Module Handbook

The MSc: 70710401 – Environmental Protection
(agriculture and water sector option) degree program

Mandatory courses

Module designation	**AIT-5106 – Research methodology in environmental sciences**
Semester(s) in which the module is taught	*1*
Person responsible for the module	*Prof., Dr. Maria Radkevich*
Language	*Uzbek, Russian*
Relation to curriculum	*Mandatory*
Teaching methods	*Lecture, practical lesson, self-learning*
Workload (incl. contact hours, self-study hours)	*Total workload: 180* *Contact hours: lecture - 20, practical lessons – 70, self-learning – 90, hours*
Credit points	*6*
Required and recommended prerequisites for joining the module	To master the course, Master Students must have basic knowledge in "Higher mathematics", "Environmental Protection", "Environmental monitoring", "Environmental impact assessment".
Module objectives/intended learning outcomes	**To know and understand:** - principles of organizing experiments; - peculiarities of experimental research in the field of environmental protection; - technologies of construction of methods of selection of the main factors of the experiment and factor plans; - principles of analysis in natural science research; - basic types of regression analysis and level 2 plans, as well as basic methods of processing experimental results; **To be able to:** - select the necessary factors and make factor plans for different types of experiments; - determine the necessary sample size; - analyze the properties of regression model parameters; - process experimental results using mathematical statistics and the application of computer programs; **To form competences in:** - independently planning and conducting scientific research; - choosing an experiment design according to the optimum criterion; - estimating the coefficients of the regression model of the experiment; - making optimal plans of scientific and technical experiments and processing the results of the experiment with the help of applied computer programs.

Content: The discipline includes the following topics. The *level of difficulty*: (1 – low, 5 high):	Research methods in modern science. Basic concepts. Brief information on probability theory and mathematical statistics. Random variables and parameters of their distribution. The law of normal distribution. Statistical approach to the analysis of natural phenomena. Identification of cause-and-effect relationships in active and passive experiments. Use of meta-analysis method for statistically efficient generalisation of results of unrelated studies. General methods of extremum search. The method of elimination. L*evel of difficulty*: 4. Experiment planning in the study of natural systems. Experiment planning in the works of foreign scientists. Planning of experiment as a component of scientific research. Selection of the experiment scheme using the optimum criterion. Dependence of the breadth and realism of conclusions on the accuracy of the results obtained. Purpose and objectives of the research. Main problems. Level of difficulty: 3. Basic principles of experiment organizing. Classification of experiments. Structural scheme of the experiment. Experimental unit and measured units. Statistical unrelatedness and structure of the experiment plan. Selection of a representative object. Prevention of errors in controlled experiments. Choice of control method in an active experiment setting. Randomization in an active experiment setting. Spatial placement of experimental units under active experiment conditions. Selection of experimental units under passive experimental conditions. Elements of error theory. Interval estimation of measurement errors. Exclusion of gross errors. Smirnov's and Dixon's criteria. Methods of increasing the accuracy of the experiment. Level of difficulty: 4. Formulating hypotheses and preparing them for experimental verification. Development of observations and hypotheses. Principles of forming hypotheses and their statistical testing. The view of natural scientists on hypothesis testing. Two types of errors that occur in hypothesis testing. Responsibility for society and accounting for small probabilities. The use of sequential statistical analysis. Level of difficulty: 3. Determining sample size. The amount of information required to estimate the parameter under study with a given precision. The amount of information needed to find a rare object. Amount of information required for statistical testing of hypotheses about correlation coefficients. Amounts of information required for statistical testing of hypotheses about mean values of normally distributed features. Level of difficulty: 4. Planning an experiment. The main problems that can be solved with the help of planning. Stages of research. Preliminary study of the object. Separation experiments. Method of graded correlation. First order plans. Making a plan of experiment. Plans for a full factorial experiment. Level of difficulty: 4. Conducting social surveys in ecological research. The axiom of social survey. Selection of criteria. Determining the sample size. Planning the survey. Creating sample questionnaires. Level of difficulty: 3. Plan an experiment to find the optimum conditions. General issues of finding an extremum from experience. The concept of extreme experiment and its scope of application. Plan extreme experiments. "Step-by-step" methods of experimental optimization. Sequence of extremum finding using methods of" steepest ascent " and interrelated gradients. Simplex method of planning. L*evel of difficulty*: 4. Planning of experiment for studying complex systems. Planning an experiment in the presence of unrelated and quantitatively variable values. Planning an experiment taking into account qualitative factors in the presence of unrelated and quantitatively changing values. Planning an experiment to study complex systems Given their heterogeneous resources. Planning an experiment at the initial stage of studying complex systems. L*evel of difficulty*: 4. Methods of mathematical processing of experiment results. Basic methods of mathematical processing. Statistical hypothesis testing (correspondence criterion, testing of the hypothesis of equality of dispersions, testing of the hypothesis of equality of mean values). Sorting of empirical formulae. Determination of parameters by the method of least squares. Checking the adequacy of the chosen theoretical model by Fisher's criterion. L*evel of difficulty*: 4. Regression and variance analysis. Regression analysis of data. Point estimation of regression dependence parameters. Estimation of regression coefficients. Factorial plans of experiments. Estimation of regression model parameters using different plans. Optimal criteria of regression plans. Analysis of variance. Methods of variance analysis. Single and multivariate analysis. Application of analysis of variance in various questions and studies. Sequence of application of simplified analysis of variance method. Factors affecting the accuracy of analysis. Accuracy of analysis in research in natural sciences. Finding the accuracy of correlation analysis. Finding the accuracy of analysis of variance. L*evel of difficulty*: 4. Processing of information obtained as a result of the experiment using applied computer programs. Processing the results of observations in MS Excel, solving basic problems of pair and multiple regression analysis. Linear polynomial regression. Polynomial regression. Construction of step polynomials with the help of MATLAB package. The system of statistics and its possibilities. Examples of STATISTICA system application. Construction of graphs and their processing in Origin package on the basis of experimental data. L*evel of difficulty*: 4. The following topics are recommended for practical classes: 1.Histogram construction, calculation of quantitative characteristics, testing the hypothesis of normal distribution. L*evel of difficulty*: 4. 2. One-factor experiment. L*evel of difficulty*: 3. 3. Finding empirical relationships for data obtained experimentally by the least squares method. L*evel of difficulty*: 3. 4.Checking the adequacy of theoretical models and experimental data by Fisher's criterion. L*evel of difficulty*: 3. 5.Analysis of experimental data by multivariate regression method. L*evel of difficulty*: 4. 6.Checking the parameters in MS Excel and determining the law of distribution. L*evel of difficulty*: 3. 7.Methods of statistical processing of experimental data. Numerical characteristics of data. L*evel of difficulty*: 3. 8.Statistical hypothesis testing. L*evel of difficulty*: 4. 9.Determination of linear regression coefficients in MS Excel. L*evel of difficulty*: 3. 10.Constructing and analysing experimental graphs in Origin software package. L*evel of difficulty*: 3.
Exams and assessment formats	*Two written midterm assessments (30 minutes each), take-home written assignments and one final oral exam (40 minutes).*

Study and examination requirements	*Requirements for successfully passing the module:* *The final grade in the module is composed of 40% performance on exams, 20 % independent work, 20 % practical work, 20 % mid-term control tests. Students must have a final grade of 60% or higher to pass*
Reading list	1. Roger E. Kirk. Experimental Design: Procedures for Behavioral Sciences, Fourth Edition. SAGE Publications Inc., 2013. – 1048 pp. 2. Siebertz K., Bebber D., Hochkirchen T. Statistische Versuchsplanung: Design of Experiments (DoE). Springer, 2010. 320 p. 3. Козлов М.В. Планирование экологических исследований: теория и практические рекомендации. - М.: КМК, 2015. - 171 с. 4. Davronov Z., Primov M. “Ilmiy tadqiqot metodologiyasi” fanidan o‘quv-uslubiy majmua. T.: Toshkent “Agronomiyada zamonaviy ilmiy tadqiqot uslublari” moduli bo‘yicha o‘quv –uslubiy majmua. T.: TDAU, 2017. 76 b. 5. Холодов В.И. Планирование экспериментов в гидробиологических исследованиях.Севастополь: Институт биологии южных морей им. А.О. Ковалевского, 2014. — 182 с.

Module designation	***GAT-5106, Geoinformation Systems***
Semester(s) in which the module is taught	*1*
Person responsible for the module	*Professor Pulatov A.S.*
Language	*English*
Relation to curriculum	*Mandatory* *This module is shared with study programme Environmental Science (Geoinformation Systems)*
Teaching methods	*Lectures practical lesson, self-learning*
Workload (incl. contact hours, self-study hours)	*Total workload: 180* *Contact hours: lecture - 20, practical lessons – 70, self-learning – 90, hours.*
Credit points	*6*
Required and recommended prerequisites for joining the module	*Geography, Cartography, Environmental protection, Environmental monitoring*
Module objectives/intended learning outcomes	**To know and understand:** - the history of formation and development of the concept of sustainable development; - the main directions of greening of industry and innovative development; - the most used in the world criteria and indicators of sustainable development; - forecast scenarios of the future, existing approaches to the interpretation of the concept of sustainable development; **To be able to:** - use global positioning systems, spatial data infrastructure, - add text and graphics to the map, - select objects, use graphic symbols and attributes, present the map; - organize the data of the geo-information system of environmental protection, agriculture and water management; - collect, store, manage, process, statistical analysis, modelling, description of spatial-geographical data and to prepare a database necessary for all sectors of the national economy. **To form competences in:** - working with the ArcGIS computer program, - performing geometric correction and geolinking of images, - performing vector and raster operations; - creating thematic agroecological maps; - solving practical problems in the field of environmental protection using ArcGIS. - identifying the most effective ways to improve land use, - improving map assessment and economic justification methods, and identifying ways to increase their effectiveness.

Content The discipline includes the following topics. The *level of difficulty*: (1 – low, 5 high):	Conceptual models of reality representation. Models of spatial objects. Spatial data models. Organization of spatial data. Models of the database management system. Geospatial models. L*evel of difficulty*: 3 Geoinformation mapping. Map analysis. Cartographic forecasts. Geographic information systems. Modeling using GIS technologies. Study of soil cover structure and ecosystem bioproductivity based on GIS technologies and remote sensing data. L*evel of difficulty*: 4 Features of GIS application in ecology. Industry use of GIS. Features of GIS application in ecology. GIS capabilities for improving the environmental situation in the region. L*evel of difficulty*: 4 Modeling of atmospheric air pollution in the city. Calculation of atmospheric pollution from industrial enterprises under the ERA program. L*evel of difficulty*: 4 Digitization of the territory of an industrial enterprise in MapInfo 5.0 from scanned images. Creation of new layers of atmospheric pollution in ArcView 3.1. Assessment of atmospheric air pollution and identification of risk zones in ArcView 3.1. L*evel of difficulty*: 4 Modeling of flood zones during floods. Digitization of scanned maps of the territories of the alleged flooding site in MapInfo 5.0. Analysis of flood zones using Spatial Analyst and 3D Analyst modules in ArcView 3.1. L*evel of difficulty*: 3 The following topics may be recommended for practical training: 1. Spatial reference of data and coordinate systems. L*evel of difficulty*: 3 2. Vectorization of data. L*evel of difficulty*: 3 3. Formation of spatial objects. L*evel of difficulty*: 4 4. Digitization of scanned maps in ArcView 3.1. 5. Working with layers in ArcView 3.1. Data analysis in ArcView 3.1. L*evel of difficulty*: 3 6. Creating thematic agroecological maps. L*evel of difficulty*: 4 7. Performing spatial analysis in ArcGIS. L*evel of difficulty*: 4 *8.* Assessment of the recreational potential of green spaces in the city. L*evel of difficulty*: 4
Exams and assessment formats	*Two Midterm assessments (80 minutes each) and one final exam (80 minutes), take-home written assignments*
Study and examination requirements	*Requirements for successfully passing the module* *The final grade in the module is composed of 40% performance on exams, 20% take-home assignments, 40% in-class participation. Students must have a final grade of 60% or higher to pass*
Reading list	1. Kolios S., Vorobev A.V., Vorobeva G.R., Stylios C. GIS and Environmental Monitoring: Applications in the Marine, Atmospheric and Geomagnetic Fields. Springer International Publishing, 2017. — 180 p. 2. Bai Tian. GIS technology applications in environmental and earth sciences. CRC Press, Taylor & Francis Group, 2016. — 256 p. 3. Chang K.T., 2011. Introduction to Geographic Information Systems. Fourth Edition. McGRAW – HILL International Edition. *4.* Васенев И.И., Мешалкина Ю.Л., Грачев Д.А. Геоинформационные системы в почвоведении и экологии. Интерактивный курс. Под ред. И.И. Васенева. — М.: РГАУ - МСХА имени К.А. Тимирязева, 2010. — 212 с

Module designation	**AE -6106 - *Agroecology***
Semester(s) in which the module is taught	*1*
Person responsible for the module	*Prof., Dr. Bakhtiyor Karimov.*
Language	*English, Uzbek*
Relation to curriculum	*Elective*
Teaching methods	*Lecture, practical lesson, self-learning*
Workload (incl. contact hours, self-study hours)	*Total workload: 180* *Contact hours: lecture - 20, practical lessons – 70, self-learning – 90, hours*
Credit points	*6*
Required and recommended prerequisites for joining the module	To master the course, Magister Students must have basic knowledge in ”General ecology and Environmental Protection”, “Hydroecology”, “Hydrology”, “Inorganic and organic chemistry”, “Ecotoxicology and Ecochemistry”, “Environmental monitoring”, “Instrumental methods of analysis", "Environmental impact assessment".
Module objectives/intended learning outcomes	**To know and understand:** - terminology in the field of agroecology and equipment (instruments) used in theoretical and applied agroecological research; - Fundamentals of agroecological knowledge, concepts about the evolutionary progress of agriculture; - Adequate understanding of environmental and anthropogenic factors and their laws of exposure to agroecosystems; - Historical analysis of the relationship between man and nature is inextricably linked with the development of various agroecosystems; - the basic physical and biological properties of natural- and agro- ecosystems, how and why their main biological communities and ecosystem characteristics differ; - the biodiversity in agroecosystems, fundamental processes that determine their composition and functions, important issues related to the preservation and management; - patterns of functioning and impact of environmental and anthropogenic factors on agroecosystems. **To be able to:** - develop or design laboratory and field research (involves the production of reliable hypotheses and the selection of appropriate equipment) to conduct research in agroecosystems in field conditions; - going into the field and conducting the field study in accordance with preliminary design; - propose on how to mitigate the negative impact of the natural and anthropogenic factors on agroecosystems environmental indicators; - consider the agroecological conditions of the regions in order to optimize the growth and formation of crops in different weather and climate conditions; - assess the role of agroecosystems in the formation of biological food products and ensuring food safety - analyse the environmental impact of intensive use of chemicals in agriculture to agroecosystems wellbeing; **To form competences in:** - practical applying the knowledge gained in science in the performance of tasks in certain environmental conditions necessary; - reducing the negative impact of traditionally developed irrigated agriculture, livestock, fisheries and other rural food production sectors on ecology; - proposing the most modern measures and solutions to restore the agroecological state and eliminate other future negative anthropogenic effects; - basic principles of adaptive agriculture on the basis of agrolandshaft; can assess the role of animal and plant waste in the environment; - predicting the negative and positive consequences of agroecosystems development and apply them in professional activities. - implementing and using basics and features of agroecology science in routine professional activities; - analyzing and interpreting the results of field research in order to correspond to requirements of a professional employer, head of scientific research, or professional journal - that is, in a case that is acceptable to all, and, writing in an in-depth scientific way, present them in the form of reports or articles.

Content: The discipline includes the following topics. The *level of difficulty*: (1 – low, 5 high):	Introduction to the science of agroecology, its origin and development. General concepts, the concept of agroecosystem. L*evel of difficulty*: 4 Origin and geographical distribution of Agriculture. Agroecosystem classification. L*evel of difficulty*: 4 Increased environmental impact in the process of progressive technical development of Agriculture. L*evel of difficulty*: 5 Ecosystem services related to agriculture. Environmental services and healthy environment. L*evel of difficulty*: 5 Processes and biotic interactions in agroecosystems, vermeculture and biogumus. L*evel of difficulty*: 5 Energy and matter flows in ecosystems. Global circulation of substances: water, carbon, oxygen, nitrogen, phosphorus. L*evel of difficulty*: 5 Environmental factors in agroecosystems and photosynthesis. The role of photosynthesis in the biosphere. L*evel of difficulty*: 5 Water and its importance in agroecosystems. Agroecological problems of water use in the Aral Sea basin. L*evel of difficulty*: 4. The role of soil in agroecosystems, its development, properties, types and classification. Soil nutrients, active reaction and soil erosion. Edaphone. L*evel of difficulty*: 4. Ecology of the interaction of agroecosystems and pests: chemical and biological methods of combating weeds and harmful insects. The following topics are recommended for practical classes: 1. Technical safety in conducting laboratory and practical agroecological studies. Study and characterize natural climate properties in agroecosystems. L*evel of difficulty*: 3 2. Learning to collect probes from flora and fauna in agroecosystems and prepare them for physico-chemical laboratory laying. L*evel of difficulty*: 4 3. Study of methods and instruments for potentiometric measurement of soil active reaction (pH) and electrical conductivity. L*evel of difficulty*: 4. 4. Assessment of the composition of ecosystem services in agroecosystems of the Uzbekistan lowland regions. L*evel of difficulty*: 4. 5. Determination of algae photosynthesis and primary organic matter production and destruction. L*evel of difficulty*: 5. 6. Agroecological assessment of pollution of agroecosystems using permissible concentrations (REC) (on the example of heavy metals). L*evel of difficulty*: 4 7. Study of the physics-chemical properties of soil. Determination of the amount of mobile nitrogen in the soil. L*evel of difficulty*: 4. 8. Study of the physics-chemical properties of soil. Determination of the amount of phosphorus in the soil. L*evel of difficulty*: 3. 9. Assessment of the level of contamination of river water with organic matter according to the indicator "chemical oxygen consumption". L*evel of difficulty*: 3. 10. Agroecological assessment of pollution of agroecosystems using permissible concentrations (REC) (on the example of organic matters). L*evel of difficulty*: 3. 11. Determination of consumption norms of plant products contaminated with nitrates. L*evel of difficulty*: 3. 12. Determination of primary organic product of field plants and high algae. L*evel of difficulty*: 4 13. Determination of the amount of motile phosphorus (P2O5) in river water by colorimetric method. L*evel of difficulty*: 3. 14. Types of soil erosion, classification by degree of erosion and developing conservation measures. L*evel of difficulty*: 4.
Exams and assessment formats	*Two written midterm assessments (30 minutes each), take-home written assignments and one final oral exam (40 minutes).*
Study and examination requirements	*Requirements for successfully passing the module:* *The final grade in the module is composed of 60% performance on exams, 20% take-home assignments, 20% in-class participation. Students must have a final grade of 60% or higher to pass.*

Reading list	1. Konrad Martin Joachim Sauerborn. Agroecology. Springer Science + Business Media Dordrecht 2013, 330p. 2. Колесников С.И. Агроэкология. 2022, 534с. **ISBN:**9785406100073. 3. Introduction to agroecology. C.D.Galdwel, Songliang Wang. Editors. Springer Nature Singapore Pte Ltd., 2020, 333p. https://doi.org/10.1007/978-981-15-8836-5 4. Эргашев А. ва бошқ. Баркарор тараққиёт ва табиатшунослик асослари. Тошкент, Baktria press, 2016, 296 б. **Information sources** 5. *www.nature.uz* *6.* " http://www.cawater-info.net/

Module designation	**GEK-5106 - Hydroecology**
Semester(s) in which the module is taught	*1*
Person responsible for the module	*Prof., Dr. Bakhtiyor Karimov.*
Language	*English, Uzbek*
Relation to curriculum	*Mandatory*
Teaching methods	*Lecture, practical lesson, self-learning*
Workload (incl. contact hours, self-study hours)	*Total workload: 180* *Contact hours: lecture - 30, practical lessons – 60, self-learning – 90, hours*
Credit points	*6*
Required and recommended prerequisites for joining the module	To master the course, Magister Students must have basic knowledge in ”General ecology and Environmental Protection”, “Hydrology”, “Inorganic and organic chemistry”, “Environmental monitoring”, “Instrumental methods of analysis", "Environmental impact assessment".

Module objectives/intended learning outcomes	**To know and understand:** - terminology in the field of hydroecology and equipment (instruments) used in hydroecology research; - the interaction of physical, chemical and biological qualities of river ecosystems and their importance in fluvial ecosystems ecological sustainability; - the basic physical and biological properties of rivers and lakes, how and why the main biological communities differ in lotic and lentic systems; - the diversity of aquatic ecosystems, fundamental processes that determine the composition and functions of the hydroecosystem; - important issues related to the preservation and management of ecosystems and their biota, critical issues associated with the conservation and management of streams and their biodiversity; - the transformation of ecological processes in fluvial and lentic ecosystems by space and time and professional understanding on what these characteristics mean in terms of hydroecosystem health and proper resource management; - the basics of hydroecological knowledge, the patterns and principles of hydroecology, the abiotic and living components of the hydrosphere on a global and local scale, the mechanisms of their origin, formation and interaction, evolutionary development; - environmental and anthropogenic factors and patterns of their influence on hydroecosystems. **To be able to:** - develop or design laboratory and field research (involves the production of reliable hypotheses and the selection of appropriate equipment) to conduct research in ecosystems in field conditions; - use of web-resources to determine the most rational roots of hydro-ecological field investigations; - going into the field and conducting the field study in accordance with preliminary design; - propose on how to mitigate the negative impact on the ecology of the internal and external environment of natural and artificial bodies of water on the part of mankind. - apply the knowledge gained in science in the performance of tasks in certain environmental conditions necessary, including irrigational and hydrotechnical construction projects implementation. - apply regulation and toxicological standards and can conducting bioindication and biotesting of polluted sewage and air; - apply methods of qualitative and quantitative determination of pollutant groups; **To form competences in:** - mastering qualitative and quantitative methods of assessment of hydro-ecological situation in various river drainages in population and ecosystem levels; - measuring the physical, chemical and biological qualities of aquatic ecosystems and have knowledge of the importance of these qualities and how they interact; - reducing conditions, preventing and restoring the sustainable hydroecological state, as well as proposing the most modern measures and solutions to eliminate other side anthropogenic effects; - Water-food-energy-environment (WEFE) Nexus approach in integrated use of water resources; - implementing and using basics and features of hydroecology science in routine professional activities; - analyzing and interpreting the results of field research in order to correspond to requirements of a professional employer, head of scientific research, or professional journal - that is, in a case that is acceptable to all, and, writing in an in-depth scientific way, present them in the form of reports or articles.

Content: The discipline includes the following topics. The *level of difficulty*: (1 – low, 5 high):	An introduction to stream ecology. Fluvial ecosystems. Lotic and lentic ecosystems. L*evel of difficulty*: 4 Streamflow, the water cycle. Effect of land use on steamflow. Environmental flows. L*evel of difficulty*: 4 Fluvial geomorphology. Sediments and their Transport. L*evel of difficulty*: 5 Water as life environment. Hydroecosystems chemistry, main the main hydrophysical indicators and dissolved chemical elements and compounds. L*evel of difficulty*: 5 Hydrobionts (aquatic organisms) and their functions in ecosystems. The impact of water flow on living organisms. L*evel of difficulty*: 5 The impact of hydrochemical factors on biota. Chemical factors of anthropogenic origin – salinization and acidification. L*evel of difficulty*: 5 Basic laws and principles of hydroecology, biological equilibrium, succession and climax.. L*evel of difficulty*: 5 Impact of irrigation and hydropower development on ecological status of hydroecosystems. Fish protection facilities. L*evel of difficulty*: 4. Climate change and hydroecology. Ecosystem services connected to hydroecosystems. L*evel of difficulty*: 4. The following topics are recommended for practical classes: 1. Ensuring technical safety in laboratory, field, and practical research. Planning and organizing field research using internet resources. L*evel of difficulty*: 3 2. Sampling of non-living (abiotic) components in hydroecosystems and preparing them for physicochemical analysis. L*evel of difficulty*: 4 3. Collecting samples of living (biotic) components in hydroecosystems and preparing them for physicochemical analysis. L*evel of difficulty*: 4. 4. Hierarchical description of various rivers in the republic of Uzbekistan using Google Earth and other online resources. L*evel of difficulty*: 4. 5. Familiarizing with instruments for analyzing hydrophysical and hydrochemical indicators in hydroecosystems. L*evel of difficulty*: 5. 6. Studying the vertical temperature distribution in lentic hydroecosystems (lakes, reservoirs, ponds). L*evel of difficulty*: 4 7. Identifying the ecological stability of lentic aquatic ecosystems (lakes, reservoirs, ponds) against pollution.. L*evel of difficulty*: 4. 8. Learning to measure electrical conductivity and temperature regime of water in various hydroecosystems using a conductometer instrument. L*evel of difficulty*: 3. 9. Comparative evaluating the degree and quality of anthropogenic salinization of the water of Amu darya and Syr darya rivers based on Uzhydromet bulletins.. L*evel of difficulty*: 3. 10. Studying the ecosystem services of hydroecosystems within the territory of the republic of Uzbekistan. L*evel of difficulty*: 3. 11. Indirect measuring water mineralization in different aquatic ecosystems using a conductometer instrument. L*evel of difficulty*: 3. 12. Bioecological assessment of water quality in hydroecosystems across the republic of Uzbekistan through analysis of Uzhydromet bulletins. L*evel of difficulty*: 4 13. Evaluating the trophic level of water in Chirchiq and Ohangaron rivers based on quantities of biogenic and organic compounds as indicated by Uzhydromet and other sources. L*evel of difficulty*: 3. 14. Study of statistical processing and report preparation of the results of hydroecological research. L*evel of difficulty*: 4.
Exams and assessment formats	*Two written midterm assessments (30 minutes each), take-home written assignments and one final oral exam (40 minutes).*
Study and examination requirements	*Requirements for successfully passing the module:* *The final grade in the module is composed of 40% performance on exams, 20% take-home assignments, 40% in-class participation. Students must have a final grade of 60% or higher to pass.*

Reading list	1. Hydroecology and ecohydrology : past, present, and future / edited by Paul J. Wood, David M. Hannah, and Jonathan P. Sadler. John Wiley & Sons, Ltd., 2007. 466p. 2. J.David Allan, Maria M.Castillo. Stream Ecology. Structura and function of running waters. Springer, 2007, 444p. 3. Dawei Han. Concise environmental engineering. 2012. ISBN 978-87-403-0197-7. 141p. E-book: download at: bookboon.com. 4. Логинова Е.В., Лопух П.С. Гидроэкология: курс лекций. МИНСК БГУ. 2011. 300 с. http://www.bsu.by/Cache/pdf/67483.pdf 5. Бестужева, А. С. "Гидроэкология." (2015). https://library.ytit.uz/All-Books 6. Visconti et al 2018. Status, trends and future dynamics of biodiversity and ecosystems underpinning nature's contributions to people. https://elibrary.ru/item.asp?id=36639236 7. Gozlan R., Karimov B., Zadereev E., Kuznetsova D., Brucet S. Status, trends and future dynamics of freshwater ecosystems in Europe and Central Asia. Inland waters (TINW), 2018, https://doi.org/10.1080/ 20442041.2018.1510271. 8. Эргашев А. ва бошқ. Баркарор тараққиёт ва табиатшунослик асослари. Тошкент, Baktria press, 2016, 296 б. **Information sources** 9. *www.nature.uz* *10.* " http://www.cawater-info.net/

Module designation	**EKE-5106 - Ecotoxicology and Ecochemistry**
Semester(s) in which the module is taught	*2*
Person responsible for the module	*Prof., Dr. Bakhtiyor Karimov.*
Language	*English, Uzbek*
Relation to curriculum	*Mandatory*
Teaching methods	*Lecture, practical lesson, self-learning*
Workload (incl. contact hours, self-study hours)	*Total workload: 180* *Contact hours: lecture - 30, practical lessons – 60, self-learning – 90, hours*
Credit points	*6*
Required and recommended prerequisites for joining the module	To master the course, Magister Students must have basic knowledge in ”General ecology and Environmental Protection”, “Inorganic and organic chemistry”, “Environmental monitoring”, “Instrumental methods of analysis", "Environmental impact assessment".
Module objectives/intended learning outcomes	**To know and understand:** - theoretical concepts about molecular, ecological and industrial toxicology, toxicokinetics, toxicodynamics, toxicometry; - the role and pathways of pollutants and compounds in the environment (in the non-living and living ecosystem components) and food chains - dependence of the toxic effect of pollutants on abiotic and biotic environmental factors of the external environment; - the mechanism of toxic action for the environment, dose-effect relationships and the degree of toxicity depending on the molecular structure and tolerance of living organisms; - principles and biological basis of bioindication and biotesting of polluted sewage and air. **To be able to:** - apply the knowledge gained in science in the performance of tasks in certain environmental conditions necessary, including emergency toxic pollution - apply regulation and toxicological standards and can conducting bioindication and biotesting of polluted sewage and air; - apply methods of qualitative and quantitative determination of pollutant groups; - work with abiotic and biotic objects of the external environment, take samples of ecosystem components from contaminated natural and artificial environments and prepare for chemical-ecotoxicological analysis. - knowledge of toxicodynamics and toxicometry features in cases of pollution with toxic chemicals. **To form competences in:** - mastering qualitative and quantitative methods of assessment ecotoxicological situation in the species, population and ecosystem levels; - implementing and using basics and features of toxicodynamics and toxicometry of toxic chemical contamination in routine professional activities; - assessing and predicting ecotoxicological situation and toxic pollution consequences; - applying methods of bioindication and biotesting of polluted sewage, soil and air to control environmental quality.

Content: The discipline includes the following topics. The *level of difficulty*: (1 – low, 5 high):	Ecotoxicology and Ecochemistry – a definition. Toxicological chemistry. The purpose, objectives and main directions of the science of Ecotoxicology and ecochemistry. L*evel of difficulty*: 4 Chemical factors and topical (priority) pollutants, their classification. Major contaminants of aquatic environment. Xenobiotics. Inorganic, organic, natural and synthetic toxicants. L*evel of difficulty*: 4 An ecosystem approach to the migration and transformation of pollutants in ecosystems. Geographic and biotic migration. Ecotoxicokinetics: mobility of pollutants in the surrounding environment. L*evel of difficulty*: 5 The concentration of toxic substances in ecosystem biotic components is the most important measure of toxic effects and toxicological situation. Background levels of toxic elements in the environment. L*evel of difficulty*: 5 Toxic effects and hazard levels of toxic pollutants for ecosystems and humans. In vivo and in vitro toxicity. The Basic Laws of toxicology. Acute and chronic (chronic) toxicity. Xenobiotics and biogeocenoses. The main toxicometric parameters. L*evel of difficulty*: 5 Ecotoxicodynamics and ecotoxicometry of contaminants. Intoxication process and ecotoxicity. Basic toxicometry parameters. Dose – effect interrelationships. The fate of pollutants in environment. L*evel of difficulty*: 5 Xenobiotics and combined toxic effects. Xenobiotic profile. Additism, synergism, antagonism. Toxicity index. Biotransformation system, first phase and conjugation reactions. L*evel of difficulty*: 5 Ecological norms of technogenic man-made pollution of natural ecosystems, regulation of environmental pollution. Maximum permissible environmental load. Assimilation capacity of the ecosystem. Microplastics in Terrestrial and Freshwater Environments. L*evel of difficulty*: 4. The methods of biological control of pollution. Sensitivity of the animals to toxicants. Biotest and bioindication are integral indicators of environmental quality. Test methods, bioconcentration. L*evel of difficulty*: 4. The following topics are recommended for practical classes: 1. Environmental Sample Collection Methods. Collecting water and soil samples and preparing them for toxicological-chemical analysis in field conditions. L*evel of difficulty*: 3 2. Collecting plant and animal species in field conditions and preparing them for toxicological (pesticides) analysis. L*evel of difficulty*: 4 3. Methods of analitical chemistry applied in ecotoxicology and environmental chemistry. L*evel of difficulty*: 4. 4. Quantitative and qualitative assessment of pollution of the environment with plastics on the example of water bodies and land areas in Tashkent region. L*evel of difficulty*: 4. 5. Collection of samples from municipal-household wastewater and determination of toxic chemicals in the composition in laboratory conditions by spectrophotometric method. L*evel of difficulty*: 5. 6. Acquaintance with maximum permissible concentrations (MPS) of toxic substances in water estblished by the U.S. Environmental Protection (EPA) agency and European Union (EU): Part I - inorganic toxicants. L*evel of difficulty*: 4 7. Acquaintance with MPSs of toxic substances in water, established by the US Environmental Protection (EPA) agency and the EU: Part II - organic toxicants. L*evel of difficulty*: 4. 8. The study of the MPSs of toxic chemicals adopted in Uzbekistan on the basis of existing regulatory documents and comparison with foreign standards. L*evel of difficulty*: 3. 9. Identification and classification of groups and concentrations of toxic chemicals in different water bodies using Uzhydromet bulletins. L*evel of difficulty*: 3. 10. Ecotoxicological comparative assessment of the flow of anthropogenic environmental pollutants in rivers in Uzbekistan. L*evel of difficulty*: 3. 11. Ecotoxicological assessment of water quality compliance with livestock and poultry requirements. L*evel of difficulty*: 3. 12. Determination of the level of toxic effects of pollutants using biotestations with aquatic organisms. L*evel of difficulty*: 4 13. Familiarization with the activities of the Department of Pharmacology and Toxicology of the Institute of Plant Chemistry of the Academy of Sciences of the Republic of Uzbekistan for conducting pharmacological, toxicological studies. L*evel of difficulty*: 3. 14. Mastering the methods of statistical processing and preparation of reports of the results of ecotoxicological research. Probit is a method of analysis. L*evel of difficulty*: 4

Exams and assessment formats	*Two written midterm assessments (30 minutes each), take-home written assignments and one final oral exam (40 minutes).*
Study and examination requirements	*Requirements for successfully passing the module:* *The final grade in the module is composed of 40% performance on exams, 20% take-home assignments, 40% in-class participation. Students must have a final grade of 60% or higher to pass.*
Reading list	1. Марченко Б.И. Экологическая токсикология. Учебное пособие. Южный федеральный университет. Ростов-на Дону, Таганрог, Из-во Южного федерального университета. 2017, 103 с. 2. A textbook of modern toxicology / edited by Ernest Hodgson. (North Carolina State University). —4th ed. Wiley-Interscience, John Wiley & Sons, 2011 3. Фрумин Г.Т. 2013. Экологическая Токсикология. Курс лекций. Санкт-Петербург, РГГМУ, 2013. – 179 с. 4. Sylvia Moes, Kees van Gestel, Gerko van Beek. 2021.Environmental toxicology, an open online textbook. 824p. https://maken.wikiwijs.nl/147644/. 5. Токсикологическая химия. Аналитическая токсикология [Электронный ресурс] : учебник / Еремин С.А., Калетин Г.И., Калетина Н.И. и др. Под ред. Р.У. Хабриева, Н.И. Калетиной - М. : ГЭОТАР-Медиа, 2010. - http://www.studentlibrary.ru/book/ISBN9785970415375.html 6. Котелевцев С. В.Экологическая токсикология и биотестирование водных экосистем: Учебное пособие / С.В. Котелевцев, Д.Н. Маторин, А.П. Садчиков - М.: НИЦ ИНФРА-М, 2015. - (Высшее образование: Бакалавриат).- ISBN 978-5-16-010160-6,5.http://e.lanbook.com 7. Лейкин Ю.А. Основы экологического нормирования: Учебник / Ю.А. Лейкин. - М.: Форум: НИЦ ИНФРА-М, 2014. ISBN 978-5-91134-863-2. 8. Экологическая токсикология: учеб.-метод. пособие для самостоят. работы студентов экол. фак. / Е. Г. Климентова, Е. В. Рассадина, Ж. А. Антонова; УлГУ, ИМЭиФК. - Ульяновск : УлГУ, 2016. - 36 с. **Information sources** 9. *Жуйкова, Т. В.* Экологическая токсикология : Учебник и практикум для бакалавриата и магистратуры / Т. В. Жуйкова, В. С. Безель. — Москва : Издательство Юрайт, 2018. — 362 с. — (Бакалавр и магистр. Академический курс). — ISBN 978-5-534-06886-3. — Текст : электронный // ЭБС Юрайт [сайт]. — URL: https://urait.ru/bcode/419577 (дата обращения: 18.05.2021) *10.* "Токсикология [Электронный ресурс] / Жуленко В.Н., Таланов Г.А., Смирнова Л.А. ; под ред. В.Н. Жуленко.- М.: Колос, С., 2013. - (Учебники и учеб. пособия для студентов высш. учебных заведений)." - http://www.studentlibrary.ru/book/ISBN9785953206495.html

Module designation	**SS- 5106 - Water quality**
Semester(s) in which the module is taught	*2*
Person responsible for the module	*Associate professor, PhD Malokhat Abdukodirova* *Associate Professor, PhD Olga Ashirova,* *Prof., Dr. Maria Radkevich*
Language	*Uzbek, Russian, English*
Relation to curriculum	*Mandatory*
Teaching methods	*Lecture, practical lesson, self-learning*
Workload (incl. contact hours, self-study hours)	*Total workload: 180* *Contact hours: lecture - 20, practical lessons – 70, self-learning – 90, hours*
Credit points	*6*
Required and recommended prerequisites for joining the module	Ecology and environmental protection, Environmental biotechnology, Drinking water supply, Multi-purpose water resources use protection
Module objectives/intended learning outcomes	**To know and understand:** - water quality indicators, methods of their determination and principles of rationing; - methods of human and environmental protection from wastewater arising in the process of providing sanitary facilities, technological processes, atmospheric precipitation; - principles of techno-economically justified choice of effective sewerage system of settlements and agro-industrial complexes; **To be able to:** - assess the impact of various natural and economic processes on water quality; - choose methods and facilities for wastewater treatment; - perform calculations of elements of treatment facilities; - draw up schemes of wastewater treatment facilities; design sewerage systems independently; - calculate elements of sewerage networks; - graphically represent engineering networks of sewerage systems; - select and calculate basic parameters of mechanical, - physical-chemical and biological treatment facilities; **To form competences in:** - wastewater quality assessment; - organize labor activity on a scientific basis, choose methods of calculation and their use for assessing the volume and consumption of wastewater formed in the conditions of settlements; - calculations of operation mode and parameters of treatment facilities; - carrying out researches and analyses of facilities operation and know the principles of rational use of sewerage facilities.

Content: The discipline includes the following topics. The *level of difficulty*: (1 – low, 5 high):	Watersheds, the Water Cycle. All the Water on Earth. Build a Watershed Model. A Look at Watershed Maps. Summary of Land Use Trends. Water supply sources. L*evel of difficulty*: 2 Water quality. Indicators of the quality of natural waters. Water quality standards in Uzbekistan and abroad. Indicators of wastewater quality. Opportunities to improve water quality. L*evel of difficulty*: 2 Statistical Analysis of Water Quality Data Spatial Decision Support System (SDSS) for Stormwater Management and Water Quality Assessment. Water.Quality Monitoring and Associated Distributed Measurement Systems. Detecting and Estimating Trends of Water Quality Parameters. Combining Statistical Methodologies in Water Quality. L*evel of difficulty*: 3 Monitoring in a Hydrological Basin - Space and Time Approaches. Statistical Tools for Analyzing Water Quality Data. L*evel of difficulty*: 3 Monitoring and Modelling of Water Quality. Exploring Potentially Hazardous Areas for Water Quality Using Dynamic Factor Analysis. Assessment of Groundwater Quality in Industrial Areas by Indexing Method. L*evel of difficulty*: 3 Water Quality Monitoring Studies. Sodium Levels in the Spring Water, Surface and Groundwater in Uzbekistan. Groundwater Quality Degradation. L*evel of difficulty*: 2 Overview of human land use impacts on water quantity and quality. Water quantity impacts. Water quality impacts (Physical, Chemical, Biological). Point and nonpoint sources of pollutants. L*evel of difficulty*: 3 Agriculture and water quantity. Role of agriculture, the challenges of feeding the world with an increased world population. Pesticides, Fertilizers. The role of pesticides in agriculture. Impacts of pesticide use on water quality. Ways of pesticides entering the water system: Drift, runoff, leaching. General water quality issues. Breaking the pesticide chain: Integrated Pest Management. Caring for Livestock with Water Quality in Mind. L*evel of difficulty*: 3 The impact of urban management on water quality. Composition and characteristics of wastewater. Composition and properties of wastewater. Colloidal, dissolved and insoluble substances in wastewater. Sanitary and chemical analysis of wastewater. Types of contaminants in wastewater. Bacteriological and biological impurities. Classification of industrial wastewater by contamination. L*evel of difficulty*: 3 Determining the required level of wastewater treatment. Determining the concentration of wastewater contamination. Conditions and rules of wastewater discharge into a water body. Process of self-purification of water in nature. Use of wastewater for irrigation. Methods of treatment of municipal wastewater. Installations of mechanical wastewater treatment. Process of self-purification of water bodies. Conditions of wastewater discharge into water bodies. L*evel of difficulty*: 3 Methods of wastewater treatment. Method and essence of mechanical wastewater treatment. Biological wastewater treatment. Biological wastewater treatment in natural and artificial conditions. Bioponds, irrigation and filtration fields. Physico-chemical treatment. Mechanical treatment of industrial wastewater. Biological, physico-chemical treatment of industrial wastewater. L*evel of difficulty*: 4 The following topics are recommended for practical classes: 1. Modelling of Water Quality L*evel of difficulty*: 2. 2. Evaluating sodium Levels in Water. L*evel of difficulty*: 3. 3. Assessing Water Quality. L*evel of difficulty*: 3. 4. Assessing the feasibility of wastewater reuse in agriculture. L*evel of difficulty*: 3. 5. Risk assessment of saline water use in crop production. L*evel of difficulty*: 3. 6. Assessment of possibilities of collector-drainage water treatment. L*evel of difficulty*: 3. 7.Justification and selection of methods of wastewater treatment. L*evel of difficulty*: 3. 8. Selection of devices for mechanical treatment of wastewater. L*evel of difficulty*: 3. 9. Function, types and design of sand traps. L*evel of difficulty*: 2. 10. Calculation of primary and secondary settling tanks. L*evel of difficulty*: 4. 11. Calculation of bioponds. L*evel of difficulty*: 3. 12.Types, functions and design of aeration tank. L*evel of difficulty*: 4. 13.Design of small sewerage system. L*evel of difficulty*: 3. 14. Function and working process of circulating oxidation channel. L*evel of difficulty*: 3. 15.Types of compact units and their working principles. L*evel of difficulty*: 4.

Exams and assessment formats	*One written midterm assessment (30 minutes), take-home written assignments and one final oral exam (40 minutes).*
Study and examination requirements	*Requirements for successfully passing the module:* *The final grade in the module is composed of 40% performance on exams, 20 % independent work, 20 % practical work, 20 % mid-term control tests. Students must have a final grade of 60% or higher to pass*
Reading list	1. Lee T.S. (Ed.) Research and Practices in Water Quality. Intech, 2015. — 263 p. 2. Voudouris Konstantinos (Kostas), Voutsa Dimitra (eds.) Water Quality: Monitoring and Assessment. AvE4EvA, 2015. — 814 p. 3. Mackenzie L. Davis. Water and Wastewater Engineering: Design Principles and Practice. McGraw-Hill Education: New York, 2010-356p. . 4. Einschlag F.S.G., Carlos L.(eds.) Waste Water: Treatment Technologies and Recent Analytical Developments. InTeOp, 2013. - 204 pages *5.* Londong Ing. J. Hentze Abwasserbehandlung. Weiterbildnes Studium Wasser und Umwelt Unterrichtsmaterialen. 5. Auflage. Bauhaus-Universitaet Weimar. 2013. 496 S.

Elective courses

Elective course 1

Module designation	**AMMN-6206 - Theoretical foundations of Environmental Protection**
Semester(s) in which the module is taught	*3*
Person responsible for the module	*Prof., Dr. Maria Radkevich*
Language	*Uzbek, Russian*
Relation to curriculum	*Elective*
Teaching methods	*Lecture, practical lesson, self-learning*
Workload (incl. contact hours, self-study hours)	*Total workload: 180* *Contact hours: lecture - 20, practical lessons – 70, self-learning – 90, hours*
Credit points	*6*
Required and recommended prerequisites for joining the module	To master the course, Master Students must have basic knowledge in ”General ecology and Environmental Protection”, “Inorganic and organic chemistry”, "Environmental impact assessment".
Module objectives/intended learning outcomes	**To know and understand:** - basic approaches to environmental protection; - basic principles of environmental standartisation; - methods of preventing environmental problems; - physical and chemical properties of various pollutants; - fundamentals and regularities of water and gas-air purification processes; - theoretical bases of defence against energy impacts. **To be able to:** - scientifically explain the phenomena and processes involved in treating gas emissions in the atmosphere, wastewater in the hydrosphere, and solid waste in the lithosphere; - evaluate the main parameters of physicochemical environmental protection processes; - correctly select the method of protection from energy impacts. **To form competences in:** - development of environmental standards; - selection, calculation and efficiency assessment of dust and gas purification equipment and water treatment equipment; - assessment and analyze of the efficiency of treatment equipment - use of specialised software packages for environmental calculations.

Content: The discipline includes the following topics. The *level of difficulty*: (1 – low, 5 high):	Basic principles and approaches to environmental protection. Structure of the environment. Biosphere, noosphere and natural-technogenic complexes. The concept of a favourable environment. Criteria and standards of environmental quality. Principles of development of environmental standards (toxicological bases of MAC establishment). General Principles of intensification of technological processes of environmental protection. Methods of prevention of environmental problems. Methods of introducing resource-saving technologies. L*evel of difficulty*: 3. Ways of solving the problem of energy resources. State and prospects of energy resources utilisation in Uzbekistan. Modern tendencies of energy saving. Biofuel: technologies of production, energy and monetary costs, environmental pollution. Secondary energy resources. L*evel of difficulty*: 3. Types and main physical and chemical properties of pollutants. Basic concepts and laws of thermodynamics. Wetting and capillary phenomena. Colloidal systems. Surface phenomena. Dissolved state of substances. Kinetics of chemical processes. Transfer properties in multicomponent systems. Kinetics of heterogeneous processes. Compositions of multicomponent systems. Structural and geometrical characteristics of porous media. L*evel of difficulty*: 4. Ways to reduce carbon dioxide emissions into the atmosphere to solve the problem of "greenhouse effect". Ways to reduce carbon dioxide emissions into the atmosphere to solve the problem of "greenhouse effect". Greenhouse gas emissions and "Kyoto Protocol": situation in the world countries. Problems of cleaning the air from carbon dioxide. Strategic directions to reduce CO2 emissions into the atmosphere. Ways to reduce CO2 emissions into the atmosphere: new developments and research in the world. Methods of purification of waste gases from CO2. Carbon dioxide utilisation using the latest technologies. L*evel of difficulty*: 3. Theoretical bases of atmospheric air protection. General characteristics of the methods of atmospheric air protection. Processes of dispersion of emissions in the atmosphere. Diffusion processes of dispersion in the atmosphere. Methods of cleaning dust and gas streams. Theoretical bases of dry and wet dust and gas purification. Design principles of purification apparatuses. Physico-chemical processes of dust and gas streams purification. Deposition of aerosol particles in electric field. Basics of electrostatic precipitators calculation. Thermophoresis of suspended aerosol particles. Mass exchange processes in dust and gas flows. Absorption of gas impurities. Equilibrium in absorption processes. Material balance and mass transfer in the absorption process. Desorption and degassing of dissolved impurities. Adsorption of gas impurities. Theory of adsorption. Mechanism of adsorption process. Desorption of adsorbed impurities from adsorbents. Crystallisation of substances from solutions. Chemical processes Catalytic processes of purification of gas emissions. Theory of catalysis. Kinetics of heterogeneous catalysis reactions. Solid-phase catalytic purification of nitrogen oxides. Catalytic purification from carbon oxide, sulphur dioxide and organic compounds. Thermal processes of purification of dust and gas streams. Condensation of vapour impurities. High-temperature gas neutralisation. L*evel of difficulty*: 4. Protection of aquatic environment from pollution. Characteristics of water environment pollution. Theoretical bases of wastewater mechanical treatment (gravity and centrifugal treatment, filtration). Physico-chemical processes of wastewater treatment. Fundamentals of coagulation and flocculation of contaminants. Processes of flotation wastewater treatment. Foam separation of surfactants. Thermal processes of wastewater treatment. Concentration of wastewater solutions. Thermal oxidative neutralisation of wastewater. Thermal neutralisation of mineralised effluents. Thermal conditioning of sewage sludge. L*evel of difficulty*: 4. Protection of lithosphere from wastes. Sources and classification of wastes. Main methods of waste processing. Evaluation of solid waste involvement efficiency in material production. Organisation of waste-free and low-waste technologies. Principles of solid waste recovery and utilisation. Application of industrial wastes for reclamation of acidic soils. Application of industrial wastes for amelioration of saline soils. Recultivation of disturbed lands. L*evel of difficulty*: 4. Assessment of economic damage from environmental pollution. Types of economic damage caused to the national economy by environmental pollution. Principles of economic damage assessment. Basic standards of payment for emissions, discharges of pollutants, waste disposal. Environmental insurance. L*evel of difficulty*: 3. Processes of environmental protection from energy impacts. Energy pollution of the environment. Theoretical bases of protection from energy impacts. Protection from mechanical and acoustic vibrations. Protection from ionising radiations. Protection from electromagnetic fields and radiations. Environmental protection from thermal pollution. L*evel of difficulty*: 3. The following topics are recommended for practical classes: 1. Principles of development of environmental regulations. L*evel of difficulty*: 3. 2. Assessment of the cost of biofuel production. L*evel of difficulty*: 3. 3. Risk assessment of bioenergy utilisation. L*evel of difficulty*: 3. 4. Design of a cyclone and evaluation of its performance efficiency. L*evel of difficulty*: 3. 5. Calculation of battery cyclones. L*evel of difficulty*: 3. 6. Determination of heat and mass transfer in wet dust collectors. L*evel of difficulty*: 4. 7. Determination of parameters, energy consumption and time of protective action of adsorber. L*evel of difficulty*: 4. 8. Estimation of economic efficiency of air purification plants. L*evel of difficulty*: 3. 10.Calculation of the basic parameters of hydrocyclone. L*evel of difficulty*: 3. 11.Calculation of parameters of fast and ultrafast filters. L*evel of difficulty*: 3. 12.Determination of parameters of foam separation plants. L*evel of difficulty*: 4. 13.Calculation of parameters of ion-exchange plants. L*evel of difficulty*: 4. 14. Determination of parameters of electrodialysis plants L*evel of difficulty*: 4. 15. Design of electrocoagulation plants. L*evel of difficulty*: 4. 16. Calculation of biofilters and aeration tanks.L*evel of difficulty*: 3.

Exams and assessment formats	*Two written midterm assessments (30 minutes each), take-home written assignments and one final oral exam (40 minutes).*
Study and examination requirements	*Requirements for successfully passing the module:* *The final grade in the module is composed of 40% performance on exams, 20 % independent work, 20 % practical work, 20 % mid-term control tests. Students must have a final grade of 60% or higher to pass*
Reading list	1. Naimpally A., Rosselot K.S. Environmental Engineering: Review for the Professional Engineering Examination. Springer New York Heidelberg Dordrecht London, 2013, IX, 274 p. 2. Science for Environmental Protection: The Road Ahead. National Academy of Sciences, 2012. - 189 p. 3. Савичев О.Г. Теоретические основы охраны окружающей среды. Учебное пособие. - Томск, ТПУ, 2012. - 126 с. 4. Волков В.А.Теоретические основы охраны окружающей среды. СПб.: Лань, 2015. -256 с. 5. Бочкарев В.В. Теоретические основы технологических процессов охраны окружающей среды. Томск: Изд-во ТПУ, 2012. – 320 с *6.* Дмитренко В.П., Сотникова Е.В., Кривошеин Д.А. Экологическая безопасность в техносфере. СПб.: Лань, 2016. -524с

Module designation	**GIO'-6206 – Global climate change**
Semester(s) in which the module is taught	*3*
Person responsible for the module	*Prof., Dr. Maria Radkevich*
Language	*Uzbek, Russian, English*
Relation to curriculum	*Elective*
Teaching methods	*Lecture, practical lesson, self-learning*
Workload (incl. contact hours, self-study hours)	*Total workload: 180* *Contact hours: lecture - 20, practical lessons – 70, self-learning – 90, hours*
Credit points	*6*
Required and recommended prerequisites for joining the module	To master the course, Master Students must have basic knowledge in "Environmental Protection", "Environmental monitoring", "Environmental impact assessment".
Module objectives/intended learning outcomes	**To know and understand:** - natural and anthropogenic causes of global climate change; - historical variations in climate indicators; - the relationship between climate change and sustainability; - opportunities for reducing greenhouse gas emissions; - principles of developing and evaluating sustainable development indicators; - market mechanisms for incentivizing low-carbon development; **To be able to:** - use of methods for estimating greenhouse gas emissions; - calculate carbon balance; - calculate of greenhouse gas emission quotas; - evaluate natural intensity indicators of the regional economy. **To form competences in:** - assess and predict possible climate change in the region; - analyze the effects of climate change on agriculture; - develop measures to mitigate the effects of climate change.

Content: The discipline includes the following topics. The *level of difficulty*: (1 – low, 5 high):	Global change in the earth's climate. Factors affecting the climate. Global indicators of climate change. Regional indicators of climate change. Greenhouse gases. Changes in the Earth's orbit. Volcanic activity. The main climatic feature of recent decades. Human activities-one of the causes of global climate change. L*evel of difficulty*: 2 Global effects of climate change. Climate change and environmental hazards. Impact of climate change on public health. Impact of climate change on the environment. Transformation of ecosystems. L*evel of difficulty*: 2 Approaches to considering climate and development issues. Traditional approach: separation of climate and development issues. Population growth. Economic growth. Carbon budget allocation. Estimation of greenhouse gas emissions (IPCC methodology). Kuznetsov environmental curve and carbon emissions. Impact of existing policies. Developmental approach. L*evel of difficulty*: 3 Green economy. The concept and general characteristic of green economy. Prerequisites of the new strategy. The main principles of strategy realization. The main directions of the green economy. Development of environmental technologies. Problems of building a green economy. L*evel of difficulty*: 2 Climate change and low-carbon development. Climate change as a threat to the transition to sustainable development. Scientific foundations of the climate change problem. Reflections of climate issues in sustainability indicators. L*evel of difficulty*: 3 Climate and economic efficiency. Methods and problems of determining and accounting for the economic value of the climate system as a natural resource. Climate change and externalities. Climate system and climate as public goods. State and international policies and mechanisms to combat climate change. Strategies for low-carbon climate-resilient development. Market mechanisms to promote low-carbon development. International development assistance for climate change. L*evel of difficulty*: 3 Adaptation to climate change in Uzbekistan. Macroeconomic situation and socio-economic trends. Natural-resource potential, efficiency of its utilization. Environmental impact, main environmental and economic problems. State policy related to transition to sustainable development. Climate change in Uzbekistan: threats to sustainable development. Measures to mitigate and adapt to climate change. L*evel of difficulty*: 3. The following topics are recommended for practical classes: 1. Estimation of greenhouse gas emissions using IPCC, ISO 14064, GHG protocol methodologies and comparison of results. L*evel of difficulty*: 3 2. Study of climate change models. L*evel of difficulty*: 2 3. Calculation of greenhouse gas quotas and analysis of their costs. L*evel of difficulty*: 3 4. Comparison of greenhouse gas emissions from biofuels and fossil fuels. L*evel of difficulty*: 3 5. Assessment of the carbon footprint of agricultural activities. L*evel of difficulty*: 3 6. Estimation of CO2 uptake capacity of plants. L*evel of difficulty*: 3 7. Estimation of the indicator of total economic value (cost) for forest resources. L*evel of difficulty*: 3.
Exams and assessment formats	*Two written midterm assessments (30 minutes each), take-home written assignments and one final oral exam (40 minutes).*
Study and examination requirements	*Requirements for successfully passing the module:* *The final grade in the module is composed of 40% performance on exams, 20 % independent work, 20 % practical work, 20 % mid-term control tests. Students must have a final grade of 60% or higher to pass*
Reading list	1. Blanco J., Kheradm H. (eds.). Climate change - socioeconomic effects. Published by InTech. Janeza Trdine 9, 51000 Rijeka, Croatia. 2011. ISBN 978-953-307-411-5, Hard cover, 454 p. 2. Адаптация к изменению климата: опыт Центральной Азии. Т.: Научно-информационный центр МКВК, 2016. – 84 с. 3. Paganetto L. (Ed.) Capitalism, Global Change and Sustainable Development. Springer, 2020. — 272 p. — (Springer Proceedings in Business and Economics). — ISBN: 978-3-030-46142-3. 4. Sharma S., Sharma K. Environment and Society: Climate Change and Sustainable Development. Routledge, 2023. — 406 p.

Module designation	**BRT-6206 Principles of sustainable development**
Semester(s) in which the module is taught	*3*
Person responsible for the module	*Prof., Dr. Maria Radkevich*
Language	*Uzbek, Russian, English*
Relation to curriculum	*Elective*
Teaching methods	*Lecture, practical lesson, self-learning*
Workload (incl. contact hours, self-study hours)	*Total workload: 180* *Contact hours: lecture - 20, practical lessons – 70, self-learning – 90, hours.*
Credit points	*6*
Required and recommended prerequisites for joining the module	To master the course, Master Students must have basic knowledge in ”General ecology and Environmental Protection”, “Environmental impact assessment”, “Environmental monitoring”.
Module objectives/intended learning outcomes	**To know and understand:** - the history of formation and development of the concept of sustainable development; - the main directions of greening of industry and innovative development; - the most used in the world criteria and indicators of sustainable development; - forecast scenarios of the future, existing approaches to the interpretation of the concept of sustainable development; **To be able to:** - justify and critically evaluate the developed principles of the concept of sustainable development; - understand, select, summarise, analyse and interpret economic information and critically perceive information; - demonstrate economic literacy and the ability to analyse environmental problems and processes occurring in society; - justify and critically evaluate existing approaches to sustainable development; **To form competences in:** - forecasting possible development of environmental problems in the future; - developing practical recommendations to ensure sustainable development; - assessing the state of ecosystems using economic approaches and using them in making professional decisions.

Content: The discipline includes the following topics. The *level of difficulty*: (1 – low, 5 high):	General issues of sustainable development. Background and basic concepts of sustainable development. Examples of unsustainable development. Rational society: problems of utopia and reality. The role of man in the evolution of the biosphere. Setting the problem of the necessity of transition to sustainable development at the international level. Problems of globalisation. L*evel of difficulty: 2* Problems of globalisation and sustainable development. Main threats that humanity faces today: Biosphere (all living things). Hydrosphere (oceans, lakes and rivers), Atmosphere (air surrounding the Earth), Lithosphere (Earth's crust). L*evel of difficulty: 2* Key documents of the world community on sustainable development. Rio Declaration on Environment and Development. Johannesburg Declaration on Sustainable Development. UN, Aarhus Convention, Reporting Requirements. Kyoto Protocol to the UN Framework Convention. Environmental compact of cities. L*evel of difficulty: 2* Melbourne Communiqué, World Congress of Chemical Engineers. Millennium Development Goals - reflecting a new stage in human development. National Sustainable Development Goals in Uzbekistan. L*evel of difficulty: 2* Directions for analysing sustainable development. Towards definition of sustainable development. Problems of science and education in the transition to sustainable development Indicators of sustainable development. The need to develop new development indicators. Approaches to the definition of sustainable development indicators. Integral indicators of sustainable development. Systems of sustainable development indicators. ESI-2005 Sustainable Development Index (Environmental Sustainable Index), description and examples of calculation. EPI (Environmental Performance Index), scope of application. L*evel of difficulty: 3* System of global measurements of sustainable development. Method of global modelling of sustainable development processes in the context of quality and safety of human life. Influence of a set of major threats on sustainable development. Network of world data centres as a tool for global analysis of sustainable development processes. Comparison of countries by sustainable development indices. L*evel of difficulty: 3* Sustainable development in the economic and technological dimension. Sustainable development, technology and the role of engineering. Problems of sustainable development of society and chemical engineering. How to change technological patterns? What role can engineers play in sustainable development? What can be achieved in an enterprise by practising the principles of sustainable development. L*evel of difficulty: 3* Sustainable Technologies and the concept of Cleaner Production. Developing approaches to environmental protection. What is Cleaner Production? Basic concepts from the field of environmental protection and Cleaner Production. Cleaner Production Project. Planning and organising a Cleaner Production project. L*evel of difficulty: 3* Sustainability, technology and standards. Examples of application of standards. Standards of the "Environmental Management Systems" series: ISO 14001 ISO 14047. Examples of application of standards in enterprises. L*evel of difficulty: 2* Assessment of ecological efficiency. Designing resource-saving technological schemes and water supply schemes. Evaluation of the implementation of sustainable development programmes at enterprises (BRIDGES to Sustainability). L*evel of difficulty: 3* Sustainable resource management. Natural capitalism - what is it? Capitalism with biological systems in mind. Resource Productivity. Imitation of nature. Service flows. Investment in natural capital. The automobile industry as an example for other industries in realising the principles of natural capitalism. L*evel of difficulty: 3* Fundamentals of material resource management theory. Basic laws and rules of resource management. Commonser's "Wreath of Laws". Modern methodologies of sustainable development assessment based on the theory of natural capital. Estimates of sustainable resource management (sustainability coefficient). L*evel of difficulty: 3* Modelling Systems: Limits to Growth and Beyond Growth Can humanity avert global catastrophe and ensure a sustainable future? A review of work on limits to growth. Limits to growth and beyond growth. Why does out of bounds and collapse happen?; Extending limits in the model with technology. Limits to growth, 30 - years later. Transition to a sustainable world. L*evel of difficulty: 3* *The following topics can be recommended for practical training* 1. Calculation of the ecological footprint for the region. L*evel of difficulty: 3* 2. Comparative assessment of environmental friendliness of goods. L*evel of difficulty: 3* 3. Integral assessment of the ecological and economic level of production. L*evel of difficulty: 3* 4. Determination of economic value of air quality deterioration. L*evel of difficulty: 3* 5. Determination of technically possible and economically feasible resource-saving potential of the region. L*evel of difficulty: 3* *6.* Calculation of the integral effect of resource saving. L*evel of difficulty: 3*
Exams and assessment formats	Two written midterm assessments (30 minutes each), take-home written assignments and one final oral exam (40 minutes).
Study and examination requirements	*Requirements for successfully passing the module:* The final grade in the module is composed of 40% performance on exams, 20% take-home assignments, 20% in-class participation, 20 % midterm tests. Students must have a final grade of 60% or higher to pass.

Reading list	1. Paganetto L. (Ed.) Capitalism, Global Change and Sustainable Development. Springer, 2020. — 272 p. — (Springer Proceedings in Business and Economics). — ISBN: 978-3-030-46142-3. 2. Бабурин С. Н. Глобализация в перспективе устойчивого развития: Монография / С.Н. Бабурин, М.А. Мунтян, А.Д. Урсул; РГТЭУ. - М.: Магистр: ИНФРА-М, 2011. - 496 с. 3. Устойчивое развитие: Новые вызовы: Учебник для вузов/ Под общ. ред. В. И. Данилова-Данильяна, Н. А. Пискуловой. — М.: Издательство «Аспект Пресс», 2015. — 336 с. 4. Дульзон А.А. Парадокс устойчивого развития. М.: Триумф, 2018. — с. 264 5. Brebbia C.A. Management of Natural Resources, Sustainable Development and Ecological Hazards. Wessex Institute of Technology UK, 2015. 277p.

Elective course 2

Module designation	**CHB-6206 - Waste management**
Semester(s) in which the module is taught	*3*
Person responsible for the module	*Prof., Dr. Maria Radkevich*
Language	*Uzbek, Russian*
Relation to curriculum	*Elective*
Teaching methods	*Lecture, practical lesson, self-learning*
Workload (incl. contact hours, self-study hours)	*Total workload: 180* *Contact hours: lecture - 20, practical lessons – 70, self-learning – 90, hours*
Credit points	*6*
Required and recommended prerequisites for joining the module	To master the course, Master Students must have basic knowledge in ”General ecology and Environmental Protection”, “Inorganic and organic chemistry”, “Environmental protection”, "Environmental impact assessment".
Module objectives/intended learning outcomes	**To know and understand:** - theoretical bases for determining the volumes of formation and accumulation of various wastes; - basic principles of waste management; - basic principles of environmental standardisation in the field of waste management; - methods to reduce the volume of waste generation at the source; - kinetics of MSW decomposition processes at landfills; - basics of organisation of low-waste and waste-free productions; - principles of selection and calculation of various treatment facilities, as well as waste processing; - physical bases of agglomeration, classification and sorting of wastes; - basics of recycling of separate types of solid domestic wastes; - methods of management of environmental protection from waste using information technologies.. **To be able to:** - use information systems and software products used for waste management; - compile mathematical models to calculate the rate and volume of biogas emission during waste decomposition; - model the composition of filtration water in waste storage areas; - explain from a scientific point of view the phenomena, processes occurring during the capture of gaseous, liquid and solid waste; - correctly choose the method and method of treatment of waste capture from industrial emissions and discharges; - select and calculate methods and equipment for classification and grinding of waste. **To form competences in:** - development of environmental standards for waste management; - selection and calculation of methods of sludge utilisation from gas and water treatment facilities; - selection and calculation of equipment for solid waste processing; - analysing of biogas emission rates and volumes, as well as the volume and composition of filtration water during waste decomposition; - evaluating the efficiency of treatment equipment

Content: The discipline includes the following topics. The *level of difficulty*: (1 – low, 5 high):	Fundamentals of waste management. - Waste classification. Norms of formation and morphology of MSW. Solid industrial waste. Gaseous and dusty wastes of industrial enterprises. Liquid wastes. L*evel of difficulty*: 3. Environmental policy and legislation in the field of waste management in Uzbekistan and foreign countries. - Main historical milestones of environmental policy development in the EU and USA. Main directives in the sphere of waste management. Legislation of the Republic of Uzbekistan in the field of waste management. L*evel of difficulty*: 2. Theoretical aspects of the problem of waste management. - Problems of formation and handling of wastes on the territory of Uzbekistan. Organisational management of waste management. Possible directions of reorganisation of the state waste management system. Information systems and software products used for waste management. L*evel of difficulty*: 2. Municipal solid waste management. - MSW accumulation. Logistics of municipal solid waste. Basic mechanical processes and technologies in the preparation and treatment of municipal solid waste. Physical fundamentals of waste shredding. Physical bases of waste agglomeration. Physical bases of waste classification. Physical bases of waste sorting. Fundamentals of recycling of certain types of municipal solid waste (waste paper, bulky waste, car waste, electronic devices). L*evel of difficulty*: 4. Problems of MSW landfilling and disposal. - Impact of MSW landfills on the environment. Kinetics of MSW decomposition processes at landfills. Kinetic model of the processes of formation of emissions from landfills. Modelling of seepage water composition in waste storage sites. Modelling of seepage water volumes generated in the landfill body. Methods to reduce emissions from landfills. Biofuel production. Vermicomposting of domestic wastes. L*evel of difficulty*: 4. Modern information technologies as a tool of waste management. - Features of decision support systems in environmental protection activity. Organisational management of environmental protection using information technologies. Methodological aspects of development of automated information-analytical systems of waste management. GIS-applications for accounting of unauthorised dumps. L*evel of difficulty*: 3. General characteristics of agriculture in Uzbekistan. Agricultural activity. Structure of arable land. Structure of agricultural production. Application of fertilizers and pesticides. Types of agricultural wastes. Characteristics of the main wastes of agriculture and agricultural production. L*evel of difficulty*: 3. Cattle breeding wastes and their utilisation. Technologies of manure and poultry manure processing. Processing of animal and bird carcasses at veterinary and sanitary enterprises for meat and bone meal production. Incineration and biothermal disinfection. Utilization of vegetable wastes. Requirements for pesticide decontamination. Treatment of collector and drainage water from pesticides. Collector and drainage waters and their reuse. Problem of collector-drainage water collection in Uzbekistan. L*evel of difficulty*: 4. Industrial wastes. - Risk assessment of solid industrial waste accumulation. Methods of calculation of waste generation volumes. Ways to reduce the volumes of waste generation. European experience of radioactive waste management. Liquid industrial wastes and methods of their utilisation. L*evel of difficulty*: 4. Protection of atmospheric air from dusty and gaseous wastes of industrial enterprises and transport. - Sources of dusty and gaseous wastes at industrial enterprises. Composition of dust and gas emissions. Theoretical bases of dust and gas streams purification (theory of sedimentation, impaction, centrifugal purification, physical and chemical purification). Methods of recovery of valuable components from sludge. Ways to reduce atmospheric pollution by transport emissions. L*evel of difficulty*: 4. The following topics are recommended for practical classes: 1. Calculation of household waste landfill parameters. L*evel of difficulty*: 3 2. Determination of gas emission volumes from the landfill. L*evel of difficulty*: 4 3. Determination of volumes of filtration effluents formed in the body of the landfill. L*evel of difficulty*: 4 4. Calculation of parameters of equipment for waste enrichment. L*evel of difficulty*: 3 5. Determination of physical and nutritive properties of cattle manure. L*evel of difficulty*: 4. 6. Estimation of average daily formation of volatile and solid substances in pig manure. L*evel of difficulty*: 3. 7. Determination of the amount of sludge produced in a poultry lagoon. L*evel of difficulty*: 3. 8. Calculation of parameters of biogas plant (digester). L*evel of difficulty*: 3 9. Calculation of waste accumulation volumes at the enterprises. L*evel of difficulty*: 4 10. Development of the line for rubber waste processing. L*evel of difficulty*: 3 11. Determination of the design characteristics of dust particles for cyclone design. L*evel of difficulty*: 4 12. Aerodynamic calculation of the path for transporting wood processing waste. L*evel of difficulty*: 3 13. Calculation of the parameters of the equipment for collection and removal of sludge from sewage treatment plants. L*evel of difficulty*: 4 14. Determination of the parameters of the press equipment. L*evel of difficulty*: 4 15. Study of furnace and reactor designs for thermal treatment of wastes. L*evel of difficulty*: 4.
Exams and assessment formats	*Two written midterm assessments (30 minutes each), take-home written assignments and one final oral exam (40 minutes).*

Study and examination requirements	*Requirements for successfully passing the module:* *The final grade in the module is composed of 40% performance on exams, 20 % independent work, 20 % practical work, 20 % mid-term control tests. Students must have a final grade of 60% or higher to pass*
Reading list	1. Wong J., Tyagi R., Pandey A. (Eds.) Current Developments in Biotechnology and Bioengineering: Solid Waste Management. Elsevier, 2017. — 512 p. 2. Saleh H.El-D.M., Rahman R.O.A. (Eds.) Management of Hazardous Wastes. ExLi4EvA, 2016. — 181 p. 3. Karthikeyan O.P., Heimann K., Muthu S.S. (Eds.) Recycling of Solid Waste for Biofuels and Bio-chemicals. Springer, 2016. — 422 p. 4. Xi B., Jiang Y., Li M., Yang Y., Huang C. Optimization of Solid Waste Conversion Process and Risk Control of Groundwater Pollution. Springer-Verlag, 2016. — 125 p. 5. Кирильчук И.О., Барков А.Н. Информационно-аналитические системы управления отходами. Курск: Университетская книга, 2015. — 112 с *6.* Вайсман Я.И. и др. Управление отходами. Сбор, транспортирование, прессование, сортировка твердых бытовых отходов. Пермь: Пермский национальный исследовательский политехнический университет, 2012. – 236 с.

Module designation	**KMCHB-6206 - Municipal waste management**
Semester(s) in which the module is taught	*3*
Person responsible for the module	*Prof., Dr. Maria Radkevich*
Language	*Uzbek, Russian*
Relation to curriculum	*Elective*
Teaching methods	*Lecture, practical lesson, self-learning*
Workload (incl. contact hours, self-study hours)	*Total workload: 180* *Contact hours: lecture - 20, practical lessons – 70, self-learning – 90, hours*
Credit points	*6*
Required and recommended prerequisites for joining the module	To master the course, Master Students must have basic knowledge in ”General ecology and Environmental Protection”, “Waste water treatment”, "Environmental impact assessment".
Module objectives/intended learning outcomes	**To know and understand:** - strategies in the field of household waste management; - components determining hazardous properties of waste; - mechanisms of waste recycling; - impact of waste components on the environment. **To be able to:** - apply theoretical knowledge for practical analysis of environmental management issues; - use laws and regulations to ensure waste management; - use methods of estimating the volume of household waste collection. **To form competences in:** - conduct research work in the field of waste management; - determine the class of waste hazard; - analyse the effectiveness of waste management systems; - calculate the fee for waste disposal.

Content: The discipline includes the following topics. The *level of difficulty*: (1 – low, 5 high):	Introduction: aim, objectives and basic concepts of science. Overview of household waste. Main sources of waste generation. Problems of utilisation and processing of household waste in Uzbekistan. History of development of the "rubbish industry" in Europe. L*evel of difficulty*: 2 Regulatory requirements for household waste management. Requirements to places (sites) of waste collection. Requirements for waste management of I-V hazard classes. Requirements for waste transport. State cadastre of waste disposal and utilisation sites.L*evel of difficulty*: 2 Classification and characterisation of domestic waste. Morphological composition of solid domestic waste. Chemical composition of solid waste. Physico-chemical indicators of solid waste. Agrochemical indicators of solid waste. Theoretical aspects of waste management problem. Theoretical prerequisites of waste management. Directions of reorganisation of the state system of waste management. Information systems and software products used for waste management. L*evel of difficulty*: 3 Modern information technologies as a means of waste management. Features of decision support systems in environmental protection. Organisational management of environmental protection using information technologies. Methodology of analysis of automated information and management system. GIS programmes for registration of unauthorised dumps.L*evel of difficulty*: 4 The concept of "zero waste". 3R-concept. Waste hierarchy. Possibilities of achieving "zero waste" in residential and public buildings. Definition of waste generation according to the product life cycle concept. Waste life cycle. L*evel of difficulty*: 3. Household waste accumulation norms. Methodology for determining the norms of accumulation of solid domestic waste. Waste collection. Waste collection schemes. Separate waste collection. L*evel of difficulty*: 3. Waste collection systems. Container systems for solid domestic waste collection. Non-removable collection system. Interchangeable container system. Determination of the number of containers required. Recommendations for the use of containers for separate waste collection and enforcement of selective solid waste collection. Waste collection inside residential and public buildings. Principles of container selection. Accumulation of waste in buildings. Types of waste transport systems in buildings. L*evel of difficulty*: 4. Waste transport systems. Frequency of waste disposal. Disposal of solid domestic waste. Transport of solid waste. Waste treatment stations. Special transport vehicles. Determination of need for special vehicles. Logistics of municipal solid waste. Development of logistic schemes of waste transport. Material flows and principles of their logistics. Disposal of separately collected waste and its material support. Long-distance transport of waste. Transport by road, railway or water transport. L*evel of difficulty*: 3. Pneumatic systems for collection and transport of household waste. Underground pneumatic modes of transport for waste collection. Mobile pneumatic transport systems. Advantages and disadvantages of using underground pneumatic transport. Examples of the use of pneumatic transport systems around the world. Selection of pipes. Methods of loading and unloading of rubbish. Principles of placement of pneumatic transport systems. L*evel of difficulty*: 3. Preparation of waste for recycling. Waste sorting stations and their types. Waste sorting manually. Conveyors and breaking drums. Physical basis of waste classification. Waste screening equipment. Aeroseparation. Equipment for separating waste from air. Water sorting (hydrocycloning). Physical bases of waste sorting. Methods of sorting dry and wet waste. Separation by density and moistening. L*evel of difficulty*: 4. Waste crushing and agglomeration processes. Physical bases of waste crushing. Equipment for waste crushing. Physical bases of waste agglomeration. Equipment for waste tableting. Briquetting of wastes. Equipment for production of pellets from waste. L*evel of difficulty*: 3. Decontamination and utilisation of solid waste. Methods of domestic waste disinfection. Thermochemical decontamination. Pyrolysis of waste. Plasma recycling of waste. Waste recycling plants. Waste disposal (burial) in landfills.L*evel of difficulty*: 3. Recycling of tare and packaging. Historical stages of tare and packaging development. History of packaging design development of famous world brands. Technical stages of tare and packaging processing. Waste paper processing and its technical stages. L*evel of difficulty*: 3. Processing of glass and plastic containers. Historical stages of glass and glassware production. Technical stages of glass containers processing. Types of plastics. Different technologies of plastic waste recycling. L*evel of difficulty*: 4. Processing of large-sized waste. Technical stages of processing large-sized waste. Disposal of old cars. Processing in shredders. Technical stages of recycling used tyres and other rubber products. L*evel of difficulty*: 3. Disposal of electronic waste. Problems of collection and recycling of electronic waste in foreign countries and the Republic of Uzbekistan. Primary sorting of electronic waste. Technical stages of utilisation of old electrical and electronic devices. L*evel of difficulty*: 4. Biological methods of organic waste processing. Aerobic processing of organic waste components. Treatment of wastewater from municipal sewage systems. Anaerobic digestion of organic waste components. Pros and cons of biological waste treatment methods. Integrated waste treatment. L*evel of difficulty*: 3. The following topics are recommended for practical classes: 1. Determination of mass and volume of waste from residential facilities. L*evel of difficulty*: 2. 2.Characterisation of domestic waste. L*evel of difficulty*: 2. 3.Determination of the necessary equipment of the household waste collection point. L*evel of difficulty*: 3. 4.Designing the household waste collection point. L*evel of difficulty*: 4. 5.Evaluate the efficiency of solid waste collection and disposal services. L*evel of difficulty*: 3. 6.Determination of all waste generated through product life cycle analysis. L*evel of difficulty*: 4. 7.Calculation of the amount of machinery and equipment required for waste collection and transportation. L*evel of difficulty*: 3. 8.Comparative evaluation of waste collection vehicles. L*evel of difficulty*: 3. 9.Determination of the optimal location of waste collection points in settlements. L*evel of difficulty*: 4. 10.Designing the routes of rubbish trucks movement. L*evel of difficulty*: 4. 11.Reduction of waste truck routes. L*evel of difficulty*: 3. 12.Assessment of the possibilities of using two-stage method of rubbish collection. L*evel of difficulty*: 4. 13.Designing a waste collection system for a building using software products. L*evel of difficulty*: 3. 14.Calculation of parameters of pneumatic transport systems for rubbish transportation. L*evel of difficulty*: 4. 15.Estimation of economic efficiency of pneumatic waste transport system. L*evel of difficulty*: 3. 16.Comparative assessment of the environmental impact of pneumatic transport system. L*evel of difficulty*: 4. 17.Calculation of the technological process of processing of large wastes. L*evel of difficulty*: 4. 18. Calculation of pollutant emissions from biothermal waste treatment. L*evel of difficulty*: 4. 19.Calculation of pollutant emissions from incineration plant. L*evel of difficulty*: 4. 20.Selection and calculation of air cleaning equipment for incinerators. L*evel of difficulty*: 3. 21.Calculation of pyrolysis equipment for waste incineration. L*evel of difficulty*: 3. 22. Calculation of aerobic stabiliser for wastewater treatment. L*evel of difficulty*: 4.

Exams and assessment formats	*Two written midterm assessments (30 minutes each), take-home written assignments and one final oral exam (40 minutes).*
Study and examination requirements	*Requirements for successfully passing the module:* *The final grade in the module is composed of 40% performance on exams, 20 % independent work, 20 % practical work, 20 % mid-term control tests. Students must have a final grade of 60% or higher to pass*
Reading list	1. Saleh H. (ed.) Municipal Solid Waste Management. InTech Open. 2019. 2. Kumar S. Municipal Solid Waste Management in Developing Countries. 1st Edition. CRC Press. 2016. 200pp. 3. Kumar E.S.(ed.) Integrated Waste Management.V.II. InTech. 2011. 482 p. 4. Вайсман Я.И. и др. Управление отходами. Сбор, транспортирование, прессование, сортировка твердых бытовых отходов: монография. Пермь: Изд-во Перм. нац. исслед. политехн. ун-та, 2012. – 236 с. 5. Радкевич М.В., Шипилова К.Б. Управление отходами. Учебное пособие. Ташкент: “Malik Print Co”, 2021 й. – 393 с. *6.* Добросердова Е.А., Федорова С.Ф. Организация и обращение с твердыми бытовыми отходами: Учебное пособие. Казань: Изд-во Казанск. гос. архитект.-строит. ун-та, 2018. – 83 с

Module designation	**QCHB-6206 - Agricultural waste management**
Semester(s) in which the module is taught	*3*
Person responsible for the module	*Prof., Dr. Maria Radkevich*
Language	*Uzbek, Russian*
Relation to curriculum	*Elective*
Teaching methods	*Lecture, practical lesson, self-learning*
Workload (incl. contact hours, self-study hours)	*Total workload: 180* *Contact hours: lecture - 20, practical lessons – 70, self-learning – 90, hours*
Credit points	*6*
Required and recommended prerequisites for joining the module	To master the course, Master Students must have basic knowledge in ”General ecology and Environmental Protection”, “Inorganic and organic chemistry”, “Environmental protection”, "Environmental impact assessment".
Module objectives/intended learning outcomes	**To know and understand:** - technologies of preparation of organic fertilisers, fodder and other products on the basis of waste and secondary raw materials of agricultural production; - possibility of obtaining energy from agricultural waste; - normative and technical documentation in the field of agricultural waste management. **To be able to:** - use methods of choosing ways of processing and utilisation of livestock wastes; - estimate the volumes of formation and accumulation of wastes in the agricultural sector; - calculate technological processes and equipment for processing of organic wastes of agriculture; - estimate the volumes of collection of wastes of agricultural machinery. **To form competences in:** - choosing methods of processing agricultural waste in an environmentally friendly way; - determining the suitability of waste for a certain degree of recycling; - assessing the possibility of obtaining energy from their waste; analyse the quality and safety of products obtained from the processing of agricultural waste; - design compost pits and predict the volume of compost produced.

Content: The discipline includes the following topics. The *level of difficulty*: (1 – low, 5 high):	General characteristics of agriculture in Uzbekistan. Agricultural activity. Structure of arable land. Structure of agricultural production. Application of fertilisers and pesticides. Types of agricultural wastes. Characteristics of the main wastes of agriculture and agricultural production. L*evel of difficulty*: 3. Cattle breeding wastes and their utilisation. Types and peculiarities of animal husbandry wastes. Norms of waste formation in animal husbandry. Impact of livestock waste on the environment. L*evel of difficulty*: 3. Quantitative and qualitative norms of manure and poultry manure, directions of utilisation. Technologies of manure and poultry manure processing. Options for energy production. Role of soil and plants in utilisation of manure and poultry manure. Relationship between soil mineralisation and agricultural waste. Nutrient uptake by plants. Balancing nutritional needs of plants with waste. L*evel of difficulty*: 3. Recycling of poultry by-products. Recycling of feather waste. Production of feed from poultry waste. Processing of egg shells. L*evel of difficulty*: 3. Disposal of biological wastes of animal husbandry. Types of biological wastes. Processing of animal and bird carcasses at veterinary and sanitary enterprises for meat and bone meal production. Incineration and biothermal disinfection. Composting. Technical equipment of animal waste management systems. Livestock waste management systems. Equipment used for waste collection, transport, storage and treatment. Use of equipment for utilisation of livestock waste. L*evel of difficulty*: 4. Fish waste utilisation. By-products of fish products processing. Utilisation of fish waste, by-products and low value fish for food and drug production. Production of biodiesel from fish oil. Utilisation of fish scales. L*evel of difficulty*: 3. Waste utilisation in beekeeping and silk production. Types of beekeeping waste. Processing and application of wastes containing wax. Utilisation of bee wastes as feed additives. Utilisation of dead bees. Silk farming in the Republic of Uzbekistan. Naming of silkworm wastes. Utilisation of pups for fodder preparation. L*evel of difficulty*: 3. Utilisation of vegetable wastes. Types of plant wastes. Degree of accumulation of vegetable wastes. Use of plant residues in animal husbandry. Use of plant residues for fertiliser. Use of plant residues in production of biodegradable packaging. Utilisation of plant waste for bioenergy production. L*evel of difficulty*: 3. Utilisation of vegetable waste in various industries. Utilisation of vegetable waste in construction industry. Dispose of cotton, sunflower and maize residues. Use of straw in mushroom cultivation. Disposal of mushroom waste. Types of mushroom waste. Instructions for the use of spent mushroom substrates. Production of granulated fertilisers. L*evel of difficulty*: 3. Pesticide residues. Collector and drainage waters. Environmental impact of pesticides. Requirements for pesticide decontamination. Treatment of collector and drainage water from pesticides. Collector and drainage waters and their reuse. Problem of collector-drainage water collection in Uzbekistan. Options for reuse of collector-drainage water. L*evel of difficulty*: 4. Problem of agricultural machinery waste accumulation. Norms of agricultural machinery waste accumulation. Composition of equipment wastes. Possible areas of confirmation and existing problems. Fundamentals of formation of industry-wide recycling system on the example of decommissioned agricultural machinery. System approach to solving the problem of machinery waste management. Technology and requirements for collection and accumulation of decommissioned agricultural machinery. The best technologies for recycling waste decommissioned agricultural machinery. L*evel of difficulty*: 4. The following topics are recommended for practical classes: 1. Calculation of the volume of manure (poultry manure) formation on a livestock farm. L*evel of difficulty*: 3. 2. Determination of physical and nutritive properties of cattle manure. L*evel of difficulty*: 4. 3. Estimation of average daily formation of volatile and solid substances in pig manure. L*evel of difficulty*: 3. 4. Determination of the amount of sludge produced in a poultry lagoon. L*evel of difficulty*: 3. 5. Calculation of lagoon size for aerobic fermentation of manure. L*evel of difficulty*: 4. 6. Site selection for the location of agricultural waste management systems. L*evel of difficulty*: 4. 7. Determination of application rates of liquid agricultural wastes taking into account soil salinity and other characteristics. L*evel of difficulty*: 4. 8.Calculation of irrigation system parameters for manure wastewater application L*evel of difficulty*: 3. 9. Calculation of parameters of manure treatment equipment (scraper, homogeniser). L*evel of difficulty*: 3. 10. Calculation of parameters of equipment for dewatering of sewage (centrifuge, drum dryer). L*evel of difficulty*: 3. 11. Determination of the number of counterflow dryers for sludge dewatering. L*evel of difficulty*: 3. 12. Calculation of equipment parameters for biogas production. L*evel of difficulty*: 3. 13. Estimation of possibilities of biogas production from livestock waste in Uzbekistan. L*evel of difficulty*: 4. 14. Determination of the size of compost pit for bird carcasses. L*evel of difficulty*: 3. 15. Calculation of crop waste collection volume. L*evel of difficulty*: 3. 16. Calculation of moisture content of compost from crop residues and the proportion of nutrients contained in it. L*evel of difficulty*: 3. 17. Calculation of the parameters of straw chisel. L*evel of difficulty*: 3. 18. Calculation of equipment for utilisation of cotton wool honeycombs. L*evel of difficulty*: 3.

Exams and assessment formats	*Two written midterm assessments (30 minutes each), take-home written assignments and one final oral exam (40 minutes).*
Study and examination requirements	*Requirements for successfully passing the module:* *The final grade in the module is composed of 40% performance on exams, 20 % independent work, 20 % practical work, 20 % mid-term control tests. Students must have a final grade of 60% or higher to pass*
Reading list	1. Zakaria Z.A. (ed.) Sustainable Technologies for the Management of Agricultural Wastes. Springer, 2018. — 154 p. 2. Голубев И.Г., Шванская И.А., Коноваленко Л.Ю., Лопатников М.В. Рециклинг отходов в АПК: справочник. — М.: ФГБНУ «Росинформагротех», 2011. – 296 с. 3. Радкевич М.В., Шипилова К.Б. Управление отходами. Учебное пособие. Ташкент: “Malik Print Co”, 2021. – 393 с. 4. Nguyen V.T. (Ed.) Recovering Bioactive Compounds from Agricultural Wastes. Wiley, 2017. — 270 p. 5. Марченко В.И. и др. Технологии утилизации отходов сельского хозяйства. Оренбург: ОрГАУ, 2015. *6.* Galvez R.P., Berge J.-P. Utilization of Fish Waste. CRC Press, 2013. — 229 p.

Elective course 3

Module designation	**GK-6206-Hydrochemistry**
Semester(s) in which the module is taught	*3*
Person responsible for the module	*Prof., Dr. Bakhtiyor Karimov.*
Language	*Uzbek, English*
Relation to curriculum	*Elective*
Teaching methods	*Lecture, practical lesson, self-learning*
Workload (incl. contact hours, self-study hours)	*Total workload: 180* *Contact hours: lecture - 30, practical lessons – 60, self-learning – 90, hours.*
Credit points	*6*
Required and recommended prerequisites for joining the module	To master the course, Magister Students must have basic knowledge in "Hydrology", "General ecology and Environmental Protection", "Physics", "Organic and Inorganic chemistry", "Analytical and Physcolloid Chemistry", "Analytical chemistry".
Module objectives/intended learning outcomes	**To know and understand:** - what is natural water, - how and why we study its structure, - what is the meaning of hydrochemical studies of applied nature. - theoretical foundations and principles on modern hydrochemistry science; - methodology for planning laboratory and field-stage hydrochemical research. **To be able to:** - create a chemical characteristic of the separate reservoir or the whole river basin, lake, water basin; - assess the impact of anthropogenic factors on changes in the composition and properties of water of reservoirs and streams; - generalise hydrochemical materials, conduct statistical analyses and prepare reports. **To form competences in:** - evaluating the water quality of a reservoir or watercourse for its use in economic and drinking, industrial, irrigation (irrigation) purposes, fish farming; - taking water samples from different water bodies; - conducting chemical analyses of natural waters to determine the ratio of chemical components in water and some other hydrochemical characteristics.

Content: The discipline includes the following topics. The *level of difficulty*: (1 – low, 5 high):	Basics of theoretical and applied hydrochemistry. Mechanics of atoms and molecules in the water media, basing it as far as possible on modern theories of the physics of atoms. In a sense the present picture of atomic structure is fairly classical, although the more recent application of wave mechanics to problems of interaction of atoms has been exceedingly fruitful.L*evel of difficulty*: 2. Chemical processes in the water cycle. Features of the water cycle in nature. Box-model representations. The surface area of a basin. A groundwater recharge area and a groundwater discharge area. The atmosphere and vegetation as important parts of the water circulation.L*evel of difficulty*: 3. Models of reservoirs and the flux of chemical constituents in basins. Models for the storage and fluxes of chemical constituents. Mixing processes in lakes and streams. L*evel of difficulty*: 3. Environmental isotopes in hydrology and hydrochemistry. Application of hydrochemistry and environmental isotopes. Establishing the origin of groundwater and estimating its recharge rate. L*evel of difficulty*: 3. Chemical composition of natural and return (sewage, collector-drainage) waters and the laws of its changing depending on the chemical, physical and biological processes that take place in the environment: the chemical structure, colligative and other properties of natural waters (surface, underground). the modern assessment of water quality for the wellbeing of aquatic ecosystems and various needs of the economics. L*evel of difficulty*: 4. The hydrochemical studies and classification of waters based on their pollution types and patterns of water quality formation of water objects under the impact of anthropogenic factors, the rules of generalization of materials of hydrochemical observations and principles of the control of natural and contaminated waters. L*evel of difficulty*: 4. The following topics are recommended for practical classes: 1. Assessment of the approximate salinity of natural waters. L*evel of difficulty*:3 2. Assessment of water hardness and calculation of the amount of reagents for its softening.L*evel of difficulty*: 3 3. Assessment of the component composition of natural water. L*evel of difficulty*: 4 4. Assessment of the aggressiveness of natural water. L*evel of difficulty*: 4
Exams and assessment formats	Two written midterm assessments (30 minutes each), take-home written assignments and one final oral exam (40 minutes).
Study and examination requirements	*Requirements for successfully passing the module:* The final grade in the module is composed of 40% performance on exams, 20% take-home assignments, 40% in-class participation. Students must have a final grade of 60% or higher to pass.
Reading list	1. Worch, Eckhard. *Hydrochemistry: basic concepts and exercises*. Walter de Gruyter GmbH & Co KG, 2023. 284p. 2. Ашкеева Р.К., Тугелбаева Л.М., Рыскалиева Р.Г. Гидрохимия. Учебное пособие. — Алматы: Қазақ университеті, 2019. — 158 с. 3. Никаноров А.М. Гидрохимия: Учебник. – 2-е издание. Гидрометеоиздат, 2001, 444с. 4. Kulmatov, R., Mirzaev, J., Taylakov, A., Abuduwaili, J., & Karimov, B. (2021). Quantitative and qualitative assessment of collector-drainage waters in Aral Sea Basin: trends in Jizzakh region, Republic of Uzbekistan. *Environmental Earth Sciences*, *80*, 1-16. 5. Karimov, B.K., Shoergashova, S.S., Li, F., Talskikh, V.N. and Latisheva, L.N., 2022. Impact of agricultural development on water quality in Zarafshan River, Uzbekistan, Central Asia: Trends since 1960s. In *Current Directions in Water Scarcity Research* (Vol. 5, pp. 411-436). Elsevier. Information sources *7.* *www.nature.uz* *8.* Гидрохимия - Справочник химика 21 (chem21.info)

Module designation	***MALE-6206 Landscape Ecology of Central Asia***
Semester(s) in which the module is taught	*1 semester*
Person responsible for the module	*Professor Pulatov A.S.*
Language	*English*
Relation to curriculum	*Elective*
Teaching methods	*Lecture and seminar*
Workload (incl. contact hours, self-study hours)	*Total workload: 180. Contact hours: lecture - 30, practical lessons – 60, self-learning – 90, hours*
Credit points	*6*
Required and recommended prerequisites for joining the module	*Ecology, Geography of Central Asia and Landscape design.*
Module objectives/intended learning outcomes	**To know and understand:** - the processes involved in the construction of specially protected natural areas, agricultural areas and settlements; - the structure of natural-territorial complexes and landscapes, - changes in landscapes as a result of human influence, - the basics of anthropogenic landscape planning **To be able to:** - use the landscape planning methods; - use GIS instruments. **To form competences in:** - landscape classification; - landscape mapping;

Content	*I*ntroduction to landscape ecology. The contribution of different disciplines to the creation of a paradigmatic framework in landscape ecology. Anthropogenic landscapes and artificial introduces the laws of ecosystems. Landscapes of Central Asia. An epistemological approach to the landscape. The nature of landscape. Landscape as system and unit. The description of landscape. The "ecological" landscape. Principles of landscape classification. Spacing: The perception of the landscape. The eco-field hypothesis. L*evel of difficulty*: 3. Theories and models incorporated in the landscape ecology framework. The emergence of complexity. The Uncertainty Hypothesis (UH). The Connection Hypothesis (CH) Information as universal coinage. Cognition and autopoiesis Semiotic, bio and eco-semiotics. The hierarchy theory and the structure of the landscape. The percolation theory Metapopulation and conservation biology. Source-sink dynamic and conservation issues L*evel of difficulty*: 3. Methods in landscape ecology. Metrics in landscape ecology. Geographic Information Systems (GIS). GIS organization. Cartographic model. Map layer. Procedures for cartographic handling and modeling. Capturing data. Some cartographic modeling procedures. Commands in GIS. GIS and remote sensing. Scaling in GIS. L*evel of difficulty*: 4 Remote sensing in landscape ecology. Effects of sensor spatial resolution on landscape structure parameters. Remote sensing and landscape boundaries. Forest ecology and remote sensing. Landscape classification using remote sensing. Calibration center concept. Global Positioning Systems (GPS) The use of GPS in landscape ecology. Spatially Explicit Population Models (SEPM) to describe population patterns in a landscape. L*evel of difficulty*: 4 Landscape Connectivity. Elements of Landscape Connectivity. Structural versus Functional Connectivity. Patch Connectivity versus Landscape Connectivity. Methods for Assessing Landscape Connectivity. Neutral Landscape Models Graph-Theoretic Approaches. Assessing Connectivity in Heterogeneous Landscapes. Assessing Connectivity in River Networks.L*evel of difficulty*: 4 Landscape Effects on Individual Movement and Dispersal: Behavioral Landscape Ecology. Scales of Movement. Movement Responses to Hierarchical Patch Structure. Allometric Scaling of Movement. Movement Responses to Patch Structure. Analysis of Movement Pathways. Tracking Animal Movements. Models of Animal Movement. Mathematical Models of Animal Movement. Space Use and Home-Range Analysis.L*evel of difficulty*: 5 The following topics are recommended for practical classes: The description of landscape. L*evel of difficulty*: 3. Landscapes classification.L*evel of difficulty*: 3. Cartographic handling and modeling. L*evel of difficulty*: 4 Landscape classification using remote sensing. L*evel of difficulty*: 4
Exams and assessment formats	*Two Midterm assessments (80 minutes each) and one final exam (80 minutes), take-home written assignments*
Study and examination requirements	*Requirements for successfully passing the module* *the final grade in the module is composed of 40% performance on exams, 20% take-home assignments, 40% in-class participation. Students must have a final grade of 60% or higher to pass*
Reading list	1. *(Ecological Research Monographs) Takakazu Yumoto (auth.), Sun-Kee Hong, Jae-Eun Kim, Jianguo Wu, Nobukazu Nakagoshi (eds.) - Landscape Ecology in Asian Cultures-Springer Japan (2011).* 2. *Ajith H. Perera, C. Ashton Drew (auth.), Ajith H. Perera, C. Ashton Drew, Chris J. Johnson (eds.) - Expert Knowledge and Its Application in Landscape Ecology-Springer-Verlag New York (2012)* 3. *Almo Farina. Principles and methods in landscape ecology. Toward a Science of Landscape. 2006 Springer* 4. *Monica G. Turner, Robert H. Gardner. Landscape Ecology in Theory and Practice. Pattern and Process. Springer New York, 2015* 5. *Naveh Z. Landscape ecology : theory and application. New York : Springer-Verlag, 2004*

Module designation	***EA-6206*–Environmental audit**
Semester(s) in which the module is taught	*3*
Person responsible for the module	*PhD, Razzakov Ruslan*
Language	*Uzbek, Russian*
Relation to curriculum	*Elective*
Teaching methods	*Lecture, practical lesson, self-learning*
Workload (incl. contact hours, self-study hours)	*Total workload: 180* *Contact hours: lecture - 30, practical lessons – 60, self-learning – 90, hours*
Credit points	*6*
Required and recommended prerequisites for joining the module	To master the course, Master Students must have basic knowledge in ”Ecology and Environmental Protection”, “Environmental impact assessment”, “Environmental monitoring”, “Environmental biotechnology”, “Environmental rights”.
Module objectives/intended learning outcomes	**To know and understand:** - Know and understand: - - principles, goals and objectives of environmental audit; - - problems of practical implementation of environmental audit and ways to solve them; - - normative documents regulating the organisation of industrial and technological environmental protection works, principles of creating environmental infrastructure **To be able to:** - apply environmental research methods in solving typical professional tasks - analyse compliance and inconsistencies in the activities of business entities with legal requirements, environmental standards and regulations - apply the principles of ecological infrastructure when reconstructing territories and restoring contaminated landscapes **To form competences in:** - conducting an environmental audit procedure to ensure sustainable development. - planning and conducting an environmental audit (including drawing up programmes and plans, collecting, evaluating, analysing and documenting audit evidence, presenting audit results in accordance with the international standard ISO 19011) - developing an action plan for monitoring environmental compliance based on environmental regulations.

Content: The discipline includes the following topics. The *level of difficulty*: (1 – low, 5 high):	Introduction. The general concept of environmental audit. Criteria for mandatory audit of organizations and enterprises. The place and role of environmental audit in the overall system of auditing activities. The procedure, forms and methods of environmental audit. L*evel of difficulty*: 4 Risk assessment methodology and environmental regulation. The concept of risk, its main types. Comparison of risk values in various sectors of the economy. The main indicators of risk assessment, their identification. Main methodological approaches and stages of environmental risk assessment L*evel of difficulty*: 3 Legal and regulatory and methodological support of environmental audit. International and national standards for environmental audit L*evel of difficulty*: 5 The procedure for conducting an environmental audit.Rights and obligations of the participants of the eco-audit. The procedure (stages) of the eco-audit. The main sources of information for conducting an environmental audit L*evel of difficulty*: 5 Environmental certification system. Forms of confirmation of conformity of certification objects. Voluntary environmental certification. Mandatory environmental certification. L*evel of difficulty*: 4 Information support of environmental audit. Sources of information formation for environmental audit, the order of environmental accounting of the enterprise L*evel of difficulty*: 3 The following topics are recommended for practical classes: The importance of environmental audit for the analysis of environmental protection activities of agricultural enterprises. L*evel of difficulty*: 4 Responsibility of persons and audit organizations conducting environmental audits L*evel of difficulty*: 3 Types of eco-audit (classification by users of the results, by the degree of detail of the analyzed indicators, by direction) L*evel of difficulty*: 4 Methods of collecting information during an environmental audit. The structure of the ecoaudit conclusion. L*evel of difficulty*: 4 Objects of environmental certification L*evel of difficulty*: 4 Organization of environmental accounting of enterprises, its main features and principles. L*evel of difficulty*: 5 The main recommendations on the procedure for providing environmental information in domestic and foreign practice. L*evel of difficulty*: 3
Exams and assessment formats	Two written midterm assessments (30 minutes each), take-home written assignments and one final oral exam (40 minutes).
Study and examination requirements	*Requirements for successfully passing the module:* The final grade in the module is composed of 40% performance on exams, 20% take-home assignments, 40% in-class participation. Students must have a final grade of 60% or higher to pass.
Reading list	1. Environmental audit. Theory and practice [Electronic resource] : Textbook for university students / I. M. Potravny [et al.]; ed. by I. M. Potravny. - Environmental audit. Theory and practice ; 2022-03-26. - Moscow : UNITY-DANA, 2017. - 583 p. - License until 26.03.2022. - ISBN 978-5-238-02424-0. URL: http://www.iprbookshop.ru/81591.html 2. Environmental management and environmental audit: textbook / E.A. Vasilyeva, L.M.Isyanov - Irkutsk 2016 – 75 p. 3. Environmental audit: textbook / L.M. Bazavlutskaya, Alekseeva L.P., Korneev D.N. - Chelyabinsk: Publishing House of A. Miller Library CJSC. - 2022 – 137 p .

Elective course 4

Module designation	**ERB-6206 - Analysis of environmental risks**
Semester(s) in which the module is taught	*3*
Person responsible for the module	*Prof., Dr. Maria Radkevich*
Language	*Uzbek, Russian*
Relation to curriculum	*Elective*
Teaching methods	*Lecture, practical lesson, self-learning*
Workload (incl. contact hours, self-study hours)	*Total workload: 180* *Contact hours: lecture - 20, practical lessons – 70, self-learning – 90, hours*
Credit points	*6*
Required and recommended prerequisites for joining the module	To master the course, Master Students must have basic knowledge in ”General ecology and Environmental Protection”, "Environmental impact assessment", “Environmental monitoring”.
Module objectives/intended learning outcomes	**To know and understand:** - theoretical basis of environmental risk assessment; - principles of public health risk assessment; - methods of environmental risk assessment; - principles of risk management. **To be able to:** - assess the degree of risk; - forecast possible environmental risks of economic activity; - develop risk management measures; **To form competences in:** - analysing the risk to ecosystems and populations; - calculating social risk from environmental pollution; - ranking risks by hazard level; - drawing up a risk matrix.

Content: The discipline includes the following topics. The *level of difficulty*: (1 – low, 5 high):	The concept of environmental risk. Definition of the concepts "hazard" and "environmental hazard". Correlation of environmental situation assessment by hazard and on the basis of traditional methods (comparison with norms). Theory and methodology of risk analysis of crisis phenomena. Types of environmental hazard. L*evel of difficulty*: 2. Normative-legal regulation of risks. The concept of hazard: a new approach to environmental policy. General regularities of formation of methods of technogenic impact risk assessment. Evolution of the concept of environmental policy in the USA. Views on environmental risk and environmental safety. REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals). L*evel of difficulty*: 3. Theory of environmental risk. Uncertainty as the basis of risk. Develop ideas about randomness. About the concept of "probability". Classification of different types of randomness, their relation to probability. L*evel of difficulty*: 4. Approaches to environmental risk assessment. Consideration of environmental risk in the system "environmental impact assessment". Scheme of environmental risk assessment. Influence of uncertainty on the processes of environmental risk assessment. Detailed analysis of processes related to environmental risk assessment. Sequence of stages of ecological risk assessment. L*evel of difficulty*: 4. Biogeochemical sources of ecological risk. Basic concepts of biogeochemistry. Biogeochemical organisation of the biosphere and physiological heterogeneity of populations. Spatial structure of biogeochemical organisation of the biosphere of Northern Eurasia. L*evel of difficulty*: 4. Anthropogenic and technogenic impact on the environment as sources of danger. Classification of anthropogenic risk factors. Influence of man and technosphere on the environment. Technogenic and natural-technogenic systems. Impact of technogenic systems on the environment. L*evel of difficulty*: 3. Principles of risk analysis. The concept of risk analysis. Taking into account the nature of probability distribution and other characteristics. Distribution with "heavy tails". Application of probability theory to calculation of annual water flow fluctuations. Chain reactions and hazard. Personal and social risk assessment. L*evel of difficulty*: 4. Hazard and risk perception. The importance of risk perception. Culture of hazard perception and types of human behaviour under hazard conditions. People's attitudes to environmental danger. Factors and mechanisms of ecological risk perception. Methods of training and education of risk culture. L*evel of difficulty*: 3. Analysis of environmental risk for health. Risk definition. Assessment of dose-response relationship. Exposure assessment. Risk characteristics. Assessment of environmental risks in the technosphere. Environmental health risk assessment. L*evel of difficulty*: 4. Environmental risk management. Levels of risk. Decision-making under conditions of uncertainty. Comparative analysis of economic and environmental risks. Environmental risk management in industry and power engineering. Emissions from stationary sources. Economic problems of environmental risk management in industry. Environmental risk management in transport systems. L*evel of difficulty*: 3. Environmental risk management in agriculture. Environmental impact of agriculture. Environmental risk management from pesticides. Control of biogeochemical cycles of biophiles. L*evel of difficulty*: 4. Environmental risk management in waste utilisation. Basic principles of waste management. Waste recycling. Waste incineration. Waste disposal in landfills. Waste water. Emissions reduction as a basis for environmental risk management. L*evel of difficulty*: 3. Environmental risks in investment projects. Components of sustainable development. Ecological and economic mechanisms for regulating urban development. The problem of investments in natural territories. Insurance of environmental risks.L*evel of difficulty*: 3. Environmental assessment of projects. Risk assessment as tools for assessing the consequences of business activities. Modern approaches to the integration of risk assessment into the system of environmental assessment of business projects. Model of integrated risk assessment procedure in the system of environmental assessment of a project. L*evel of difficulty*: 3. The following topics are recommended for practical classes: 1 Determination of the degree of environmental risks. L*evel of difficulty*: 3. 2. Cost of risk and the principle of optimising risk reduction options. L*evel of difficulty*: 3. 3. Calculation of social risk. L*evel of difficulty*: 3. 4. Assessment of public health indicators. L*evel of difficulty*: 3. 5. Assessment of public health risk in chemical pollution of the environment. L*evel of difficulty*: 4. 6. Health risk assessment in case of radiation exposure. L*evel of difficulty*: 4. 7. Assessment of ecological risk of the enterprise L*evel of difficulty*: 3. 8. Calculation of the risk of air pollution due to incineration of rubbish at the solid domestic waste landfill.L*evel of difficulty*: 3. 9. Application of the method of qualitative risk analysis. Analysis of "failure and event trees". L*evel of difficulty*: 4. 10. Prioritisation of environmental risks. L*evel of difficulty*: 3. 11. Perception ratings L*evel of difficulty*: 3. 12. Analysis of environmental risks in the territories of the Republic of Uzbekistan L*evel of difficulty*: 4.
Exams and assessment formats	*Two written midterm assessments (30 minutes each), take-home written assignments and one final oral exam (40 minutes).*

Study and examination requirements	*Requirements for successfully passing the module:* *The final grade in the module is composed of 40% performance on exams, 20 % independent work, 20 % practical work, 20 % mid-term control tests. Students must have a final grade of 60% or higher to pass*
Reading list	1. Hernandez-Soriano M.C. (Ed.) Environmental Risk Assessment of Soil Contamination. Intech, 2014. — 903 p. 2. Popov G., Lyon B.K., Hollcroft B.D. Risk Assessment: A Practical Guide to Assessing Operational Risks. 2nd edition. — Wiley, 2022. — 1114 p. — ISBN 978-1-119-75594-4. 3. Theodore L., Dupont R.R. Environmental Health and Hazard Risk Assessment: Principles and Calculations. CRC Press, 2012. — 619 p. — ISBN: 1439868875, 9781439868874 4. Vallero D.A., Peirce J.J. Engineering The Risks of Hazardous Wastes. Butterworth-Heinemann, 2003. —306 p. ISBN-10: 0750677422 *5.* Марченко Б.И. Анализ риска: основы оценки экологического риска. Учебное пособие. Ростов-на-Дону; Таганрог: Южный федеральный университет, 2018. — 148 с. ISBN 978-5-9275-3061-8.

Module designation	**AMTB - 6206 Environmental Impact Assessment**
Semester(s) in which the module is taught	*3*
Person responsible for the module	*Prof., Dr. Maria Radkevich*
Language	*Uzbek, Russian, English*
Relation to curriculum	*Elective*
Teaching methods	*Lecture, practical lesson, self-learning*
Workload (incl. contact hours, self-study hours)	*Total workload: 180* *Contact hours: lecture - 30, practical lessons – 60, self-learning – 90, hours.*
Credit points	*6*
Required and recommended prerequisites for joining the module	To master the course, Magister Students must have basic knowledge in ”General ecology and Environmental Protection”, “Environmental impact assessment”, “Environmental monitoring”.
Module objectives/intended learning outcomes	**To know and understand:** - the basics of nature management, economics of nature management and sustainable development; - basics of environmental impact assessment; - theoretical basics of environmental monitoring, rationing and reduction of environmental pollution; - the role of risk assessment in environmental policy; **To be able to:** - categorise the anthropogenic risk factors, - assess the environmental impact of man-made systems, - use principles of risk analysis, and environmental risk assessment in the Technosphere; **To form competences in:** - developing environmental impact management plans; - decision-making under conditions of uncertainty, - analysing economic and environmental risks in agriculture; - analysing and forecasting the environmental impact of planned economic activities.

Content: The discipline includes the following topics. The *level of difficulty*: (1 – low, 5 high):	History, methodology and main functions of environmental impact assessment (EIA). A brief historical overview of the formation of EIA and environmental expertise in the Republic of Uzbekistan and abroad. The goals, objectives and scope of the EIA. The importance of EIA in ensuring the environmental safety of the development of territories and solving various environmental problems in the main sectors of the economy. L*evel of difficulty: 2* Theoretical and methodological foundations of environmental impact assessment. Principles of mandatory and scientific validity of the EIA, independence in its organization and conduct, wide publicity and public participation in the discussion of the results, presumption of potential environmental hazards and priority of environmental safety, complexity of assessment, reliability and completeness of information. Application of methods of component-by-component assessment, regulatory approach, factor analysis and expert assessments during the EIA. L*evel of difficulty: 3* Regulatory framework, stages and requirements of the EIA. Regulatory and legal framework of the EIA. Planning of the EIA. Objects of environmental design (preparation of an EIA). Participants and performers of the EIA. Public participation in the EIA process. Collecting general information and special information about the object. Stages of the EIA procedure. Requirements for the EIA materials. L*evel of difficulty: 3* Engineering and environmental surveys as a preliminary stage of environmental impact assessment. Methodology and sequence of work on the assessment of the state of the habitat. Preliminary cameral stage. Field stage. Socio-economic research. The final cameral stage. L*evel of difficulty: 3* Methods of conducting an EIA. Overlap methods. Check-lists. Matrix method of impact assessments. Networks. Joint analysis of maps. The method of flowcharts and network graphs. Natural assessment. Special nature assessment. Technological assessment. Economic assessment. Social assessment. Social compatibility of projects. Environmental assessment. Criteria base of impact assessments. L*evel of difficulty: 3* Assessment of cumulative impacts and interaction of various types of impacts. Cumulative effects. Indirect effects. Identification of possible cumulative impacts. Screening of impacts. Assessment of transboundary impacts. L*evel of difficulty: 4* Geoecological expertise. Main directions of geo-ecological expertise of project documentation. Geo-ecological expertise of design documentation for construction of groundwater intakes. Monitoring of geological environment for the purposes of geo-ecological expertise. L*evel of difficulty: 4* **E**cological and economic assessment of environmental impact. Indicators of ecological and economic assessment of the impact of enterprises' activities on the environment, methods of economic assessment of damage from environmental pollution. L*evel of difficulty: 3* Assessment of significance of residual impacts. Criteria of significance. Determination of spatial scale of impact. Determination of the temporal scale of impact. Determining the magnitude of impact intensity. Calculation of the integrated assessment and significance of impacts on the natural environment. L*evel of difficulty: 4* Environmental quality standardisation (ecological standardisation). Norming of pollutants in the atmospheric air. Analysis of calculations of pollution of the surface layer of atmospheric air, norms of maximum permissible emissions. Norming of pollutants in water bodies. Classification of water bodies. Categories of water use. Analysis of calculations of pollution of watercourses and reservoirs and norms of permissible discharges. Norming of sanitary and protective zones. L*evel of difficulty: 3* Management of environmental impact. Environmental management plan. Principles of reducing negative impact on the environment. Environmental risk management. Risk levels. Decision making in conditions of uncertainty. Comparative analysis of economic and environmental risk. Types of mitigation measures in industry, agriculture and water management. L*evel of difficulty: 3* *The following topics can be recommended for practical training* Ecological substantiation of project implementation and industrial location. L*evel of difficulty: 3* Engineering-ecological surveys for development and justification of project investments. L*evel of difficulty: 3* Assessment of ecological hazard of atmospheric pollution in the city. L*evel of difficulty: 3* Matrix method of assessment of economic activity impact on the environment. L*evel of difficulty: 3* Assessment of ecological risk of soil salinity and reclamation measures. L*evel of difficulty: 3* Ecological and economic assessment of soil desalinisation measures. L*evel of*

Exams and assessment formats	Two written midterm assessments (30 minutes each), take-home written assignments and one final oral exam (40 minutes).
Study and examination requirements	*Requirements for successfully passing the module:* The final grade in the module is composed of 40% performance on exams, 20% take-home assignments, 20% in-class participation, 20% midterm tests. Students must have a final grade of 60% or higher to pass.
Reading list	1. Mareddy Anji R. Environmental Impact Assessment. Theory and Practice. Butterworth-Heinemann, Elsevier, 2018. — 616 p. — ISBN 978-0-12-811139-0. 2. Arjun Kumar R. Handbook of Environmental Impact Assessment. Cambridge Scholars Publishing, 2021. — 620 p. 3. Hernandez-Soriano M.C. (Ed.) Environmental Risk Assessment of Soil Contamination. Intech, 2014. — 903 p. 4. Sanford Robert M., Holtgrieve Donald. Environmental Impact Assessment in the United States. Routledge, 2022. — 336 p. 5. Theodore L., Dupont R.R. Environmental Health and Hazard Risk Assessment: Principles and Calculations. CRC Press, 2012. — 619 p. 6. Довлетярова Э.А., Васенев И.И. Оценка воздействия на окружающую среду (ОВОС) и экологическое проектирование в различных экосистемах. Учебное пособие.М.: РУДН, 2008. - 75 с. 7. Кудрявцева О.В., Ледащева Т.Н., Пинаев В.Е. Методика и практика оценки воздействия на окружающую среду. Проектная документация. М.: Экономический факультет МГУ имени М. В. Ломоносова, 2016. — 170 с.

Module designation	**EE-6206 - Ecological expertise**
Semester(s) in which the module is taught	*3*
Person responsible for the module	*Prof., Dr.* Bakhodirhodja Ismailhodjaev
Language	*Uzbek, Russian*
Relation to curriculum	*Elective*
Teaching methods	*Lecture, practical lesson, self-learning*
Workload (incl. contact hours, self-study hours)	*Total workload: 180* *Contact hours: lecture - 30, practical lessons – 60, self-learning – 90, hours*
Credit points	*6*
Required and recommended prerequisites for joining the module	To master the course, Master Students must have basic knowledge in ”General ecology and Environmental Protection”, "Environmental impact assessment", “Environmental monitoring”.
Module objectives/intended learning outcomes	**To know and understand:** - basics of environmental legislation regulating activities in the field of design, state and public environmental expertise. - main sources, types and scales of environmental pollution; - basics of organisation of state and public environmental expertise. **To be able to:** - use basic knowledge of environmental protection methods in practice; - carry out general procedures of investment design and environmental expertise. **To form competences in:** - determining the level of exceeding MPC of pollutants; - analysing pre-project and project materials - forecast and assess damage to the environment from pollution.

Content: The discipline includes the following topics. The *level of difficulty*: (1 – low, 5 high):	Subject, methods and objectives of the science of environmental expertise. Formation and development of environmental expertise as a new subject and subject of study. Object of ecological expertise, methods of research. L*evel of difficulty*: 2. Scientific and methodological bases of ecological expertise. Basis of ecological expertise of ecological laws, rules and principles. Assessment of environmental impact in environmental expertise. Control over the directions of interaction between nature and society in environmental expertise. The basis of ecological laws, rules, principles in interrelation with ecological expertise. Basic concepts of ecological expertise and evaluation criteria. L*evel of difficulty*: 2. Ecological situation in Uzbekistan and its expert assessment. Assessment of anthropogenic negative impact on environment, normative requirements to project materials, initial composition of natural-climatic and socio-economic data in projects subject to environmental expertise. Parameter and criteria for assessing the condition of the regions where the projected facilities are located, ecological description of the projected facility, assessment of impact on components of nature. General information on ecological situation in Uzbekistan. Territorial differences of ecological situation of natural objects and their consideration in ecological expertise. Use of international environmental expertise in research. L*evel of difficulty*: 2. Basic principles of environmental expertise. General principles of environmental expertise. Scientific principles of environmental expertise. Legal principles of environmental expertise. Systems of legal bases of environmental expertise. Rights and duties, responsibility of participants in relation to environmental expertise. Legal basis of ecological expertise, legal norms - laws of the Republic of Uzbekistan, legal obligations of decrees and orders of the President of the Republic of Uzbekistan on ecological expertise, systems of legal basis, participants of relations. L*evel of difficulty*: 3. Types of environmental expertise. Types and stages of environmental expertise, methods of their implementation. State environmental expertise. Environmental audit. Public environmental expertise. Use of different forms of environmental expertise (state, public, audit, departmental, scientific). Mandatory expertise of objects, expertise carried out in public organisations and assessment of the state of ecological natural autonomy of a particular object of audit expertise. L*evel of difficulty*: 3. Requirements for environmental expertise and environmental impact assessment. General requirements to environmental expertise. Classification of environmental expertise objects by their impact on the environment and nature use. Differences in the impact of environmental expertise objects on the natural environment. Classification of objects of environmental expertise on the impact of the environment on the natural environment. Documents to be submitted for expertise in the course of environmental expertise, several stages of environmental impact assessment, studies in the course of the stages, their implementation, differences in the impact of objects on the environment. L*evel of difficulty*: 3. Main areas of environmental expertise. Technological environmental expertise. Environmental expertise of enterprises and urban planning. Environmental expertise of projects on the use of natural resources and transformation of nature. Complexes of the main directions of ecological expertise - ecological expertise of technological enterprise projects, town-planning, natural resources use. L*evel of difficulty*: 3. Requirements to the organisation of the environmental expertise service and the conclusion of the state environmental expertise. The procedure of environmental expertise. Organisation of the state environmental expertise service. Requirements to the structure and content of the conclusion of the state environmental expertise. Content and text of the conclusion of the state environmental expertise. Financing of the state environmental expertise. Procedure for confirmation of the conclusion of the public environmental expertise. Organisation of environmental expertise service in foreign countries. L*evel of difficulty*: 3. The following topics are recommended for practical classes: The following topics are recommended for practical classes: 1.Familiarisation with legal documents of environmental expertise. L*evel of difficulty*: 2 2.Criteria of expert assessment and ecological zoning of ecological situation in Uzbekistan. L*evel of difficulty*: 2 3.Familiarisation with the structure, content and method of preparation of the environmental expertise conclusion. L*evel of difficulty*: 2 4.Assessment of impact on atmosphere, water, fauna and flora, soil layer. L*evel of difficulty*: 3 5. Use of international environmental expertise in experiments in Uzbekistan. L*evel of difficulty*: 3.

Exams and assessment formats	*Two written midterm assessments (30 minutes each), take-home written assignments and one final oral exam (40 minutes).*
Study and examination requirements	*Requirements for successfully passing the module:* *The final grade in the module is composed of 40% performance on exams, 20 % independent work, 20 % practical work, 20 % mid-term control tests. Students must have a final grade of 60% or higher to pass*
Reading list	1. Jumaev T. Ekologik ekspertiza. O‘quv qo‘llanma. T., TDIU, 2014.128 b. 2. Tyldesley D. A Handbook on Environmental Impact Assessment. Scottish Natural Heritage. Glazgo. 2005 – 278 p 3. Донченко В.К. Пичурка В.М. Экологическая экспертиза.Учебное пособие. М.: Академ наук. 2010.- 502 с *4.* Ismailxodjaev B.Sh. Ekologik ekspertiza fanidan amaliy mashg‘ulotlarni o‘tish bo‘yicha metodik ko‘rsatma. T.: TIMI 2013 – 20 b

Internship

Module designation	**ILM-52312 - Research Internship**
Semester(s) in which the module is taught	*2*
Person responsible for the module	*Senior Lecturer, PhD, Kamila Shipilova* *Prof., Dr. Maria Radkevich*
Language	*Uzbek, Russian*
Relation to curriculum	*Mandatory*
Teaching methods	*practice, conducting scientific research, self-learning*
Workload (incl. contact hours, self-study hours)	*Total workload: 900* *self-learning – 900, hours*
Credit points	*30*
Required and recommended prerequisites for joining the module	To master the course, Master Students must have basic knowledge in "Research methodology", "Experiment planning", "Environmental Protection", "Waste water treatment", "Environmental impact assessment".
Module objectives/intended learning outcomes	The main objective of the Master's research practice is to gain experience in the study of an actual scientific problem, as well as the selection of necessary materials for the fulfilment of the Master's thesis. **As a result of Master's research practice the Master student must:** **know and understand:** - information sources on the topic under development in order to use them in the master's thesis; - methods of modelling and research of socio-economic processes; - methods of analysing and processing static data; - information technologies used in scientific research, software products related to the professional sphere; - requirements to the design of scientific and technical documentation; **be able to:** - analyse, systematise and summarise information on the topic of research; - independently plan and conduct observations; - comparison of research results of the object of development with domestic and foreign analogues;t. **form competences in:** - formation and verification of scientific hypotheses; - analysing the scientific and practical significance of the conducted research; - processing of the obtained experimental data; - registration of research results in the form of scientific manuscripts.
Content: The discipline includes the following topics.	Instruction on information search in accordance with the goals and objectives of the internship in the organisation (Research Institute, Scientific Laboratory, etc.). Drawing up an internship plan. Familiarisation with the organisational structure and the content of the activities of the internship object. Collection, synthesis and systematisation of the main indicators, necessary for the fulfilment of the individual task. Experimental stage. Selection of the method of experimental research. Planning and carrying out the experiment in accordance with the topic of the master's thesis. Processing and analysis of the obtained information. Comprehensive study and analysis of information technologies, software and information support in the organisation in accordance with the individual assignment. Processing and analysis of data. Final stage. Preparation of the draft report. Formalisation of the report on scientific internship, preparation for its defence.
Exams and assessment formats	Following the results of the internship, students are required to: • provide an internship diary • prepare and defend reports based on the collected data. The final Internship Report is defended at a meeting in the presence of a commission appointed by the head of the graduating department (20 minutes).
Study and examination requirements	*Requirements for successfully passing the module:* The final grade in the module is composed of 40% defence of the internship report, 40 % participation in the internship, 20% completion of the internship diary and report. Students must have a final grade of 60% or higher to pass

Reading list	1. Environmental Engineering Internship. Complete 2023 Guide. Available at: https://careeremployer.com/work-experience/environmental-engineering-internship/ 2. Маркина Т.А., Пенской А.В., Штенников Д.Г., Авксентьева Е.Ю., Ильина А.Г., Производственная практика магистрантов: организация и проведение – СПб: Университет ИТМО, 2020. – 50 с. 3. Козлов М.В. Планирование экологических исследований: теория и практические рекомендации. - М.: КМК, 2015. - 171 с. 4. Davronov Z., Primov M. “Ilmiy tadqiqot metodologiyasi” fanidan o‘quv-uslubiy majmua. T.: Toshkent “Agronomiyada zamonaviy ilmiy tadqiqot uslublari”

Module designation	**MAL-52312 - Professional internship**
Semester(s) in which the module is taught	*2*
Person responsible for the module	*Senior Lecturer, PhD, Kamila Shipilova* *Prof., Dr. Maria Radkevich*
Language	*Uzbek, Russian*
Relation to curriculum	*Mandatory*
Teaching methods	*practice*, self-study
Workload (incl. contact hours, self-study hours)	*Total workload: 360* *practical lessons – 72, self-learning – 108, hours*
Credit points	*12*
Required and recommended prerequisites for joining the module	To master the course, Master Students must have basic knowledge in ”General ecology and Environmental Protection”, “Waste water treatment”, "Environmental impact assessment" , methodology of scientific research
Module objectives/intended learning outcomes	**To know and understand:** - the subject and object of the chosen direction and profile of professional training; - the range of his/her future professional duties; - methods and techniques of self-education; - criteria of professional success; - computer system and software aimed at solving environmental problems. **To be able to:** - work in a team, - demonstrate responsibility for the results of work; - self-actualisation and self-education, demonstrate personal growth and leadership qualities in the professional sphere of activity; - readiness to use achievements of science and technology in the field of nature protection technologies, methods for development of modern technical, organisational and innovative hardware and software solutions. **To form competences in:** - ability to realise the main problems of their subject area, in solving which there is a need for complex choice problems, which require - using modern scientific research methods, - ability to set tasks and determine ways of search and means of their solution, - application of knowledge of modern research methods to the solution of applied professional tasks.
Content: The discipline includes the following topics.	The purpose of professional internship of a master student is to develop the ability to independently carry out research work related to the solution of complex professional problems in innovative conditions, as well as the acquisition by students of professional skills and experience of professional activity and preparation for future professional activity in the field of environmental protection. Professional internship consits of following phases: Preparatory phase: safety briefing. Instruction on information search in accordance with the goals and objectives of the internship in the organisation. Drawing up a plan for the internship. Familiarisation with the organisational structure and the content of activity of the practice object. Familiarisation with their duties and workplace during the internship. Collection, synthesis and systematisation of the main indicators necessary for the performance of the individual task. Processing and analysis of the received information. Comprehensive study and analysis of information technologies, software and information support in the organisation in accordance with the individual task Preparation of a draft report on internship. Formalisation of the report on internship, preparation for its defence.
Exams and assessment formats	Following the results of the internship, students are required to: • provide an internship diary • prepare and defend reports based on the collected data. The final Internship Report is defended at a meeting in the presence of a commission appointed by the head of the graduating department (20 minutes).
Study and examination requirements	*Requirements for successfully passing the module:* The final grade in the module is composed of 40% defence of the internship report, 40 % participation in the internship, 20% completion of the internship diary and report. Students must have a final grade of 60% or higher to pass.

Reading list	1. Environmental Engineering Internship. Complete 2023 Guide. Available at: https://careeremployer.com/work-experience/environmental-engineering-internship/ 2. Маркина Т.А., Пенской А.В., Штенников Д.Г., Авксентьева Е.Ю., Ильина А.Г., Производственная практика магистрантов: организация и проведение – СПб: Университет ИТМО, 2020. – 50 с. 3. Arjun Kumar R. Handbook of Environmental Impact Assessment. Cambridge Scholars Publishing, 2021. — 620 p 4. Основы промышленной экологии: учеб. пособие / А.А. Челноков, Л.Ф. Ющенко М.: Высш. Шк., 2001 – 343 с. 5. Родионов, А.И. Технологические процессы экологической безопасности / А.И. Родионов, В.Н. Клушин, В.Г. Систер - Калуга: Изд-во Н. Бочкаревой, 2000 - 800 с.