Appendix
to Senate Resolution No. 85/WAT/2021
dated 28 October 2021

WOJSKOWA AKADEMIA TECHNICZNA
im. Jarosława Dąbrowskiego
(Military University of Technology)

PROGRAMME OF STUDY

Level: **Second cycle studies**

Major: **CHEMISTRY**

Resolution of the Senate of Wojskowa Akademia Techniczna im. Jarosława Dąbrowskiego No. 85/WAT/2021 of 28 October 2021

authorising the adoption of a programme of study for a degree in Chemistry

Effective from the academic year 2021-2022

Warsaw

2021

PROGRAMME OF STUDY

Major: CHEMISTRY

Level: **Second cycle studies**

Profile: **General academic profile**

Mode: **Full-time**

Degree awarded to graduates: **Master Engineer**

Polish Qualifications Framework Level: **7**

Classification of the major:
Branch of science: **Exact and Natural Sciences**
Scientific field: **Chemical Sciences** (100% ECTS)

Language of instruction: **English**

No. of semesters: **3**

Total no. of hours:

Specialisation according to elective subjects	No. of hours
Explosives and Pyrotechnics	**1,032**
Hazardous Materials and Chemical Emergency Response	**1,032**

No. of ECTS credits required to complete the studies: **90**

Total no. of ECTS credits that students must earn in the course of the studies:

- courses with direct participation of academic teachers or other instructors

Specialisation according to elective subjects	ECTS credits
Explosives and Pyrotechnics	**50**
Hazardous Materials and Chemical Emergency Response	**50**

- humanities or social sciences courses[1]: **8**

Length, no. of ECTS credits, rules and form of internship: **No internship**

[1] *Not applicable to majors that fall into the field of humanities or social sciences respectively.*

The description of learning outcomes includes:

- universal first-cycle characteristics set out in the Appendix to the Act of 22 December 2015 on the Integrated Qualifications System
- second-cycle characteristics set out in the Appendix to the Regulation of Minister of Science and Higher Education of 14 November 2018 on the second-cycle characteristics of learning outcomes for level 6-8 qualifications of the Polish Qualifications Framework, including requirements for obtaining engineering qualifications[2]

and it comprises three categories:

- the **knowledge (W)** category which specifies:
  - size and depth **(G)** - completeness of the cognitive perspective and relationships,
  - context **(K)** - conditions, effects.

- the **skills (U)** category which specifies:
  - in terms of application of knowledge (**W**) - problems to be solved and tasks to be performed,
  - in terms of communication (**K**) - receiving and formulating statements, spreading knowledge in the scientific community and speaking English language,
  - in terms of work organisation (**O**) - planning and teamwork,
  - in terms of learning (**U**) - planning own personal development and development of others.

- the **social competences (K)** category which specifies:
  - in terms of evaluations (**K**) - critical approach,
  - in terms of responsibility (**O**) - fulfilling civic duties and acting in the public interest,
  - in terms of professional role (**R**) - independence and formation of professional ethos.

Symbols:

- in the **Outcome Symbol and Number** column:
  - K - major-specific learning outcomes;
  - W, U, K (after underscore) - category: W for knowledge, U for skills, K for social competences;
  - 01, 02, 03, ... - no. of learning outcome.
- in the **Description Component Code** column: Inż[3]*_P7S_WG - description component code for second-cycle characteristics for level 7 qualifications of the Polish Qualifications Framework.*

[2] *Applicable to majors that finish with the award of the following degrees: inż., mgr inż.*
[3] *For engineering qualifications.*

Outcome Symbol and Number	Description of Learning Outcomes	Description Component Code
KNOWLEDGE	**Graduate:**	
K_W01	Has a deep knowledge and understanding of the nature, place and role of social sciences and humanities and of their relationship to other sciences.	P7S_WK
K_W02	Has a solid and advanced knowledge of the chosen specialisation area.	P7S_WG
K_W03	Knows the contemporary views on the structure and properties of chemical compounds.	P7S_WG
K_W04	Has an advanced knowledge of the techniques of organic and inorganic synthesis, methods of extraction and purification of chemical compounds and their identification based on classical and instrumental methods.	P7S_WG Inż_P7S_WG
K_W05	Knows the fundamentals of quantum chemistry, statistical thermodynamics and molecular mechanics.	P7S_WG
K_W06	Knows selected computer programmes for molecular modelling of particles and particle systems and understands the fundamentals of computational methods used in those programmes.	P7S_WG Inż_P7S_UW
K_W07	Has a knowledge of IT and chemistry required to effectively use commercial chemistry packages and research databases.	P7S_WG
K_W08	Knows the types of intermolecular interactions and the thermodynamic properties of surfaces and interfaces. Has an advanced knowledge of adsorption and catalysis.	P7S_WG
K_W09	Knows the contemporary views on phase transitions and their systematic description. Knows the elements of thermochemistry of solids and the methods of thermal analysis.	P7S_WG
K_W10	Knows the theoretical foundations of atomic and molecular spectroscopy and has an advanced knowledge of spectroscopic techniques for determination of the structure of chemical compounds.	P7S_WG
K_W11	Has an advanced knowledge of analytical chemistry required for explanation of the theoretical rationale for choosing a specific analytical method, determination of chemical composition of a substance or mixture.	P7S_WG
K_W12	Knows the classical and instrumental analytical methods, their analytical potential and theoretical foundations. Has a knowledge of the methods of verifying the reliability of results of chemical analysis and is able to use statistical methods to evaluate the results of analyses. Knows the development trends for analytical instruments.	P7S_WG
K_W13	Is acquainted with the methods of validation of analytical methods and with the rules of managing an analytical laboratory in accordance with EU requirements.	P7S_WG
K_W14	Knows the mathematical description of symmetry of crystals, the fundamentals of diffraction methods for crystal structure analysis and basic crystallographic calculations.	P7S_WG

K_W15	Has a sufficient knowledge of mathematics to use mathematical methods for quantitative description of matter and chemical processes.	P7S_WG
K_W16	Has a general knowledge of current development directions and the latest discoveries of chemistry and related branches.	P7S_WG
K_W17	Knows the occupational health and safety rules, including the procedures for safe handling of chemical substances and hazardous materials. Knows the fundamental legislation related to broadly understood chemical safety.	P7S_WK
K_W18	Has a basic knowledge of the legal requirements and ethical principles related to scientific and teaching activities.	P7S_WG
K_W19	Has a knowledge and understanding of the basic concepts and principles of industrial property protection and copyright, and of the need for intellectual property management.	P7S_WK
K_W20	Knows the general rules of starting and developing a business.	P7S_WK Inż_P7S_WK
SKILLS	**Graduate:**	
K_U01	Demonstrates a knowledge of English language consistent with B2+ level according to the Common European Framework of Reference for Languages, which allows for spoken and written communication on general topics and advanced communication using specialist terminology.	P7S_UK
K_U02	Is able to identify and interpret the fundamental social, humanistic and legal phenomena and processes to the extent relevant to the chosen field of study.	P7S_UW
K_U03	Is able to plan and conduct experimental studies and observations in a chemical laboratory in accordance with occupational health and safety rules, chemical safety procedures and chemical waste selection and disposal guidelines.	Inż_P7S_UW
K_U04	Is able to evaluate the usefulness of standard methods and tools in solving problems related to chemical synthesis, composing materials, determination of their chemical composition, structure and physical and chemical properties based on the results of literature research and experimental studies.	Inż_P7S_UW
K_U05	Is able to use advanced spectroscopic tools to determine the structure of a chemical compound.	P7S_UW
K_U06	Is able to use research and scientific instruments to analyse mixtures and environmental samples.	P7S_UW, Inż_P7S_UW
K_U07	Is able to determine the structure of materials and their physical and chemical properties based on radiography, adsorption studies, thermophysical analyses, optical and other methods.	P7S_UW
K_U08	Is able to perform a critical assessment of results of experiments, observations and theoretical calculations and discuss measurement errors.	P7S_UW Inż_P7S_UW
K_U09	Is able to use professional software to analyse results and run simulations associated with chemistry problems.	P7S_UW

K_U10	Is able to find necessary information in professional literature, databases and other sources, knows the major chemistry journals and is able to assess the reliability of acquired information.	P7S_UW
K_U11	Is able to apply chemical knowledge to related branches of science and scientific fields.	P7S_UW
K_U12	Is able to present results of research in an original Magister thesis containing a description of its purpose, the applied methods, results and their significance in the context of similar studies.	P7S_UW
K_U13	Is able to present in an approachable manner the discoveries in chemistry and related fields and hold discussions about them.	P7S_UK
K_U14	Is able to independently plan and implement lifelong learning and provide others with guidance in that respect.	P7S_UU
K_U15	Is able to formulate written and oral works in English on a wide range of chemistry topics based on studies in English language as well as own observations and findings.	P7S_UW
K_U16	Is able to interact with others within a team and assume leadership of the team.	P7S_UO
K_U17	Is able to use his/her knowledge to formulate and solve complex and atypical problems and perform tasks in an innovative manner in unpredictable conditions.	P7S_UW
K_U18	Is able to formulate and test hypotheses associated with simple research problems.	P7S_UW
SOCIAL COMPETENCES	**Graduate:**	
K_K01	Recognises the importance of knowledge in solving cognitive and practical problems and of consulting experts in the case of difficulties with solving a problem independently. Is able to critically analyse communicated statements.	P7S_KK
K_K02	Is prepared to fulfil his/her civic duties, inspire and organise initiatives for the benefit of the community and initiate actions serving the public interest.	P7S_KO
K_K03	Is prepared to fulfil his/her professional role responsibly in consideration of the changing social needs, make a contribution to the profession's output, maintain its ethos, obey and develop principles of professional ethics and promote the compliance with such principles.	P7S_KR
K_K04	Understands the social aspects of practical application of acquired knowledge and skills (especially in business) and the associated responsibility.	P7S_KO
K_K05	Possesses an entrepreneurial mindset.	P7S_KO

Subject groups / subjects[4], their brief description (framework programmes), assigned ECTS credits and learning outcomes (reference to major-specific outcomes)

No.	Subject group subject name[5]: brief description (framework programme)	No. of ECTS credits	Field code[6]	Reference to major-specific outcomes
	General Education - General Subjects			
1	**PRESENTATION OF SCIENTIFIC AND TECHNICAL SUBJECTS** Terminology of mathematics. Terminology of general physics. Rudiments of general, inorganic and physical chemistry. Nomenclature of organic compounds. Materials engineering terminology. Conference presentations. Papers. Oral presentations supported by multimedia.	2	NC	K_W02, K_U01, K_U10, K_U15, K_K04
2	**ECONOMICS** Acquainting students with the fundamental principles of economic theory relating to a business and its immediate surroundings. Theoretical foundations of microeconomics, including: market principles, fundamentals of the consumer choice theory, fundamentals of the theory of production, fundamentals of the theory of business, fundamentals of the theory of wages. Practical aspects of decisions made by a business to ensure optimum levels of use of the factors of production, achievement of the target level of costs, revenues and income.	3	NC	K_W01, K_W20, K_U02, K_K04, K_K05
3	**PHILOSOPHY** Philosophy as a science and its branches. Origins: Ionian natural philosophers. Pythagoreans. Democritus. Socrates. Plato. Aristotle. Stoicism, Epicureanism, Scepticism, medieval philosophy, Saint Augustine, Eriugena, Pantheism, Scholasticism. Thomas Aquinas, arguments for the existence of God and their criticism. René Descartes, mechanical philosophy. Debate on the origins of knowledge, Bacon's and Locke's empiricism, Berkeley's immaterialism and the criticism of realist interpretation of Newtonian mechanics. Criticism of religion and Hume's causality, Kant and a priori knowledge. Bruno and Renaissance natural philosophy, Bacon and the empirical scientific method. Contemporary philosophy - Comte's positivism, empiricism, dialectical materialism. Spencer's theory of evolution, divisions of philosophy.	3	NC	K_W01, K_U02, K_K01, K_K02
4	**OCCUPATIONAL HEALTH AND SAFETY** Current OHS legislation. Occupational (educational) health and safety - safety procedures required in a specific job (activity) according to scientific and technical rationale. Protection from hazards to students' health and safety. Use of personal protective equipment in class. Accident insurance.		NC	K_W17, K_U03, K_K04

[4] Subject information sheets are prepared and made available 30 days before the start of the semester in which the subject is to be taught - for a model see Appendix no. 4.
[5] Names of subject groups / subjects.
[6] Field codes as per Appendix no. 10.

No.	Subject group subject name[5]: brief description (framework programme)	No. of ECTS credits	Field code[6]	Reference to major-specific outcomes
	Procedures to be followed in case of accidents and in hazardous situations. Premedical first aid training.			
	Core Education - Core Subjects			
1	**MATHEMATICS II** This course aims to help students understand basic concepts and theorems of mathematics, in particular, differential and integral calculus of vector-valued functions, group theory and the calculus of variations, and master basic arithmetic skills and knowledge in the following areas: curves and areas in three-dimensional space, the concepts and examples of vector fields, directed and undirected line integrals, oriented and unoriented surface integrals, basic theorems of integral calculus of vector-valued functions, groups and subgroups, transformation groups, group representations, fundamentals of the calculus of variations, extrema and extremals of functionals.	4	NC	K_W14, K_W15, K_U08, K_U10, K_U14, K_U17, K_K01
2	**GENERAL AND INORGANIC CHEMISTRY II** The course aims to acquaint students with contemporary views on the structure of coordination complexes; provide a systematic description of the properties of solids and interdisciplinary relations between advanced technology and chemistry, geochemistry and biochemistry on the basis of selected inorganic materials. The course also aims to acquaint students with the chemical aspects of modern technology, its potential to analyse the characteristics and behaviour of materials relative to their structure, their practical applications and disposal.	4	NC	K_W02, K_W03, K_U03, K_U08, K_U10, K_U14, K_K01, K_K02
3	**ORGANIC CHEMISTRY II** Advanced organic chemistry course focusing on teaching students how to plan the synthesis of complex organic compounds.	6	NC	K_W02, K_W04, K_W17, K_U03, K_U04, K_U14, K_K01, K_K03
4	**INSTRUMENTAL ANALYSIS** Problems of contemporary instrumental analysis. Sample collection. Sample preparation. Separation methods of analysis – chromatography and electrophoresis. Electrochemical methods of analysis. Spectral methods of analysis. Thermal methods of analysis. Validation of analytical methods.	5	NC	K_W11, K_W12, K_U06, K_U10, K_K01
5	**THEORETICAL CHEMISTRY** The old quantum theory and introduction to the quantum mechanical model. The postulates of quantum mechanics. The Schrödinger equation in quantum mechanics used to interpret physical phenomena and the structure of atoms and molecules. Approximation methods in theoretical chemistry. Basic interpretations of spectroscopic methods with the quantum mechanical model. Quantum generators of radiation. Elements of statistical thermodynamics.	5	NC	K_W02, K_W05, K_W06, K_W09, K_W12, K_W15, K_U08, K_U09, K_U10, K_U13, K_U14, K_U15
6	**ANALYTICAL CHEMISTRY II** Quantitative analysis of complex systems and natural materials. Speciation analysis. Calibration methods in analytical chemistry. Methods of verifying the reliability of results of chemical analyses. The role of certified reference materials.	3	NC	K_W11, K_W12, K_W13, K_U06, K_U08, K_U10, K_U16

No.	Subject group subject name[5]: brief description (framework programme)	No. of ECTS credits	Field code[6]	Reference to major-specific outcomes
	Validation of analytical methods, determination of basic validation parameters.			
	Major Education - Major Subjects			
1	**SPECTROSCOPY** Theoretical foundations of spectroscopy, measurement instruments and techniques for various spectroscopic methods. Impact of the structure of compounds on the spectrum and spectrum interpretation.	4	NC	K_W10, K_U04, K_U05, K_U15, K_U16
2	**CRYSTALLOGRAPHY** Basic concepts and laws of crystallography. Classification of crystal structures. Radiographic methods of examination of crystals.	3	NC	K_W10, K_W14, K_W15, K_W14, K_U04, K_U07, K_U14, K_K01
3	**PHYSICAL CHEMISTRY OF PHASE TRANSITIONS** Basic concepts and laws of thermodynamics, phase transitions in chemical substances, multicomponent phases, classification of phase transitions, thermomicroscopy of phase transitions, thermal analysis of phase transitions.	2	NC	K_W02, K_W09, K_U04, K_U07, K_U08, K_U09, K_U10
4	**PHYSICAL CHEMISTRY OF SURFACE PHENOMENA** X-ray photoelectron spectroscopy (XPS). Scanning electron microscopy (SEM). Transmission electron microscopy (TEM). Adsorption in liquid-gas systems. Gibbs adsorption isotherm. Adsorption in solid-gas, solid-liquid systems. Adsorption isotherms. Adsorption kinetics. The heat of adsorption. Homogeneous and heterogeneous catalysis, carriers, photocatalysts. Catalysis as the foundational pillar of green chemistry. Reactions in multiphase systems. Colloid systems. Models of electric double layer.	2	NC	K_W07, K_W08, K_W15, K_W16, K_U04, K_U05, K_U09, K_U10, K_U15, K_U16, K_K04
	Elective Education - Elective Subjects			
1	**HANDLOADING OF EXPLOSIVES** Explosives and handloading materials. Handloading of the body of a bomb and cartridges by casting. Handloading of the body of cartridges by pressing. Methods of dismantling ammunition and disposal of explosive materials.	3	NC	K_W02, K_W17, K_U03, K_U04, K_U16, K_K04
2	**THE PHYSICS OF AN EXPLOSION** Broadening knowledge about the phenomena that occur during detonation in solid explosives and gaseous mixtures and the process of transition from burning to detonation in those agents. Learning to use thermochemical codes to calculate the parameters of an explosion and detonation of condensed explosives and becoming acquainted with the methods of calculation of the parameters of the main damaging factors of explosion and hazard zones for people and buildings.	3	NC	K_W02, K_W07, K_W15, K_W17, K_U09, K_U11, K_U14, K_U15, K_U16
3	**FUNDAMENTALS OF AMMUNITION MAKING** Classification of warfare agents and the procedures for safe handling of ammunition. The structure, working principles and labelling of small-arms cartridges and shells and their impact on the target. The structure of mines and air-defence and anti-tank missile systems. The structure and working	3	NC	K_W02, K_W16, K_W17, K_U10, K_U11, K_K01, K_K04

No.	Subject group subject name[5]: brief description (framework programme)	No. of ECTS credits	Field code[6]	Reference to major-specific outcomes
	principles of fuzes and the development directions of warfare agents.			
4	**INSTRUMENTAL METHODS FOR ANALYSIS OF EXPLOSIVES** The course looks into contemporary methods designed for the analysis and detection of explosives. Some of those methods were already discussed in other courses and will be elaborated in more detail. The prior knowledge will be applied to solve problems associated with the detection and analysis of explosives. Students should gain knowledge about the potential of the analytical methods and their important limitations enabling them to correctly interpret results of analyses.	3	NC	K_W11, K_W12, K_U04, K_U06, K_U10, K_U13, K_U14, K_U16, K_K04
5	**NEW-GENERATION EXPLOSIVES** Overview of modern explosives. Low-sensitivity explosives. Nanostructured explosives. Methods of reducing sensitivity of common explosives. Fundamentals of crystallisation. Fuel-air explosives. Thermobaric explosives. Initiating explosives from the coordination complex group. High-energy and nitrogen-rich salts. Explosive ionic liquids. New components of powders and rocket fuels.	2	NC	K_W02, K_W03, K_W04, K_W10, K_W11, K_W12, K_W17, K_U03, K_U04, K_U05, K_U06, K_U07, K_U10, K_U13, K_U14, K_U15, K_U16, K_K01, K_K04
6	**CHEMICAL SENSORS** The course covers knowledge required for the operation of modern chemical sensors. It explains the working principles of thermal, electrochemical, optical, gravimetric sensors and ionisation detectors. A part of the course is devoted to the methods of signal processing, including simple chemometric analysis. It also provides an overview of the methods of examination and calibration of sensors.	3	NC	K_W02, K_W11, K_W12, K_W15, K_U06, K_U08, K_U16
7	**PREDICTING THE EFFECTS OF EXPLOSIONS** Learning about the processes that occur in explosives during detonation and near the explosive load. Learning about the methods of estimating the parameters of detonation waves in gaseous and solid explosive mixtures, characteristics of blast waves and the speed of thrown objects. Assessing the risk of blast and throw of debris to people and buildings.	2	NC	K_W02, K_W15, K_W17, K_U04, K_U08, K_U11, K_U15, K_U16, K_K01, K_K02, K_K05
8	**NUCLEAR CHEMISTRY** Radiochemical methods of analysis; Chemical effects of nuclear transformations; Radionuclide production and use as indicators of labelled compounds; Isotope effects and their applications; Mechanisms of radiation reactions; Radiolysis of water and organic compounds and their solutions; Radiation chemistry of solids; Radiation protection and working with open radioactive sources; Deactivation.	3	*NC*	K_W02, K_W04, K_W12, K_W17, K_U03, K_U06, K_U16, K_K02,
9	**DETECTION AND ASSESSMENT OF HAZARDOUS SUBSTANCES** The course aims to systematise students' analytical knowledge and enable them to use it to recognise and identify risks associated with hazardous materials. As	3	NC	K_W02, K_W07, K_W17, K_U03, K_U06, K_U10, K_U14, K_U16, K_K04

No.	Subject group subject name[5]: brief description (framework programme)	No. of ECTS credits	Field code[6]	Reference to major-specific outcomes
	part of the course students are acquainted with the specifics of detection and assessment of hazardous substances for risk assessment and implementation of safety procedures (hygiene standards, protection), as well as with the methods and instruments used to detect and assess hazardous substances, including direct-reading portable instruments. The course prepares students for using specialist literature.			
10	**RADIOACTIVE MATERIALS** Natural radioactive elements. Artificial radioactive isotopes. Applications of radioactive isotopes. Environmental samples.	2	NC	K_W02, K_W12, K_W17, K_U03, K_U06, K_U08, K_U16, K_K02,
11	**BURNING AND DETONATION INITIATING AGENTS** Initiating mixtures - basic components, their role and selection criteria. Initiating agents of burning. Electric, non-electric and electronic excitation systems. Detonating fuses, boosters. Initiating agents used in military devices. Mining research methods for initiating agents.	1	NC	K_W02, K_W17, K_U03, K_U14, K_U16, K_K02, K_K03,
12	**FUNDAMENTALS OF EMERGENCY MEDICAL CARE** Introduction. Course syllabus of Fundamentals of Emergency Medical Care. Organisation of emergency medical services - legal basis. Basic medical terminology. Elements of human anatomy and physiology, preliminary examination and detailed examination. Bones and joints. Circulatory system. Respiratory system. Digestive system. Genitourinary system. Victim assessment. Personal safety, victim safety and accident site safety. Unconscious victim. Evacuation from hazard zone.	2	NC	K_W02, K_W17, K_U11, K_U14, K_K01
13	**NANOPOROUS MATERIALS** The latest accomplishments in nanostructures. Overview of techniques for analysing the structure, morphology, chemical composition and surface and thermal properties of nanomaterials. Nitrogen and argon adsorption as a complete method of assessment of the specific surface area, porosity and surface properties of nanoporous materials. The latest accomplishments in the production of nanoporous silica materials. The latest accomplishments in the production of nanoporous carbon materials. Calculating the parameters of a porous structure of materials on the basis of adsorption isotherms.	1	NC	K_W02, K_W16, K_U03, K_U07, K_U18, K_K04
14	**COLLECTION AND PREPARATION OF SAMPLES FOR CHEMICAL ANALYSES** Collection and preparation of samples for further chemical analyses: air, water and soil samples as well as samples of other materials, including natural samples. General foundations of the sample collection process, representativeness of samples, components of a sample (matrix, analyte). Problems of trace analysis. Units of measurement of the concentration of trace analytes. Sampling for environmental analysis. Sample registration and storage and the issues associated with analyte loss. Matrices and their impact on sample preparation.	2	NC	K_W02, K_W11, K_W12, K_U03, K_U06, K_U14, K_U16, K_K01, K_K02, K_K04, K_K05

No.	Subject group subject name[5]: brief description (framework programme)	No. of ECTS credits	Field code[6]	Reference to major-specific outcomes
	Traditional methods of sample preparation compared to modern separation techniques. Extraction techniques (including liquid-liquid extraction, gas phase extraction, solid phase extraction, solid phase microextraction, extraction of solid samples). Membrane technology and other modern techniques. Examples of sample collection and preparation.			
15	**FUNDAMENTALS OF THE THEORY OF EXPERIMENT** The course covers the problems associated with the following questions: What is the theory of experiment? Experiment plan. Measures of location and dispersion of results. Significance assessment. Approximation of object function. Experimental optimisation.	1	NC	K_W12, K_W15, K_U03, K_U08
16	**FUNCTIONAL NANOSTRUCTURES** Basic concepts and impact of nanostructures on the development of science. Theory of thin film stacks. Types of thin film coatings. Introduction to photonic crystals. Graphene and other flat (2D) carbon structures. Carbon optoelectronics and composites for functional optimisation of material properties. Methods of surface modification. Layer-growth kinetics. Atomic force microscope. Microoptoelectromechanical systems (MOEMS) technology. Analysis of surface structures. The role of nanotechnology in light of national security.	2	NC	K_W02, K_W10, K_W16, K_U10, K_U13, K_U14, K_U15, K_U16
17	**FUNDAMENTALS OF METEOROLOGY AND CLIMATOLOGY** The course provides students with knowledge about the atmosphere and climate and basic synoptic analysis skills.	2	NC	K_W02, K_U10, K_U14, K_U15, K_K01
18	**EXPLOSION TECHNOLOGIES IN MATERIALS ENGINEERING** The course covers the physical foundations of explosion technologies used in the production of materials and modification of their properties. It looks into basic applications of explosion technologies: explosive metal hardening, production of superhard materials, explosive compaction of powders, explosive welding, explosive pressing. Students learn to choose the right explosion technology to obtain a material with specific properties, and to estimate the numerical value of parameters that characterise explosion technologies and select technological parameters on such basis. Students become acquainted with the practical preparation of explosive systems and evaluation of the effects of explosive loading.	2	NC	K_W16, K_W17, K_U03, K_U04, K_U11, K_K04
19	**PHOTOCHEMISTRY** The range and properties of electromagnetic radiation used in photochemistry. Wave and corpuscular theory of light. Emission and nonradiative processes. The effects of interaction of light and matter. Basic concepts and laws of photochemistry. Excited state of molecules. Basic photochemical reactions and their kinetics. Instruments and methods for analysis of photochemical reactions. Light sources of radia-	2	NC	K_W05, K_W10, K_W11, K_W12, K_U05, K_U08, K_U09, K_U11, K_U16, K_K01

No.	Subject group subject name[5]: brief description (framework programme)	No. of ECTS credits	Field code[6]	Reference to major-specific outcomes
	tion and lasers. Flash photolysis. Actinometry. Photopolymerisation. Photographic processing. Atmospheric photochemistry.			
20	**MODERN METHODS OF ORGANIC SYNTHESIS** This lecture on organic synthesis presents modern methods of forming carbon-carbon, carbon-nitrogen, carbon-halogen and carbon-oxygen bonds.	2	NC	K_W02, K_W04, K_U01, K_U03, K_U04, K_U10, K_U11, K_U16, K_K04
21	**FUNDAMENTALS OF CHROMATOGRAPHY** The invention and history of chromatography. Gas, liquid and supercritical chromatography. Capillary electrophoresis. The significance and applications of chromatography.	2	NC	K_W11, K_W12, K_U06, K_U10, K_U14, K_U16, K_K01, K_K02
22	**SYNTHESIS OF LIQUID CRYSTALS** Introduction to the field of liquid crystals and its main present applications. Introduction to correlations between molecular structure and liquid crystalline properties with special attention to the field of fluorinated organic materials. Short survey on main generations of liquid crystals and main classes of intermediates, their importance and synthesis.	2	NC	K_W03, K_W04, K_W09, K_W10, K_U01, K_U03, K_U04, K_U10, K_U11, K_U14, K_U16, K_K01, K_K02, K_K04
23	**HAZARDOUS MATERIALS DETECTION TECHNOLOGIES** The objective of the course is: to provide an introduction into the field of hazardous materials, to introduce the problems related to air monitoring, to familiarize students with various sampling and detection technologies for hazardous materials, to teach how to take a sample containing trace amounts of hazardous substances and analyse it, to teach how to prepare analytical reports.	2	NC	K_W02, K_W07, K_W11, K_W12, K_U03, K_U06, K_U10, K_U16, K_K01, K_K02, K_K04
24	**MEASUREMENTS IN CHEMISTRY** The main goal of the lectures is to teach basics of the theory of experiments and theoretical models of measurement instruments as well as to transfer the knowledge about modern methods of experimental methods specific for chemistry.	2	NC	K_W02, K_W12, K_U07, K_U08, K_K03
25	**ORGANIC PHYSICAL CHEMISTRY** The extended knowledge on physical chemistry for organic compounds will be presented during the lectures. Some of the lectures will be extended by the auditorium and the laboratory exercises in order to accomplish all requirements to pass the exam.	2	NC	K_W02, K_W03, K_W05, K_U03, K_U04, K_K03
	Thesis			
1	**GRADUATION SEMINAR** The aim of the seminar is to acquaint students with research methods and teach them how to present results of their original research.	2	NC	K_W11, K_W12, K_W16, K_W18, K_U10, K_U12, K_U13, K_U15, K_K01
2	**GRADUATION LABORATORY** The organisation and course of the thesis writing process. Performance of individual tasks in research labs.	3	NC	K_W02, K_W04, K_W11, K_W17, K_U03, K_U12,

No.	Subject group subject name[5]: brief description (framework programme)	No. of ECTS credits	Field code[6]	Reference to major-specific outcomes
				K_U17, K_U18, K_K01
3	**THESIS** The aim of the module is to extend and solidify student's knowledge of chemistry and the chosen area of specialisation, in particular the topic covered by student's thesis, and verify student's ability to apply it. The key objective is to help students develop the ability to independently solve a scientific problem or a scientific and engineering problem, develop their original work methods and the ability to use the acquired knowledge in the process of innovative design and experimentation. Students learn to select the right reference literature and perform a critical analysis of sources. Students learn to use IT solutions that support them in solving scientific and engineering problems, documenting the course of scientific and engineering work and graphic representation of results.	20	NC	K_W02, K_W16, K_W18, K_U10, K_U12, K_U13, K_U17, K_U18, K_U15, K_K01, K_K03
Total		**90**		

Methods of verification and assessment of learning outcomes[7] achieved by the student throughout the entire education cycle:

The achievement of learning outcomes of the Chemistry major is assessed on the basis of grades in exams and non-examinable subjects as well as grades for projects or studies presented at seminars and outcomes reported on internship reports. The ultimate test of the learning outcomes is the thesis writing process. To be able to take the final exam student must meet the requirements set out in the programme of study and submit his/her thesis which must receive a passing grade from thesis supervisor and reviewer.

The choice of the method of verification of learning outcomes depends on the type of classes and number of hours. Prior to laboratory classes students take a test assessing their knowledge of the task at hand and after the task is completed students write reports in which they analyse the results and formulate conclusions on the basis of theoretical knowledge. The quality of obtained results is determined by their practical skills of carrying out physical and physicochemical measurements and conducting technological processes (engineering skills). Arithmetic is practised during interactive tutorials. Students are provided with model solutions that they use to solve problems on their own in class and as part of independent study. Students' skills are evaluated on a regular basis in class and through written tests covering particular units of the course. Students' theoretical knowledge is assessed through oral and written assessments and exams. Student's ability to independently solve problems and present them in a systematic written form is evidenced by their thesis. The ability to discuss topics related to the studied area and present results of research is checked during subject seminars and graduation seminars.

Detailed information on the methods of verification of learning outcomes achieved by students is provided in module information sheets.

Plan of Studies - Appendix no. 1

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[7] *Overview only - for details see specific subject information sheets.*

Appendix no. 1

ppendix no. 1 to the Programme of Stu

Wojskowa Akademia Techniczna

PLAN OF FULL-TIME SECOND CYCLE STUDIES, GENERAL ACADEMIC PROFILE

SCIENTIFIC FIELD: CHEMICAL SCIENCES

MAJOR: CHEMISTRY

Specialisation according to elective subjects:

1. EXPLOSIVES AND PYROTECHNICS
2. HAZARDOUS MATERIALS AND CHEMICAL EMERGENCY RESPONSE

Effective from the academic year 2021-2022

	SUBJECT GROUPS / SUBJECTS	Scientific field	Total no. of hours / ECTS credits		ECTS / science skills development	ECTS part. of academic	Including:					no. of hours/evaluations/ECTS credits per semester: I		II		III		organisational unit administering the course	Comments
			hours	ECTS			lecture	tutorial	laborator	project	seminar	hours	ECTS	hours	ECTS	hours	ECTS		
	A. General Subjects		124	8	2	3,5	36	88				34	3,0	60	4,0	30	1,0		
1	PRESENTATION OF SCIENTIFIC AND TECHNICAL SUBJECTS .	NC	60	2	2	1,5		60						30 +	1	30 +	1	WTC/IFT	
2	ECONOMICS	NC	30	3		1	16	14				30 +	3					WLO	
3	PHILOSOPHY	NC	30	3		1	16	14						30 +	3			WLO	
4	OCCUPATIONAL HEALTH AND SAFETY	NC	4				4					4 +						OHS team	
	B. Core Subjects		408	27	25	16	162	102	126		18	286	19,0	122	8,0				
1	MATHEMATICS II	NC	60	4	2	2	30	30				60 +	4					WCY	
2	GENERAL AND INORGANIC CHEMISTRY II	NC	60	4	4	2,5	30	20			10	60 x	4					WTC/ICH	
3	ORGANIC CHEMISTRY II	NC	90	6	6	3,5	26	20	44			90 x	6					WTC/ICH	
4	INSTRUMENTAL ANALYSIS	NC	76	5	5	3	30	8	30		8	76 x	5					WTC/ICH	
5	THEORETICAL CHEMISTRY	NC	76	5	5	3	36	24	16					76 x	5			WTC/IFT	
6	ANALYTICAL CHEMISTRY II	NC	46	3	3	2	10		36					46 +	3			WTC/ICH	
	C. Major Subjects		150	11	11	5,5	70	30	44		6	120	8,0	30	3,0				
1	SPECTROSCOPY	NC	60	4	4	2,5	24	12	24			60 +	4					WTC/ICH	
2	CRYSTALLOGRAPHY	NC	30	3	3	1	14	8	8					30 +	3			WTC/IFT	
3	PHYSICAL CHEMISTRY OF PHASE TRANSITIONS	NC	30	2	2	1	14	4	12			30 +	2					WTC/ICH	
4	PHYSICAL CHEMISTRY OF SURFACE PHENOMENA	NC	30	2	2	1	18	6			6	30 +	2					WTC/ICH	
	D. Elective Subjects		258	19	19	12,5	126	40	68	16	8			198	15,0	60	4,0		
	SPECIALISATION: EXPLOSIVES AND PYROTECHNICS		182	14	14	7,5	88	28	50	16				152	12	30	2		
1	HANDLOADING OF EXPLOSIVES	NC	30	3	3	1,5	16		14					30 x	3			WTC/ICH	
2	THE PHYSICS OF AN EXPLOSION	NC	46	3	3	2	22	8	8	8				46 x	3			WTC/ICH	
3	FUNDAMENTALS OF AMMUNITION MAKING	NC	30	3	2	1,5	14	8		8				30 +	3			WML	
4	INSTRUMENTAL METHODS FOR ANALYSIS OF EXPLOSIVES	NC	46	3	3	1,5	20	12	14					46 +	3			WTC/ICH	
5	NEW-GENERATION EXPLOSIVES	NC	30	2	3	1	16		14							30 +	2	WTC/ICH	
	SPECIALISATION: HAZARDOUS MATERIALS AND CHEMICAL EMERGENCY RESPONSE		182	14	14	7,5	70	40	50		22			152	12	30	2		
1	CHEMICAL SENSORS	NC	46	3	3	2	16	4	12		14			46 x	3			WTC/ICH	
2	PREDICTING THE EFFECTS OF EXPLOSIONS	NC	46	3	3	2,5	18	10	10		8			46 x	3			WTC/ICH	
3	NUCLEAR CHEMISTRY	NC	30	3	3	1	18		12					30 +	3			WTC/ICH	
4	DETECTON AND ASSESSMENT OF HAZARDOUS SUBSTANCES	NC	30	3	3	1	6	16	8					30 +	3			WTC/ICH	
5	RADIOACTIVE MATERIALS	NC	30	2	2	1	12	10	8							30 +	2	WTC/ICH	
	ALL SPECIALISATIONS - ELECTIVE SUBJECTS		76	5	5	5	38	12	18		8			46	3	30	2		
1	BURNING AND DETONATION INITIATING AGENTS	NC	16	1	1	0,5	10		6					16 +	1			WTC/ICH	
2	FUNDAMENTALS OF EMERGENCY MEDICAL CARE	NC	30	2	2	1	12	8	10					30 +	2			WTC/ICH	
3	NANOPOROUS MATERIALS	NC	16	1	1	0,5	10	6						16 +	1			WTC/ICH	
4	COLLECTION AND PREPARATION OF SAMPLES FOR CHEMICAL ANALYSES	NC	30	2	2	1	22		8					30 +	2			WTC/ICH	
5	FUNDAMENTALS OF THE THEORY OF EXPERIMENT	NC	16	1	1	0,5	10		6					16 +	1			WML	
6	FUNCTIONAL NANOSTRUCTURES	NC	30	2	2	1	16		12		2			30 +	2			IOE	
7	FUNDAMENTALS OF METEOROLOGY AND CLIMATOLOGY	NC	30	2		1	16	4			10			30 +	2			WIG	
8	EXPLOSION TECHNOLOGIES IN MATERIALS ENGINEERING	NC	30	2	2	1	16	4	10					30 +	2			WML	
9	PHOTOCHEMISTRY	NC	30	2	2	1	14		10		6			30 +	2			IOE	
10	MODERN METHODS OF ORGANIC SYNTHESIS	NC	30	2	2	1	20	10								30 +	2	WTC/ICH	
11	FUNDAMENTALS OF CHROMATOGRAPHY	NC	30	2	2	1	14		8		8					30 +	2	WTC/ICH	
12	SYNTHESIS OF LIQUID CRYSTALS	NC	30	2	2	1	14		16							30 +	2	WTC/ICH	
13	HAZARDOUS MATERIALS DETECTION TECHNOLOGIES	NC	30	2	2	1	14		8		8					30 +	2	WTC/ICH	
14	MEASUREMENTS IN CHEMISTRY	NC	30	2	2	1	14	8	8							30 +	2	WTC/ICH	
15	ORGANIC PHYSICAL CHEMISTRY	NC	30	2	2	1	16	14								30 +	2	WTC/ICH	
	E. Thesis		92	25	25	12,5			46		46					92	25		
1	GRADUATION SEMINAR	NC	46	2	2	1					46					46 +	2	WTC/ICH	
2	GRADUATION LABORATORY	NC	46	3	3	1,5			46							46 +	3	WTC/ICH	
3	THESIS	NC		20	20	10											20	WTC/ICH	
	F. Internship	No. of weeks					Completion date												
	TOTAL NO. OF HOURS / ECTS credits for the specialisation: Explosives and Pyrotechnics		1032	90	82	50	394	260	284	16	78	440	30	410	30	182	30		
	Acceptable deficit of ECTS credits											18		15					
	Type and number of required evaluations:											no. of exams x		3		3			
												no. of assessments +		6		8	3		
												no. of interim projects				2			
	TOTAL NO. OF HOURS / ECTS credits for the specialisation: Hazardous Materials and Chemical		1032	90	82	50	376	272	284		100	440	30	410	30	182	30		
	Acceptable deficit of ECTS credits											18		15					
	Type and number of required evaluations:											no. of exams x		3		3			
												no. of assessments +		6		6	3		
												no. of interim projects							

Semester II-III - education cycle includes elective subjects

OPINIA

Rady Samorządu Studenckiego Wydziału Nowych Technologii i Chemii WAT

dotycząca projektu **Programu studiów**

Rada Samorządu Studenckiego Wydziału Nowych Technologii i Chemii WAT po zapoznaniu się z przedstawionym projektem **Programu stacjonarnych studiów drugiego stopnia** o profilu ogólnoakademickim na kierunku **chemistry** prowadzonych w języku angielskim i rozpoczynających się w roku akademickim 2021/2022 nie wnosi uwag oraz propozycji zmian i tym samym wyraża o nim pozytywną opinię.

Przewodniczący Rady Samorządu WTC

st. szer. pchor. inż. Wojciech Lasek

Wojskowa
Akademia
Techniczna

Uchwała
Rady Dyscypliny Naukowej „Nauki Chemiczne"
Wojskowej Akademii Technicznej
im. Jarosława Dąbrowskiego

nr 19/RDN_NCh/2021 z dnia 15 września 2021 r.

w sprawie zaopiniowania projektu programu studiów drugiego stopnia prowadzonych w języku angielskim na kierunku chemia rozpoczynających się w roku akademickim 2021/2022

Na podstawie § 25 ust. 1 pkt 13 Statutu WAT, stanowiącego załącznik do uchwały Nr 16/WAT/2019 Senatu WAT z dnia 25 kwietnia 2019 r. w sprawie uchwalenia Statutu Wojskowej Akademii Technicznej im. Jarosława Dąbrowskiego (t.j. obwieszczenie Rektora WAT nr 2/WAT/2019 z dnia 9 października 2019 r.), uchwala się, co następuje:

§1

Rada Dyscypliny Naukowej „Nauki Chemiczne" pozytywnie opiniuje projekt programu studiów drugiego stopnia prowadzonych w języku angielskim na kierunku chemia rozpoczynających się w roku akademickim 2021/2022 na Wydziale Nowych Technologii i Chemii.

§ 2

Uchwała wchodzi w życie z dniem podjęcia.

Przewodniczący

prof. dr hab. inż. Krzysztof CZUPRYŃSKI

Wojskowa Akademia Techniczna

Wydział Nowych Technologii i Chemii

STANOWISKO

Wydziałowej Rady ds. Kształcenia
Wydziału Nowych Technologii i Chemii

nr 9/WRK/WTC/2021 z dnia 09 września 2021 r.

w sprawie wyrażenia opinii o Programie studiów drugiego stopnia na kierunku chemia rozpoczynających się w roku akademickim 2021/2022 prowadzonych w języku angielskim

Na podstawie § 92 ust. 1 pkt 1 Statutu Wojskowej Akademii Technicznej im. Jarosława Dąbrowskiego, stanowiącego załącznik do uchwały Nr 16/WAT/2019 Senatu WAT z dnia 25 kwietnia 2019 r. w sprawie uchwalenia Statutu Wojskowej Akademii Technicznej im. Jarosława Dąbrowskiego (t. j. obwieszczenie Rektora WAT nr 2/WAT/2019 z dnia 9 października 2019 r.), postanawia się, co następuje:

§ 1

Pozytywnie zaopiniować przedstawiony w Załączniku nr 2 do protokołu z posiedzenia WRK w dniu 09 września 2021 roku opracowany program studiów drugiego stopnia na kierunku chemia rozpoczynających się w roku akademickim 2021/2022 prowadzonych w języku angielskim.

§ 2

Przekazać Dziekanowi WTC zaopiniowany program.

PRZEWODNICZĄCY
Wydziałowej Rady ds. Kształcenia
Wydziału Nowych Technologii i Chemii WAT

dr inż. Zbigniew ZARAŃSKI, prof. WAT

Sporządziła Alicja Sikorska – sekretarz WRK