# Module Handbook

The MSc: 70812307– Water Resources Planning and Management degree program

**1.1. Mandatory disciplines**

| **Module designation** | ***ITM 5102, Research methodology*** |
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| Semester(s) in which the module is taught | *1* |
| Person responsible for the module | *Professor, Yangiyev Asror* |
| Language | *Uzbek/English* |
| Relation to curriculum | *Compulsory (Mandatory disciplines)* |
| Teaching methods | *Lecture, practical works, SAW (Student autonomous work), two midterm assessments and exam,* |
| Workload (incl. contact hours, self-study hours) | *Total workload – 120 hours;*<br>*Lecture – 20 hours*<br>*Practical works – 10 hours*<br>*SAW (Student autonomous work) – 30 hours*<br>*Form of final control Exam*<br>*Final assessment method Quiz* |
| Credit points | *2 ECTS* |
| Required and recommended prerequisites for joining the module | *Basic knowledge of hydrology, Environmental science, Statistics Water quality, Water supply system, Irrigation and land reclamation, Use of hydromelioration systems, Water-saving technologies, hydrometry, hydrogeology,* |

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| Module objectives/intended learning outcomes | *Knowledge:*<br>✓ *Understanding the principles of water cycle, precipitation, evaporation, and groundwater flow;*<br>✓ *Knowledge of water quality parameters, pollutants, and methods for water quality assessment;*<br>✓ *Understanding water resource systems, allocation, and sustainable management practices.*<br>✓ *Familiarity with local, national, and international water-related policies and regulations.*<br>✓ *Proficiency in collecting hydrological data, conducting statistical analyses, and using relevant software/tools.*<br>✓ *Understanding different hydrological models and their applications in simulating water-related processes.*<br>✓ *Awareness of the impact of climate change on water resources and adaptation strategies.*<br>✓ *Knowledge of water supply and distribution systems, dams, reservoirs, and irrigation systems.*<br>*Skills:*<br>✓ *Ability to formulate research questions, hypotheses, and develop research methodologies.*<br>✓ *Proficient in field data collection techniques, including water sampling, sensor deployment, and surveys.*<br>✓ *Skilled in data processing, statistical analysis, and interpretation of results.*<br>✓ *Effective communication of research findings through scientific reports and papers.*<br>✓ *Ability to present research findings in conferences and seminars.*<br>✓ *Analytical thinking and problem-solving skills to address complex water-related issues.*<br>*Competencies:*<br>✓ *Ability to integrate knowledge from various disciplines to address water management challenges.*<br>✓ *Ability to the ethical considerations and sustainability principles in water management.*<br>✓ *Competency in engaging with diverse stakeholders, including communities, government agencies, and NGOs.*<br>✓ *Ability to adapt to changing environmental and research conditions.*<br>✓ *Competence in influencing water-related policies and advocating for sustainable practices.*<br>✓ *Competency in assessing risks associated with water-related projects and proposing mitigation strategies;*<br>✓ *Capacity to lead and collaborate within research teams and projects.* |

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| Content | *Subjects and tasks of the science of scientific research methodology. Science and creativity. Science is one of the oldest objects of philosophy. The concept of creativity. Difficulty level: 2*<br>*Scientific research methods, Theoretical research methodology, Experimental research methodology, Field research methodology. Difficulty level: 2*<br>*Modeling problems in scientific creation. Concept of "modeling". Modeling problems in scientific cognition. The role of modeling and analogy in cognition. Similarity theory. Newton's law of similarity. Geometric similarity. Kitematic and dynamic similarity terms .Difficulty level: 3*<br>*Analogy of hydrodynamic processes. From the Nave-Stokes equation to the criteria Fr, Re, Sh, Ei. Dimensional theory: basic concepts and principles, dimensional formulas. Difficulty level: 4*<br>*Experiment planning: purpose, factors, types of experiments, randomization. Analysis of experimental data, tasks, differentiation and integration of obtained functions, comparison. finding functional relationships, tables, graphs, interpolation and extrapolation. Difficulty level: 5* |
| Exams and assessment formats | *During one semester, MSc students answered two oral questions (midterm assessments), with each question lasting 5 minutes. They collected a total of 60 points, evenly distributed with 30 points for the first set of questions and 30 points for the second set.*<br>*Additionally, there was a final exam for MSc students, which lasted 40 minutes. There were short computer-based quizzes, and MSc students could collect up to 40 points.* |
| Study and examination requirements | *MSc Students must have a final grade of 60% or higher to pass* |
| Reading list | *1. Maidanov A.S. Methodology of scientific creation. Moscow., 2008.*<br>*2. Zimnyaya I.A. Research work: methodology, theory, practice of organization and implementation. -Moscow, 2000.*<br>*3. Rahmatullaev Sh. Fundamentals of scientific research. - Tashkent, 2002.*<br>*4. Shermuhamedova N. Philosophy and science methodology. – Tashkent, 2009. - 436 p*<br>*5. Bhaskar, R. Reclaiming Reality: A Critical Introduction to Contemporary Philosophy. Abingdon: Routledge (originally published by Verso 1989). 2011 – 456 p.*<br>*6. Blaikie, N. Designing Social Research (2nd edn). Cambridge: Polity. 2010.*<br>*7. Chia, R. (2003) 'Organization theory as a postmodern science', in H. Tsoukas and C. Knudsen (eds) The Oxford Handbook of Organization Theory: Meta-Theoretical Perspectives. Oxford: Oxford University Press, pp. 113–40.* |

| **Module designation** | ***WST5104, Water treatment*** |
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| Semester(s) in which the module is taught | *1* |
| Person responsible for the module | *PhD, Ashirova Olga Aleksandrovna* |
| Language | *Uzbek/English* |
| Relation to curriculum | *Compulsory (Mandatory disciplines)* |
| Teaching methods | *Lecture, practical works, SAW (Student autonomous work), Course project, two midterm assessments and exam,* |
| Workload (incl. contact hours, self-study hours) | *Total workload – 120 hours;*<br>*Lecture – 30 hours*<br>*Practical works – 30 hours*<br>*SAW (Student autonomous work) – 60 hours*<br>*Course project – independence work*<br>*Form of final control Exam*<br>*Final assessment method Quiz* |
| Credit points | *4 ECTS* |
| Required and recommended prerequisites for joining the module | *Engineering Geodesy, fundamentals of Geology and hydrogeology, pumping and pumping stations, hydraulics.* |
| Module objectives/intended learning outcomes | ***To know and understand:***<br>*- methods for assessing and analyzing the quality of natural water and the basic methods of its preparation for domestic drinking water supply, technological and livestock needs;*<br>*- the essence of the processes of clarification and discoloration of water, the types and designs of structures used, the basis for their calculation;*<br>*- methods of water disinfection, removal of odors and tastes;*<br>*- basic requirements and principles for the layout of water clarification, decolorization and disinfection stations;*<br>*- the main directions of scientific research work on the development and modernization of natural and wastewater treatment systems;*<br>***To be able to:***<br>*- assess the quality of natural waters, determine the required degree of purification, select the optimal treatment technology and consist of facilities;*<br>*- evaluate the efficiency of the water treatment plant as a whole and its individual facilities;*<br>*- use regulatory, reference, scientific and technical literature and relevant computer software;*<br>*- analyze the economic efficiency of engineering projects and enterprise activities.*<br>***To form competences in:***<br>*- basic modern methods of calculation and design of structures, carry out technical drawings using modern computer programs;*<br>*- skills in performing verification calculations of existing structures;*<br>*- modern requirements and methods of carrying out necessary water protection measures;*<br>*- methods for calculating economic indicators of environmental management and water use projects;*<br>*- the main tools for quality management at all stages of the product life cycle.* |

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| Content | *The importance of water. Surface water consumption and quality. Requirements for water quality of surface and underground natural waters of various types of consumers. CSR requirements for drinking water quality. Level of difficulty: 3*<br>*Improving the quality of natural waters and special water treatment. Water purification methods. Level of difficulty: 4*<br>*Water clarification. Law of sedimentation of floating particles. Coagulation process. Strainers, their types, selection conditions. Level of difficulty: 3*<br>*Water filtration and disinfection. Fast and slow filters, their structure, calculation, working cycles. Two layer fast filters. Level of difficulty: 3*<br>*Basic methods of water disinfection. Chlorination, ozonation and disinfection in bactericidal devices. Level of difficulty: 5*<br>*Composition and characteristics of wastewater. Composition and amount of impurities in wastewater. Level of difficulty: 3*<br>*Determining the pollution concentration of wastewater by suspended substances and biochemical oxygen demand. Level of difficulty: 3*<br>*Wastewater treatment methods. Sanitary and chemical analysis of wastewater. Level of difficulty: 4*<br>*Selection of the technological scheme of wastewater treatment. Technological scheme of mechanical wastewater treatment. Level of difficulty: 4*<br>*Sedimentation tanks. Their types and construction. Primary and secondary sedimentation tanks. Level of difficulty: 4*<br>*Biological treatment of waste water in biofilters. Types of biofilters, structure. Level of difficulty: 3*<br>*Peculiarities of industrial wastewater treatment. Cleaning of industrial wastewater by mechanical and physico-chemical methods. Level of difficulty: 4*<br>*Biological treatment of wastewater under natural conditions. Irrigation fields and filtration fields. Bioreservoirs. Level of difficulty: 4*<br>*Sewerage of small settlements and individual objects. Simple ways to improve the quality of wastewater. Level of difficulty: 3*<br>*Sewerage scheme of livestock farms. The composition of livestock wastewater. Treatment of wastewater from livestock and poultry farms and its use in agriculture. Level of difficulty: 3* |
| Exams and assessment formats | *During one semester, MSc students answered two oral questions (midterm assessments), with each question lasting 5 minutes. They collected a total of 60 points, evenly distributed with 30 points for the first set of questions and 30 points for the second set.*<br>*Additionally, there was a final exam for MSc students, which lasted 40 minutes. There were short computer-based quizzes, and MSc students could collect up to 40 points.* |
| Study and examination requirements | *MSc Students must have a final grade of 60% or higher to pass* |

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| Reading list | *1. Djalilova A.Ю., Xamidov A.O., Abduqodirova M.H. "Sewage and wastewater treatment" Handbook. Tashkent - 2012 y -200 p.*<br>*2. Mahmudova I.M., Ahmedova T.A. "Fundamentals of natural and wastewater quality assessment and treatment". Handbook. Tashkent:- 2015 -146 p.*<br>*3. Maxmudova I.M., Abdukadirova M.N. "Improving the quality of natural waters" Methodical Instruction for course projects. Tashkent. 2015. 36p.*<br>*4. Mackenzie L. Davis. Water and Wastewater Engineering: Design Principles and Practice. McGraw-Hill Education: New York,2010- 356p.*<br>*5. Soares, A. Wastewater treatment in 2050: Challenges ahead and futur e vision in a European context. Environ. Sci. Ecotechnol. 2020, 2, 10003 0. https://doi.org/10.1016/j.ese.2020.100030*<br>*6. Francis Xavier, L.; Money, B.K.; John, A.; Rohit, B. Removal of cadm ium heavy metal ion using recycled black toner powder. Mater. Today P roc. 2021, in press. https://doi.org/10.1016/j.matpr.2021.12.190.*<br>*7. Kumar, Ajay, and Vineet Kumar. "A comprehensive review on application of lignocellulose derived nanomaterial in heavy metals removal from wastewater." Chemistry Africa 6, no. 1 (2023): 39-78.* |

| **Module designation** | ***WRM5108, Multi purposes water resources use and protection*** |
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| Semester(s) in which the module is taught | *Two semester ( 1st and 2nd)* |
| Person responsible for the module | *Associate professor Karimov Akmal Khayitovich* |
| Language | *Uzbek/English/Russia* |
| Relation to curriculum | *Compulsory (Mandatory disciplines)* |
| Teaching methods | *Lecture, practical works, SAW (Student autonomous work), Course project, two midterm assessments and exam,* |
| Workload (incl. contact hours, self-study hours) | *Total workload – 240 hours;*<br>*Lecture – 60 hours*<br>*Practical works – 60 hours*<br>*SAW (Student autonomous work) – 120 hours*<br>*Course project – independence work*<br>*Form of final control Exam*<br>*Final assessment method Quiz* |
| Credit points | *8 ECTS* |
| Required and recommended prerequisites for joining the module | *Hydrology; Hydrogeology; Irrigated agriculture; water saving technologies;* |
| Module objectives/intended learning outcomes | ***Knowledge:***<br>✓ *Water resources assessment;*<br>✓ *Rational water use in different sectors of economy;*<br>✓ *Water resources allocation strategic planning;*<br>***Skills:***<br>✓ *strategic thinking; technical and social drivers of affecting water management;*<br>✓ *ability to estimate water resources, estimate demand for water in different sectors of economy;*<br>✓ *practical skills in using WEAP, IHA models.*<br>***Competences:***<br>✓ *integration of knowledge on demand for water and water use in different sectors of economy;*<br>✓ *elaborate schemes of multipurpose water for river basins;*<br>✓ *develop scenarios of water availability for future;*<br>✓ *develop adaptation measures to climate change, able to integrate technical and social aspects of water management* |

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| Content | *Introduction to the discipline Multi purposes water resources use and their protection. Level of difficulty: 4*<br>*The water cycle in nature. Uneven distribution of water resources. Anthropogenic activity and the water cycle. Resources and reserves of water in Central Asia, including in Uzbekistan. Level of difficulty: 5*<br>*Cyclical climate change and its impact on the availability of water and energy resources. Impact of solar activity and greenhouse gases on climate change. Climate change mitigation and adaptation to change. Level of difficulty: 4*<br>*Impact of climate change on water resources and water use, Problems of climate change and its impact on water resources and agriculture (basins of the Mekong, Amudarya and Syrdarya rivers). Measures to mitigate the effects of climate change and adaptation to the climate-changed conditions in Uzbekistan. Level of difficulty: 5*<br>*Assessment of water resources of river basins. Water resources of Uzbekistan - their current use and problems. Level of difficulty: 4*<br>*Resources and reserves of underground waters. Definitions. Groundwater modeling. Level of difficulty: 4*<br>*The use of GIS technologies in the assessment of water resources. Estimation of effective precipitation. Level of difficulty: 3*<br>*WMS members. Dependencies and contradictions between water demands of WMS participants. Groups of WMS participants - the sequence of water allocation. Water consumption and water use. Level of difficulty: 4*<br>*Water sources. Goals and norms of water use. water quality requirements. Water use schemes. Quantity and quality of wastewater. Ways to regulate water use. Ways to improve the efficiency of water use in the MWU. Wastewater treatment process and efficient use of waste. Negative impact of MWU on the environment. Reuse of municipal wastewater. Level of difficulty: 5*<br>*Ways to improve the efficiency of water resources use in industry. Level of difficulty: 4*<br>*Water sources. Goals and norms of water use. water quality requirements. Water use schemes. Quantity and quality of wastewater. Ways to regulate water use. Wastewater treatment process and efficient use of waste. The negative impact of industry on the environment. Circular use of industrial effluents. Level of difficulty: 5*<br>*Goals and norms of water use. Quantity and quality of wastewater. Ways to regulate water use. Ways to reduce water consumption for cooling. The impact of thermal power engineering on the environment. Thermal power engineering and adaptation to climate change. Level of difficulty: 5*<br>*Hydropower and adaptation to climate change. Hydropower impact on environment and other participants of WMS. Small and big hydropower. Level of difficulty: 4*<br>*Water sources. Requirements for the quantity and quality of water. Water-saving irrigation technologies. Volumes of drainage waters and their quality. Impact of irrigated agriculture on the environment. Impact of climate change on irrigated agriculture. Circular system of water use in irrigated agriculture. Level of difficulty: 4*<br>*The purpose and objectives of water use in fisheries. Types of fishery farms. Hydraulic structures in fisheries. Negative impact of fisheries development on the environment. Level of difficulty: 4*<br>*The purpose and objectives of water use in livestock. Requirements for the quantity and quality of water. Volumes of sewage waters and their quality. Impact of livestock on the environment. Circular system of water use in livestock. Level of difficulty: 5*<br>*The concept of ecological flow. Difference between sanitary flow and ecological flow. Services of aquatic ecosystems. Relationship between river runoff components and ecosystems. IHA model. Estimation of ecological flow. Savanah process. Level of difficulty: 5*<br>*Definitions. Water use categories. Water consumption. Water saving and water conservation Level of difficulty: 4*<br>*Description of the natural conditions of the river basin. Water resources assessment. Evaluation of water requirements for WMS participants. Water management balance. Water management and water protection measures. Level of difficulty: 4*<br>*Population growth based scenarios. Climate change based scenarios.* |

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| Exams and assessment formats | *During one semester, MSc students answered two oral questions (midterm assessments), with each question lasting 5 minutes. They collected a total of 60 points, evenly distributed with 30 points for the first set of questions and 30 points for the second set.*<br>*Additionally, there was a final exam for MSc students, which lasted 40 minutes. There were short computer-based quizzes, and MSc students could collect up to 40 points.* |
| Study and examination requirements | *MSc Students must have a final grade of 60% or higher to pass* |
| Reading list | *1.Valiev X.I., Murodov Sh.O., Xolboev B. "Multi-purpose use of water resources and protection"(Uzbek), Textbook. Tashkent: 2010. - 167 p.*<br>*2. R.Quentin Grafton, Karen Hussey "Water resources planning and management", London 2011, Cambridge University Press.423 p.*<br>*3. A.T.Salohiddinov, R.Q.Boirov, K.Milov, R.Taha, D.Zigler "Suv resurslarini havzaviy boshqarish va rejalashtirish"(English, Russian and Uzbek), Handtbook. Tashkent. 2020-162 p.*<br>*4. Valiev Kh.I. Methodological instructions for the implementation of the course project "Multi purposes water resources and their protection" from the discipline " Water Resources Planning and Management ". - ashkent: TIIM, 2012, 164 p.*<br>*5. Salokhiddinov A.T. av bosh. "Suvdan foydalanish asoslari" O'quv qo'llanma, Toshkent, Sharq 2008, 297 b.*<br>*6. Savenije, Hubert HG. "Water resources management: concept and tools." IHE, 2001.*<br>*7. Jaspers, Frank GW. "Institutional arrangements for integrated river basin management." Water policy 5.1 (2003): 77-90.* |

| **Module designation** | ***IWRM5108, Water cadastre. Integrated water resources management*** |
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| Semester(s) in which the module is taught | *Two semester ( 1st and 2nd)* |
| Person responsible for the module | *Senior Lecturer, Mamatov Sobitjon Alimjanovich* |
| Language | *Uzbek/English/Russia* |
| Relation to curriculum | *Compulsory (Mandatory disciplines)* |
| Teaching methods | *Lecture, practical works, SAW (Student autonomous work), two midterm assessments and exam,* |
| Workload (incl. contact hours, self-study hours) | *Total workload – 240 hours;*<br>*Lecture – 60 hours*<br>*Practical works – 60 hours*<br>*SAW (Student autonomous work) – 120 hours*<br>*Form of final control Exam*<br>*Final assessment method Quiz* |
| Credit points | *8 ECTS* |
| Required and recommended prerequisites for joining the module | *Hydrology; Hydrogeology; Irrigated agriculture; water saving technologies;* |
| Module objectives/intended learning outcomes | ***Knowledge:*** *water resource accounting systems, water facilities in the world and Central Asia - the distribution of rivers, lakes, reservoirs and glaciers, surface and groundwater reserves and resources, operational water resources, hydrometric network designed to take into account River Water Resources, the use of local streams and the protection of water facilities, the foundations of Integrated Water Resource Management, international problems in the management of cross-border Water Resources.*<br>***Skills:*** *forecasts for the return of succulent and low periods in water sources, short and long-term predictions of river flow, monthly information about the amount of precipitation in the winter period and estimates of the wateriness of its rivers for the growing season, images of the study of winter precipitation, snow reserves, methodological foundations for the assessment of annual renewable aquaculture resources, public participation in.*<br>***Competences****: calculation of water balance in natural and artificial water bodies, assessment of hydrologic - quality of collected river waters by hydrochemical indicators, assessment of potential exploitation resources of groundwater by Trunk river basins, prediction of changes in river flow due to human economic activity, drawing up a water use plan.* |

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| Content | *Understanding of the water cadastre, goals and tasks. Main gools and objections, working with legal documents about water cadastre Uzbekistan. Level of difficulty: 4;*<br>*Surface water resources. Allocation of water bodies in Central Asia - rivers, lakes, reservoirs and glaciers. Level of difficulty: 5;*<br>*Underground water resources. Exploitable and potentially exploitable underground water reserves. Level of difficulty: 5;*<br>*River water resource accounting is a hydrometric network that accounts for river water resources. Level of difficulty: 5;*<br>*The catchment area of the river. Level of difficulty: 4*<br>*The natural hydrological regime of rivers. Level of difficulty: 4*<br>*Hydrometric information, annual flow of rivers, flow rates, return of wet and dry periods. Level of difficulty: 4*<br>*Short and long-term river flow forecasts. Level of difficulty: 3*<br>*Measurements, winter precipitation, snow storage images, methodology for estimating annual renewable water resources. Level of difficulty: 4*<br>*Assessment of long-term variability of water resources. Level of difficulty: 5;*<br>*Statistical descriptions of surface water quality, river water quality. Level of difficulty: 5;*<br>*Methodological basis of the evaluation of the operational reserve of underground water, assessment of the potential operational reserve of underground water in the main river basins. Artificial supply or establishment of underground water. Level of difficulty: 5;*<br>*Use of water resources, general information about water management facilities, use of surface and underground water. Level of difficulty: 5;*<br>*Water resources and their future use. Predicting changes in river flow due to human economic activities. Level of difficulty: 4;*<br>*Hydrological annals. Hydrological prediction. Level of difficulty: 4;*<br>*Modern sources of hydrological and hydrogeological information. Conditions for organizing monitoring of hydrological studies, water resources cadastre - a collection of hydrological data on surface and underground waters. Level of difficulty: 5;*<br>*Introduction to integrated water resources management. Important issues of integrated management of water resources. Level of difficulty: 4;*<br>*Implementation of integrated management of water resources. Development of a strategic vision in the integrated management of water resources. Level of difficulty: 5;*<br>*Water resources management planning. Water resources management planning cycle. Level of difficulty: 4;*<br>*Activating the water resources management planning process. Development of a work plan for integrated management of water resources. Level of difficulty: 5;*<br>*Participation of interested parties in the development of the work plan for integrated management of water resources. Level of difficulty: 4;*<br>*Situation analysis in the process of planning water resources management. Analysis of the state of water resources in the process of water resources management planning. Level of difficulty: 5;*<br>*Water resources management strategy and options. Preparation and approval of an integrated water resources management plan. Level of difficulty: 4;*<br>*Factors affecting the integrated management of water resources. Public participation in integrated management of water resources. Level of difficulty: 5;*<br>*Cooperative management of water resources. Hydrographization. Level of difficulty: 4;*<br>*Cooperative management of water and land resources. Monitoring of water resources and their assessment. Level of difficulty: 5;* |

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| Exams and assessment formats | *During one semester, MSc students answered two oral questions (midterm assessments), with each question lasting 5 minutes. They collected a total of 60 points, evenly distributed with 30 points for the first set of questions and 30 points for the second set.*<br>*Additionally, there was a final exam for MSc students, which lasted 40 minutes. There were short computer-based quizzes, and MSc students could collect up to 40 points.* |
| Study and examination requirements | *MSc Students must have a final grade of 60% or higher to pass* |
| Reading list | *1. R. Quentin Grafton, Karen Hussey Water Resources Planning and Management Cambridge University Press Cambridge, UK, 2011. 249 r.*<br>*2. Salokhiddinov A.T., Ikromov R.K., Temirova M.N. Water resources management. Handbook. Tashkent, 2015 - 246 p.*<br>*3. Saloxiddinov A.T., Raximov N.R. Fundamentals of integrated water resources management. 2018 y. 136 b.*<br>*4. Water is a critical resource for Uzbekistan UN Uzbekistan 2005-102p.*<br>*5. Savenije, Hubert HG, and Pieter Van der Zaag. "Integrated water resources management: Concepts and issues." Physics and Chemistry of the Earth, Parts A/B/C 33.5 (2008): 290-297*<br>*6. Caponera, Dante A., and Marcella Nanni. Principles of water law and administration: national and international. Routledge, 2019.*<br>*7. Katusiime, Juliet, and Brigitta Schütt. "Integrated water resources management approaches to improve water resources governance." Water 12.12 (2020): 3424.* |

| **Module designation** | ***WDC5104, International and national water relations*** |
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| Semester(s) in which the module is taught | *2* |
| Person responsible for the module | *Associate professor, Ziganshina Dinara Ravilevna* |
| Language | *Uzbek/English* |
| Relation to curriculum | *Compulsory (Mandatory disciplines)* |
| Teaching methods | *Lecture, practical works, SAW (Student autonomous work), two midterm assessments and exam,* |
| Workload (incl. contact hours, self-study hours) | *Total workload – 120 hours;*<br>*Lecture – 30 hours*<br>*Practical works – 30 hours*<br>*SAW (Student autonomous work) – 60 hours*<br>*Form of final control Exam*<br>*Final assessment method Quiz* |
| Credit points | *4 ECTS* |
| Required and recommended prerequisites for joining the module | *Environmental Science, Civil Engineering, Hydrology and Hydrogeology*<br>*Environmental Policy and Law, International Relations or Political Science, Economics, Basic water law.* |
| Module objectives/intended learning outcomes | *Knowledge:*<br>✓ *Water governance, treaties, and policies.*<br>✓ *Hydrology and hydrogeology fundamentals.*<br>✓ *Environmental sustainability and ecosystem impacts.*<br>✓ *Geopolitical factors and international organizations.*<br>✓ *Legal frameworks for transboundary water resources.*<br>✓ *Research ethics.*<br>✓ *Quantitative and qualitative research methods.*<br>*Skills:*<br>✓ *Data collection and analysis.*<br>✓ *Critical thinking and problem-solving.*<br>✓ *Effective communication.*<br>✓ *Cross-cultural competence.*<br>*Competencies:*<br>✓ *Research design and methodology.*<br>✓ *Interdisciplinary collaboration.*<br>✓ *Policy analysis.*<br>✓ *Conflict resolution and negotiation.*<br>✓ *Project management.*<br>✓ *Adaptability.*<br>✓ *Leadership in water-related fields.* |
| Content | *General concepts.*<br>*Water and Society. Water legislation as an object of regulation; Definition and sources of water legislation. Level of difficulty: 5;*<br>*System of water legislation. Distribution of water resources of Central Asia and documents defining the water resources use rights. Level of difficulty: 5;*<br>*Regulation on the use of water flows the international watercourses, include, Strategy of the United Nations Economic Commission for Europe in the field of environmental protection in relation to international watercourses: new borders and new potential for solving transboundary environmental problems. Level of difficulty: 5;*<br>*Convention on the protection and use. of transboundary watercourses and international lakes (Helsinki, 1992.) and Convention on the Law of the Non-Navigational Uses of International Watercourses (New York, 1997). Level of difficulty: 5;*<br>*Elements of a Legal Strategy for International Watercourses management: The Aral Sea Basin (Laurence Boisson de Chazournes) Level of difficulty: 5;* |

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| Exams and assessment formats | *During one semester, MSc students answered two oral questions (midterm assessments), with each question lasting 5 minutes. They collected a total of 60 points, evenly distributed with 30 points for the first set of questions and 30 points for the second set.*<br>*Additionally, there was a final exam for MSc students, which lasted 40 minutes. There were short computer-based quizzes, and MSc students could collect up to 40 points.* |
| Study and examination requirements | *MSc Students must have a final grade of 60% or higher to pass* |
| Reading list | *1. Salohiddinov A.T., Ismailhodjaev B.SH., Mirzaqobulov J.B. "International and state water relations", textbook for master students "TIIAME" pub. T: 2020 y. 225 p.*<br>*2. Shafiqul Islam, Lawrence E. Susskind "Water Diplomacy: A Negotiated Approach to Managing Complex Water Networks" RFF Press, Nyu York, 2012.*<br>*3. H. Yusupov, Z. Mamatova "Transboundary rivers and large dams: threats, losses and safety measures" Scientific and popular research, Tashkent: 2015. 266 p.*<br>*4. Ziganshina, Dinara. "International water law in Central Asia: Commitments, compliance and beyond." Journal of Water Law 20.2/3 (2009): 96-107.*<br>*5. Ziganshina, Dinara, and Barbara Janusz-Pawletta. "The principle of no significant harm in the Central Asian context." International Environmental Agreements: Politics, Law and Economics 20.4 (2020): 713-730.*<br>*6. Dukhovny, Viktor A., and Dinara Ziganshina. "Ways to improve water governance." Irrigation and Drainage 60.5 (2011): 569-578.*<br>*7. Ziganshina, Dinara R. "Institutional mechanisms for preventing and resolving cross-border water disputes." American Journal of International Law 115 (2021): 195-200.* |

| **Module designation** | ***EE6104, Environmental expertise*** |
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| Semester(s) in which the module is taught | *3* |
| Person responsible for the module | *Professor Ismailkhodjayev Bakhodirkhodja Sharipkhodjaevich* |
| Language | *Uzbek/English* |
| Relation to curriculum | *Compulsory (Mandatory disciplines)* |
| Teaching methods | *Lecture, practical works, SAW (Student autonomous work), two midterm assessments and exam,* |
| Workload (incl. contact hours, self-study hours) | *Total workload – 120 hours;*<br>*Lecture – 30 hours*<br>*Practical works – 30 hours*<br>*SAW (Student autonomous work) – 60 hours*<br>*Form of final control Exam*<br>*Final assessment method oral answers* |
| Credit points | *4 ECTS* |
| Required and recommended prerequisites for joining the module | *Hydrology; Hydrogeology; environmental science, biology, ecology, chemistry, geology, geography* |

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| Module objectives/intended learning outcomes | *Knowledge:*<br>✓ *Understand the fundamental principles of environmental science, including ecosystems, biodiversity, climate change, and sustainability;*<br>✓ *Gain a deep understanding of various research methodologies commonly used in environmental research, such as quantitative and qualitative methods, fieldwork, and laboratory techniques;*<br>✓ *Develop proficiency in statistical software and techniques to analyze environmental data effectively, including hypothesis testing, regression analysis, and spatial analysis;*<br>✓ *Familiarizing with environmental policies, regulations, and laws at local, national, and international levels, as these play a crucial role in shaping environmental research and decision-making;*<br>✓ *Learning how to collect, organize, and manage environmental data, ensuring accuracy, consistency, and ethical data handling practices;*<br>✓ *To gain expertise in GIS software and spatial analysis techniques for mapping and analyzing environmental data;*<br>✓ *Learning how to plan and conduct fieldwork, including data collection in diverse environmental settings and the use of specialized equipment.*<br>*Skills:*<br>✓ *Proficiency in crafting meticulous and pertinent research methodologies to address precise environmental research inquiries;*<br>✓ *Adeptness in data analysis utilizing statistical software and the aptitude to faithfully construe the ensuing outcomes;*<br>✓ *The cultivation of critical thinking capabilities to scrutinize research discoveries, discern their constraints, and proffer substantial remedies;*<br>✓ *Proficiency in conveying research discoveries proficiently via verbal presentations and visual aids;*<br>✓ *Diligent adherence to ethical standards and unwavering commitment to research integrity across all facets of research, spanning data acquisition, analysis, and reporting;*<br>✓ *Ability to engage in multidisciplinary collaboration, collaborating with experts from diverse fields to dissect complex environmental dilemmas from a myriad of perspectives.*<br>*Competencies:*<br>✓ *Developing ability and a strong problem-solving mindset to tackle complex environmental challenges creatively.*<br>✓ *Be adaptable and open to new research methods and emerging technologies in the field.*<br>✓ *Advocate for environmentally responsible practices and policies based on research findings.*<br>✓ *Effectively communicate research results competently through data visualization techniques and tools.*<br>✓ *Exhibiting leadership skills when working on research projects and collaborating with colleagues and stakeholders.*<br>✓ *To gain competence in writing grant proposals to secure funding for research projects.*<br>✓ *To highlight the global interconnectedness of environmental issues and their impact on different regions and communities.* |

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| Content | *Formation and development of the field of environmental expertise in the Republic of Uzbekistan. The subject, object, research methods of ecological expertise as an educational subject. Level of difficulty: 5;*<br>*Scientific and methodological bases of ecological expertise. Ecological situation in Uzbekistan and its expert assessment. Level of difficulty: 4;*<br>*Environmental status of natural components and their expert assessment. Basic principles of ecological expertise. Level of difficulty: 3;*<br>*Legal basis of ecological expertise. Types of ecological expertise. Level of difficulty: 4;*<br>*Environmental expertise requirements and environmental impact assessment. Level of difficulty: 5;*<br>*The main areas of ecological expertise. Organization of the ecological expertise service and requirements for the conclusion of the state environmental expertise. Level of difficulty: 5;* |
| Exams and assessment formats | *During one semester, MSc students answered two oral questions (midterm assessments), with each question lasting 5 minutes. They collected a total of 60 points, evenly distributed with 30 points for the first set of questions and 30 points for the second set.*<br>*Additionally, there was a final exam for MSc students, which lasted 40 minutes. There were short computer-based quizzes, and MSc students could collect up to 40 points.* |
| Study and examination requirements | *MSc Students must have a final grade of 60% or higher to pass* |
| Reading list | *1. Ismailkhodjaev B.Sh. "Environmental expertise". Study guide. T., Press."TIIAME" NRU 2022 -146 p.*<br>*2. Ismoilkhodjaev B.Sh., Abdullaev B.D., Mirzoqobulov J., "Environmental expertise" Handbook. - NIU "TIIIMSX". 2022.- 90 st.*<br>*3. David Tyldesley. A Handbook on Environmental Impact Assessment. Scottish Natural Heritage. Glasgow. 2005 – 278 p.*<br>*4. Turnhout, E., Tuinstra, W., & Halffman, W. Environmental Expertise. In Environmental Expertise: Connecting Science, Policy and Society (p. I). Cambridge: Cambridge University Press. 2019*<br>*5. Lidskog, Rolf, Adam Standring, and James M. White. "Environmental expertise for social transformation: roles and responsibilities for social science." Environmental Sociology 8.3 (2022): 255-266.*<br>*6. Lidskog, Rolf, and Göran Sundqvist. "Environmental expertise as group belonging: Environmental sociology meets Science and Technology Studies." Nature and Culture 13.3 (2018): 309-331.*<br>*7. Sörlin, Sverker. "Reconfiguring environmental expertise." Environmental science & policy 28 (2013): 14-24.* |

| **Module designation** | ***MF6102, The special subjects' teaching methods*** |
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| Semester(s) in which the module is taught | *3* |
| Person responsible for the module | *Professor Ismailova Zuhra Karabayevna* |
| Language | *Uzbek/English* |
| Relation to curriculum | *Compulsory (Mandatory disciplines)* |
| Teaching methods | *Lecture, practical works, SAW (Student autonomous work), two midterm assessments and exam,* |
| Workload (incl. contact hours, self-study hours) | *Total workload – 120 hours;*<br>*Lecture – 10 hours*<br>*Practical works – 20 hours*<br>*SAW (Student autonomous work) – 60 hours*<br>*Form of final control Exam*<br>*Final assessment method oral answers* |
| Credit points | *2 ECTS* |
| Required and recommended prerequisites for joining the module | *Vocational education methodology*<br>*Pedagogical technologies and pedagogical skills* |

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| Module objectives/intended learning outcomes | ***Knowledge:***<br>✓ *Understanding the content and intricacies of the special subject to be taught, including its foundational concepts, theories, and practical applications;*<br>✓ *Familiarity with various pedagogical theories and their relevance to teaching special subjects;*<br>✓ *Knowledge of effective teaching strategies, methods, and approaches tailored to special subjects, considering diverse learning styles;*<br>✓ *Understanding various assessment techniques and tools specific to evaluating students' understanding and performance in special subjects;*<br>✓ *Knowledge of how to design and adapt curricula for special subjects, aligning them with educational standards and objectives;*<br>✓ *Understanding the psychological aspects of learning, motivation, and behavior to create an engaging and supportive learning environment;*<br>✓ *Familiarity with the integration of technology tools and resources to enhance special subject instruction;*<br>✓ *Knowledge of relevant laws, regulations, and ethical standards in education and the teaching of special subjects.*<br>***Skills:***<br>✓ *Instructional Design: The ability to plan and design effective lesson plans, units, and instructional materials tailored to special subjects;*<br>✓ *Differentiation: Skill in adapting teaching methods and materials to accommodate diverse learners and their unique needs;*<br>✓ *Assessment and Feedback: The ability to develop and implement assessments and provide constructive feedback to students for their improvement;*<br>✓ *Classroom Management: Effective classroom management skills to create a positive and productive learning environment.*<br>✓ *Communication: Strong communication skills to convey complex concepts in a clear and understandable manner to students;*<br>✓ *Problem-Solving: Skill in addressing challenges and adapting teaching strategies as needed to facilitate learning in special subjects;*<br>✓ *Technology Integration: Competence in using educational technology tools and platforms to enhance instruction and student engagement.*<br>***Competencies:***<br>✓ *Adaptability: The ability to adjust teaching methods to meet the evolving needs of students and changing educational contexts;*<br>✓ *Cultural Competence: Competence in fostering an inclusive classroom environment that respects and values diverse cultural backgrounds;*<br>✓ *Data-Driven Decision-Making: The capacity to analyze student data and adjust instructional approaches based on evidence of student performance;*<br>✓ *Professional Development: A commitment to continuous learning and self-improvement as an educator, staying updated with the latest developments in special subjects and pedagogy;*<br>✓ *Collaboration: The ability to collaborate with colleagues, parents, and stakeholders to support student success and growth;*<br>✓ *Critical Thinking: Competence in critically evaluating educational practices and making informed decisions to enhance teaching methods in special subjects;*<br>✓ *Reflective Practice: The habit of regularly reflecting on teaching experiences to refine and improve instructional strategies.* |

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| Content | *The Subject, Purpose, and Tasks of "Methodology of Teaching Special Subjects" Level of difficulty: 4;*<br>*Understand the subject's scope, objectives, and specific tasks. Laws and Principles in Teaching Special Subjects. Level of difficulty: 4;*<br>*Explore the laws and fundamental principles that underpin teaching special subjects. Educational Normative Documents and Methodical Resources for Special Subject Instruction. Level of difficulty: 5;*<br>*Examine the educational regulations and methodological materials relevant to special subject teaching, including planning, organization, and instructional strategies. Overview of Teaching Approaches for Special Subjects. Level of difficulty: 5;*<br>*Provide an overview of various teaching methods and forms employed in teaching special subjects. Developing Visual Aids for Special Subject Instruction. Level of difficulty: 4;*<br>*Explore the methodology for creating visual teaching aids specifically designed for special subject instruction. Independent Learning and Its Methodological Aspects. Level of difficulty: 5;*<br>*Investigate strategies for promoting independent learning among students, including the special method for preparing course work (projects) and case studies related to special subjects. Level of difficulty: 5;*<br>*Objectives, Tasks, and Methodological Foundations of "Methodology of Teaching Special Subjects" Level of difficulty: 4;*<br>*Define the objectives and tasks of the subject "Methodology of Teaching Special Subjects" and its methodological foundations. Understanding Teaching Laws and Principles for Special Subjects. Level of difficulty: 4;*<br>*Gain a deeper understanding of the laws and principles governing the teaching of special subjects. Study and Application of Educational Normative Documents and Methodical Resources for Special Subject Instruction. Level of difficulty: 5;*<br>*Learn how to effectively study, apply, and organize educational regulations and methodological materials for teaching special subjects.*<br>*Practical Application of Teaching Approaches for Special Subjects. Level of difficulty: 4;*<br>*Apply teaching methods and forms in practical settings when instructing special subjects. Practical Approaches to Creating Visual Teaching Materials for Special Subjects. Level of difficulty: 4;*<br>*Put into practice the methods for developing visual teaching materials specific to special subject instruction. Independent Learning Practices and Methodological Organization. Level of difficulty: 4;*<br>*Implement strategies for fostering independent learning, including the preparation of course work (projects) and case studies in special subjects.*<br>*Utilizing Problem-Based and Interactive Methods in Teaching Special Subjects. Level of difficulty: 5;*<br>*Incorporate problem-based and interactive teaching methods into the instruction of special subjects. Assessment of Student Knowledge, Skills, and Abilities in Special Subject Instruction. Level of difficulty: 5;*<br>*Assess and evaluate students' knowledge, skills, and abilities during the teaching of special subjects. Integration of Pedagogical Technologies in Teaching Special Subjects. Level of difficulty: 5;*<br>*Explore the practical use of pedagogical technologies within the context of teaching special subjects. Implementing a Modular Approach and Distance Education in Special Subject Instruction. Level of difficulty: 5;*<br>*Integrate modular approaches and distance education methods into the teaching of special subjects. Level of difficulty: 4;* |

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| Exams and assessment formats | *During one semester, MSc students answered two oral questions (midterm assessments), with each question lasting 5 minutes. They collected a total of 60 points, evenly distributed with 30 points for the first set of questions and 30 points for the second set.*<br>*Additionally, there was a final exam for MSc students, which lasted 40 minutes. There were short computer-based quizzes, and MSc students could collect up to 40 points.* |
| Study and examination requirements | *MSc Students must have a final grade of 60% or higher to pass* |
| Reading list | *1. Ismailova Z.K., Makhsudov P.M. Ergashev O.K., Matkarimov K.J. Methodology of teaching special subjects. Study guide, T.: "Navroz", 2019.*<br>*2. Akimova O.B., Ismailova Z.K., Maksudov P.M. Utkina S.N. Методика профессионального обучения.Учебное пособие . T. "Navroz", 2020.*<br>*3. Ismailova Z.K., Makhsudov P.M., Ergashev O. Methodology of teaching special subjects. Textbook. "Lesson Press" 2021.228 pages*<br>*4. Marable, Michele A., Kimberly Leavitt-Noble, and Marya Grande. "Book talks in special education methods courses: Using literature to influence, inspire, and prepare teacher candidates." Teacher Education and Special Education 33.2 (2010): 143-154.*<br>*5. Fan, Lianghuo. "Textbook research as scientific research: towards a common ground on issues and methods of research on mathematics textbooks." ZDM 45 (2013): 765-777.*<br>*6. Westwood, Peter S., and Peter Westwood. What teachers need to know about teaching methods. Aust Council for Ed Research, 2008.*<br>*7. Crockett, Jean B., Bonnie Billingsley, and Mary Lynn Boscardin, eds. Handbook of leadership and administration for special education. Routledge, 2012.* |

## 1.2. Elective disciplines

**Elective discipline 1 (MSc students have the opportunity to choose one of three elective disciplines)**

| **Module designation** | ***IMA5102 Instrumental methods of analysis*** |
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| Semester(s) in which the module is taught | *1* |
| Person responsible for the module | *Professor, Karimov Bakhtiyor Kuranbayevich* |
| Language | *Uzbek/English* |
| Relation to curriculum | *Elective discipline (1)* |
| Teaching methods | *Lecture, practical works, SAW (Student autonomous work), two midterm assessments and exam,* |
| Workload (incl. contact hours, self-study hours) | *Total workload – 60 hours;*<br>*Lecture – 10 hours*<br>*Practical works – 20 hours*<br>*SAW (Student autonomous work) – 30 hours*<br>*Form of final control – Exam*<br>*Final assessment method – take-home written assignments and oral exam* |
| Credit points | *2 ECTS* |
| Required and recommended prerequisites for joining the module | *General ecology and Environmental Protection, Physics, Analytical and Physcolloid Chemistry, Analytical chemistry.* |
| Module objectives/intended learning outcomes | ***Knowledge:***<br>✓ *theoretical foundations and principles on modern instrumental methods and instruments of physical-chemical analyses;*<br>✓ *their importance in ensuring environmental sustainability against anthropogenic pollution;*<br>✓ *their understanding and knowledge of the methodology for planning laboratory and field-stage analytical hydrochemical research of the quality of non-living and living components in natural and artificial ecosystems under anthropogenic impact.*<br>***Skill:***<br>✓ *select and apply most advanced instrumental appropriate methods of chemical analyses to reduce, prevent and reverse the ecological situation and other anthropogenic impacts of irrigation and other rural and aquatic production sectors caused by diversion of contaminants into surrounding environment;*<br>✓ *have the skills of collecting, documenting and storing environmental samples, using equipment and maintaining them in accordance with the requirements of maintenance and operation, qualitative and quantitative analysis of external environmental components and statistical processing of the results obtained and conduct other related activities.*<br>***Competences:***<br>✓ *selection of a complex of the most advanced and rational instrumental methods of environmental quality analysis, which, if necessary, will be used to accurately and correctly assess the state of the environment as a whole;*<br>✓ *estimate the pros and cons of anthropogenic influence on the process of water quality formation, especially under impact of effluents from the fields of agriculture and water economy.*<br>✓ *practical applying the knowledge gained in science in the performance of tasks in certain environmental conditions necessary;*<br>✓ *analyzing and interpreting the results of field research in order to correspond to requirements of a professional employer of nature protection agencies, 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, presentations or articles.* |

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| Content | *Classification of Analytical Chemistry and its methods. Physical methods of analysis. Level of difficulty: 4;*<br>*Instrumental (physicochemical) methods of analysis, their classification, advantages and disadvantages. Level of difficulty: 4;*<br>*Electro-chemical methods of analysis and their classification. Methods for expressing solutions and concentrations. Level of difficulty: 5;*<br>*Potentiometry techniques of analysis. Comparison and indicator electrodes in potentiometry. Level of difficulty: 4;*<br>*Membranous (ionselective) electrodes. Indirect potentiometry (ionometry). Potentiometric titration. Conductometry. Electrical conductivity of electrolytes. Indirect conductometry. Conductometric titration; Introduction to spectroscopic methods of analysis-electromagnetic radiation (spectrum). Level of difficulty: 4;*<br>*Scientific basis and classification of spectroscopic techniques. Atomic-spectroscopy techniques. Atom-emission analysis. Level of difficulty: 5;*<br>*Spectroscopy in visual and ultraviolet radiation spectrum ranges, qualitative and quantitative analysis of atomic-radiation Spectra.Portable instruments of analysis in determining the state of the external environment. Level of difficulty: 4;*<br>*Introduction, the origin of the need for portable instruments of analysis. Portable analysis instruments with monoparameters and multiparameters, their advantages, disadvantages and main manufacturers and suppliers. History of the introduction and use of such instruments in our territory. Level of difficulty: 4;*<br>*Introduction to chromatography methods, their discovery, development and classification. Level of difficulty: 5;*<br>*A summary of chromatographic separation theory. Column chromatography. Level of difficulty: 4;*<br>*Thin layer chromatography. Chromatographic process scheme. Chromatographic peak and its parameters; Gas chromatography techniques and equipment. Detectors in gas chromatography. Level of difficulty: 5;*<br>*Gas-liquid chromatography: features of the chromatography process and apparatus. High efficiency liquid chromatography. Level of difficulty: 5;* |
| Exams and assessment formats | *During one semester, MSc students answered two oral questions (midterm assessments), with each question lasting 5 minutes. They collected a total of 60 points, evenly distributed with 30 points for the first set of questions and 30 points for the second set.*<br>*Additionally, there was a final exam for MSc students, which lasted 40 minutes. There were take-home written assignments and one final oral exam (40 minutes)., and MSc students could collect up to 40 points.* |
| Study and examination requirements | *MSc Students must have a final grade of 60% or higher to pass* |
| Reading list | *1. Karimov B.Q. Instrumental methods of analysis. Tashkent, TIIAME, 2020, 154p*<br>*2. V. I. Kocherov, I. S. Alyamovskaya, H.E. Darienko, S. Yu. Saraeva T. S. Svalova, A. I. Matern. S.Yu.Sarajevo, Instrumental methods of analysis: laboratory. Moscow: Pres: Ural, 2015. - 96 p. ISBN 978-5-7996-1385.*<br>*3. Eltsov I.V., A.A. Nefedov. Dictionary of specialized terms in the discipline "instrumental methods of analysis". Teaching aid. Novosibirsk State University, 2013, 62 p.*<br>*4. Rouessac, Francis, and Annick Rouessac. Chemical analysis: modern instrumentation methods and techniques. John Wiley & Sons, 2022.*<br>*5. Chatwal, Gurdeep R. Instrumental methods of chemical analysis. Himalaya publishing house, 2022.*<br>*6. Namieśnik, Jacek. "Trends in environmental analytics and monitoring." Critical Reviews in Analytical Chemistry 30.2-3 (2000): 221-269.*<br>*7. Cazes, Jack, ed. Analytical instrumentation handbook. CRC Press, 2004.* |

| **Module designation** | ***GEK5102 Hydroecology*** |
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| Semester(s) in which the module is taught | *1* |
| Person responsible for the module | *Prof., Dr. Bakhtiyor Karimov.* |
| Language | *Uzbek/English* |
| Relation to curriculum | *Elective discipline (1)* |
| Teaching methods | *Lecture, practical works, SAW (Student autonomous work), two midterm assessments and exam,* |
| Workload (incl. contact hours, self-study hours) | *Total workload – 60 hours;*<br>*Lecture – 10 hours*<br>*Practical works – 20 hours*<br>*SAW (Student autonomous work) – 30 hours*<br>*Form of final control Exam*<br>*Final assessment method Quiz* |
| Credit points | *2 ECTS* |
| Required and recommended prerequisites for joining the module | *General ecology and Environmental Protection, Hydrology, Inorganic and organic chemistry, Environmental monitoring, Instrumental methods of analysis, Environmental impact assessment.* |

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| Module objectives/intended learning outcomes | ***To know and understand:***<br>- *terminology in the field of hydroecology and equipment (instruments) used in hydroecology research;*<br>- *the interaction of physical, chemical and biological qualities of river ecosystems and their importance in fluvial ecosystems ecological sustainability;*<br>- *the basic physical and biological properties of rivers and lakes, how and why the main biological communities differ in lotic and lentic systems;*<br>- *the diversity of aquatic ecosystems, fundamental processes that determine the composition and functions of the hydroecosystem;*<br>- *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;*<br>- *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;*<br>- *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;*<br>- *environmental and anthropogenic factors and patterns of their influence on hydroecosystems.*<br>***To be able to:***<br>- *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;*<br>- *use of web-resources to determine the most rational roots of hydro-ecological field investigations;*<br>- *going into the field and conducting the field study in accordance with preliminary design;*<br>- *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.*<br>- *apply the knowledge gained in science in the performance of tasks in certain environmental conditions necessary, including irrigational and hydrotechnical construction projects implementation.*<br>- *apply regulation and toxicological standards and can conducting bioindication and biotesting of polluted sewage and air;*<br>- *apply methods of qualitative and quantitative determination of pollutant groups;*<br>***To form competences in:***<br>- *mastering qualitative and quantitative methods of assessment of hydro-ecological situation in various river drainages in population and ecosystem levels;*<br>- *measuring the physical, chemical and biological qualities of aquatic ecosystems and have knowledge of the importance of these qualities and how they interact;*<br>- *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;*<br>- *implementing and using basics and features of hydroecology science in routine professional activities;*<br>- *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.* |

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| Content | *An introduction to stream ecology. Fluvial ecosystems. Lotic and lentic ecosystems. Level of difficulty: 4*<br>*Streamflow, the water cycle. Effect of land use on steamflow. Environmental flows. Level of difficulty: 4*<br>*Fluvial geomorphology. Sediments and their Transport. Level of difficulty: 5*<br>*Water as life environment. Hydroecosystems chemistry, main the main hydrophysical indicators and dissolved chemical elements and compounds. Level of difficulty: 5*<br>*Hydrobionts (aquatic organisms) and their functions in ecosystems. The impact of water flow on living organisms. Level of difficulty: 5*<br>*The impact of hydrochemical factors on biota. Chemical factors of anthropogenic origin – salinization and acidification. Level of difficulty: 5*<br>*Basic laws and principles of hydroecology, biological equilibrium, succession and climax.. Level of difficulty: 5*<br>*Impact of irrigation and hydropower development on ecological status of hydroecosystems. Fish protection facilities. Level of difficulty: 4.*<br>*Climate change and hydroecology. Ecosystem services connected to hydroecosystems. Level of difficulty: 4.*<br>*The following topics are recommended for practical classes:*<br>*1. Ensuring technical safety in laboratory, field, and practical research. Planning and organizing field research using internet resources. Level of difficulty: 3*<br>*2. Sampling of non-living (abiotic) components in hydroecosystems and preparing them for physicochemical analysis. Level of difficulty: 4*<br>*3. Collecting samples of living (biotic) components in hydroecosystems and preparing them for physicochemical analysis. Level of difficulty: 4.*<br>*4. Hierarchical description of various rivers in the republic of Uzbekistan using Google Earth and other online resources. Level of difficulty: 4.*<br>*5. Familiarizing with instruments for analyzing hydrophysical and hydrochemical indicators in hydroecosystems. Level of difficulty: 5.*<br>*6. Studying the vertical temperature distribution in lentic hydroecosystems (lakes, reservoirs, ponds). Level of difficulty: 4*<br>*7. Identifying the ecological stability of lentic aquatic ecosystems (lakes, reservoirs, ponds) against pollution.. Level of difficulty: 4.*<br>*8. Learning to measure electrical conductivity and temperature regime of water in various hydroecosystems using a conductometer instrument. Level of difficulty: 3.*<br>*9. Comparative evaluating the degree and quality of anthropogenic salinization of the water of Amu darya and Syr darya rivers based on Uzhydromet bulletins.. Level of difficulty: 3.*<br>*10. Studying the ecosystem services of hydroecosystems within the territory of the republic of Uzbekistan. Level of difficulty: 3.*<br>*11. Indirect measuring water mineralization in different aquatic ecosystems using a conductometer instrument. Level of difficulty: 3.*<br>*12. Bioecological assessment of water quality in hydroecosystems across the republic of Uzbekistan through analysis of Uzhydromet bulletins. Level of difficulty: 4*<br>*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. Level of difficulty: 3.*<br>*14. Study of statistical processing and report preparation of the results of hydroecological research. Level of difficulty: 4.* |
| Exams and assessment formats | *During one semester, MSc students answered two oral questions (midterm assessments), with each question lasting 5 minutes. They collected a total of 60 points, evenly distributed with 30 points for the first set of questions and 30 points for the second set.*<br>*Additionally, there was a final exam for MSc students, which lasted 40 minutes. There were short computer-based quizzes, and MSc students could collect up to 40 points.* |

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| Study and examination requirements | *MSc 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.*<br>*2. J.David Allan, Maria M.Castillo. Stream Ecology. Structura and function of running waters. Springer, 2007, 444p.*<br>*3. Dawei Han. Concise environmental engineering. 2012. ISBN 978-87-403-0197-7. 141p. E-book: download at: bookboon.com.*<br>*4. Loginova E.V., Lopukh P.S. Hydroecology: a course of lectures. MINSK BSU. 2011. 300 p. http://www.bsu.by/Cache/pdf/67483.pdf*<br>*5. Бестужева, А. С. "Гидроэкология." (2015). https://library.ytit.uz/All-Books*<br>*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*<br>*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.*<br>*8. Ergashev A. and others. Basics of sustainable development and natural science. Tashkent, Baktria press, 2016, 296 p.*<br>*Information sources*<br>*9. www.nature.uz*<br>*10. " http://www.cawater-info.net/* |

| **Module designation** | ***EWM5104 Economics of water management*** |
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| Semester(s) in which the module is taught | *1* |
| Person responsible for the module | *PhD, associated prof, Sattorov Orif Boymurodovich* |
| Language | *Uzbek/English* |
| Relation to curriculum | *Elective discipline(1)* |
| Teaching methods | *Lecture, practical works, SAW (Student autonomous work), two midterm assessments and exam,* |
| Workload (incl. contact hours, self-study hours) | *Total workload – 60 hours;*<br>*Lecture – 10 hours*<br>*Practical works – 20 hours*<br>*SAW (Student autonomous work) – 30 hours*<br>*Form of final control Exam*<br>*Final assessment method Quiz* |
| Credit points | *2 ECTS* |
| Required and recommended prerequisites for joining the module | *Economic theory, Integrated water resources management, water resources planning and management.* |

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| Module objectives/intended learning outcomes | *Knowledge:*<br>✓ *Understanding the economic principles and concepts related to water resources, including supply and demand dynamics, pricing, and market structures;*<br>✓ *Familiarity with the economic valuation of environmental impacts and ecosystem services related to water management, such as the cost-benefit analysis of water-related projects;*<br>✓ *Knowledge of water-related policies, regulations, and legal frameworks, both at the national and international levels;*<br>✓ *Understanding the economics of water infrastructure development, including the financing mechanisms, project appraisal, and infrastructure asset management;*<br>✓ *Proficiency in using economic models to analyze water-related issues, such as economic impact assessments, resource allocation, and investment decisions;*<br>✓ *Knowledge of sustainable water management practices and strategies, including water conservation, integrated water resource management, and adaptive management approaches;*<br>✓ *Ability to analyze water markets, including water trading, water rights, and the impact of market forces on water allocation and pricing.*<br>*Skills:*<br>✓ *Proficiency in collecting, analyzing, and interpreting data related to water resources, economic variables, and environmental factors;*<br>✓ *Ability to conduct cost-benefit analyses of water projects, taking into account economic, social, and environmental factors;*<br>✓ *Skill in applying statistical and econometric methods to analyze water-related data and make informed decisions;*<br>✓ *Capability to assess the economic implications of water policies and regulations and provide policy recommendations;*<br>✓ *Competence in financial modeling and assessing the financial viability of water infrastructure investments;*<br>✓ *Effective communication skills to convey complex economic concepts and findings to diverse stakeholders, including policymakers, communities, and industry professionals;*<br>*Competencies:*<br>✓ *The ability to identify and address complex economic challenges and trade-offs in water management, such as balancing economic development with environmental conservation;*<br>✓ *Competence in working collaboratively with experts from various fields, including hydrology, ecology, engineering, and sociology, to develop holistic water management solutions;*<br>✓ *Understanding and adherence to ethical principles in economic analysis, especially concerning equitable access to water resources and environmental stewardship;*<br>✓ *The capacity to adapt to changing economic conditions, climate variability, and evolving water management paradigms;*<br>✓ *The ability to lead and influence stakeholders in the development and implementation of economically sound water management strategies;*<br>✓ *A commitment to staying updated with the latest research, policy developments, and innovations in the field of economics of water management.* |

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| Content | *Content, Goals, and Tasks of Water Economy:The water economy encompasses the management and utilization of water resources, including surface and groundwater, for various sectors such as agriculture, industry, and domestic use. Its goals include efficient water resource management, water conservation, and sustainable development. Tasks involve the allocation of water resources, infrastructure development, and ensuring water quality. Level of difficulty: 4;*<br>*Water Resources and Their Use in the National Economy: Water resources are essential for agriculture, industry, energy production, and urban areas. Efficient use involves allocation, conservation, and treatment of water to meet the needs of these sectors while preserving the environment. Level of difficulty: 5;*<br>*Structural Changes Implemented in the Water Management System and Its Effectiveness: Structural changes may include the reorganization of water management agencies, decentralization, or privatization to improve efficiency and accountability. The effectiveness of these changes is assessed based on factors like water resource management, service delivery, and environmental impact. Level of difficulty: 4;*<br>*Personnel, Labor Productivity, and Wages in the Water Industry: Personnel management, labor productivity, and wage levels are crucial aspects of the water industry. Adequate training, fair wages, and efficient labor practices are necessary to ensure the sustainable operation of water facilities. Level of difficulty: 5;*<br>*Fixed Assets and Working Capital of Basin Management Organizations and Water Management: Basin management organizations require fixed assets for infrastructure and working capital to cover operational costs. Proper financing is crucial to maintain and upgrade water infrastructure. Level of difficulty: 4;*<br>*The Role of Leasing in Water Management Development:Leasing can be a financial mechanism for water infrastructure development. It allows organizations to access assets without large upfront investments, which can aid in expanding water management capabilities. Level of difficulty: 5;*<br>*Prices, Profits, and Production Profitability: Pricing policies in water management influence profits and production profitability. Balancing affordability for users with the need for infrastructure maintenance and investment is a critical challenge. Level of difficulty: 4;*<br>*Economic Efficiency of Capital Investments in Water Management Activities: Assessing the economic efficiency of capital investments involves analyzing the returns on investments in water infrastructure projects and their long-term benefits for the economy and society. Level of difficulty: 5;*<br>*Economy of Using Techniques in Water Management: Employing advanced techniques, such as water-saving technologies and sustainable practices, can lead to cost savings and resource conservation in water management. Level of difficulty: 4;*<br>*Organizational Structure of Management: The organizational structure of water management agencies and institutions can impact their efficiency and effectiveness in delivering water services and managing resources. Level of difficulty: 5;*<br>*Economic Efficiency of Water-Saving Technologies: Evaluating the economic efficiency of water-saving technologies involves assessing their cost-effectiveness in reducing water use while maintaining or improving productivity in various sectors. Level of difficulty: 5.* |
| Exams and assessment formats | *During one semester, MSc students answered two oral questions (midterm assessments), with each question lasting 5 minutes. They collected a total of 60 points, evenly distributed with 30 points for the first set of questions and 30 points for the second set.*<br>*Additionally, there was a final exam for MSc students, which lasted 40 minutes. There were short computer-based quizzes, and MSc students could collect up to 40 points.* |

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| Study and examination requirements | *MSc Students must have a final grade of 60% or higher to pass* |
| Reading list | *1. David L. Debertin. A. Agricultural Production Economics. Second Edition, Amazon Createspace 2012. 242 p.*<br>*2. U. Sangirova, Kh. Yakubova, U. Kholiyorov, G. Kholmurodova "Economics and Management" Textbook TIIAME – 2021 г.*<br>*3. Sangirova U.R., Sattorov O.B., Economics and management of water management. Textbook. "TIIAME" MTU. 2022*<br>*4. Anderson, David A. Environmental economics and natural resource management. Routledge, 2019.*<br>*5. Tietenberg, Tom, and Lynne Lewis. Environmental and natural resource economics. Routledge, 2018.*<br>*6. Van den Bergh, Jeroen CJM, ed. Handbook of environmental and resource economics. Edward Elgar Publishing, 2002.*<br>*7. Folmer, Henk, and H. Landis Gabel. Principles of environmental and resource economics: a guide for students and decision-makers. Edward Elgar Publishing Ltd, 2000.* |

| **Module designation** | ***HC5104 Hydrochemistry*** |
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| Semester(s) in which the module is taught | *1* |
| Person responsible for the module | *Professor, Karimov Bakhtiyor Kuranbayevich* |
| Language | *Uzbek/English* |
| Relation to curriculum | *Elective discipline(2)* |
| Teaching methods | *Lecture, practical works, SAW (Student autonomous work), two midterm assessments and exam,* |
| Workload (incl. contact hours, self-study hours) | *Total workload – 120 hours;*<br>*Lecture – 30 hours*<br>*Practical works – 30 hours*<br>*SAW (Student autonomous work) – 60 hours*<br>*Form of final control Exam*<br>*Final assessment method – take-home written assignments and oral exam* |
| Credit points | *4 ECTS* |
| 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:***<br>- *what is natural water,*<br>- *how and why we study its structure,*<br>- *what is the meaning of hydrochemical studies of applied nature.*<br>- *theoretical foundations and principles on modern hydrochemistry science;*<br>- *methodology for planning laboratory and field-stage hydrochemical research.*<br>***To be able to****:*<br>- *create a chemical characteristic of the separate reservoir or the whole river basin, lake, water basin;*<br>- *estimate water quality of the reservoir or watercourse in order to use them in domestic and drinking, industrial, irrigation (watering) purposes, fish farming;*<br>- *have practical skills of the water sampling of various water reservoirs;*<br>- *the chemical analysis of natural waters for determination of the ratio of chemical components in the water and some other hydro-chemical characteristics,*<br>- *as well as the generalization of hydro-chemical materials, statistical analyses and report writing.*<br>***To form competences in:***<br>- *fundamentals of the theory of formation and metamorphism of chemical composition of waters of different types, classes and groups, the most common in the hydrochemical classification of natural waters;*<br>- *influence of the composition of waters of natural water sources on the environment in conditions of arid climate and irrigated agriculture;*<br>- *influence of anthropogenic factors on changes in the composition and properties of waters of reservoirs and streams.* |

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| **Module designation** | **GCC5104 Global climate change** |
| Semester(s) in which the module is taught | 1 |
| Person responsible for the module | Prof. Dr. Maria Radkevich |
| Language | Uzbek/English |
| Relation to curriculum | Elective discipline (2) |
| Teaching methods | Lecture, practical works, SAW (Student autonomous work), two midterm assessments and exam |
| Workload (incl. contact hours, self-study hours) | Total workload – 120 hours;<br>Lecture – 30 hours;<br>Practical works – 30 hours;<br>SAW (Student autonomous work) – 60 hours; |
| Exams and assessment formats | Form of final control – Exam<br>Final assessment method – Quiz |
| Credit points | 4 ECTS |
| Content | *The aim of the discipline is to introduce master students with the basics of theoretical and applied hydrochemistry - the science of the 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) studied by hydrochemistry with methods of chemical analysis of natural waters, the modern assessment of water quality for the wellbeing of aquatic ecosystems and various needs of the economics, 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, etc.*<br>*During one semester, MSc students answered two oral questions (midterm assessments), with each question lasting 5 minutes. They collected a total of 60 points, evenly distributed with 30 points for the first set of questions and 30 points for the second set.*<br>*Additionally, there was a final exam for MSc students, which lasted 40 minutes. There were take-home written assignments and one final oral exam (40 minutes)., and MSc students could collect up to 40 points.* |
| Study and examination requirements | *MSc 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.*<br>*2. Ашкеева Р.К., Тугелбаева Л.М., Рыскалиева Р.Г. Гидрохимия. Учебное пособие. — Алматы: Қазақ университеті, 2019. — 158 с.*<br>*3. Никаноров А.М. Гидрохимия: Учебник. – 2-е издание. Гидрометеоиздат, 2001, 444с.*<br>*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.*<br>*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.*<br>*Information sources*<br>*1. www.nature.uz* |

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| Required and recommended prerequisites for joining the module | *Geography, Geology, Climatology, Hydrology, Environmental Protection, Environmental monitoring, Environmental impact assessment.* |
| Module objectives/intended learning outcomes | *To know and understand:*<br>- *natural and anthropogenic causes of global climate change;*<br>- *historical variations in climate indicators;*<br>- *the relationship between climate change and sustainability;*<br>- *opportunities for reducing greenhouse gas emissions;*<br>- *principles of developing and evaluating sustainable development indicators;*<br>- *market mechanisms for incentivizing low-carbon development;*<br>*To be able to:*<br>- *use of methods for estimating greenhouse gas emissions;*<br>- *calculate carbon balance;*<br>- *calculate of greenhouse gas emission quotas;*<br>- *evaluate natural intensity indicators of the regional economy.*<br>*To form competences in:*<br>- *assess and predict possible climate change in the region;*<br>- *analyze the effects of climate change on agriculture;*<br>- *develop measures to mitigate the effects of climate change.* |

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| Content | *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. Level of difficulty: 2*<br>*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. Level of difficulty: 2*<br>*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. Level of difficulty: 3*<br>*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. Level of difficulty: 2*<br>*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. Level of difficulty: 3*<br>*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. Level of difficulty: 3*<br>*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. Level of difficulty: 3.*<br>*The following topics are recommended for practical classes:*<br>*1. Estimation of greenhouse gas emissions using IPCC, ISO 14064, GHG protocol methodologies and comparison of results. Level of difficulty: 3*<br>*2. Study of climate change models. Level of difficulty: 2*<br>*3. Calculation of greenhouse gas quotas and analysis of their costs. Level of difficulty: 3*<br>*4. Comparison of greenhouse gas emissions from biofuels and fossil fuels. Level of difficulty: 3*<br>*5. Assessment of the carbon footprint of agricultural activities. Level of difficulty: 3*<br>*6. Estimation of CO2 uptake capacity of plants. Level of difficulty: 3*<br>*7. Estimation of the indicator of total economic value (cost) for forest resources. Level of difficulty: 3.* |
| Exams and assessment formats | *During one semester, MSc students answered two oral questions (midterm assessments), with each question lasting 5 minutes. They collected a total of 60 points, evenly distributed with 30 points for the first set of questions and 30 points for the second set.*<br>*Additionally, there was a final exam for MSc students, which lasted 40 minutes. There were short computer-based quizzes, and MSc students could collect up to 40 points.* |
| Study and examination requirements | *MSc Students must have a final grade of 60% or higher to pass* |

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| 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.*<br>*2. Адаптация к изменению климата: опыт Центральной Азии. Т.: Научно-информационный центр МКВК, 2016. – 84 с.*<br>*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.*<br>*4. Sharma S., Sharma K. Environment and Society: Climate Change and Sustainable Development. Routledge, 2023. — 406 p.*<br>*5. Letcher, Trevor, ed. "Climate change: observed impacts on planet Earth." (2021).*<br>*6. Williams, Jeremy. Climate change is racist: Race, privilege and the struggle for climate justice. Icon Books, 2021.*<br>*7. Chomsky, Noam, and Robert Pollin. Climate crisis and the global green new deal: The political economy of saving the planet. Verso Books, 2020.* |

| **Module designation** | ***ASS5104 Irrigation and land reclamation*** |
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| Semester(s) in which the module is taught | *1* |
| Person responsible for the module | *Professor, Dr. Khamidov Mukhamadkhan Khamidovich* |
| Language | *Uzbek/English* |
| Relation to curriculum | *Elective discipline(2)* |
| Teaching methods | *Lecture, practical works, SAW (Student autonomous work), two midterm assessments and exam,* |
| Workload (incl. contact hours, self-study hours) | *Total workload – 120 hours;*<br>*Lecture – 30 hours*<br>*Practical works – 30 hours*<br>*SAW (Student autonomous work) – 60 hours*<br>*Form of final control Exam*<br>*Final assessment method Quiz* |
| Credit points | *4 ECTS* |
| Required and recommended prerequisites for joining the module | *Scientific Research Methodology, Global Climate Change and Water Supply and Water Resources Measurement and Instrumentation.* |
| Module objectives/intended learning outcomes | **To know and understand:**<br>- rational and efficient use of land;<br>- irrigation and irrigation systems;<br>- irrigation regime of agricultural crops;<br>- modern irrigation methods and irrigation techniques;<br>- irrigation networks and their requirements;<br>- water resources, their formation, their rational use;<br>- water sources and their management;<br>- drainage systems;<br>- soil types and their salinity, causes and levels;<br>- causes of salt distribution in soils;<br>- regular increase of soil fertility;<br>- productivity and productivity of agricultural crops through irrigation;<br>- implementation of land reclamation in connection with highly productive agrotechnical measures;<br>- ways to improve land reclamation.<br>**To be able to:**<br>- design of hydromelioration systems;<br>- design of irrigation network constructions, irrigation equipment hydraulic calculations and cuts;<br>- know and be able to use irrigation erosion and complex measures against it.<br>**To form competences in:**<br>- full mechanization of work on reclamation areas in agriculture and application of industrial methods in reclamation;<br>- efficient use of water resources;<br>- mastering the issues of full mechanization and automation of reclamation processes, irrigation and other works;<br>- sanitization of saline lands;<br>- development of new lands;<br>- design, construction, operation and maintenance of hydromelioration systems;<br>- management of irrigation networks, finding technical and economical options for carrying out water measurement and distribution works in them;<br>- automation of work and improvement of system activity. |

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| Content | Irrigation, irrigation systems, their elements and functions, irrigation regime of agricultural crops, hydromodule zoning of irrigation areas, irrigation methods and irrigation techniques, classification of irrigation systems, main elements, construction and their design.<br>Estimated water consumption of channels. Efficiency value of canals and system, water wastage in canals, hydraulic calculations of canals, construction of irrigation systems, road networks and protective trees, water sources, their characteristics, irrigation by mechanical lifting of water.<br>Drainage reclamation, causes of salinity of irrigated lands, reclamation measures against land salinity, general and private water balance equations of irrigated lands, natural and artificial drainage, hydrotechnical drainage, biological drainage, design of drainage networks. |
| Exams and assessment formats | *During one semester, MSc students answered two oral questions (midterm assessments), with each question lasting 5 minutes. They collected a total of 60 points, evenly distributed with 30 points for the first set of questions and 30 points for the second set.*<br>*Additionally, there was a final exam for MSc students, which lasted 40 minutes. There were short computer-based quizzes, and MSc students could collect up to 40 points.* |
| Study and examination requirements | *MSc Students must have a final grade of 60% or higher to pass* |
| Reading list | *1. Khamidov M., Suvanov B., Isabaev K. "Irrigation melioration" Training manual. T.: 2020, 266 p.*<br>*2. Khamidov M.Kh., Begmatov I.A., Isaev S.Kh., Mamatov S.A. "Water-saving irrigation technologies" Training manual. T.: TIMI, 2015, 232 p.*<br>*3. Khamidov M.Kh., Shukurlaev Kh.I., Mamataliev A.B. "Agricultural hydrotechnical melioration". Textbook. T. East, 2009, 379 pages.*<br>*4. Shukurlaev X.I., Baraev A.A., Mamataliev A.B. "Selskohozyaystvennye hydrotechnicheskie melioratsii". Uchebnoe posobie. T. 2007, 300 pages.*<br>*5. Gabr, Mohamed Elsayed, and Ehab Mostafa Fattouh. "Assessment of irrigation management practices using FAO-CROPWAT 8, case studies: tina plain and east South El-Kantara, Sinai, Egypt." Ain Shams Engineering Journal 12.2 (2021): 1623-1636.*<br>*6. Sargentis, G-Fivos, et al. "Agricultural land or photovoltaic parks? The water–energy–food nexus and land development perspectives in the thessaly plain, Greece." Sustainability 13.16 (2021): 8935.*<br>*7. Ouaadi, Nadia, et al. "Irrigation amounts and timing retrieval through data assimilation of surface soil moisture into the FAO-56 approach in the South Mediterranean region." Remote Sensing 13.14 (2021): 2667.* |

| **Module designation** | ***MTWR 5104 Water resources Measurement and tools*** |
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| Semester(s) in which the module is taught | *2* |
| Person responsible for the module | *Professor, Dr. Khamidov Mukhamadkhan Khamidovich* |
| Language | *Uzbek/English* |
| Relation to curriculum | *Elective discipline(3)* |
| Teaching methods | *Lecture, practical works, SAW (Student autonomous work), two midterm assessments and exam,* |
| Workload (incl. contact hours, self-study hours) | *Total workload – 120 hours;*<br>*Lecture – 30 hours*<br>*Practical works – 30 hours*<br>*SAW (Student autonomous work) – 60 hours*<br>*Form of final control Exam*<br>*Final assessment method Quiz* |
| Credit points | *4 ECTS* |
| Required and recommended prerequisites for joining the module | *Scientific Research Methodology, Global Climate Change, Water Supply, Irrigation and land reclamation* |
| Module objectives/intended learning outcomes | *Expected Learning Objectives:*<br>*- in the conditions of global climate change and scarcity of water resources, to have an idea about their rational management and their effective use, water accounting, water measuring devices, including digital devices, and their use;*<br>*- water measurement methods, structures, equipment and their use in water sources for irrigation, in the calculation of water resources in the irrigation system, "Smart water" digital technologies in the management and consumption of water resources and their implementation, new water measurement to have the skills to conduct scientific research on the creation of equipment;*<br>*- must have skills in standardization of water measuring devices used in irrigation systems, "calibrating" them, placing them in a water body, obtaining and analyzing data, various water measurement methods, including digital water measuring devices.* |
| Content | *Content of the subject: Introduction to the subject of "Measurement and tools of water resources". The purpose and tasks of science. Water resources. Their management and use (complexity level -1).*<br>*Water measuring stations, their locations and types. Water level measuring systems and tools. Water depth and flow rate measuring tools (complexity level -2).*<br>*Measurement of water consumption of rivers. Water measuring tools. Determination of pollutants in river water. Sampling tools. Sizot waters. Means of determining their level and mineralization. Soil water and methods of their determination (complexity level -2).*<br>*Measurement of water consumption of irrigation networks. Measuring tools. Innovative technologies in the measurement of water resources (complexity level -3).* |
| Exams and assessment formats | *During one semester, MSc students answered two oral questions (midterm assessments), with each question lasting 5 minutes. They collected a total of 60 points, evenly distributed with 30 points for the first set of questions and 30 points for the second set.*<br>*Additionally, there was a final exam for MSc students, which lasted 40 minutes. There were short computer-based quizzes, and MSc students could collect up to 40 points.* |
| Study and examination requirements | *MSc Students must have a final grade of 60% or higher to pass* |

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| **Module designation** | **SS5104 Water quality** |
| Semester(s) in which the module is taught | 2 |
| Person responsible for the module | Associate professor, PhD Malokhat Abdukodirova,<br>Associate Professor, PhD Olga Ashirova,<br>Prof., Dr. Maria Radkevich |
| Language | Uzbek/English/Russian |
| Relation to curriculum | Elective discipline(3) |
| Teaching methods | Lecture, practical works, SAW (Student autonomous work), two midterm assessments and exam |
| Workload (incl. contact hours, self-study hours) | Total workload – 120 hours;<br>Lecture - 30 hours<br>Practical works - 30 hours<br>SAW (Student autonomous work) – 60 hours |
| Credit points | Form of final control: Exam<br>Final assessment method: Quiz<br>4 ECTS |
| Required and recommended prerequisites for joining the module | Ecology and environmental protection, Environmental biotechnology; Drinking water supply, Multi-purpose water resources use protection |
| Reading list | 1. M.Khamidov, Sh.Ch.Botirov, B.U.Suvanov, D.G.Yulchiev "Measurement and tools of water resources" Training manual. Tashkent, Press; TIIAME, 2019. 185 p.<br>2. Khamidov M.Kh., Begmatov I.A., Isaev S.Kh., Mamatov S.A. "Water saving irrigation technologies" Training manual. Tashkent. Press, TIIM, 2015. 243 p.<br>3. A. Akbarov, D. Nazaraliev, F. Hikmatov. HYDROMETRY. Study guide. Tashkent, Press, TIIM, 2014. 144 p.<br>4. Wang, Wei, et al. "The effect of development in water-saving irrigation techniques on spatial-temporal variations in crop water footprint and benchmarking." Journal of Hydrology 577 (2019): 123916.<br>5. Borzì, Iolanda, et al. "Improving Climate Resilience of Agricultural Systems through the Development of Drought Vulnerability Curves." Book of Abstracts Modelling for action with a flood of data and a cloud of uncertainty 2021: 2021.<br>6. Dirwai, Tinashe Linder, Aidan Senzanje, and Tafadzwanashe Mabhaudhi. "Calibration and evaluation of the FAO AquaCrop model for cabbage (Brassica napus) under varied moisture irrigation regimes." Agriculture 11.5 (2021): 410.<br>7. Surendran, U., et al. "FAO CROPWAT model-based irrigation requirements for coconut to improve crop and water productivity in Kerala, India." Sustainability 11.18 (2019): 5132. |

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| Module objectives/intended learning outcomes | *To know and understand:*<br>- *water quality indicators, methods of their determination and principles of rationing;*<br>- *methods of human and environmental protection from wastewater arising in the process of providing sanitary facilities, technological processes, atmospheric precipitation;*<br>- *principles of techno-economically justified choice of effective sewerage system of settlements and agro-industrial complexes;*<br>*To be able to:*<br>- *assess the impact of various natural and economic processes on water quality;*<br>- *choose methods and facilities for wastewater treatment;*<br>- *perform calculations of elements of treatment facilities;*<br>- *draw up schemes of wastewater treatment facilities; design sewerage systems independently;*<br>- *calculate elements of sewerage networks;*<br>- *graphically represent engineering networks of sewerage systems;*<br>- *select and calculate basic parameters of mechanical,*<br>- *physical-chemical and biological treatment facilities;*<br>*To form competences in:*<br>- *wastewater quality assessment;*<br>- *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;*<br>- *calculations of operation mode and parameters of treatment facilities;*<br>- *carrying out researches and analyses of facilities operation and know the principles of rational use of sewerage facilities.* |

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| Content | *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. Level of difficulty: 2*<br>*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. Level of difficulty: 2*<br>*Statistical Analysis of Water Quality Data*<br>*Spatial Decision Support System (SDSS) for Stormwater Management and Water Quality Assessment. Water.Quality Monitoring and Associated Distributed Measurement Systems.*<br>*Detecting and Estimating Trends of Water Quality Parameters. Combining Statistical Methodologies in Water Quality. Level of difficulty: 3*<br>*Monitoring in a Hydrological Basin - Space and Time Approaches. Statistical Tools for Analyzing Water Quality Data. Level of difficulty: 3*<br>*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. Level of difficulty: 3*<br>*Water Quality Monitoring Studies. Sodium Levels in the Spring Water, Surface and Groundwater in Uzbekistan. Groundwater Quality Degradation. Level of difficulty: 2*<br>*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. Level of difficulty: 3*<br>*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. Level of difficulty: 3*<br>*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. Level of difficulty: 3*<br>*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. Level of difficulty: 3*<br>*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. Level of difficulty: 4*<br>*The following topics are recommended for practical classes:*<br>*1. Modelling of Water Quality Level of difficulty: 2.*<br>*2. Evaluating sodium Levels in Water. Level of difficulty: 3.*<br>*3. Assessing Water Quality. Level of difficulty: 3.*<br>*4. Assessing the feasibility of wastewater reuse in agriculture. Level of difficulty: 3.*<br>*5. Risk assessment of saline water use in crop production. Level of difficulty: 3.*<br>*6. Assessment of possibilities of collector-drainage water treatment. Level of difficulty: 3.*<br>*7.Justification and selection of methods of wastewater treatment. Level of difficulty: 3.*<br>*8. Selection of devices for mechanical treatment of wastewater. Level of difficulty: 3.*<br>*9. Function, types and design of sand traps. Level of difficulty: 2.*<br>*10. Calculation of primary and secondary settling tanks. Level of difficulty: 4.*<br>*11. Calculation of bioponds. Level of difficulty: 3.*<br>*12.Types, functions and design of aeration tank. Level of difficulty: 4.*<br>*13.Design of small sewerage system. Level of difficulty: 3.* |

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| Exams and assessment formats | *During one semester, MSc students answered two oral questions (midterm assessments), with each question lasting 5 minutes. They collected a total of 60 points, evenly distributed with 30 points for the first set of questions and 30 points for the second set.*<br>*Additionally, there was a final exam for MSc students, which lasted 40 minutes. There were short computer-based quizzes, and MSc students could collect up to 40 points.* |
| Study and examination requirements | *MSc 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.*<br>*2. Voudouris Konstantinos (Kostas), Voutsa Dimitra (eds.) Water Quality: Monitoring and Assessment. AvE4EvA, 2015. — 814 p.*<br>*3. Mackenzie L. Davis. Water and Wastewater Engineering: Design Principles and Practice. McGraw-Hill Education: New York, 2010-356p. .*<br>*4. Einschlag F.S.G., Carlos L.(eds.) Waste Water: Treatment Technologies and Recent Analytical Developments. InTeOp, 2013. - 204 pages*<br>*5. Londong Ing. J. Hentze Abwasserbehandlung. Weiterbildnes Studium Wasser und Umwelt Unterrichtsmaterialen. 5. Auflage. Bauhaus-Universitaet Weimar. 2013. 496 S.*<br>*6. Boyd, Claude E. Water quality: an introduction. Springer Nature, 2019.*<br>*7. Summers, J. Kevin, ed. Water Quality: Science, Assessments and Policy. BoD–Books on Demand, 2020.* |

| **Module designation** | ***WL5104 Water Legislation*** |
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| Semester(s) in which the module is taught | *2* |
| Person responsible for the module | *Associate professor Nazarov Kholmurod* |
| Language | *Uzbek/English* |
| Relation to curriculum | *Elective discipline(3)* |
| Teaching methods | *Lecture, practical works, SAW (Student autonomous work), two midterm assessments and exam,* |
| Workload (incl. contact hours, self-study hours) | *Total workload – 120 hours;*<br>*Lecture – 30 hours*<br>*Practical works – 30 hours*<br>*SAW (Student autonomous work) – 60 hours*<br>*Form of final control Exam*<br>*Final assessment method Quiz* |
| Credit points | *4 ECTS* |
| Required and recommended prerequisites for joining the module | *Law, Environmental Science/Studies, Natural Resource Management, Civil Engineering, Geography, Public Policy, Political Science, International Relations* |
| Module objectives/intended learning outcomes | ***Knowledge:***<br>*Understanding Laws: Gain a deep understanding of water-related legal frameworks at various levels.*<br>*Water Resource Basics: Acquire knowledge about hydrology and water resource management.*<br>*Legal Instruments: Familiarize yourself with international and regional water-related agreements.*<br>*Real-world Insights: Analyze practical water-related case studies.*<br>***Skills:***<br>*Legal Analysis: Develop the ability to interpret and apply water laws effectively.*<br>*Research: Enhance research skills for legal precedents and data.*<br>*Problem-Solving: Apply legal principles to solve water-related issues.*<br>*Document Drafting: Gain practical experience in creating water-related legal documents.*<br>*Effective Communication: Communicate legal concepts clearly, both in writing and verbally.*<br>***Competences:***<br>*Holistic Solutions: Combine knowledge from multiple disciplines to address water challenges.*<br>*Ethical Considerations: Promote ethical and sustainable water management practices.*<br>*Advocacy Skills: Advocate effectively for water-related issues.*<br>*Adaptability: Be flexible in responding to changing legal and environmental dynamics.*<br>*Cross-Cultural Awareness: Navigate cultural diversity in water law contexts.* |
| Content | *Introduction to Water Legislation. Legal Frameworks for Water Management. Water Rights and Allocation. Level of difficulty: 3;*<br>*Water Quality and Pollution Control. Transboundary Water Issues; Environmental Protection and Ecosystems. Public Participation and Stakeholder Engagement. Level of difficulty: 4;*<br>*Water Scarcity and Climate Change. Water Infrastructure and Development. Level of difficulty: 5;*<br>*Case Studies and Jurisprudence. Ethical and Social Dimensions; Emerging Water Issues. Level of difficulty: 4;*<br>*Practical Exercises and Simulations. Field Visits and Guest Lecturers. Research Projects and Capstone Assignments. Level of difficulty: 5;* |

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| Exams and assessment formats | *During one semester, MSc students answered two oral questions (midterm assessments), with each question lasting 5 minutes. They collected a total of 60 points, evenly distributed with 30 points for the first set of questions and 30 points for the second set.*<br>*Additionally, there was a final exam for MSc students, which lasted 40 minutes. There were short computer-based quizzes, and MSc students could collect up to 40 points.* |
| Study and examination requirements | *MSc Students must have a final grade of 60% or higher to pass* |
| Reading list | *1. Blomquist, W. ("Water Law and Policy: Governance without Government?" Cambridge University Press. 2019.*<br>*2. Uzbekistan Ministry of Water Resources. (Year). "Water Law of the Republic of Uzbekistan." Tashkent.*<br>*3. Uzbekistan Ministry of Water Resources. (2015). "National Strategy for Integrated Water Resources Management in the Republic of Uzbekistan for the period until 2030." Tashkent.*<br>*4. Ziganshina, Dinara. "Water Law Reforms in Central Asian Countries: Recent Trends and Developments." Chinese Journal of Environmental Law 6.2 (2022): 295-322.*<br>*5. Shermatovich, Khayitov Khasan. "Emergence and development of water legislation in Uzbekistan." Periodica Journal of Modern Philosophy, Social Sciences and Humanities 2 (2022): 21-23.*<br>*6. Caponera, Dante A., and Marcella Nanni. Principles of water law and administration: national and international. Routledge, 2019.*<br>*7. Goldfarb, William. Water law. CRC Press, 2020.* |

| **Module designation** | ***EM5104 Ecological modeling*** |
|---|---|
| Semester(s) in which the module is taught | *2* |
| Person responsible for the module | *Professor. Pulatov Alim Salimovich* |
| Language | *Uzbek/English* |
| Relation to curriculum | *Elective discipline(4)* |
| Teaching methods | *Lecture, practical works, SAW (Student autonomous work), two midterm assessments and exam,* |
| Workload (incl. contact hours, self-study hours) | *Total workload – 120 hours;*<br>*Lecture – 30 hours*<br>*Practical works – 30 hours*<br>*SAW (Student autonomous work) – 60 hours*<br>*Form of final control Exam*<br>*Final assessment method Quiz* |
| Credit points | *4 ECTS* |
| Required and recommended prerequisites for joining the module | *Botany, Biology, Algebra, Natural Science. Ecology, Geography, Basics of Statistics.* |

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| Module objectives/intended learning outcomes | *Knowledge:*<br>✓ *Understanding of fundamental principles of environmental science, including ecology, geology, atmospheric science, and hydrology.*<br>✓ *Proficiency in mathematical and statistical techniques used to represent environmental processes and phenomena.*<br>✓ *Knowledge of data collection methods, data quality assessment, and statistical analysis techniques for environmental data.*<br>✓ *Understanding of ecological systems, including food webs, nutrient cycling, and biodiversity.*<br>✓ *Knowledge of climate systems, climate change, and the factors influencing climate variability.*<br>✓ *Familiarity with programming languages (e.g., Python, R) for developing and running environmental models.*<br>✓ *Awareness of local, national, and international environmental regulations and their implications for modeling.*<br>✓ *Understanding of chemical processes in natural systems and their impact on the environment.*<br>*Skills:*<br>✓ *Proficiency in creating and customizing environmental models to simulate specific systems or processes.*<br>✓ *Skill in to interpret and visualize complex environmental data to extract meaningful insights.*<br>✓ *Skill in calibrating and validating models using observational data to ensure accuracy.*<br>✓ *Expertise in using GIS tools to analyze spatial patterns and relationships in environmental data.*<br>✓ *Effective communication of model results and findings to both technical and non-technical audiences.*<br>✓ *Analytical and critical thinking skills to address complex environmental challenges through modeling.*<br>✓ *Working collaboratively with interdisciplinary teams, including scientists, engineers, and policymakers.*<br>✓ *Managing environmental modeling projects from data collection to model development and reporting.*<br>*Competencies:*<br>✓ *Environmental models are built upon mathematical equations that describe the relationships and processes within the environment. These equations are used to simulate how various factors interact and change over time.*<br>✓ *Accurate environmental modeling requires the integration of observational data from various sources. This data serves to calibrate and validate models, ensuring their reliability.*<br>✓ *Environmental models account for the dynamic nature of natural systems, considering how environmental conditions change over time, from daily weather patterns to long-term climate trends.*<br>✓ *Environmental modeling is inherently interdisciplinary, drawing from fields such as ecology, hydrology, atmospheric science, and more. Collaboration across disciplines is crucial for comprehensive modeling* |
| Content | *Intro to Environmental Modeling, Mathematical Foundations, Data Collection & Processing. Level of difficulty: 4;*<br>*Model Types & Approaches, Model Calibration & Validation. Level of difficulty: 5;*<br>*Environmental Dynamics. Spatial Modeling (GIS). Level of difficulty: 4;*<br>*Climate & Weather Modeling. Level of difficulty: 4;*<br>*Ecosystem Modeling. Air Quality Modeling. Level of difficulty: 5;*<br>*Hydrological Modeling. Natural Hazard Modeling. Level of difficulty: 5; Policy & Decision Support. Level of difficulty: 4;*<br>*Advanced Modeling Techniques, Interdisciplinary Applications. Level of difficulty: 5;* |

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| Exams and assessment formats | *During one semester, MSc students answered two oral questions (midterm assessments), with each question lasting 5 minutes. They collected a total of 60 points, evenly distributed with 30 points for the first set of questions and 30 points for the second set.*<br>*Additionally, there was a final exam for MSc students, which lasted 40 minutes. There were short computer-based quizzes, and MSc students could collect up to 40 points.* |
| Study and examination requirements | *MSc Students must have a final grade of 60% or higher to pass* |
| Reading list | *1. Bolker, Benjamin M. Ecological models and data in R. Princeton University Press, 2008.*<br>*2. Jørgensen, Sven Erik, and Brian D. Fath. Fundamentals of ecological modelling: Applications in environmental management and research. Elsevier, 2011.*<br>*3. Suter II, Glenn W. Ecological risk assessment. CRC press, 2016.*<br>*4. Wilkinson, Richard G. Poverty and progress: an ecological model of economic development. Taylor & Francis, 2022.*<br>*5. Bruce, Bertram C., and Maureen P. Hogan. "The disappearance of technology: Toward an ecological model of literacy." Writing in a technological world. Routledge, 2019. 191-207.*<br>*6. Bond, William J. Open ecosystems: ecology and evolution beyond the forest edge. Oxford University Press, 2019.*<br>*7. Chalmers, Neil, Stephen Gough, and William Scott. Sustainable development and learning: Framing the issues. Routledge, 2003.* |

| **Module designation** | ***AW5104 Academic writing*** |
|---|---|
| Semester(s) in which the module is taught | *2* |
| Person responsible for the module | *Professor Karimov Bakhtiyor Kuranbayevich* |
| Language | *Uzbek/English* |
| Relation to curriculum | *Elective discipline(4)* |
| Teaching methods | *Lecture, practical works, SAW (Student autonomous work), two midterm assessments and exam,* |
| Workload (incl. contact hours, self-study hours) | *Total workload – 120 hours;*<br>*Lecture – 30 hours*<br>*Practical works – 30 hours*<br>*SAW (Student autonomous work) – 60 hours*<br>*Form of final control Exam*<br>*Final assessment method Quiz* |
| Credit points | *4 ECTS* |
| Required and recommended prerequisites for joining the module | *Uzbek Language and Literature, Writing and Composition, History, Philosophy, Sociology, Science and Engineering, Environmental Studies* |

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| Module objectives/intended learning outcomes | *Knowledge:*<br>✓ *Understanding various research methodologies, including qualitative and quantitative approaches, is essential for gathering and analyzing data effectively.*<br>✓ *Knowledge of different citation styles such as APA, MLA, Chicago, and Harvard is crucial for properly citing sources and avoiding plagiarism.*<br>✓ *A deep understanding of the subject matter you are writing about is essential for producing credible and well-informed academic work.*<br>✓ *Familiarity with the conventions of academic writing, including proper structure, tone, and language usage.*<br>✓ *Understanding how to conduct a thorough literature review to identify gaps in existing research and contribute to the academic discourse.*<br>✓ *The ability to critically evaluate and analyze research, arguments, and evidence.*<br><br>*Skills:*<br>✓ *Proficiency in searching for academic sources, evaluating their credibility, and extracting relevant information.*<br>✓ *The ability to articulate complex ideas clearly and concisely in written form. This includes structuring essays, papers, and reports effectively.*<br>✓ *Skill in revising and proofreading to eliminate grammar, spelling, and style errors.*<br>✓ *The capacity to synthesize information from multiple sources to create cohesive arguments and narratives.*<br>✓ *Effective time management is crucial for meeting deadlines and producing high-quality work.*<br>✓ *The ability to construct persuasive arguments supported by evidence and logical reasoning.*<br>*Competencies:*<br>✓ *Being open to feedback and willing to revise work based on constructive criticism.*<br>✓ *A commitment to academic integrity and avoiding plagiarism through proper citation and referencing.*<br>✓ *The competence to organize research materials, notes, and drafts efficiently.*<br>✓ *Effective communication skills to convey complex ideas to diverse audiences.*<br>✓ *The ability to draw upon knowledge from multiple disciplines when needed to enrich your work.*<br>✓ *Proficiency in using relevant software and statistical tools for data analysis, if applicable.*<br>✓ *The capability to provide constructive feedback to peers and engage in collaborative writing projects.*<br>✓ *Being open to receiving and learning from feedback, whether from peers, professors, or reviewers.*<br>✓ *If pursuing a career in academia, knowledge of the publishing process and how to submit articles to academic journals.*<br>✓ *A commitment to staying updated with the latest developments in the field of academic writing and research methodologies.* |

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| Content | *Background to writing. Reading: finding suitable sources. Level of difficulty: 3;*<br>*Reading: developing critical approaches. Avoiding plagiarism. Level of difficulty: 4;*<br>*From understanding titles to planning. Finding key points and note-making. Level of difficulty: 3;*<br>*Paraphrasing. Summarising. References and quotations. Level of difficulty: 5;*<br>*Combining sources. Organising paragraphs. Level of difficulty: 4;*<br>*Introductions and conclusions. Rewriting and proof-reading. Level of difficulty: 4;*<br>*Elements of writing. Argument and discussion. Cause and effect. Cohesion. Comparisons. Definitions. Generalisations. Level of difficulty: 5;* |
| Exams and assessment formats | *During one semester, MSc students answered two oral questions (midterm assessments), with each question lasting 5 minutes. They collected a total of 60 points, evenly distributed with 30 points for the first set of questions and 30 points for the second set.*<br>*Additionally, there was a final exam for MSc students, which lasted 40 minutes. There were short computer-based quizzes, and MSc students could collect up to 40 points.* |
| Study and examination requirements | *MSc Students must have a final grade of 60% or higher to pass* |
| Reading list | *1. Bailey S. Academic writing. Handbook for international students. Ed. 3. 2006.*<br>*2. Whitaker A. Academic writing guide. 2010.*<br>*3. Blake J. Academic writing. Jennifer.Blake@manchester.ac.uk*<br>*4. Tseng T.J. Tips for effective academic writing. Teaching Excellence Project. 2009*<br>*5. Cobb K. Principles of effective writing.*<br>*6. Oshima A. and Ann Hogue. Introduction to Academic Writing: Level 3.*<br>*7. Zainab Jaafar Auda. Academic writing. Lecture 1. Paragraphs. 2016* |

| **Module designation** | ***PM5104 Project management*** |
|---|---|
| Semester(s) in which the module is taught | *2* |
| Person responsible for the module | *PhD, Khamidov Azaz Adilovich* |
| Language | *Uzbek/English* |
| Relation to curriculum | *Elective discipline (4)* |
| Teaching methods | *Lecture, practical works, SAW (Student autonomous work), two midterm assessments and exam,* |
| Workload (incl. contact hours, self-study hours) | *Total workload – 120 hours;*<br>*Lecture – 30 hours*<br>*Practical works – 30 hours*<br>*SAW (Student autonomous work) – 60 hours*<br>*Form of final control Exam*<br>*Final assessment method Quiz* |
| Credit points | *4 ECTS* |
| Required and recommended prerequisites for joining the module | *Environmental modelling, mathematical modelling, Water resources planning and management* |
| Module objectives/intended learning outcomes | ***Knowledge:***<br>✓ *Students will acquire a comprehensive understanding of core project management concepts, methodologies, and best practices.*<br>✓ *Students will become familiar with the various project management frameworks, tools, and techniques used in different industries.*<br>✓ *Students will gain knowledge about project management history, theories, and emerging trends.*<br>***Skills:***<br>✓ *Students will develop the ability to plan and execute projects effectively, considering scope, time, cost, quality, and risk factors.*<br>✓ *Students will acquire cognitive skills in critical thinking, problem-solving, and decision-making, which are essential for successful project management.*<br>✓ *Students will cultivate practical skills in using project management software, creating project schedules, and managing project teams.*<br>✓ *Students will enhance their communication and stakeholder management skills, enabling them to interact effectively with project team members and stakeholders.*<br>***Competences:***<br>✓ *Students will integrate their knowledge of project management principles with practical application, demonstrating their ability to initiate, plan, execute, monitor, control, and close projects.*<br>✓ *Students will develop competences in teamwork, leadership, and conflict resolution, allowing them to manage diverse project teams.*<br>✓ *Students will apply ethical and sustainable project management practices, demonstrating social responsibility.*<br>✓ *Students will gain competence in adapting project management methodologies to various project types, including traditional, Agile, and hybrid approaches.*<br>✓ *Students will have the capacity to analyze and mitigate project risks, ensuring project success in complex environments.*<br>✓ *Students will demonstrate the ability to synthesize and present project data, enabling effective decision-making by project stakeholders.* |

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| Content | *Understanding Project Management. Project Initiation. Level of difficulty: 4;*<br>*Project Planning. Project Execution. Level of difficulty: 5;*<br>*Project Monitoring and Control. Project Closure. Level of difficulty: 4;*<br>*Project Management Methodologies. Level of difficulty: 4;*<br>*Project Management Tools and Software. Level of difficulty: 5;*<br>*Challenges in Project Management. Emerging Trends in Project Management. Level of difficulty: 5;*<br>*Case Studies in Project Management. Level of difficulty: 4;* |
| Exams and assessment formats | *During one semester, MSc students answered two oral questions (midterm assessments), with each question lasting 5 minutes. They collected a total of 60 points, evenly distributed with 30 points for the first set of questions and 30 points for the second set.*<br>*Additionally, there was a final exam for MSc students, which lasted 40 minutes. There were short computer-based quizzes, and MSc students could collect up to 40 points.* |
| Study and examination requirements | *MSc Students must have a final grade of 60% or higher to pass* |
| Reading list | *1. Schwalbe, K. (2021). Information Technology Project Management. Cengage Learning.*<br>*2. Caniels, Marjolein C J, and Ralph J J M Bakens, 'Project Management Information Systems in a Multi-Project Environment', in HANDBOOK ON PROJECT MANAGEMENT AND SCHEDULING, VOL 2, ed. by C Schwindt and J Zimmermann, International Handbooks on Information Systems, 2015, pp. 1355–83*<br>*3. Gros, Helene, 'Project Management', in DYNAMIC SYSTEM RECONFIGURATION IN HETEROGENEOUS PLATFORMS: THE MORPHEUS APPROACH , 2009, xl, 267–72*<br>*4. Gray, Clifford F., Erik W. Larson, and Gautam V. Desai. Project management: The managerial process. Vol. 97. New York: McGraw-Hill/Irwin, 2008.*<br>*5. Lock, Dennis. Project management. Routledge, 2020.*<br>*6. Newell, Michael, and Marina Grashina. The project management question and answer book. Amacom, 2003.*<br>*7. Burke, Rory. Project management: planning and control techniques. John Wiley & Sons, 2013.* |

| **Module designation** | ***GISWRM6104 GIS in Water resources management*** |
|---|---|
| Semester(s) in which the module is taught | *3* |
| Person responsible for the module | *Professor. Pulatov Alim Salimovich* |
| Language | *Uzbek/English* |
| Relation to curriculum | *Elective discipline (5)* |
| Teaching methods | *Lecture, practical works, SAW (Student autonomous work), two midterm assessments and exam,* |
| Workload (incl. contact hours, self-study hours) | *Total workload – 120 hours;*<br>*Lecture – 30 hours*<br>*Practical works – 30 hours*<br>*SAW (Student autonomous work) – 60 hours*<br>*Form of final control – Exam*<br>*Final assessment method – take-home written assignments* |
| Credit points | *4 ECTS* |
| Required and recommended prerequisites for joining the module | *Geography, Cartography* |
| Module objectives/intended learning outcomes | ***To know and understand:***<br>- *spheres of GIS application;*<br>- *principles of spatial data organisation in GIS;*<br>- *software tools for GIS development*<br>- *possibilities of using GIS in the field of nature protection;*<br>***To be able to:***<br>- *use global positioning systems, spatial data infrastructure,*<br>- *add text and graphics to the map,*<br>- *select objects, use graphic symbols and attributes, present the map;*<br>- *organize the data of the geo-information system of environmental protection, agriculture and water management;*<br>- *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.*<br>***To form competences in:***<br>- *working with the ArcGIS computer program,*<br>- *performing geometric correction and geolinking of images,*<br>- *performing vector and raster operations;*<br>- *creating thematic agroecological maps;*<br>- *solving practical problems in the field of environmental protection using ArcGIS.*<br>- *identifying the most effective ways to improve land use,*<br>- *improving map assessment and economic justification methods, and identifying ways to increase their effectiveness.* |

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| Content | *Introduction to GIS. Data models and data storage. Conceptual models of reality representation. Models of spatial objects. Spatial data models. Organization of spatial data. Models of the database management system. Geospatial models. Dereferencing, datum and map projections. Geovisualization. Level of difficulty:3*<br>*Queries, Data transformation, Raster data handling. Vector data handling. Learning about geographic data: how geographic data is stored; raster and vector models; shapefiles; coverages; CAD data; geodatabase- basic geodata; geodatabases. vector models; shapefiles; coverages; CAD data; geodatabase - basic concepts and advantages of working with data stored in a geodatabase; file and personal geodatabases; loading and importing data; data sources, working with map projections and datums. Topology of geodatabase. Level of difficulty:4*<br>*Digital elevation models and surface analysis. Data action models. Sources of elevation data. 4 types of source point sets.*<br>*Digital Terrain Model (DTM or Digital Elevation Model (DEM)) and Digital Surface Model (DSM). Level of difficulty:4*<br>*Global positioning system. Advantages of using satellite positioning methods for GIS.Global Positioning System (GPS) and Global Navigation Satellite System (GLONASS).Level of difficulty:4*<br>*Spatial data infrastructure.The objectives of the creation of the Spatial Data Infrastructure. Objectives of INSPIRE. SDI Standards. ISO 19100 standards.Tasks solved by satellite systems. Level of difficulty:4*<br>*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. Level of difficulty: 4*<br>*The following topics may be recommended for practical training:*<br>*1. Spatial reference of data and coordinate systems. Level of difficulty: 3*<br>*2. Vectorization of data. Level of difficulty: 3*<br>*3. Formation of spatial objects. Level of difficulty: 4*<br>*4. Digitization of scanned maps Level of difficulty: 3*<br>*5. Creating thematic agroecological maps. Level 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*<br>*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.*<br>*2. Bai Tian. GIS technology applications in environmental and earth sciences. CRC Press, Taylor & Francis Group, 2016. — 256 p.*<br>*3. Chang K.T., 2011. Introduction to Geographic Information Systems. Fourth Edition. McGRAW – HILL International Edition.*<br>*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*<br>*5. Kovar, K., and H. P. Nachtnebel. "Application of geographic information systems in hydrology and water resources management." Proceedings of the HydroGIS. Vol. 93. 1985.*<br>*6. McKinney, Daene C., and Ximing Cai. "Linking GIS and water resources management models: an object-oriented method." Environmental Modelling & Software 17.5 (2002): 413-425.*<br>*7. Dixon, Barnali, and Venkatesh Uddameri. GIS and geocomputation for water resource science and engineering. John Wiley & Sons, 2016.* |

| **Module designation** | ***RS6104 Remote sensing*** |
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| Semester(s) in which the module is taught | *3* |
| Person responsible for the module | *PhD, Rakhmonov Sherzod* |
| Language | *Uzbek/English* |
| Relation to curriculum | *Elective discipline (5)* |
| Teaching methods | *Lecture, practical works, SAW (Student autonomous work), two midterm assessments and exam,* |
| Workload (incl. contact hours, self-study hours) | *Total workload – 120 hours;*<br>*Lecture – 30 hours*<br>*Practical works – 30 hours*<br>*SAW (Student autonomous work) – 60 hours*<br>*Form of final control – Exam*<br>*Final assessment method – Quiz* |
| Credit points | *4 ECTS* |
| Required and recommended prerequisites for joining the module | *Geography, Basics of GIS, Geodesy, Astronomy, Informatics* |

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| Module objectives/intended learning outcomes | *Knowledge:*<br>✓ *Understanding the basic principles of remote sensing, including electromagnetic radiation, sensors, and the interaction of light with the Earth's surface.*<br>✓ *Knowledge of various remote sensing sensors, such as optical, thermal, radar, and LiDAR, and their characteristics.*<br>✓ *Proficiency in image processing techniques, including image enhancement, classification, and data extraction.*<br>✓ *Understanding geospatial data formats, coordinate systems, and georeferencing techniques.*<br>✓ *Knowledge of environmental processes and phenomena relevant to remote sensing applications, such as land cover, vegetation dynamics, and climate change.*<br>✓ *Familiarity with different remote sensing platforms, including satellites, drones, and airborne platforms.*<br>✓ *Competence in statistical and analytical methods for interpreting remote sensing data.*<br>✓ *Integration of remote sensing data with GIS for spatial analysis and visualization.*<br>✓ *Understanding the various applications of remote sensing, including agriculture, forestry, urban planning, disaster management, and environmental monitoring.*<br>*Skills:*<br>✓ *Proficiency in planning and conducting remote sensing data acquisition missions using appropriate sensors and platforms.*<br>✓ *Competence in using software tools such as ENVI, ArcGIS, QGIS, and remote sensing-specific software like ERDAS Imagine.*<br>✓ *Familiarity with remote sensing software for data analysis, such as MATLAB, or R.*<br>✓ *Ability to collect ground truth data for validation and calibration of remote sensing products.*<br>✓ *Remote Sensing Interpretation: Skill in visually interpreting remote sensing imagery to identify features and patterns.*<br>✓ *Capability to integrate data from multiple sensors or sources for comprehensive analysis.*<br>✓ *Proficiency in supervised and unsupervised classification methods for land cover mapping.*<br>✓ *Ability to detect and analyze changes in the Earth's surface over time using remote sensing data.*<br>✓ *Ensuring the quality and accuracy of remote sensing data through preprocessing and validation.*<br>*Competence:*<br>✓ *Competence in addressing real-world problems by applying remote sensing techniques.*<br>✓ *The ability to make informed decisions based on remote sensing data analysis.*<br>✓ *Collaboration with professionals from various fields, such as geography, environmental science, and engineering, to address complex issues.*<br>✓ *The capacity to adapt to evolving remote sensing technologies and methodologies.*<br>✓ *Competence in adhering to ethical guidelines when collecting and using remote sensing data, particularly regarding privacy and data ownership.*<br>✓ *Competence in managing remote sensing projects, including budgeting, planning, and execution.*<br>✓ *The commitment to staying updated with the latest advancements in remote sensing technology and research.*<br>✓ *Effective communication skills to convey complex technical information to non-experts and stakeholders.* |
| Content | *Remote sensing techniques. Concepts and methods (analysis of digital images, correction of images from geometric and atmospheric effects, interaction with geographic information systems.* |

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| Exams and assessment formats | *During one semester, MSc students answered two oral questions (midterm assessments), with each question lasting 5 minutes. They collected a total of 60 points, evenly distributed with 30 points for the first set of questions and 30 points for the second set.*<br>*Additionally, there was a final exam for MSc students, which lasted 40 minutes. There were short computer-based quizzes, and MSc students could collect up to 40 points.* |
| Study and examination requirements | *MSc Students must have a final grade of 60% or higher to pass* |
| Reading list | *1. Sh. Shokirov, I.M. Musaev, M.S. Akbarov. Remote sensing. Tashkent, Economics and Finance, 2015.*<br>*2. J. Guo and P. J. Mason, Image processing and GIS for remote sensing. John Wiley & Sons, Ltd., 2016.*<br>*3. Rafael C. Gonzalez, Richard E. Woods. Digital Image Processing. 4th Edition, 2017.*<br>*4. Berlyant A.M. Geoiconika-M.: MSU, AEN RF, "Astreya", 2011.*<br>*5. Rees, Gareth. The remote sensing data book. Cambridge university press, 1999.*<br>*6. Lasaponara, Rosa, and Nicola Masini, eds. Satellite remote sensing: A new tool for archaeology. Vol. 16. Berlin: Springer, 2012.*<br>*7. Gibson, Paul. Introductory remote sensing principles and concepts. Routledge, 2013.* |

| **Module designation** | ***WEFE6104 Water-Foot-Energy-Environment (WEFE) Nexus*** |
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| Semester(s) in which the module is taught | *3* |
| Person responsible for the module | *Associate professor Karimov Akmal Khayitovich* |
| Language | *Uzbek/English* |
| Relation to curriculum | *Elective discipline (5)* |
| Teaching methods | *Lecture, practical works, SAW (Student autonomous work), two midterm assessments and exam,* |
| Workload (incl. contact hours, self-study hours) | *Total workload – 120 hours;*<br>*Lecture – 30 hours*<br>*Practical works – 30 hours*<br>*SAW (Student autonomous work) – 60 hours*<br>*Form of final control – Exam*<br>*Final assessment method – Quiz* |
| Credit points | *4 ECTS* |
| Required and recommended prerequisites for joining the module | *Multipurpose water use, integrated water resources management, hydrotechnical construction* |

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| Module objectives/intended learning outcomes | *Knowledge:*<br>✓*Understanding of water resource management, water quality, hydrology, and the distribution and availability of water sources.*<br>✓*Knowledge of energy production, distribution, and consumption, including renewable and non-renewable energy sources.*<br>✓*Familiarity with ecological systems, environmental impact assessment, and conservation practices.*<br>✓*Understanding the causes and effects of climate change on water and energy systems and the broader environment.*<br>✓*Knowledge of national and international policies, regulations, and agreements related to water, energy, and the environment.*<br>✓*Proficiency in data collection, analysis, and modeling techniques for assessing WEFE Nexus interactions.*<br>✓*Awareness of the connections between water, energy, and the environment and their impacts on society, economics, and human health.*<br>*Skills:*<br>✓*Ability to think holistically and analyze complex systems to identify cause-and-effect relationships within the WEFE Nexus.*<br>✓*Proficiency in using statistical and modeling tools to analyze data and simulate scenarios in the WEFE Nexus.*<br>✓*Skills in assessing the environmental impact of water and energy projects and proposing mitigation measures.*<br>✓*The capability to evaluate and contribute to policy development in areas related to the WEFE Nexus.*<br>✓*Effective communication and collaboration with diverse stakeholders, including government agencies, NGOs, communities, and industries.*<br>✓*Skills to plan, execute, and monitor projects related to the WEFE Nexus, ensuring timely and cost-effective outcomes.*<br>✓*Familiarity with technologies and innovations that can improve water and energy efficiency while minimizing environmental impact.*<br>*Competence:*<br>✓*The ability to critically assess and solve complex problems within the WEFE Nexus, considering environmental, social, and economic dimensions.*<br>✓*The capacity to adapt to evolving technologies, policies, and environmental conditions in the WEFE Nexus.*<br>✓*An understanding of ethical considerations in decision-making regarding water, energy, and the environment, including social justice and equity.*<br>✓*The capability to lead teams and projects in the WEFE Nexus field, inspiring others to work towards sustainable solutions.*<br>✓*Effective communication of complex ideas and findings to both technical and non-technical audiences.*<br>✓*The ability to work collaboratively with professionals from various backgrounds and disciplines to address WEFE Nexus challenges.*<br>✓*The drive to seek innovative solutions that improve the efficiency and sustainability of water and energy systems while minimizing environmental impacts.*<br>✓*A commitment to staying up-to-date with the latest research, technologies, and best practices in the WEFE Nexus field.* |

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| Content | *Resource Interconnectedness: Water, food, and energy are closely connected. Agriculture uses a lot of water and energy, while energy relies on water. Environmental sustainability is crucial for long-term resource availability. Level of difficulty:4;*<br>*Resource Competition: Growing global populations and increased demand for water, food, and energy lead to competition. The WEFE Nexus seeks sustainable solutions to balance resource use while protecting the environment. Level of difficulty:5;*<br>*Climate Change: Climate change worsens WEFE Nexus challenges. Rising temperatures, changing precipitation, and extreme weather affect water availability for agriculture and energy, risking food and energy stability. Level of difficulty:5;*<br>*Environmental Care: The WEFE Nexus promotes responsible resource management and environmental protection. Healthy ecosystems are vital for clean water, fertile soil, and renewable energy. Level of difficulty:4;*<br>*Policy and Governance: Effective governance is vital for managing the WEFE Nexus. Coordinated local, national, and international efforts are needed to balance water, food, energy, and environmental goals. Level of difficulty:4;*<br>*Sustainable Development: The WEFE Nexus aligns with UN Sustainable Development Goals, such as Zero Hunger, Clean Water, Affordable Clean Energy, and Climate Action. It fosters holistic sustainable development. Level of difficulty:5;*<br>*Innovative Solutions: WEFE Nexus experts explore resource-efficient, renewable, and sustainable practices to meet demands. Level of difficulty:5;*<br>*Global Collaboration: Global collaboration is essential due to resource challenges. The WEFE Nexus encourages sharing knowledge and technology to address shared vulnerabilities. Level of difficulty:4*<br>*Resilience and Adaptation: Building resilience involves adapting to changing resources and conditions, like diversifying energy sources, improving water efficiency, and climate-resilient agriculture. Level of difficulty:5;*<br>*Education and Awareness: Public awareness and stakeholder education about the WEFE Nexus' interconnectedness are crucial for informed decision-making and sustainable resource management. Level of difficulty:4.* |
| Exams and assessment formats | *During one semester, MSc students answered two oral questions (midterm assessments), with each question lasting 5 minutes. They collected a total of 60 points, evenly distributed with 30 points for the first set of questions and 30 points for the second set.*<br>*Additionally, there was a final exam for MSc students, which lasted 40 minutes. There were short computer-based quizzes, and MSc students could collect up to 40 points.* |
| Study and examination requirements | *MSc Students must have a final grade of 60% or higher to pass* |

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| Reading list | *1. Allouche, J., Middleton, C., and Gyawali, D. (2015). Technical Veil, Hidden Politics: Interrogating the Power Linkages behind the Nexus. Water Altern. 8, 610–626.*<br>*2. Bazilian, M., Rogner, H., Howells, M., Hermann, S., Arent, D., Gielen, D., et al. (2011). Considering the energy, water and food nexus: towards an integrated modelling approach. Energy Policy 39, 7896–7906. doi: 10.1016/j.enpol.2011.09.039.*<br>*3. Benson, D., Gain, A. K., and Rouillard, J. J. (2015). Water governance in a comparative perspective: from IWRM to a 'Nexus' approach? Water Altern. 8, 756–773.*<br>*4. Biggs, E. M., Bruce, E., Boruff, B., Duncan, J. M. A., Horsley, J., Pauli, N., et al. (2015). Sustainable development and the water–energy–food nexus: a perspective on livelihoods. Environ. Sci. Policy 54, 389–397. doi: 10.1016/j.envsci.2015.08.002.*<br>*5. Boulding, K. E. (1966). "The economics of the coming spaceship earth," in Environmental Quality in a Growing Economy, ed H. Jarrett (Baltimore: Resources for the Future, Johns Hopkins University Press), 3–14.*<br>*6. Brundtland, G. H. (1987). Our Common Future. Report of theWorld Commission on Environment and Development .* |