

International Environmental Doctoral School by the Centre for Polar Studies of the University of Silesia in Katowice (IEDS)

Organizational units:

University of Silesia (cat. A)
Institute of Geophysics PAS (cat. A+) Institute of
Mathematics PAS (cat. A+) Institute of Oceanology PAS
(cat. A+)

Associated units:

Maria Curie-Skłodowska University in Lublin.

1) specification of knowledge area, field of science and scientific discipline or area of art and artistic discipline;

Field of exact and life sciences
Disciplines: mathematics, science about Earth and environment

Area of engineering and engineering
trades Disciplines: materials engineering

2) Indication of connection between education and the development strategy of the university and institutes;

International Environmental Doctoral School (IEDS) by the Centre for Polar Studies at the University of Silesia in Katowice has a goal of strengthening development possibilities of scientific research of the young generation of scientists at the highest level, combined with teaching and practical methodical training for intellectual development and scientific advantages of doctoral students. These objectives match the overall strategy of the University of Silesia in Katowice and the units of the Polish Academy of Science.

The goal of the University in Silesia in Katowice as well as the units of the Polish Academy of Science is to reach the highest quality of education and effects of carrying out scientific research through parametrised evaluation. International Environmental Doctoral School may substantially contribute to achieving this goal through educating the young personnel and conducting

research in cooperation with renowned foreign educational centres. To date, activity of the Centre for Polar Studies at the University of Silesia in Katowice and the Interdisciplinary Polar Studies KNOW have allowed to use the gained experience in order to reach this goal.

In the framework of IEDS, cooperation with foreign centres will be established the employees of which will become the supervisors or assistant supervisors and lecturers as well as accepting doctoral students to foreign internships. This cooperation will allow to educate doctoral students on a very high level which constitutes a priority goal for the didactics at the University of Silesia in Katowice and for the Polish Academy of Science.

3) specification of basic educational goals, including qualifications obtained by graduates;

The key goal of education is to obtain competencies by graduates in placing new, innovative and applicable research questions along with possessing modern scientific workshop with the use of the most state-of-the-art methods and analytical techniques at the world level. Doctoral school will enable the graduate to possess the latest, specialized knowledge with regards to exact sciences and life sciences and engineering-technical sciences, including interdisciplinary understanding of the functioning of environment in the context of global climate changes. It will also allow to better promote the knowledge and own research results in the academic environment and the society.

4) specification of educational modules and the assumed effects and reference to the characteristics of 8 level of the Polish Qualification Framework;

Educational effects for International Environmental Doctoral School by the Centre for Polar Studies at the University of Silesia in Katowice (IEDS)		
No.	Competencies of graduates of the International Environmental Doctoral School at the Centre for Polar Studies at the University of Silesia in Katowice (IEDS)	Reference to the characteristics of level 8 of the Polish Qualification Framework (PQF)
Knowledge		
MŚSD_W01	Understands complex phenomena and natural, social and economic processes as well as multidimensional nature of factors that impact these phenomena and processes	P8S_WK, P8S_WG
MŚSD_W02	Has an in-depth knowledge in the scope of organizing their scientific workshop and elaboration and Review of scientific works	P8S_WG
MŚSD_W03	Has an advanced knowledge in the scope of the selected disciplines of exact and life sciences as well as engineering-technical sciences	P8S_WG
MŚSD_W04	Has an advanced statistical-mathematical knowledge in the scope of the selected disciplines and exact and life sciences and engineering-technical sciences enabling explanation, modelling and forecasting the processes concerning the selected scientific discipline	P8S_WG, P8S_WK
MŚSD_W05	Has an in depth knowledge about currently discussed issues in the Polish and Foreign subject literature in the scope of the selected exact and life sciences disciplines and engineering-technical sciences	P8S_WK, P8S_WG
MŚSD_W06	Has an in-depth knowledge covering the principles of planning and carrying out researches by means of advanced techniques and research tools in the scope of the selected disciplines and exact and natural sciences and engineering-technical sciences. Has an extensive knowledge on scientific databases and their resources, with special consideration of natural and social databases.	P8S_WG
MŚSD_W07	Knows the principles of safety and hygiene at work, especially with regards to field research	P8S_WK

MSSD_W08	Knows the principles of creating and developing forms of individual entrepreneurship and possibilities of using scientific research in practice in the scope of the selected disciplines of exact sciences and life sciences as well as engineering-technical sciences	P8S_WK
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MŚSD_W09	Knows legal conditions in the selected disciplines of exact and life sciences And engineering-technical sciences as well as the overall structure of concepts and principles in the scope of industrial property and copyright protection	P8S_WK
MŚSD_W10	Knows and understands scientific and creative achievements and their implications for practice in the selected exact and life sciences disciplines and engineering-technical sciences	P8S_WK, P8S_WG
MŚSD_W11	Knows and understands theoretical bases, general issues and selected issues for the selected disciplines of exact and life sciences as well as engineering-technical Sciences in a degree that enables a review of the existing paradigms	P8S_WK
MŚSD_W12	Knows and understands the processes occurring in biomaterials and tissue under the influence of external factors	P8S_WG
MŚSD_W13	Defines biomaterials according to various criteria and describes properties and use of biomaterials in regeneration medicine, tissue engineering, implantology and targeted therapy	P8S_WG
Skills		
MŚSD_U01	Has the ability to apply advanced techniques and adequate research tools in order to solve complex scientific issues in the selected disciplines of life and environment sciences and engineering-technical sciences	P8S_UW
MŚSD_U02	Fluently uses Polish and world scientific literature, has the ability to perform a critical analysis of literature and materials stemming from electronic sources	P8S_UW, P8S_UU
MŚSD_U03	Has the skills to gather materials and information from various sources (also originating from own research), elaborate the gathered material and formulate conclusions	P8S_UW, P8S_UO
MŚSD_U04	Has the ability to creatively develop the so far models and theoretical concepts and create own research concepts	P8S_UW, P8S_UU, P8S_UO
MŚSD_U05	Has methodological and methodical skills (theoretical and practical), enabling the planning and conduct of autonomous scientific research and realization of expertise	P8S_UW, P8S_UO, P8S_UU
MŚSD_U06	Shows the ability to carry out didactic classes and prepare various forms of presentation and verbal lectures in Polish and a foreign language in the scope of life sciences, environment sciences as well as engineering-technical sciences	P8S_UK, P8S_UU
MŚSD_U07	Indicates ability to write an extended scientific work (doctoral dissertation) and various smaller scientific elaborations (articles, polemics, abstracts, reports, reviews), including also works in a foreign language	P8S_UW, P8S_UK

MŚSD_U08	Has the ability to independently direct one's own professional and scientific career	P8S_UK, P8S_UO, P8S_UU
MŚSD_U09	Is able to analyse in a comprehensive manner the causes and course of social processes, Economic processes and phenomena related to earth sciences and environmental sciences as well as engineering- Technical sciences, formulate own opinions in their regard and place hypotheses for their verification as well as being able to prognose and model the assumed social, economic processes and processes related to the use of advanced methods and research tools	P8S_UW
MŚSD_U10	Is able to use knowledge from various fields for creative identification, formulation and innovative resolving of complex issues or conduct tasks of research nature, including in particular: defining the goal and subject of research, formulate research hypothesis, develop methods, techniques and research tools as well as creatively apply and draw conclusions on the basis of research outcomes	P8S_UW, P8S_UO, P8S_UU
MŚSD_U11	Has command of a foreign language in a degree that enables participation in international scientific and professional environment	P8S_UK, P8S_UO, P8S_UU
MŚSD_U12	Is able to analyse the specific features of biomaterials and tissue and perform the selection of biomaterials for a specific use in biological environments	P8S_UW
Social competencies		
MŚSD_K01	Understands the need to learn and increase qualifications throughout life and the impact in this regard on behaviours of other people	P8S_KK, P8S_KO, P8S_KR
MŚSD_K02	Is able to cooperate and work in a group assuming various roles within it	P8S_KO
MŚSD_K03	Is able to specify and select priorities targeted at realization of a task specified by them or by others	P8S_KK
MŚSD_K04	Correctly identifies and resolves dilemmas related to carrying out a profession. Is ready to fulfil social obligations of researchers and creators	P8S_KO, P8S_KR
MŚSD_K05	Understands the need of systematic acquainting oneself with Polish and foreign scientific journals necessary to increase general and specialist knowledge in the scope of a given discipline of sciences about earth	P8S_KK, P8S_KR
MŚSD_K06	Indicates responsibility for assessing threats stemming from the applied techniques and research tools in research	P8S_KK, P8S_KO

MŚSD_K07	Indicates the need and systematically update their knowledge in order to use it in practice	P8S_KK
MŚSD_K08	Has an in-depth knowledge about the system of financing scientific research, methods of obtaining	P8S_KR

	Means for research and their settling	
MŚSD_K09	Is ready to carry out independent research and undertake challenges in the professional and public domain bearing in mind: their ethical dimension, responsibilities for their effects and shaping proper patterns of proceeding in such situations	P8S_KO, P8S_KR
MŚSD_K10	Understands the social role of interference of an engineer in a living organism	P8S_KR

Characteristics of PQF levels typical for qualifications obtained under higher education training

L= level of PQF (6...8)

C = characteristics typical for qualifications obtained under Higher education

K = knowledge

D = depth and scope

C = context

S = skills

U = use of knowledge

C = communication O

= organization of work

L= learning

S = Social competencies

C = critical assessment

R = responsibility

P= professional role

Characteristics of 8 level of Polish Qualification Framework according to the Ministry of Science and Higher Education from 14 November 2018 regarding characteristics of the second-cycle studies for qualification at levels 6-8 of the Polish Qualification Framework (Journal of Laws from 2018, item 2218).

Category of characteristics of effects Of learning	Descriptive category - aspects regarding basic importance	Component code Of description	Characteristics of learning effects
Knowledge: knows and understands	Scope and depth - completeness of cognitive perspective	P8S_WG	In a degree enabling review of the changing paradigms - world achievements covering theoretical bases and general issues as well as the selected specific issues - proper for the given scientific or artistic discipline Key development tendencies of scientific and artistic disciplines in which education occurs Methodology of scientific research Principles of promoting the results of scientific activity, also in the mode of open access
	Context - conditions, effects	P8S_WK	Fundamental dilemmas of modern civilization Economic, legal, ethical and other significant conditions of scientific actions Basic principles of knowledge transfer to economic and social zone and commercialization of scientific activity results And know-how related to these results
Skills: is able	Use of knowledge - resolved issues and carried out tasks	P8S_UW	Use knowledge from various fields of science or art for creative identification, formulating and innovative resolving of complex issues or conduct of tasks of research character and, in particular: - defining the goal and subject of scientific research, formulating research hypothesis, - developing methods, techniques and research tools as well as apply them in a creative manner, - drawing conclusions on the basis of scientific research results Performing critical analysis and assessment of scientific research results, expert actions and other works of creative nature and their impact on knowledge development Transferring the results of scientific activity for economic and social zone
	Communicating - receiving and creating answers, promoting knowledge in the scientific environment and command of a foreign language	P8S_UK	Communicating on specialist topics in a degree allowing for an active participation in the international environment Promoting scientific activity results, also in popular forms Initiating debates Participating in scientific discussions Command of a foreign language at B2 level of the European System of Language Command Description in a degree enabling participating in international scientific and professional environments
	Organization of work - planning and team work	P8S_UO	Planning and realizing individual and team research or creative ventures, also in the international environment
	Learning - planning own development and the development of others	P8S_UU	Individual planning and acting towards self-development and inspiring and organizing the development of others Planning classes and groups of classes and realizing them with the use of modern methods and tools
Social competencies: is ready to	Assessment - critical approach	P8S_KK	Critical assessment of scientific achievements under a given scientific or artistic discipline Critical assessment of one's impact in a given scientific or artistic discipline Acknowledgement of importance of knowledge in understanding cognitive and practical issues
	Responsibility - performing social obligations and acting towards public interest	P8S_KO	Fulfilling social obligations of researchers and creators Initiating actions towards public interest Thinking and acting in an entrepreneurial manner
	Professional role - independence and Growth of ethos	P8S_KR	Sustaining and developing ethos among research and creative societies, including: - carrying out scientific activity in an independent manner, - Respecting the principles of public ownership of the results of scientific activity, bearing in mind the principles of intellectual property rights

Educational modules including the assumed learning effects			
Educational modules	ECTS	Assumed educational outcomes	Manner of verifying the assumed educational effects Achieved by the doctoral student
Specialist English	2	Doctoral student obtains the skills related to preparing and reviewing scientific works in English. Freely operates on English literature and is able to work in a team (MŚSD_W02, MŚSD_U02, MŚSD_K02).	Graded assignment
Methodological workshop: social, legal issue, career planning, writing publications, elaborating project applications, transfer of knowledge to students and pupils (coordinator: US INS + MCSU)	1	The workshops introduces social and legal issues of conducting scientific research to doctoral students. The module will enable doctoral students to familiarize with the aspects of organizing their scientific workshop and, firstly, the techniques of writing and presenting scientific works (MŚSD_W02). This topic will be presented in a broader context of the principles of financing scientific research and knowledge transfer on a world and international scale, along with the issue of data bases (bibliographic and indexes of quotations), contests for grants and copyrights (MŚSD_W05, MŚSD_W06, MŚSD_W09, MŚSD_K08). Doctoral students could gain the skills of better understanding the conditions of a scientific career (MŚSD_K01, MŚSD_K04, MŚSD_K05, MŚSD_U11) and its self-planning (MŚSD_U08, MŚSD_U05).	Graded assignment
Specialist courses (abroad)	10	Doctoral student learns the latest achievements in the scope of exact and natural sciences and engineering-technical sciences, use of knowledge in identifying research issues and promoting the results, fulfilling social obligations in maintaining relations in international professional environment (MŚSD_W01, MŚSD_W05, MŚSD_U11, MŚSD_K07, MŚSD_K09, MŚSD_K10).	Exams/Credits
Seminar	2	Understands the need of systematic acquainting oneself with Polish and foreign scientific journals necessary to increase general and specialist knowledge in the scope of exact and natural as well as engineering-technical sciences. Indicates responsibility for assessing threats stemming from the applied techniques and research tools in research. Indicates the need and systematically update their knowledge in order to use it in practice. Shows the ability to carry out didactic classes and prepare various forms of presentation and verbal lectures in Polish and a foreign language in the scope of exact and natural sciences as well as engineering-technical sciences. Indicates ability to write an extended scientific work (doctoral dissertation) and various smaller scientific elaborations (articles, polemics, abstracts, reports, reviews), including also works in a foreign language. Has the ability to independently direct one's own professional and scientific career. Understands complex phenomena and natural, social and economic processes as well as multidimensional nature of factors that impact these phenomena and processes. Has an in-depth knowledge in the scope of organizing their scientific workshop and elaboration and review of scientific works. Has an in-depth knowledge concerning issues currently discussed in the subject Polish and foreign literature in the scope of exact, natural and engineering-technical sciences (MŚSD_K06, MŚSD_K07, MŚSD_K05, MŚSD_U06, MŚSD_U07, MŚSD_U08, MŚSD_U11, MŚSD_W02, MŚSD_W01, MŚSD_W05, MŚSD_W08).	Graded assignment

Professional traineeship – according to internal rules of home university of the doctoral student	2	Doctoral student participates in trainings, gaining knowledge regarding safety and hygiene of work as well as skills of applying advanced techniques and didactic tools (MŚSD_W07, MŚSD_W08, MŚSD_U01, MŚSD_K09).	
Introduction to statistics: elements of probability theory; drawing conclusions: statistical hypotheses and tests; elements of programming with R and Statistics (coordinator: Institute of Mathematics PAS)	1	Doctoral student familiarizes with the basic formal apparatus and the fundamental concepts of mathematical statistics. The participant familiarizes with the key concepts of theory of probability and certain useful distributions of probability for data analysis. Learns the basics of the theory of testing statistical hypotheses which are a scientific tool to verify research hypotheses. The module enables also familiarization of doctoral students with the popular statistical software which allows to carry out a broad range of statistical analyses (MŚSD_W02, MŚSD_U01, MŚSD_U04, MŚSD_U05, MŚSD_U08, MŚSD_U11).	Graded assignment
General geophysics: the Earth's crust; magnetism and palaeomagnetism; atmospheric physics with biomedical elements (coordinator: Institute of Geophysics PAS)	1	Doctoral student familiarizes with the basic issues targeted at improving their understanding of development and modern geosystem status, understood as interactions of various zones on Earth: lithosphere, atmosphere and hydrosphere, with significant consequences for biosphere and finally, for anthroposphere. Gains the basic knowledge regarding the processes governing geosystem, broadens the gained knowledge beyond own specialization and better understands natural aspects of their specialist research. Gains knowledge about the basic distribution (depending on the time and place on earth) of fields and electric currents in magnetosphere, ionosphere and atmosphere and during calmer magnetically days as well as disrupted days. Familiarizes with models that describe electric phenomena in the ionosphere and atmosphere as well methods of verification of the results of calculations with application of these models on the basis of the selected parameters of the atmosphere. Extends knowledge by certain issues from the area of atmosphere physics and methods of analysis as well as description of the processes occurring in the atmosphere. Learns about the basic physical processes ruling the weather and the climate. Gains knowledge in the scope of dynamic meteorology, atmosphere thermodynamics, transfer of radiation by the atmosphere and electricity of atmosphere in a degree enabling the use of current literature and solving own scientific issues concerning natural environment. Broadens knowledge regarding chemical-dynamic processes, related to stratospheric ozone, tropospheric and ground level ozone. Familiarizes with such concepts as photochemical smog, repair of the ozone layer, global chemical-dynamic models of the earth's atmosphere, statistical methods of designating trends in atmospheric ozone, ozone versus climate changes. Gains information about the basic properties of sunlight, sizes of applied in the assessment biological effects of sunlight, time-space volatility on a global scale of sunlight in the scope of ultraviolet/visible as well as photobiological processes. (MŚSD_K05, MŚSD_U03, MŚSD_U02, MŚSD_U01, MŚSD_U11, MŚSD_W01, MŚSD_W05)	Exam
Fundamentals of physical oceanography: Characteristics of the ocean's physical environment (exchange of mass and heat between the ocean and the atmosphere; thermohaline circulation; optical processes); the role of the ocean	1	Doctoral student discovers the characteristics of physical environment in marine areas. Understands complex phenomena and natural processes as well as multi-layer nature of factors impacting these phenomena and processes (in particular with regards to the polar regions). Understands the role of the ocean in shaping the climate. Has an in-depth knowledge concerning issues currently discussed in the Polish and foreign subject literature in the scope of physical oceanography and mutual interactions between ocean circulation and climate. Knows current oceanographic research programmes of world scope and those carried out in polar areas. Knows the principles of safety and hygiene at work, especially with regards to field research,	Exam

<p>in shaping the climate; research methods in physical oceanography; examples of oceanographic research programmes (coordinator: IO PAS)</p>		<p>also on board of a ship. Is able to apply advanced techniques and research tools in order to solve scientific issues in the scope of oceanographic research. Is proficient in the Polish and world scientific literature, has the skills of critical analysis of literature and materials coming from electronic sources. Has the ability to gather materials and information from various sources (also coming from own research, including from the ship's board), elaboration of gathered material and formulating conclusions. Understands the need of systematic acquainting oneself with Polish and foreign scientific journals necessary to increase general and specialist knowledge in the scope of a physical oceanography. Shows the need and systematically updates knowledge about nature in order to use it in practice (MŚSD_W01, MŚSD_W05, MŚSD_W07, MŚSD_U01, MŚSD_U02, MŚSD_U03, MŚSD_U11, MŚSD_K05, MŚSD_K07).</p>	
<p>The application of remote sensing and GIS in the study of natural environment, including computer analysis of images (coordinator: US INS)</p>	<p>1</p>	<p>The module enables doctoral students to familiarize with the latest achievements in the area of re-detection and GIS in environmental and technical research (MŚSD_W05, MŚSD_W06, MŚSD_U02). Doctoral students will gain the skills of designating morphometric parameters of glaciers and snow covers as well as tracking the dynamics of glacier processes and analyses of changes of natural environment and the use of tele-detection in engineering with the application of various methods of digital and geographic images analysis. Information systems (MŚSD_W08, MŚSD_U01, MŚSD_U03, MŚSD_U04, MŚSD_U11, MŚSD_K05, MŚSD_K07).</p>	<p>Graded assignment</p>
<p>Biomaterials and tissue engineering: definitions and classification of biomaterials; significance and areas of application of engineering materials in medicine (coordinator: US Faculty of Science and Technology)</p>	<p>1</p>	<p>The module enables doctoral students to familiarize with a comprehensive knowledge in the scope of biomaterial engineering and tissues in consideration of modern trends in medicine. Doctoral students will familiarize themselves with the processes occurring in the implant-organism system, construction and functions of the bone tissue, tissue engineering and cell replies, definitions and biomaterial classification, meaning and areas of applying engineering materials in medicine, criteria of selecting engineering materials for biomedical application, production and characteristics of the basic engineering materials applied in medicine, biomaterial surface engineering, modern methods applied in biomaterial tests and tissues as well as international standards regulating biocompatibility assessment (MŚSD_W01, MŚSD_W10, MŚSD_W11, MŚSD_W12, MŚSD_W13, MŚSD_U01, MŚSD_U09, MŚSD_U10, MŚSD_U11, MŚSD_U12, MŚSD_K10).</p>	<p>Exam</p>
<p>Basics of Mathematical Analysis and Algebra: Basics of linear algebra and differential equations, general and partial equations, basic lecture from differential equations and calculus with application in natural and technical sciences (coordinator: Institute of Mathematics PAS)</p>	<p>2</p>	<p>Doctoral student learns the basics of linear algebra, differential equations and calculus with emphasis on their application in natural sciences. Learns one and multiple-dimension derivatives and their geometric meaning, operators of mathematical physics and elements of differential geometry of the area in three-dimensional area. Doctoral student obtains the skills of calculating calculus and their application. In the second part of the course, doctoral student gains knowledge about the basics of differential equations with emphasis on their application in natural sciences, life sciences and earth sciences. Calculates sets of ordinary linear equations and fundamental operators. (MŚSD_W02, MŚSD_W04, MŚSD_U01, MŚSD_U02, MŚSD_U04, MŚSD_U05, MŚSD_U08, MŚSD_U09, MŚSD_U11).</p>	<p>Graded assignment</p>

<p>Modelling and quantitative methods in geophysics and hydrology: classical mechanics with the elements of continuum mechanics; hydraulic and hydrological processes (coordinator: Institute of Geophysics PAS)</p>	<p>1</p>	<p>The goal of classes in this module is to introduce to doctoral students the basics of classic mechanics (principle of the least action, Nether's claim, Hamiltonow approach and Lagrange's approach) and teaching the basics of the theory of plasticity, elasticity and mechanics of liquids. Permanent centres are the foundations of seismology, hydrology, dynamics of atmosphere, dynamics of earth's core.</p> <p>Doctoral student learns mechanistic hydrological models (based on data) and based on physical equations. Characterizes the components of hydrological cycle. Discovers the methods of modelling selected cycle elements by means of models of various complexities: models based on mathematical physics equations, conceptual models based on expert knowledge and mechanistic models based solely on observations.</p> <p>Doctoral student learns how to model the river flow upon a variable component of roughness. Discovers single-dimensional equation of flow and its simplifications, numerical methods of single-dimension solution of flow, empirical methods of estimating roughness coefficient, characteristics of flow in the river bed with glacier cover. Specifies the coefficient of roughness of the lower area of the glacier cover based on measurements of velocity distribution.</p> <p>Doctoral student obtains fuller information regarding indicator methods in polar environment research. During classes isotopic methods, of particular importance in the polar research. Doctoral student will be able to familiarize not only with the selected radioactive isotopes designated for dating in ice but also with how to use the diversity of stable isotopes in samples for determining diversity of natural environment in individual time intervals and how they may be used to specify the dynamics and directions of flow of pollution into the Arctic (MŚSD_K06, MŚSD_U04, MŚSD_U03, MŚSD_U02, MŚSD_U01, MŚSD_W04, MŚSD_W01, MŚSD_W05, MŚSD_W01, MŚSD_W05, MŚSD_K05, MŚSD_U03, MŚSD_U02, MŚSD_U01, MŚSD_U11, MŚSD_W07).</p>	<p>Graded assignment</p>
<p>Natural environment of the Arctic, the Antarctic and mountain regions: geophysical methods in the study of cryosphere, snow and naval processes; meteorology and climate; glaciology (coordinator: Faculty of Earth Sciences at the University of Silesia)</p>	<p>1</p>	<p>Within the module doctoral students will obtain knowledge in the scope of geophysical methods applied in research on individual elements of cryosphere and the issues of polar environment possible to be solved by means of these methods (MŚSD_W01, MŚSD_W04, MŚSD_W07). Has the skills of practical application of geophysical tools for identifying the state and processes occurring in the glacial and periglacial environment (MŚSD_U01, MŚSD_K02). Doctoral students will gain the skills of obtaining as well as processing geophysical data and interpreting the obtained results (MŚSD_U01, MŚSD_U03) based on the knowledge of processes occurring among the polar environment components (based on literature sources and the knowledge obtained in the course of education; MŚSD_W05). Based on the correctly carried out interpretation doctoral students will be able to carry out drawing conclusions concerning the course of processes taking place in the cryosphere and correctly indicate their causes and environmental effects (MŚSD_W04). Gaining knowledge in the scope of trends in applying geophysical techniques and knowledge of the current research issues in the cryosphere of the polar areas (MŚSD_W01, MŚSD_W05) will allow doctoral students to specify the key research hypotheses in this area, methods of their verification and correct research and interpretation processes (MŚSD_U04, MŚSD_K03, MŚSD_K06). Doctoral students will also gain the skills related to appropriate presentation and publication of geophysical results (MŚSD_U07).</p> <p>The module will enable doctoral students to familiarise themselves with physical processes, parameterization and modelling the issues of snow cover bearing in mind topographic and meteorological conditions (MŚSD_W01,</p>	<p>Exam</p>

		<p>MŚSD_W05 MŚSD_K05). Furthermore, doctoral students will be able to obtain the skills of marking physical features of the snow cover, elaborate and present the gathered data (MŚSD_U01 MŚSD_U03) and discover the principles of winter safety (MŚSD_W07). As a result of participation in the module the doctoral student will understand the functioning of complex climate system in polar areas bearing in mind the processes and interactions occurring among its components (MŚSD_W01). Doctoral student obtains knowledge regarding modern climate changes in polar areas; on the basis of the indicated literature and current information on the Internet verifies and critically assesses development and quality of information (MŚSD_W05, MŚSD_U02, MŚSD_K05).</p> <p>Classes show doctoral students the bases and latest research results on glaciers and glacial processes as well as the interaction of glaciers with the climate. The classes cover current changes in the ice glacier of the Earth, measurements and modelling the balance of mass and energy balance of glaciers, issues of hydrology and the dynamics of glaciers (including the processes of breaking off of icebergs and charges). Doctoral students will work in teams and independently, using original measurement data and the current Polish and foreign literature. Doctoral student learns and obtains the skills of obtaining the available meteorological and climate data, applying methods of analysis of climate data, including research methods of relations between climate elements and climate-forming factors as well as presenting the obtained results (MŚSD_U01, MŚSD_U03). As a result doctoral student is able to cooperate in a creative manner and work in a team, assuming various roles in it (MŚSD_K02, MŚSD_K03, MŚSD_K06, MŚSD_U04, MŚSD_U03, MŚSD_U02, MŚSD_U01, MŚSD_U07, MŚSD_W07, MŚSD_W01, MŚSD_W05).</p>	
<p>Geochemical study of seas and oceans: fundamental chemistry of seawater and marine sediments; biogeochemical processes in marine environment; chemical pollution of natural environment and its consequences; the impact of climate changes on the circulation of chemical substances of natural and anthropogenic origin; regional variability; elements of marine radiochemistry; modern instrumental methods used in ocean chemistry (coordinator: Institute of Oceanology PAS)</p>	<p>1</p>	<p>Doctoral student has the basic knowledge concerning the flow of chemical substances of natural and anthropogenic origins in marine ecosystems. Understands complex phenomena and natural processes as well as multi-layer nature of factors impacting these phenomena and processes (in particular with regards to the polar regions). Has knowledge concerning the use of isotope methods in environmental research. Has an in-depth knowledge concerning currently discussed in the subject Polish and foreign literature issues in the scope of chemistry of the sea with detailed consideration of the impact of climate changes on the flow of chemical substances. Knows the principles of safety and hygiene at work with regards to field research and laboratory works, including also on board of a ship.</p> <p>Is able to apply advanced techniques and research tools in order to solve scientific issues in the scope of chemistry of the sea with special consideration of issues of natural environment pollutions. Is proficient in the Polish and world scientific literature, has the skills of critical analysis of literature and materials coming from electronic sources. Has the ability to gather materials and information from various sources (also coming from own research, including from the ship's board), elaboration of gathered material and formulating conclusions. Understands the need of systematic acquainting oneself with Polish and foreign scientific journals necessary to increase general and specialist knowledge in the scope of chemistry of the sea, with special focus on the issue of natural environment pollution and the impact of climate changes on</p> <p>The flow of chemical substances.</p>	<p>Exam</p>

		Shows the need and systematically updates knowledge about nature in order to use it in practice (MŚSD_W01, MŚSD_W05, MŚSD_W07, MŚSD_U01, MŚSD_U02, MŚSD_U03, MŚSD_U11, MŚSD_K05,	
Biomaterial and tissue degradation study methods: the effect of biological environment and external factors of biomaterials (coordinator: US Faculty of Science and Technology)	1	The module enables doctoral student to familiarize with the complex knowledge about the phenomena related to biological environment impact and external factors on biomaterials and tissue as well as characterizing the processes of their degradation. Doctoral students familiarise themselves with the basic concepts and definitions related to the degradation of biomaterials and tissues, the essence of the impact of the biologically active environment and external factors on biomaterials and tissues, modern in vitro and in vivo research methods to assess the susceptibility of biomaterials and tissues to degradation at the macro, micro and nano scale, mechanisms of basic degradation processes of metallic, ceramic and polymer biomaterials and tissues, as well as identification of degradation products of biomaterials and tissues (MŚSD_W01, MŚSD_W10, MŚSD_W11, MŚSD_W12, MŚSD_W13, MŚSD_U01, MŚSD_U09, MŚSD_U10, MŚSD_U11, MŚSD_U12, MŚSD_K10).	Exam
Unity and diversity of environmental and polar sciences (coordinator: Faculty of Earth Sciences at the University of Silesia)	1	Doctoral students learn about the relationship between polar sciences and other disciplines and fields of knowledge. They acquire the ability to comprehensively analyse the causes, course and effects of natural and socio-economic processes in the polar areas. They also familiarise themselves with the literature and leading journals in the field of polar sciences and fields related to polar sciences. They learn and understand the legal conditions of Polish and international activity in the Arctic and Antarctic. They also learn the principles of safe exploration of polar areas and assessment of risk resulting from the use in research of techniques and tools specific for work in polar conditions (MŚSD_W08, MŚSD_K05, MŚSD_K06, MŚSD_U09, MŚSD_U11, MŚSD_W03, MŚSD_W07, MŚSD_W01, MŚSD_W05, MŚSD_W09, MŚSD_K09).	Exam
Modern methods of data analysis: techniques of supervised learning and unsupervised (coordinator: Institute of Mathematics PAS)	1	The module enables doctoral students to learn about the main classes of machine learning problems: supervised learning and unsupervised learning. As regards the typical applications, supervised learning relates to classification and regression problems, while unsupervised learning includes segmentation methods or dimension reduction methods. Doctoral students gain knowledge on the methods available in this field and how to use them in research areas. The material included will make it possible for doctoral students to deepen their knowledge and enable further, independent, continuation of development in this field. It will also enable the use of specialist literature related to data analysis methods (MŚSD_W02, MŚSD_W04, MŚSD_U01, MŚSD_U02, MŚSD_U04, MŚSD_U05, MŚSD_U08, MŚSD_U09, MŚSD_U11).	Exam
Biomaterials inspired by nature: production and application of materials inspired by biology (coordinator: Faculty of Computer Science and Material Science at the University of Silesia)	1	The module allows doctoral students to learn about the current approach in the production of materials inspired by biology, with particular emphasis on their mechanical, surface and adaptive properties, and assessment of the structure-properties relationship. Doctoral students learn about nature as an inexhaustible source of ideas, inspirations and engineering solutions, biomaterials inspired by nature as a solution to key challenges of modern medicine, basics of engineering in biological materials, replication of the principles of biological design in synthetic materials, biomimetic biomaterials and current scientific trends regarding the use of	Graded assignment

		intelligent biomaterials in regenerative medicine, tissue engineering, implantology and targeted therapy (MŚSD_W01, MŚSD_W08, MŚSD_W10, MŚSD_W11, MŚSD_W12, MŚSD_W13, MŚSD_U01, MŚSD_U09, MŚSD_U10, MŚSD_U11, MŚSD_U12, MŚSD_K10).	
Abiotic systems or environmental monitoring and geosphere monitoring, including polar areas (coordinator: Institute of Geophysics PAS)	1	<p>As part of the classes, monitoring systems and international databases functioning in the Arctic will be presented by specialists from abroad. Doctoral students familiarise themselves with the requirements for placing online data in data centres of organizations such as AMAP, SAON, CEON, CALM, WGMS, NORSAR, ERLINET-NASA, IMAGE, EUROMAGNET, GLISN. During the seminar classes, the practical possibility and way of using the results of the work and the data presented in databases, which are directly accessible by polar researchers, will also be presented.</p> <p>Doctoral students learn and understand concepts regarding individual components of the geosphere. They learn (based on examples) the interpenetration and specificity of individual spheres in polar areas, such as disturbances in the ionosphere and their impact on weather conditions and the dynamics of changes in the atmosphere. They learn the relationships and regularities in the interrelationships of natural processes, resulting from long and short-term changes in individual spheres, e.g. between the hydrosphere and the cryosphere during periods of warming and cooling of climate (MŚSD_K02, MŚSD_K03, MŚSD_U03, MŚSD_U02, MŚSD_U01, MŚSD_U07, MŚSD_U11, MŚSD_W01, MŚSD_W05).</p>	Exam
Current changes in marine ecosystems: fundamentals of ocean ecology; deep-sea and costal ecosystems; ecology of polar regions; sea ice ecosystem; the impact of climate changes on the functioning of ecosystems; basic study methods; genetic aspect of environmental changes (coordinator: Institute of Oceanology PAS)	1	<p>Doctoral student has basic knowledge about ecological processes in marine ecosystems. Understands complex phenomena and natural processes as well as multi-faceted factors influencing these phenomena and processes (in particular in relation to the polar regions), has in-depth knowledge of the issues of marine ecology currently discussed in the Polish and foreign literature in this field, with particular emphasis on the impact of climate change on the functioning ecosystems. Knows the principles of safety and hygiene at work with regards to field research and laboratory works, including also on board of a ship.</p> <p>Is able to apply advanced techniques and research tools in order to solve scientific issues in the scope of ecology of the sea. Is proficient in the Polish and world scientific literature, has the skills of critical analysis of literature and materials coming from electronic sources. Has the ability to gather materials and information from various sources (also coming from own research, including from the ship's board), elaboration of gathered material and formulating conclusions.</p> <p>Understands the need of systematic acquainting oneself with Polish and foreign scientific journals necessary to increase general and specialist knowledge in the scope of ecology of the sea. Indicates the need and systematically updates their knowledge in order to use it in practice (MŚSD_W01, MŚSD_W05, MŚSD_W07, MŚSD_U01, MŚSD_U02, MŚSD_U03, MŚSD_U11, MŚSD_K05, MŚSD_K07).</p>	Graded assignment

5) Doctoral School educational programme;

General educational programme of IEDS

Year 1

Compulsory classes					
Module code w USOS	Module name	Form of classes	Form of assessment	Number of contact hours	Number of ECTS ECTS
04-S3-IMSD-WS	Introduction to statistics: elements of probability theory; drawing conclusions: statistical hypotheses and tests; Elements of programming in R and Statistica (coordinator: Institute of Mathematics PAS)	Lecture + seminar	Graded assignment	Lecture: 15 hrs, Seminar: 15 hrs	1
04-S3-IMSD-GO	General geophysics: Earth's crust, Magnetism and paleomagnetism, Atmospheric physics with elements of biomedicine (coordinator: Institute of Geophysics PAS)	L + S	Exam	L 15 hrs, S: 15 hrs	1
04-S3-IMSD-POF	Fundamentals of physical oceanography: Characteristics of the ocean's physical environment (exchange of mass and heat between the ocean and the atmosphere; thermohaline circulation; optical), role of the ocean in shaping climate, research methods in physical oceanography, examples of oceanographic research programmes (coordinator: Institute of Oceanology PAS)	L + S	Exam	L:15 hrs, S: 15 hrs	1
04-S3-IMSD-GIS	The application of remote sensing and GIS in the study of natural environment, including computer analysis of images (coordinator: Faculty of Earth Sciences at the University of Silesia) Faculty of Earth Sciences at the University of Silesia	L + S	Graded assignment	L:15 hrs, S: 15 hrs	1
04-S3-IMSD-IBT	Biomaterials and tissue engineering: definitions and classification of biomaterials; significance and areas of application of engineering materials in medicine (coordinator: Faculty of Computer Science and Material Science at the University of Silesia)	L + S	Exam	L:15 hrs, S: 15 hrs	1
04-S3-IMSD-JA	Specialist English	S	Graded assignment	S: 60	2
04-S3-IMSD-WM	Methodological workshop: social and legal issues; career planning; writing papers and project proposals; transferring knowledge to pupils and students (coordinator: US INS + MCSU)	L + S	Graded assignment	L:6 hrs, S: 6h	1
04-S3-IMSD-SD	Seminar	S	Graded assignment	S: 60 hrs	2
04-S3-IMSD-PZ	Professional traineeship – according to internal rules of a doctoral student's parent institution	-	Graded assignment	60h	2
TOTAL				342h	12

The educational programme is offered from the beginning of the academic year 2019/2020 onwards.

General educational programme of IEDS

Year 2

Compulsory classes					
Module code w USOS	Module name	Form of classes	Form of assessment	Number of contact hours	Number of ECTS ECTS
04-S3-IMSD-PAMA	Basics of Mathematical Analysis and Algebra: Basics of linear algebra and differential equations, general and partial equations, basic lecture from differential equations and calculus with application in natural and technical sciences (coordinator: Institute of Mathematics PAS)	Lecture + seminar	Graded assignment	Lecture: 30h, seminar 15hrs	2
04-S3-IMSD-MMGGH	Modelling and quantitative methods in geophysics and hydrology: classical mechanics with the elements of continuum mechanics; hydraulic and hydrological processes (coordinator: (coordinator: Institute of Geophysics PAS)	L + S	Graded assignment	L:15 hrs, S: 15 hrs	1
04-S3-IMSD-SPAA	Natural environment of the Arctic, the Antarctic and mountain regions: geophysical methods in the study of cryosphere, snow and naval processes; meteorology and climate; glaciology (coordinator: Faculty of Earth Sciences at the University of Silesia	L + S	Exam	L:15 hrs, S: 15 hrs	1
04-S3-IMSD-BGMO	Geochemical study of seas and oceans: fundamental chemistry of seawater and marine sediments; biogeochemical processes in marine environment; chemical pollution of natural environment and its consequences; the impact of climate changes on the circulation of chemical substances of natural and anthropogenic origin; regional variability; elements of marine radiochemistry; modern instrumental methods used in ocean chemistry of the sea	L + S	Exam	L:15 hrs, S: 15 hrs	1
04-S3-IMSD-MBDBT	Biomaterial and tissue degradation study methods: the effect of biological environment and external factors of biomaterials (coordinator: Faculty of Computer Science and Material Science at the University of Silesia	L + S	Exam	L:15 hrs, S: 15 hrs	1
04-S3-IMSD-JA	Specialist English	S	Graded assignment	S: 60	2
04-S3-IMSD-SD	Seminar	S	Graded assignment	S: 60 hrs	2
04-S3-IMSD-PZ	Professional traineeship – according to internal rules of a doctoral student’s parent institution	-	Graded assignment	60h	2
TOTAL				345h	12

The educational programme is offered from the beginning of the academic year 2019/2020 onwards.

General educational programme of IEDS

Year 3

Compulsory classes					
Module code w USOS	Module name	Form of classes	Form of assessment	Number of contact hours	Number of ECTS ECTS
04-S3-IMSD-JRN	Unity and diversity of natural and polar sciences (coordinator: Faculty of Earth Sciences at the University of Silesia)	Lecture + seminar	Exam	Lecture: 15 hrs, Seminar: 15 hrs	1
04-S3-IMSD-NMAD	Modern methods of data analysis: techniques of supervised learning and unsupervised (coordinator: Institute of Mathematics PAS)	L + S	Exam	L:15 hrs, S: 15 hrs	1
04-S3-IMSD-BIN	Biomaterials inspired by nature: production and application of materials inspired by biology (coordinator: Faculty of Computer Science and Material Science at the University of Silesia)	L + S	Graded assignment	L:15 hrs, S: 15 hrs	1
04-S3-IMSD-ASMŚ	Abiotic systems or environmental monitoring and geosphere monitoring, including polar (coordinator: Institute of Geophysics PAS)	L + S	Exam	L:15 hrs, S: 15 hrs	1
04-S3-IMSD-WZEM	Current changes in marine ecosystems: fundamentals of ocean ecology; deep-sea and costal ecosystems; ecology of polar regions; sea ice ecosystem; the impact of climate changes on the functioning of ecosystems; basic study methods; genetic aspect of environmental changes (coordinator: Institute of Oceanology PAS)	L + S	Graded assignment	L:15 hrs, S: 15 hrs	1
04-S3-IMSD-SD	Seminar	S	Graded assignment	S: 60 hrs	2
04-S3-IMSD-PZ	Professional traineeship – according to internal rules of a doctoral student’s parent institution	-	Graded assignment	60h	2
TOTAL				270h	9

The educational programme is offered from the beginning of the academic year 2019/2020 onwards.

General educational programme of IEDS

Year 4

Compulsory classes					
Module code w USOS	Module name	Class types	Form of assessment	Number of contact hours	Number of ECTS ECTS
04-S3-IMSD-SD	Seminar	seminar	Graded assignment	60h	2
04-S3-IMSD-PZ	Professional traineeship – according to internal rules of a doctoral student's parent Institution	-	Graded assignment	60h	2
TOTAL				120h	4

The entire cycle of education (Year I – IV)

Compulsory classes					
Module code w USOS	Module name	Form of classes	Form of assessment	Number of contact hours	Number of ECTS points
04-S3-IMSD-KS	Specialist courses (abroad)	L + S	Graded assignment / Exam	L + S 150–300 hrs	10
TOTAL				150–300 hrs	10

The educational programme is offered from the beginning of the academic year 2019/2020 onwards.

6) Determination of duration of doctoral school;

4 Years

7) Indication of degree obtained by graduates;

University of Silesia in Katowice:

Doctor of exact sciences and natural sciences in the discipline of Earth and life science

Doctor of engineering-technical science disciplines: materials engineering

Institute of Geophysics of PAS:

Doctor of exact sciences and natural sciences in the discipline of Earth and life science

Institute of Oceanology of PAS:

Doctor of exact sciences and natural sciences in the discipline of Earth and life science

Institute of Mathematics of PAS:

Doctor of exact sciences and natural sciences in the discipline of mathematics