

CHEMISTRY

Learning outcomes and course learning content:

Course: **BASIC CHEMISTRY**

On successful completion of the course and validation of its learning outcomes, a student is able to:

- understand and explain basic chemical concepts, theories and the basic chemical laws
- explain the mechanisms of basic chemical reactions
- indicate the chemical properties of substances depending on their structure/composition, determines and justifies the properties of substances on the basis of the structure, knows and describes chemical compounds, including those recently discovered
- define, describe, plan and carry out the basic processes of chemical synthesis
- explain the basic laboratory and analytical techniques, show the possibilities of economic optimization of chemical processes
- use basic chemical terminology in accordance with IUPAC and PTChem recommendations
- use mathematical methods in chemical and physico-chemical calculations, choose and apply statistical methods to describe chemical and physico-chemical phenomena and data analysis
- conduct chemical and physico-chemical experiments following the description, use analytical techniques to explain basic chemical and physico-chemical phenomena
- analyze and develop research results, prepare a final report on the conducted chemical and physicochemical experiments
- apply health and safety rules in chemical laboratory and assess correctly the risk when carrying out chemical experiment

Course learning content:

- basic definitions, concepts and chemical laws, stoichiometric calculations
- knowledge on the structure of the atom, electronic configurations
- periodic table of elements
- chemical bonds, molecular structure, intermolecular interactions
- chemical reactions, types of reactions, chemical equations
- basic thermochemistry, chemical transformations and their directions
- basics of chemical kinetics, chemical equilibria, ionic equilibria, acids and bases
- redox reactions
- complex compounds and their properties
- basic laboratory equipment
- basic laboratory techniques
- standard solutions of acids and bases
- methods of separations of mixtures
- chemical properties of elements
- health and safety rules in a laboratory of basic chemistry
- basic information on chemical calculations
- concentration of solutions (percentage, mol), conversion of concentrations and mixing of solutions

Course: **BASIC ANALYTICAL CHEMISTRY**

On successful completion of the course and validation of its learning outcomes, a student is able to:

- explain and apply the basic laws of analytical chemistry
- use classical methods of analytical chemistry
- use and apply the rules of health and safety in laboratory work
- select the right conditions and appropriate analytical techniques depending on the component to be determined
- perform calculations in the basic area (preparation of solutions of the desired concentration, calculation of the pH value) and calculations related to the results estimation
- perform the analytical course correctly (sampling, quantitative and qualitative analysis, interpretation of the results, preparation of a report)
- interpret the results of analytical determination correctly

- perform analytical determinations independently in the scope of qualitative and quantitative analysis
- use the names and formulas of chemical compounds used in analytical chemistry and records the reactions carried out

Course learning content:

- health and safety in a laboratory work
- basic inorganic analytical chemistry, basic laws and relationships, chemical literature
- laboratory equipment and glassware
- sampling for analysis, mineralization
- practical use of classical analytical methods of qualitative and quantitative analysis
- equilibrium in aqueous solutions
- weight analysis
- titration (volumetric) analysis
- oxidation and reduction processes
- calculations used in analytical chemistry and basic statistics
- final report on final analytical determination
- quick analytical methods

Course: **BASIC ANALYTICAL CHEMISTRY**

On successful completion of the course and validation of its learning outcomes, a student is able to:

- explain and apply the basic laws of analytical chemistry
- use classical methods of analytical chemistry
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- select the right conditions and appropriate analytical techniques depending on the component to be determined
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Course learning content:

- health and safety in a laboratory work
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- calculations used in analytical chemistry and basic statistics
- final report on final analytical determination
- quick analytical methods

Course: **BASIC PHYSICAL CHEMISTRY**

On successful completion of the course and validation of its learning outcomes, a student is able to:

- understand and use the basic concepts of physical chemistry
- understand and use the basic laws of physical chemistry and their consequences
- use basic kinetics and mechanisms of chemical reactions
- recognize the chemical aspects in natural sciences
- explain the physicochemical properties of substances depending on their structure or composition
- use simple measuring equipment
- use basic analytical techniques to investigate specific physicochemical phenomena
- report the obtained results of experiment and analyzes them
- perform simple physicochemical calculations and interpret their results

- participate and argue in a discussion on physicochemical topics
- use the indicated literature sources

Course learning content:

- mass transport phenomena
- Electrochemistry
- chemical kinetics
- dispersed systems
- magnetic and electrical properties of molecules, basic spectroscopy

Course: **BASIC PHYSICAL CHEMISTRY**

On successful completion of the course and validation of its learning outcomes, a student is able to:

- understand and use the basic concepts of physical chemistry
- understand and use the basic laws of physical chemistry and their consequences
- use basic kinetics and mechanisms of chemical reactions
- recognize the chemical aspects in natural sciences
- explain the physicochemical properties of substances depending on their structure or composition
- use simple measuring equipment
- use basic analytical techniques to investigate specific physicochemical phenomena
- report the obtained results of experiment and analyzes them
- perform simple physicochemical calculations and interpret their results
- participate and argue in a discussion on physicochemical topics
- use the indicated literature sources

Course learning content:

- gases
- I Law of Thermodynamics
- II Law of Thermodynamics
- phase transformations
- thermodynamics of solutions
- chemical equilibria

Course: **BASIC INORGANIC CHEMISTRY**

On successful completion of the course and validation of its learning outcomes, a student is able to:

- use the theories of chemical bonds and the structure of chemical compounds
- use the basic concepts of chemical thermodynamics
- use the basic concepts of equilibrium and chemical kinetics
- use the basic concepts of the theory of acids and bases
- use the basic concepts of oxidation and reduction reactions
- use the basic concepts of coordination chemistry
- use the methods of obtaining, physical and chemical properties and the most important applications of hydrogen, s and p-block elements, and their compounds

Course learning content:

- description of the educational content
- chemical bond theories
- structure of chemical compounds
- basic chemical thermodynamics
- chemical equilibrium
- chemical kinetics
- acid and base theories
- oxidation and reduction
- basic coordination chemistry
- obtaining and properties of s, p block elements and their compounds

Course: **BASIC INORGANIC CHEMISTRY**

On successful completion of the course and validation of its learning outcomes, a student is able to:

- define and apply concepts in the field of coordination chemistry

- understand and apply the theories of bonds in order to explain particular properties of metal complexes
- understand and explain the basic mechanisms of reactions in coordination chemistry
- use the methods of obtaining, physical and chemical properties and the most important applications of hydrogen, d-block elements, f-block elements and their compounds
- characterize selected organometallic compounds of the elements of the main and transition groups in terms of their preparation, structure and chemical properties
- use and explain the basic concepts of catalysis with metal complexes
- plan and organize laboratory work properly
- apply the basic techniques of laboratory work correctly
- interpret the results of laboratory research correctly, formulates conclusions based on the performed experiments
- apply the health and safety rules in the inorganic chemistry laboratory

Course learning content:

- the concepts of coordination chemistry
- bond theories in coordination chemistry
- kinetics and mechanism of basic reactions in coordination chemistry
- synthesis, structure and properties of d and f block elements and their most important compounds
- organometallic compounds of the main group metals and transition metals
- basic concepts of catalysis with metal complexes
- organization of laboratory research, laboratory techniques used in inorganic chemistry
- interpretation of research results, methods of writing reports on the basis of performed experiments
- health and safety in a lab, particular sources of danger in a lab of inorganic chemistry

Course: **BASIC ORGANIC CHEMISTRY**

On successful completion of the course and validation of its learning outcomes, a student is able to:

- explain the properties of compounds depending on their structure, formulate systematic names correctly, demonstrate knowledge of common names of compounds
- understand the consequences of carbon atom hybridization and their impact on the type of C-C and C-X bonds formed
- distinguish between electrophilic and nucleophilic molecules
- understand and create reaction mechanisms, illustrate the movement of electrons properly and the formation and breaking of bonds
- plan to synthesize an organic compound, also in several stages
- propose the result of a chemical reaction depending on the reagents used and the reaction conditions
- recognize and name constitutional isomers and stereoisomers
- interpret the results of spectral analyses of organic compounds, propose an appropriate method to study various aspects of the structure
- use literature sources, textbooks and tables, also in English
- interpret the results of the conducted experiments correctly
- write a laboratory report / journal on the experiment performed
- evaluate objectively the contribution of one's own work and that of others in the joint research and report preparation
- apply the health and safety rules in a lab

Course learning content:

- explain the properties of compounds depending on their structure, formulate systematic names correctly, demonstrate knowledge of common names of compounds
- understand the consequences of carbon atom hybridization and their impact on the type of C-C and C-X bonds formed
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- interpret the results of the conducted experiments correctly
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Course: **BASIC ORGANIC CHEMISTRY**

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- plan to synthesize an organic compound, also in several stages
- propose the result of a chemical reaction depending on the reagents used and the reaction conditions
- recognize and name constitutional isomers and stereoisomers
- interpret the results of spectral analyses of organic compounds, proposes an appropriate method to study various aspects of the structure
- use literature sources, textbooks and tables, also in English

Course learning content:

- introduction to organic chemistry, carbon atom hybridization, chemical bonds, their types, atomic and molecular orbitals
- polarity of molecules, influence of structure on properties, intermolecular interactions
- acids and bases in organic chemistry, basic theories of acidity (Bronsted, Lewis), protic and aprotic solvents
- aliphatic hydrocarbons, structure and properties, isomerism, radical substitution reactions, radical stability and structure
- stereochemistry I, the concept of configuration and conformation, alkanes conformations, Newman projections, cycloalkanes and their stereochemistry, elasticity theory, cyclohexane conformations
- unsaturated hydrocarbons: alkenes and alkynes, methods of preparation and reactivity, addition reactions and the rules governing them, acidity of terminal alkynes
- conjugated dienes, stabilization effect by coupling, addition 1,2 and 1,4, kinetic and thermodynamic control, Diels-Alder reaction
- aromatic compounds, the concept and criteria of aromaticity, resonance stabilization, polycyclic aromatic compounds; benzene reactions, aromatic electrophilic substitution, substituent effect, synthesis of benzene derivatives, aromatic nucleophilic substitution
- stereochemistry II, enantiomers, chirality, graphical representation of stereoisomerism, Fischer projection, enantiomers, diastereoisomers, meso compounds, configuration determination (relative and absolute)
- alkyl halides, substitution reactions, nucleophilic substitution, substitution stereochemistry, concepts: nucleophile, nucleophilicity and basicity. Substitution stereochemistry, SN1 and SN2 mechanisms, dependence on the structure and reaction conditions
- Grignard reactions, application of organometallic compounds in organic synthesis
- elimination reactions, rules applicable in these reactions, E1 and E2 mechanisms, elimination stereochemistry, competition of elimination and substitution, factors influencing the dominant direction of the reaction
- alcohols – synthesis reaction, properties, reactivity, acidity of the OH group, reactions of alcohols, types of leaving groups, oxidation of alcohols, transformation into ethers
- properties and structure of ethers, cyclic ethers, epoxides, ethers complexing properties, crown ethers
- carbonyl compounds, oxidation reactions, hybridization of carbonyl group atoms and bond polarization, addition reactions (hemiacetals, acetals, oximes, hydrazones, Schiff bases)

- carboxylic acids and their derivatives, acidity of the carboxyl group, different reactivity of derivatives in the substitution reaction at the carbonyl group, reactions for the synthesis and conversion of acid derivatives
- acidity of hydrogen atoms in the alpha position to the carbonyl group, application in synthesis (malonate, acetoacetate, acetylacetone), enolization of carbonyl compounds and reactivity of enols
- amines- structure and basicity, synthesis reactions, inversion on the nitrogen atom. Hoffman's elimination
- organic synthesis - examples of synthesis preparation
- spectroscopic methods for studying the structure of organic compounds (IR, NMR, MS, UV-VIS), examples of spectrum interpretation
- basic classes of organic reactions: addition, elimination, substitution, condensation, rearrangement, pericyclic reactions
- basic canons of organic synthesis
- analysis of changes and transformations in organic chemistry - the ability to suggest reaction mechanisms - on the basis of basic canons
- understanding and explaining the nature of organic changes (reactivity, rearrangements)

Course: **BASIC CHEMICAL TECHNOLOGY**

On successful completion of the course and validation of its learning outcomes, a student is able to:

- describe the basic technological principles, operations and unit processes
- describe the basic technological processes
- read technological diagrams and use the terminology used in chemical technology
- indicate the possibilities of limiting the formation of by-products or proposes the possibilities of their use or disposal
- describe how the devices used in chemical technology work
- describe and apply analysis techniques that allow for the proper selection of the quality and value of raw materials and products
- choose the optimal raw materials to obtain the expected product
- use the literature sources, also in foreign languages
- write reports on the exercises performed, analyze the results and draw conclusions
- apply health and safety rules in a lab

Course learning content:

- health and safety rules in a lab
- basic physicochemical knowledge of technological processes, technological principles, operations and unit processes
- dynamic, thermal and diffusion operations
- construction and principle of operation of installations and devices used in industry for the discussed unit operations
- basic raw materials and criteria for their selection for industrial processes, environmental aspects in the chemical industry
- analysis of typical technological processes (soda production, fuel processing)
- analysis techniques (chemical, spectral, sieve analysis, chromatographic) allowing for the proper selection of raw materials and products
- interpreting the results and writing an exercise report

Course: **BACHELOR LAB**

On successful completion of the course and validation of its learning outcomes, a student is able to:

- understand and apply basic definitions and concepts in the field of chemistry
- use the chemical properties of basic chemical compounds
- use the basic techniques of laboratory work correctly
- analyze the research results correctly and draw conclusions based on them
- follow the health and safety rules in a lab
- use databases in English
- write a bachelor's thesis on the basis of conducted experiments
- use ethical rules as a chemist

Course learning content:

- organization of laboratory research

- selection and application of laboratory methods used in chemistry
- health and safety rule in a lab
- methods of writing the final report in the form of a BA thesis based on experiments and literature data
- interpretation of the results of experimental research

Course: **BACHELOR LAB**

On successful completion of the course and validation of its learning outcomes, a student is able to:

- understand and apply basic definitions and concepts in the field of chemistry
- use the chemical properties of basic chemical compounds
- use the basic techniques of laboratory work correctly
- analyze the research results correctly and draw conclusions based on them
- follow the health and safety rules in a lab
- use databases in English
- write a bachelor's thesis on the basis of conducted experiments
- use ethical rules as a chemist

Course learning content:

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- health and safety rule in a lab
- methods of writing the final report in the form of a BA thesis based on experiments and literature data
- interpretation of the results of experimental research

Course: **LEGAL PROTECTION OF INNOVATION**

On successful completion of the course and validation of its learning outcomes, a student is able to:

- uses the definitions and concepts related to the content of the subject
- is able to assess the risk of running a business
- uses the general principles of creating and developing a form of individual entrepreneurship using knowledge in the field of chemistry
- uses the basic concepts of tax rules, running a business, and marketing

Course learning content:

- entrepreneurship and entrepreneur versus innovation
- types of technological ventures
- the decision to start the project and the choice of its organizational and legal form
- protection of intellectual property
- sources of financing projects, small business financial system
- business plan of a technological project and the procedure for its development
- marketing of technological ventures
- entrepreneurship and entrepreneur versus innovation

Course: **INFORMATION TECHNOLOGY**

On successful completion of the course and validation of its learning outcomes, a student is able to:

- use the MS-Windows and its resources
- edit and format simple and complex documents
- perform calculations using user formulas and standard functions, as well as display data using a spreadsheet
- create a multimedia presentation and poster
- create two- and three-dimensional structures of chemical compounds and processes using the ChemSketch software
- use resources and services available on the network
- apply health and safety rules in a computer lab
- apply the principles of legal protection of licensed software and copyrights of Internet resources

Course learning content:

- health and safety in a computer lab, legal protection of computer software and copyrights of Internet resources

- MS-Windows and management of its resources, user accounts, their profiles, utility software and file systems in the MS-Windows environment, number systems: binary and hexadecimal, units used in computer science
- MS Word text editor - editing and formatting simple and complex documents
- MS-Excel spreadsheet - data types; user formulas; standard functions; charts; regression
- MS Power Point - slide types, templates, transitions between slides, custom animations, slide template
- ChemSketch software for editing chemical formulas, two- and three-dimensional imaging of chemical structures and processes.
- working in a computer network
- basic network services: websites, e-mail, discussion groups, social networks

Course: **INTRODUCTION TO INORGANIC CHEMISTRY**

On successful completion of the course and validation of its learning outcomes, a student is able to:

- formulate correctly systematic names of inorganic compounds, writes correctly formulas of chemical compounds
- use the theories of chemical bonds and the structures of chemical compounds and explain the properties of compounds depending on their structures
- use the concepts of the theory of acids and bases and distinguish appropriate examples of such compounds and reactions with them

Course learning content:

- introduction to inorganic chemistry, systematic names of inorganic compounds and correct notation of summary formulas of chemical compounds
- properties of non-metals, octet rule, hybridization, particle shape prediction, chemical resonance, the MO theory and energy diagrams for X₂ and AB molecules, bond polarization, dipole moment
- properties of ionic compounds, crystal structures with the densest packing, lattice nodes, octahedral and tetrahedral gaps, lattice energy, factors determining the value of lattice energy
- properties of metals, band theory, energy diagrams of conductors, semiconductors and dielectrics (insulators)

Course: **INTRODUCTION TO ORGANIC CHEMISTRY**

On successful completion of the course and validation of its learning outcomes, a student is able to:

- explains the properties of compounds depending on their structure, formulates systematic names correctly, demonstrates knowledge of common names of compounds
- understands the consequences of carbon atom hybridization and their impact on the type of bonds formed
- distinguishes between electrophilic and nucleophilic molecules
- understands reaction mechanisms

Course learning content:

- introduction to organic chemistry, hybridization of carbon atom, chemical bonds, their types, atomic and molecular orbitals
- polarity of molecules, influence of structure on properties, intermolecular interactions
- acids and bases in organic chemistry, basic theories of acidity (Bronsted, Lewis), protic and aprotic solvents
- aliphatic hydrocarbons, structure and properties, isomerism, radical substitution reactions, radical stability and structure

Course: **ENGLISH**

On successful completion of the course and validation of its learning outcomes, a student is able to:

- use the appropriate lexical and grammatical content and provide answers about a healthy diet, cuisine habits, eating habits, etc.
- use the appropriate lexical and grammatical content and express his/her opinion on the family model in Poland and introduce his family; express his/her plans for the future, promises, forecasts, etc.; characterize the personality of himself/herself, a friend, a family member
- use the appropriate lexical and grammatical content and give statements about earning and spending family money, etc.

- use the appropriate lexical and grammatical content and express himself/herself about the way of traveling and various means of transport, can buy a ticket and reserve a seat.
- use the appropriate lexical and grammatical content and describe his present and past skills, talk about feelings concerning a given situation; talk about the use of telephones and behaviors related to their use, can describe various behaviors typical of personal culture
- use the relevant lexical and grammatical content and summarize the given texts; talk about his sports interests or popular sports in Poland; describe a sports event, an injury he suffered, etc.
- use the appropriate lexical and grammatical content and describe favorite movie and talk about favorite director and movie location
- use the appropriate lexical and grammatical content and present the situation using a conditional; comment on his current development and achievements related to education; describe his place of residence, talk about the advantages and disadvantages of different locations of the house or apartment.
- use the appropriate lexical and grammatical content and express himself/herself about his/her consumer habits; give advice on product complaints and talk about their experiences related to it.
- use the appropriate lexical and grammatical content and express an opinion about his/her professional predispositions, talents, weaknesses; describe the stages of applying for a job or present the career development path of a selected person / leader in business, etc.
- use the appropriate lexical and grammatical content and summarize the text; express an opinion on the role of electronics in everyday life, introduce an antithesis to his speech (however, but, on the other hand)

Course learning content:

- Food and Diet
- Family
- Spending and saving
- Travel
- Abilities Culture and manners
- Sports
- Art.
- Education
- Shopping
- Jobs
- Technology

Course: **ENGLISH**

On successful completion of the course and validation of its learning outcomes, a student is able to:

- use the relevant lexical and grammatical content and conduct an informal conversation, ask questions and answer questions, exchanges opinions and information about interpersonal relations, use paraphrases, use direct and indirect (apparent) questions
- use the appropriate lexical and grammatical content and use the job interview scheme and frequently asked questions; conduct an interview both as an employer and a candidate
- use the appropriate lexical and grammatical content, expresses opinions on medicine and health care, alternative medicine; describe the symptoms of an illness or injury and instruct how to provide first aid
- use the appropriate lexical and grammatical content and conduct a dialogue on preferences in terms of fashion; respond to the opinions given; describe the appearance of a colleague / character from the illustration, take into account the details of clothing; conduct a dialogue on different lifestyles
- use the appropriate lexical and grammatical content and play heard stories, tell real stories, write a story, continue the story from a given phrase, move at the airport, describe safety procedures
- use the appropriate lexical and grammatical content and express himself/herself about weather phenomena, climate change and the threats that these changes bring, express opinions on the predicted future and respond to the opinions of colleagues
- use the appropriate lexical and grammatical content and conduct a dialogue on dangerous activities, anticipate what may happen, provide that certain circumstances occur
- use the appropriate lexical and grammatical content and describe emotions related to the performance of certain activities or events from the past; speculate about the past and present, use adjectives with a strong emotional tone.

Course learning content:

- People: Relationships and Personality
- Job Interview
- Illness / Treatment / Medical Vocabulary
- Stereotypes, Clothes and Fashion
- Air Travel, Stories
- Weather and Environment
- Risk Taking
- Human Psychology

Course: **ENGLISH**

On successful completion of the course and validation of its learning outcomes, a student is able to:

- use the appropriate lexical and grammatical content and exchange opinions about dangers, risks, show irritation and the need to change the existing state of affairs, evaluate past events
- use the appropriate lexical and grammatical content and talk about music, TV and radio programs, conduct an interview with an artist, use correct verb forms, e.g. forget to do, forget doing
- use the appropriate lexical and grammatical content and talk about repeated activities in the past and now, conduct a dialogue on preferences and addictions, expresse an opinion on a balance between rest and time devoted to work
- use the appropriate lexical and grammatical content and exchange opinions on typically female and typically male behaviors, expresse an opinion on the division of household duties, assesse the diversity and difference of behaviors, conclude about events in the past
- use the appropriate lexical and grammatical content and name and interpret gestures and body language, describe sensory feelings, describe objects using various senses
- write a formal or informal letter using vocabulary and phrase appropriate to the selected form

Course learning content:

- Feelings
- Music
- Sleep / Work-life Balance
- Everyday negotiations / Overcoming Conflicts
- The Body / Body Language
- Writing

Course: **ENGLISH**

On successful completion of the course and validation of its learning outcomes, a student is able to:

- use the appropriate lexical and grammatical content and conduct a dialogue on court proceedings, law, judgments; report on the course of the accident / trial, express opinions on the legitimacy and amount of the penalty; name crimes and offenses; inform where and what services can be used (have sth done)
- use the relevant lexical and grammatical content and write down the dialogue based on the text in direct speech, report on dialogues in indirect speech, quote statements and opinions of other people, speak about the reliability of the media, predict the content of articles based on the read titles
- use the relevant lexical and grammatical content and describe the commercial market in his country in relation to the newly introduced product, describe advertisements, express opinions on their effectiveness, conduct a dialogue on brand names, famous companies and their products, develop statements using subordinate clause creating extensive reports of events.
- use the relevant lexical and grammatical content and name and explain the problems of big cities, conduct a discussion on their solutions, indicate the most interesting cities in terms of tourism, justify his/her opinion
- use the appropriate lexical and grammatical content and speak about the ethical dilemmas posed by scientific discoveries / inventions, conduct a dialogue on the latest discoveries and their potential use, speculate what the modern world would look like without some scientific solutions.
- use the appropriate lexical and grammatical content and know the rules of public speaking, present a short speech on a selected topic
- write a formal or informal letter using vocabulary and phrases appropriate to the selected form

Course learning content:

- Crime and Punishment
- Media

- Business and Advertising
- Urban Experience
- Science / Technology
- Presentation Skills, Speaking in Public
- Writing

Course: **PHYSICS**

On successful completion of the course and validation of its learning outcomes, a student is able to:

- use the basic physical laws
- understand and explain the essence of basic physical phenomena
- analyze and predict the course of physical processes
- use basic vector algebra
- solve problems using vector algebra
- describe the fields: gravitational, electric and magnetic as well as electromagnetic wave
- determine how electric and, magnetic fields and electromagnetic waves interact with matter
- use literature sources
- co-work with a group by solving problems

Course learning content:

- basic classical mechanics
- elements of hydromechanics
- vibrations and waves in elastic media
- electric and magnetic properties of matter
- electromagnetic waves
- polarization, interference and diffraction of waves
- elements of wave and geometric optics
- elements of acoustics
- elements of solid state physics
- natural radioactivity

Course: **MATHEMATICS**

On successful completion of the course and validation of its learning outcomes, a student is able to:

- perform all chemical calculations (in the selected range) using mathematical methods
- understand the importance of the mathematics in the description of chemical phenomena
- present basic chemical problems in the language of mathematics
- use basic mathematical analysis and its application
- solve problems with the use of differential calculus
- use the indicated and own sources from the literature
- analyze and interpret descriptions of various phenomena in the language of mathematics
- indicate in the description of chemical phenomena the terms used in the field of mathematical analysis
- use the basic linear algebra and its role in chemical calculations
- use the integral calculus for calculations of a geometric type

Course learning content:

- numbers, basic arithmetic operations and operations on fractions, elements of logic, the principle of complete induction, functions: bounded, monotonic, convex, review of elementary functions and their occurrence in chemical problems, types of coordinates
- sequences and series of numbers: sequence, sequence convergence, limitation, theorem of sequences, improper convergence, indefinite expressions, subsequences, Bolzano Weierstrass theorem, monotonic sequences, Euler number
- definition of a convergence of series, series in chemical problems, criteria of convergence: comparative, the ratio test, square root, Abel's, Dirichlet's, alternating series and Leibnitz criterion
- limit and continuity of a function, limit of a function of one variable, properties of limits, one-sided limits, uniform continuity, properties of a continuous function, points of discontinuity
- the concept of derivative, derivative of a function of one variable, geometric interpretation of derivative, derivative in chemical applications, derivatives of elementary functions, higher-order derivatives, Taylor's formula
- complex numbers, basic properties, operations on complex numbers

- elements of linear algebra, vectors and operations on vectors, matrices and determinants, systems of equations and methods of solving them
- indefinite integral, basic methods of calculating integrals, Riemann integral and its applications, Newton-Leibnitz formula
- multivariable functions, partial derivatives, extremes of multivariable functions, double and triple integrals and their applications
- differential equations and their applications in chemistry

Course: **MATHEMATICS**

On successful completion of the course and validation of its learning outcomes, a student is able to:

- is able to perform all chemical calculations (in the selected range) using mathematical methods
- understands the importance of the mathematics in the description of chemical phenomena
- can present basic chemical problems in the language of mathematics
- knows basic mathematical analysis and its application
- can solve problems with the use of differential calculus
- uses the indicated and own sources from the literature
- can analyze and interpret descriptions of various phenomena in the language of mathematics
- can indicate in the description of chemical phenomena the terms used in the field of mathematical analysis
- knows the basic linear algebra and its role in chemical calculations
- is able to use the integral calculus for calculations of a geometric type

Course learning content:

- numbers, basic arithmetic operations and operations on fractions, elements of logic, the principle of complete induction, functions: bounded, monotonic, convex, review of elementary functions and their occurrence in chemical problems, types of coordinates
- sequences and series of numbers: sequence, sequence convergence, limitation, theorem of sequences, improper convergence, indefinite expressions, subsequences, Bolzano Weierstrass theorem, monotonic sequences, Euler number
- definition of a convergence of series, series in chemical problems, criteria of convergence: comparative, the ratio test, square root, Abel's, Dirichlet's, alternating series and Leibnitz criterion
- limit and continuity of a function, limit of a function of one variable, properties of limits, one-sided limits, uniform continuity, properties of a continuous function, points of discontinuity
- the concept of derivative, derivative of a function of one variable, geometric interpretation of derivative, derivative in chemical applications, derivatives of elementary functions, higher-order derivatives, Taylor's formula
- complex numbers, basic properties, operations on complex numbers
- elements of linear algebra, vectors and operations on vectors, matrices and determinants, systems of equations and methods of solving them
- indefinite integral, basic methods of calculating integrals, Riemann integral and its applications, Newton-Leibnitz formula
- multivariable functions, partial derivatives, extremes of multivariable functions, double and triple integrals and their applications
- differential equations and their applications in chemistry

Course: **PROTECTION OF INTELLECTUAL PROPERTY**

On successful completion of the course and validation of its learning outcomes, a student is able to:

- present issues in the field of intellectual property protection, use the basic terminology and relations with other scientific disciplines
- use the relationship between the achievements in the field of chemistry and the possibilities of their use in socio-economic life
- use consciously and understand social aspects of the practical application of acquired knowledge and skills, as well as related to this responsibility
- understand the importance of the legal conditions for the protection of intellectual property and the related responsibility
- use available information sources, in particular electronic sources (online patent databases)
- search for, analyze, evaluate, select and use information from patent databases
- be active in taking actions in the field of intellectual property protection independently

Course learning content:

- intellectual and industrial property - basic concepts, international and Polish legal regulations
- rights protection system - international organizations, the role and tasks of the Patent Office
- the role of intellectual and industrial property protection and its benefits in science and economy
- forms and procedures of industrial property protection - inventions and patents, utility and industrial models, trademarks, geographical indications, topographies of integrated circuits
- intellectual property - copyright and related rights
- protection of industrial and intellectual property rights versus the use of someone else's solutions for research and industrial purposes
- informacja patentowa - źródła informacji patentowej, rodzaje badań patentowych
- patent information - sources of patent information, types of patent research
- rights and obligations of authors and users of works, investigation and enforcement of intellectual property rights, trading in exclusive rights - purchase and sale of new solutions, license agreements, know-how

Course: **BASIC INSTRUMENTAL ANALYSIS**

On successful completion of the course and validation of its learning outcomes, a student is able to:

- explain the structure of analytical equipment and indicate the possibilities of its use
- explain the essence of the operation of analytical equipment
- use analytical techniques: refractometry, potentiometry, conductometry, UV-Vis, fluorimetry, IR, AAS, GC
- select the appropriate techniques depending on the component to be determined and the matrix present
- interpret the results of analytical determinations correctly
- write a report on the performed analytical determination

apply health and safety rules in an analytical laboratory

Course learning content:

- health and safety in a laboratory
- stages of analytical process
- spectroscopic methods
- electroanalytical methods
- chromatographic methods
- thermoanalytical methods
- patterns and reference materials
- processing the results and their statistical evaluation

Course: **PHYSICAL EDUCATION**

On successful completion of the course and validation of its learning outcomes, a student is able to:

- has knowledge of physical culture
- has basic knowledge of selected sports discipline and applied it in practice
- has knowledge about the impact of physical exercise on human health
- takes care of health and physical fitness
- promotes the social and cultural importance of sport and physical activity

Course learning content:

- health and safety rules and regulations of selected physical activities
- theoretical introduction to a selected sports discipline
- developing physical activity and technical skills