. The graduate is able to select an optimal method and to carry out calculations, use the results to analyse experimental data as well as critically evaluate the results. |
| K_U11 | The graduate is able to plan and carry out an experiment as well as to analyse its results critically. The graduate is able to apply an exemplary software package for the statistical analysis of an experiment. |
| K_U12 | The graduate is able to plan, find in the field literature, predict potential trends, perform and verify the method of synthesis, determination of composition and properties of a new chemical compound. |
| K_U13 | The graduate is able to analyse selected types of spectra (e.g. NMR, UV-Vis, IR, EPR) and draw conclusions with regard to the structure of compounds. The graduate is able to search for and compare spectra with those collected in various databases. |
| K_U14 | The graduate is able to deal with a selected group of analytical methods and to critically evaluate analysis results, and to discuss measurement errors. |
| **SOCIAL COMPETENCES (the graduate is willing to)** | |
| K_K01 | The graduate is aware of their knowledge and its limitations and understands the need for lifelong learning. The graduate is able to undertake actions to extend and deepen the knowledge of chemistry on their own. |
| K_K02 | The graduate is able to cooperate and work in a team (assuming various roles in this team) as well as to creatively solve problems concerning research studies and chemical synthesis. |

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| K_K03 | The graduate is aware of potential practical implementation and economic importance of chemical compounds and new materials as well as potential hazards connected with their use. The graduate is able to identify and solve related problems. |
| K_K04 | The graduate knows legal, economic, environmental, and social aspects connected with the production of chemicals, use of bioenergy as well as industrial and municipal waste treatment. The graduate is aware of their responsibility for research and experiments undertaken. |
| K_K05 | The graduate is able to specify priorities in order to solve a chemical problem posed by themselves or by other persons. |
| K_K06 | The graduate is aware of the importance of being professional, recognises and appreciates intellectual honesty and integrity, and observes the code of professional ethics both in their actions and the actions undertaken by other persons. |
| K_K07 | The graduate can formulate and present opinions on fundamental chemical issues and developments in this field. |

**Part *B) of the study programme***

## Description of the process resulting in the achievement of learning outcomes

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|---|---|
| **Faculty offering the field of study:** | Faculty of Chemistry |
| **Field of study:** | Chemistry |
| **Level of study:** | second cycle |
| **Level of the Polish Qualifications Framework:** | Level 7 |
| **Degree profile:** | general academic |
| **Allocation of the field of study within academic or artistic discipline(s), to which learning outcomes for a given field of study refer:** | Discipline: chemical sciences (100 %)<br>**Major discipline**: chemical sciences |
| **Mode of study:** | full-time programme |
| **Number of semesters:** | 4 |
| **Number of ECTS required for the award of qualifications corresponding to the level:** | 120 |
| **Total number of teaching hours:** | 975 |
| **Professional degree awarded to the graduate:** | Master of science (MSc) - magister |
| **The relationship between the study programme and NCU mission and strategy:** | Prosperity and development of modern society requires the use and continuous development of advanced technology. The need to train highly specialized chemists is therefore one of the conditions for maintaining the current status of our society. That condition requires high skills gained in their studies of chemical secondary education. In this context, the program of Chemistry is perfectly in keeping with the mission of the Nicolaus Copernicus University in Torun, assuming the implementation of the basic objective is to develop and disseminate knowledge by teaching at an academic level corresponding to the content of the current and future needs and aspiration of society. The study program fits well with the strategy of UMK assuming that "the university will focus its efforts on achieving the highest level of teaching full-time second and third degree." |

**Courses/course modules along with expected learning outcomes**

| Course module | Course | Expected learning outcomes | Forms and methods of teaching ensuring the | Methods of verifying and assessing expected learning |
|---|---|---|---|---|

| | | | achievement of learning outcomes | outcomes achieved by the student |
|---|---|---|---|---|
| **Course module Basic** | Theoretical chemistry<br>Transition Metal Chemistry and Magnetochemistry<br>Solid and Surface Chemistry<br>Advanced Instrumental Analysis<br>Chemical Technology<br>Hyphenated Separation Techniques | Student upon the graduation with a M.Sc. degree: has theoretical and practical knowledge of modern methods of bioactive substances synthesis and identification; Knows theoretical fundamentals of quantum chemistry computational methods; Knows correlations between the results obtained by theoretical computations and various experimental techniques. Has general knowledge of transition metals chemistry, its development trends and recent findings. Knows and understands theoretical fundamentals of various analytical methods and their application to the interpretation of measurement results. Knows advanced techniques applied in chemical processes; Is able to plan, find in literature, predict possible trends, perform and verify the method of synthesis, determination of composition and properties of a new chemical compound; Is able to specify scientific problems in chemistry, | Lecture: introductory method - problematic lecture, informative (conventional) Laboratory: independent student work; experiment method; methods programmed with the use of a computer | Continuous assessment (involvement of theoretical preparation for classes, manual proficiency, knowledge and respecting safety regulations); Written tests; short tests; evaluation of individual exercise reports; final test; written exam |

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| | | to search for solutions, to present the results of work in the form of written reports as well as an individually prepared project. | | |
| **Course module II Directional** | Molecular Spectroscopy<br>Physical Chemistry of Materials<br>Natural and Synthetic Organic Materials<br>Crystallochemistry<br>Physicochemistry of Polymers<br>Nanochemistry and Nanomaterials | Student upon the graduation with a M.Sc. degree: has knowledge of synthesis and characteristics of inorganic as well as organic compounds, catalysts, absorbents, carbon materials, natural and organometallic compounds, polymers, nanomaterials, and their practical use; Knows terms which allow to determine the symmetry of a molecule and crystallographic system and uses the results to obtain information about a substance tested; Knows and understands theoretical fundamentals of analytical methods and their application to the interpretation of measurement results. Is able to plan, find in literature, predict possible trends, perform and verify the method of synthesis, determination of composition and properties of a new chemical compound; Is able to specify scientific problems in chemistry, to search for solutions, to present the results of work in the form of written reports as well as an individually prepared project. | Lecture: introductory method - problematic lecture, informative (conventional) Laboratory: independent student work; experiment method; methods programmed with the use of a computer | Continuous assessment (involvement of theoretical preparation for classes, manual proficiency, knowledge and respecting safety regulations); Written tests; short tests; evaluation of individual exercise reports; final test; written exam |

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|---|---|---|---|---|
| **Course module optional** | Pharmaceutical and Cosmetic Materials<br>Membrane Processes in Chemical Technology<br>Materials in Coordination Chemistry<br>Adsorbents and Catalysts | Has in-depth knowledge of a selected branch of chemistry; Knows advanced techniques applied in chemical processes; Is able to prepare and present papers as well as conduct content- related discussions with specialists. | Lecture: introductory method - problematic lecture, informative (conventional) Laboratory: independent student work; experiment method; methods programmed with the use of a computer | Continuous assessment (involvement of theoretical preparation for classes, manual proficiency, knowledge and respecting safety regulations); Written tests; short tests; evaluation of individual exercise reports; final test; written exam |
| **Practical** | Conductive and Photosensible Polymer Materials<br>Organometalic and Bioinorganic Materials<br>Carbon Materials Preparation and Properties | Has in-depth knowledge of a selected branch of chemistry; Knows advanced techniques applied in chemical processes; Is able to prepare and present papers as well as conduct content- related discussions with specialists. | Lecture: introductory method - problematic lecture, informative (conventional) Laboratory: independent student work; experiment method; methods programmed with the use of a computer | Continuous assessment (involvement of theoretical preparation for classes, manual proficiency, knowledge and respecting safety regulations); Written tests; short tests; evaluation of individual exercise reports; final test; written exam |
| **Elective course module, e.g., university-wide courses or courses included in another field of study that are unrelated to a specific field of study** | University-wide courses | He acquires general knowledge from other fields and scientific disciplines, eg humanistic. Acquires the ability to independently manage their own intellectual development and interdisciplinary interests. He is focused on constantly acquiring new knowledge, he sees limitations of his own knowledge and understands the need for continuous education. | Lecture: introductory method - problematic lecture, informative (conventional) | Determined by lecturers, graded credit or exam |

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| **Foreign language classes** | English in Chemistry II | Has knowledge about the connections between chemistry and other areas of knowledge, necessary for the implementation of the diploma thesis. Can use English at intermediate level, I use this knowledge during my studies while studying and preparing my diploma thesis. He works alone and in a team, he is responsible for the tasks related to team work | Exercises: Cognitive and communication method using various techniques, media, authentic materials and varied forms of student work with an emphasis on academic discourse including: discussion, text analysis, data interpretation and presentation of work results | written exam (oral) or oral exam The continuous assessment determined by the lecturers (commitment, diligence, preparation for classes) |
| **Diploma project and/ or diploma examination **** | Seminar<br>Diploma laboratory*- individual | Is able to find information in scientific journals and popular science magazines as well as chemical databases; Is able to design and perform an experiment as well as analyse its results critically; Is aware of his/her level of knowledge and understands the need for lifelong learning. Is able to undertake actions to extend and deepen the knowledge of chemistry;<br>Is aware of the importance of being professional, recognising and appreciating intellectual honesty, observing the code of professional ethics both in his/her activities and activities undertaken by other persons.<br>Has sufficient knowledge of occupational health and safety regulations that allows to work independently and perform unsupervised research or measurement-related work; Can | Laboratory: independent student work; experiment method Seminar: student presentations, discussion diploma exam | The continuous assessment determined by the lecturers (commitment, diligence, theoretical preparation for classes, manual proficiency, knowledge and compliance with health and safety regulations);<br>oral diploma exam |

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| | | formulate and present opinions on fundamental chemical issues and developments in this area | | |

**Detailed allocation of ECTS credits**

**Academic or artistic disciplines, to which learning outcomes refer:**

| | **Artistic or academic discipline** | **ECTS credits** | |
|---|---|---|---|
| | | **number** | **%** |
| **1.** | **Chemical sciences** | **120** | **100** |

| **Course modules** | **Course** | **No of ECTS credits** | **No of ECTS credits in the discipline:** *(enter names of disciplines)**** | | | **No of ECTS credits for elective courses** | **No of ECTS credits obtained by the student in classes within contact hours with the teacher or tutor** | **No of ECTS credits obtained by the student as a result of: courses related to academic activity within a discipline or disciplines, to which the field of study is assigned ****/ courses focused on training practical skills ****** |
|---|---|---|---|---|---|---|---|---|
| | | | chemical sciences | l linguistics | other | | | |
| **Course module Basic** | Theoretical chemistry | 6 | 6 | | | | 2,8 | 6 |
| | Transition Metal Chemistry and Magnetochemistry | 6 | 6 | | | | 2,8 | 6 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Solid and Surface Chemistry | 6 | 6 | | | | 2,8 | 6 |
| | Advanced Instrumental Analysis | 6 | 6 | | | | 2,8 | 6 |
| | Chemical Technology | 6 | 6 | | | | 2,8 | 6 |
| | Hyphenated Separation Techniques | 6 | 6 | | | | 2,8 | 6 |
| **Course module Directional** | Molecular Spectroscopy | 6 | 6 | | | | 2,8 | 6 |
| | Physical Chemistry of Materials | 6 | 6 | | | | 2,8 | 6 |
| | Natural and Synthetic Organic Materials | 6 | 6 | | | | 2,8 | 6 |
| | Crystallochemistry | 6 | 6 | | | | 2,8 | 6 |
| | Physicochemistry of Polymers | 6 | 6 | | | | 2,8 | 6 |
| | Nanochemistry and Nanomaterials | 6 | 6 | | | | 2,8 | 6 |
| **Course module optional** | Pharmaceutical and Cosmetic Materials | 6 | 6 | | | 6 | 2,8 | 6 |
| | Membrane Processes in Chemical Technology | | | | | | | |
| | Materials in Coordination Chemistry | 6 | 6 | | | 6 | 2,8 | 6 |
| | Adsorbents and Catalysts | | | | | | | |
| **Course module practice** | Conductive and Photosensible Polymer Materials | 4 | 4 | | | 4 | 2,8 | 4 |
| | Organometalic and Bioinorganic Materials | | | | | | | |

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|---|---|---|---|---|---|---|---|---|
| | Carbon Materials Preparation and Properties | | | | | | | |
| **Elective course module, e.g., university-wide courses or courses included in another field of study that are unrelated to a specific field of study** | University-wide courses | 2 | | | 2 | | | |
| **Foreign language classes** | English in chemistry II | 3 | | 3 | | | 1,8 | |
| **Diploma project and/or diploma examination **** | Seminar | 2 | 2 | | | 2 | 1,2 | 2 |
| | Diploma laboratory* - individual | 25 | 25 | | | 25 | 16 | 25 |
| | **IN TOTAL:** | **120** | **115/95,8%** | **3/2,5%** | **2/1,7%** | **43/35,8%** | **61/50,8%** | **115/95,8%** |

* The programme of practically oriented studies provides for vocational internships that last at least:
- 6 months – on first cycle and long cycle studies,
- 3 months – on second cycle studies.

**The diploma project is:
- obligatory on second cycle and long cycle studies,
- optional on first cycle studies.

*** names of academic and artistic disciplines must be compliant with the regulation of the Minister of Science and Higher Education of 11 October 2022 on fields of science and academic disciplines and artistic disciplines (Journal of Laws [Dz. U.] of 2022, item 2202 as amended)
******** refers to academically oriented profile
********* refers to practically oriented profile

| **Course modules** | **Course** | **Programme content** |
|---|---|---|
| **Course module Basic** | Theoretical chemistry | The objective of the course is to introduce students to the methods of computational chemistry by providing theoretical background and creating opportunities for practical applications of theory. Students will learn how to use suitable methods and basis sets and how to critically assess quality of their results. At the conclusions of the course students will be expected to be able to design their own simple calculations to assist in solving problems of chemical importance. |
| | Transition Metal Chemistry and Magnetochemistry | The main teaching problem is to acquaint students with transition metal chemistry and the magnetic properties of free atoms, ions and complexes, and the basics of the Electron Paramagnetic Resonance (EPR) method. The utilitarian nature of a number types of transition metal compounds is emphasized. |

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| | Solid and Surface Chemistry | The aim of the subject is to acquaint students with the problems connected with the chemistry of surface phenomena and the chemistry of solids. |
| | Advanced Instrumental Analysis | The student learns advanced analytical methods of molecular, atomic, electron and microscopic spectroscopy as well as combined techniques in chemical analysis. Analysis methods used in chemistry, biology, biotechnology, physics, materials chemistry and medicine. The aim of the course is to familiarize the student with the possibilities of using analytical equipment available at the Faculty of Chemistry of the Nicolaus Copernicus University in applications for identification and quantitative analysis of chemical compounds. |
| | Chemical Technology | Acquainting students with the tasks of chemical technology, the choice of operating conditions of a technological process and its division into separate operations (unit operations, unit processes), and the principles of the rational use of energy and raw materials based on given processes from inorganic and organic technologies |
| | Hyphenated Separation Techniques | The aim of course is to familiarize students with the theoretical basics and possibilities of the application of modern methods, especially chromatographic techniques in analytics. |
| **Course module Directional** | Molecular Spectroscopy | They are to transfer the knowledge on molecular spectroscopy and its application in chemistry. |
| | Physical Chemistry of Materials | Extension of the knowledge associated with physical chemistry (basic thermodynamics laws utilized to the description various equilibrium and non-equilibrium processes, chemical kinetics electrochemistry, katalysis, adsorpction and diffusion). Acquiring of knowledge related to the preparation, modification and physicochemical description of novel materials and nanomaterials. |
| | Natural and Synthetic Organic Materials | The course aims to familiarize students with selected groups of natural and synthetic compounds, their properties, modifications, and laboratory synthesis methods. Students will also learn about modern methods of synthesizing selected groups of compounds. |
| | Crystallochemistry | The aim of this course is to teach students basics of crystallochemistry. Students are familiarized with geometrical crystallography, symmetry of molecules and the crystal lattices, elements of the group theory, use of diffraction methods for the substance identification, determination of unit cell parameters and crystal lattice symmetry. Students get knowledge on basic types of crystal structures and dependence between chemical and physical properties of materials and their 3D structure. |
| | Physicochemistry of Polymers | Basic concepts of polymers. Division of polymers. Discussion of the concept of polydispersity and average molecular weights of polymers. Thermodynamics and kinetics of polymerisation. Methods for the preparation of polymer. Discussion of the properties of polyelectrolyte solutions. Basic concepts of polymer rheology and changes in the macromolecular compounds under the influence of thermal factors. Handling apparatus used in the studies of viscoelasticity and heat resistance. The use of test methods to examine the chemical composition and microstructure of a chain polymers and copolymers, temperature and enthalpy of phase transitions and the degree of crystallinity. Identification and sorting of polymeric materials-organoleptic and spectroscopic methods. Equipment used in the processing of polymers. Preparation of film, |

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| | | pipe and bottles of various polymeric materials. Eco-balance. Methods of recycling basic polymers. Industrial recycling of PET bottles. |
| | Nanochemistry and Nanomaterials | The aim of the course will be to provide students with basic knowledge of nanochemistry, nanomaterials, chemical synthesis and structural characteristics of nanomaterials, and also the study on their physicochemical, mechanical, and biological properties. The discussed issues will be concern metal nanoparticles, transition metal oxides, thin layers of inorganic materials, high-molecular semiconductors, inorganic-organic hybrid polymers and materials forming self-assembling nanostructures. The lecture will considers elements of inorganic chemistry, physical chemistry, instrumental analysis, chemistry and advanced materials engineering. The aim of the laboratory classes will be to provide students with basic knowledge of the production of modern materials using vapor deposition techniques, sol-gel and chemical synthesis of nanoparticles, their structural characteristics and the study of physicochemical properties. |
| **Course module optional** | Optional | Syllabus content depending on the student's choice of subject |
| **Course module practice** | Practical speciality laboratories | Syllabus content depending on the student's choice of subject |
| **Foreign language classes** | English in chemistry II | Students participate in a specialist English course (EAP/ESP). Number of hours: 30 per 1 semester. The program is based on developing language competences according to Common European Framework at B2+ level with special emphasis put on communication with the use of specialist terminology, with a broad variety of interlocutors. The course ends with a final exam at the B2+ level (CEFR). |
| **Elective course module** | University-wide courses | Syllabus content depending on the student's choice of subject |
| **Diploma project and/or diploma examination ***** | Seminar | Syllabus content dependent on the student's choice of supervisor and thesis topic. |
| | Diploma laboratory* - individual | |

This study programme is effective as of winter semester of the academic year 2022/2023.