

COURSE DESCRIPTION

Course code	Volume in ECTS credits	Institution	Faculty	Department
MIŠ8001	8	VMU - AA	Forest sciences and ecology	Forest science

Course title in Lithuanian

Miško ekologija

Course title in English

Forest ecology

Study methods	Volume in ECTS credits
Lectures	5
Consultations	1
Seminars	1
Individual work	1

Short course annotation in Lithuanian (up to 500 characters)

Miško ekologijos mokymasis turėtų padėti doktorantui nagrinėti savo mokslinio darbo rezultatus šiuolaikinės miško ekologijos mokslo šviesoje. Išklausęs kursą doktorantas giliau supras miško ekosistemų raidos procesus, jos ryšių su aplinka sudėtingumą įvairiais lygmenimis, sugebės išsivaizduoti žmogaus ūkinės veiklos galimas pasekmes klimatui, miško ekosistemų gyvybingumui ir įvairovei. Susipažinęs su miško ekosistemų funkcionavimu ir įvairių veiksnių įtaka miško ekosistemų vystimuisi doktorantas turėtų mokėti prognozuoti nepalankių aplinkos veiksnių pasekmes miško ekosistemoms, darbe pasirinkti aplinką tausojančią taktiką ir strategiją.

Short course annotation in English (up to 500 characters)

Learning of Forest ecology will help for PhD student analyse and interpret own study results under modern science. After completing the course PhD student will understand deeper forest ecosystem development, the complexity of its relation with environment on various levels, be able to vision forest management by humans to climate change, forest ecosystem sustainability and diversity. PhD student will be able to forecast the results of negative environment factors to forest ecosystem as well as in its own research to select environmental friendly statistics and strategy.

Relevance of the course

The subject is important for proper evaluation and deep ecological understanding of the PhD student research and evaluate gained results

Course aims

The aim of the subject is to provide knowledges on peculiarities of forest ecosystem functioning, impact of environment to forest ecosystem, develop abilities to identify forest ecological problems and solve it by using scientific methods.

Content (topics) and methods

1. *Introduction*. Concept of forest ecology. Forest as a geographical type of vegetation; Relation of forest ecology with other disciplines; origin and development of Forest ecology;
2. *Forest ecosystem*. Definition of forest ecosystem; Levels of ecosystems; Biogeocoenosis; functional and structural ecosystem elements; ecological factors in forest ecosystem; forest formation and succession;
3. *Forest community* (phytocoenosis). Components of forest community: stand, undergrowth, shrubs, herbaceous cover; litter; interactions among trees; tree differentiation and elimination processes; tree social class classification;
4. *Forest and climatic factors (factorial ecology)*.
Forest and light. Sun radiation; physiological active radiation; photosynthesis as a process and it's significance; light intensity alter plant anatomy and morphology; light demand of tree species and classification; distribution of light in forest; edge effect; vertical regulation of light in stand;

Forest and temperature. Global heat balance; optimal temperature regime and tree toleration of heat in physiological processes; tree species demands for temperature regimes; resistance for extreme cold and spring frosts; temperature inside forest; landscape effect on forest for temperature; regulation of temperature within stand;

Forest and humidity. Tree demands of water resources; species drought tolerance; soil water potential; water forms in soil; available water for plant; optimal humidity for tree species and tree classification; air humidity in stand; water balance in forest; impact of forested areas for precipitation, effect for humidity on landscape level; forest as water protection tool;

Forest and atmosphere. Atmospheric air content; CO₂ concentration; oxygen ionization and phytoncides; air pollution and its impact for forest health; tree species sensitivity for air pollution; ozone impact for forest; forest as air protection tool; the role of wind; positive and negative role of wind; decrease of negative effect of wind for forest; forest influence for wind strength;

5. *Forest and soil.* Role of soil for forest, granulometric content of soil, soil humus, soil pH, soil physical and chemical features, impact for forest; soil fertility and tree species demands on soil fertility, forest effect on soil phylogenesis, forest litter, roots of trees, dynamics of nutritive contents in the soil, impact of forest management for soil quality, contamination of soil, forest fires and soil, forest as a tool for soil protection.
6. *Forest wildlife.* Forest wildlife and its significance for forest, wildlife as integrative part of forest ecosystem, wildlife populations, the role of fauna for forest ecosystems;
7. *Forest typology.* Forest discrete and continuity; concept of forest ecotone and continuity, classification of forest ecosystems, forest typology: understanding, development and directions. Forest typology in Lithuania, Forest typological classification.
8. *Forest regeneration.* Seed and vegetative regeneration, factors affecting successful regeneration: forest type, stand structure, tree species biology. Effect of forest litter for regeneration, evaluation of regeneration;
9. *Forest change.* General knowledges about succession. Forest species change during geological ages, first trees and forests, Forest succession during Holocene, current forest successions (reasons, stability, short and long term forest communities), forest communities age structure and its changes, main successions of boreal forests, natural and human induced forest successions; short term changes of forest in Lithuania, practical evaluation of forest changes.
10. *Alien species in forest.* History of alien species, spread and routes of alien species, alien species in Europe and its natural areas, invasiveness of alien species, research of alien species invasiveness;
11. *Forest as a part of biosphere.* World forests and its geographical features, the zone of temperate forests; forest regions in Lithuania, protective role of forest in landscape.

Structure of cumulative score and value of its constituent parts

Individual assignment 30%; Exams - 70 %

Compulsory reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Basalykas A. 1977. Lietuvos TSR kraštovaizdis.- Vilnius: Mokslas.- 239 p.
2.	Bukantis A. 1994. Lietuvos klimatas. Vilnius, Vilniaus universiteto leidykla, 187 p.
3.	Burton V. Barnes, Donald R. Zak, Shirley R. Denton, Stephen H. Spurr. 1998. Forest ecology / John Wiley & Sons, 774 p.
4.	Dagys J. 1980. Augalų ekologija. Vilnius: Mokslas, 238 p.
5.	David M. Smith, Bruce C. Larson, Matthew J. Kelty, P. Mark S. Ashton. 1997. The practice of silviculture: applied forest ecology. New York : John Wiley, 537 p.
6.	Hasenauer H., Glazda A., Konnerth M., Lapin K., Mohren G., Spiecker H., Loo M., Potzelsberger E. Non-native tree species for European forests: experiences, risks and opportunities. 2017. BOKU
7.	Joe Landsberg, Peter Sands. 2011. Physiological ecology of forest production [elektroninis išteklius]: principles, processes and models. Amsterdam ; Boston : Elsevier/Academic Press, 331 p.
8.	Karaziņa S. 1988. Lietuvos miškų tipai. V.: Mokslas, 212 p.

9.	Karazija S., Vaičiūnas V. 2000. Ekologinis miškų vaidmuo Lietuvoje. Kaunas, „Lututė“, 152 p.
10.	Kimmins, J.P. 1987. Forest ecology : a foundation for sustainable forest management and environmental ethics in forestry. Prentice Hall, 611p.
11.	Lietuvos miškų būklė ir ją sąlygojantys veiksniai (red. R. Ozolinčius). 1999. Kaunas, „Lututė“, 312p.
12.	Melekov I.S. 1980. Lesovedeniye, Maskva, 406p.
13.	Miškininkystė (autorių kolektyvas, sud. L. Kairiūkštis). 1979. V.: Mokslas, 352 p.
14.	Motuzas A.J., Buivydaitė V., Danilevičius V., Šleivys R. 1996. Dirvotyra, V.: Mokslas, 375 p.
15.	Ozolinčius R. 1998. Lietuvos spygliuočiai: morfologinės struktūros transformacijos bei jas indukuojantys veiksniai. Kaunas, „Lututė“, 300 p.
16.	Pauliukevičius G. 1982. Miškų ekologinis vaidmuo. V.: Mokslas, 112 p.
17.	Ruseckas J. 2002. Miško ir drėgmės sąveika. Kaunas. „Lututė“, 200 p.
	Stravinskienė V. 2003. Bendroji ekologija.-Kaunas: Šviesa, 232 p.

Supplementary reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Baleišis R., Bluzma P., Balčiauskas L. 1987. Lietuvos kanopiniai žvėrys. V., 200 p.
2.	Belova O. 2001. Medžiojamųjų gyvūnų etologija. Vilnius: Mokslas, 256 p.
3.	Heinrich D., Hergt M. 2000. Ekologijos atlasas. Vilnius: Alma litera, 280 p.
4.	Juknys R (red.). 1994. Lietuvos gamtinė aplinka, būklė, procesai, tendencijos. Vilnius. 114 p.
5.	Kairiūkštis L., Juodvalkis A. 1985. Etaloniniai medynai ir jų formavimas.- V.: Mokslas, 244 p.
6.	Kapustinskaitė T. 1983. Juodalksnynai. V.: Mokslas, 227 p.
7.	Karazija S., Jurgelionis J., Vaičiūnas V. 1997. Savaiminis ažuolynų atžėlimas – Lietuvos ažuolynai. Išsaugojimo ir atkūrimo problemos.- 136-146 p.
8.	Kimmins J.P. 1998. Forest ecology. Pretice-Hall, 1997 p.
9.	Lietuvos miško ūkio statistika. 2005. MEC, Vilnius, 111 p.
10.	Lietuvos miškų ūkis (autorių kolektyvas, sud. V. Verbyla). 1992. V., 207 p.
11.	Lietuvos Respublikos biologinės įvairovės išsaugojimo strategija ir veiksmų planas. 1997. V., 108 p.
12.	Lietuvos TSR miškai (autorių kolektyvas, sud. L. Kairiūkštis). 1962. V., 366 p.
13.	Miškininko žinynas. 1991. V., 450 p.
14.	Padaiga V. 1996. Medžioklės ūkio biologiniai pagrindai. V., 211 p.
15.	Pauliukevičius G. 1986. Cheminių elementų keliai landsaifte. V.: Mokslas, 128 p.
16.	Pauliukevičius G., Kenstavičius J. 1995. Ekologiniai miškų teritorinio išdėstymo pagrindai, 290 p.
17.	Račkauskas V. 1991. Bendroji ekologija. V., 239 p.
18.	Riepišas E. 1981. Miškas ir žmogaus poilsis. Vilnius: Mokslas,
19.	Vaičys M., Raguotis A., Šleivys R. 1979. Miško dirvožemių žinynas, V.: Mokslas, 200 p.
20.	Žiogas A. 1997. Miško entomologija. Kaunas, 268 p.

Course programme designed by

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1	Gediminas Brazaitis	VMU-AA	dr.	gediminas.brazaitis@vdu.lt
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The description of the study subject is valid until 2026 February 28

COURSE DESCRIPTION

Course code	Volume in ECTS credits	Institution	Faculty	Department
MIŠ8002	8	VMU - AA	Forest Science and Ecology	Forest Science

Course title in Lithuanian Miškotyros metodologija

Course title in English Methodology of Forest Research

Study methods	Volume in ECTS credits
Lectures	4
Consultations	1
Seminars	1
Individual work	2

Short course annotation in Lithuanian (up to 500 characters)

Kursas skirtas pirmųjų studijų metų doktorantams. Kurso tikslas suteikti doktorantui gebėjimų pasirinkti tinkamus miškotyroje naudojamus mokslinių tyrimų ir statistinės analizės metodus reikalingus konkrečiam mokslo darbui atlikti, kūrybingai juos pritaikyti ir teisingai interpretuoti gautus rezultatus. Doktorantai įgyja kompetencijų naudotis mokslinės informacijos šaltiniais, rengti mokslinių tyrimų metodikas, rinkti ir apdoroti duomenis, analizuoti, įvertinti, apibendrinti ir aprašyti mokslinio tyrimo rezultatus, naudotis statistinės analizės programiniais paketais (Statistica, SPSS, Maple), parengti platinimui ir naudojimui mokslinio tiriamojo darbo kūrinis, planuoti mokslinio tiriamojo darbo projektus

Studijų formos: paskaitos, pratybos, savarankiškas darbas, seminarai ir baigiamasis egzaminas

Short course annotation in English (up to 500 characters)

The course is designed for PhD students of the first year of studies. The aim of the course is to give the doctoral student the ability to choose the appropriate methods of research and statistical analysis used in forest sciences, to perform a specific research work, to apply them creatively and to correctly interpret the obtained results. Doctoral students acquire competencies to use scientific information sources, to develop research methodologies, to collect and process data, to analyze, evaluate, summarize and describe research results, to use statistical analysis software packages (Statistica, SPSS, Maple), to prepare for publishing and use of research works to plan scientific research projects.

Forms of studies: lectures, practicums, seminars, individual work and final exam.

Relevance of the course

PhD students will have sufficient knowledge and skills to analyze, develop and apply research methodologies in forest science, based on applied statistical methods, to produce scientific reports and articles, to plan, organize and carry out forest research work.

Course aims

To give the doctoral student the ability to choose the appropriate methods of research and statistical analysis needed for specific research work, to apply them creatively and to correctly interpret the obtained results and to submit to the global scientific community of forest researchers

Content (topics) and methods

1. Topic Introduction: the concept of science, classification, object, subject; scientific research - concept, classification, object, subject; the results of the research and the forms of their presentation. Study methods: lectures, seminars, exam.
2. Topic Scientific information: information, concept of information system and information ratio, types of information, characteristics of social information; information sources; bibliographic classification of information sources, bibliographic description of information sources;

searching for information sources; use of information sources in research work. Study methods: lectures, seminars, exam.

3. Topic Methodology and methods of scientific research: methodology, method, methodic: conception and levels; general research methods; methods of empirical research; methods of theoretical research; experimental (theoretical and empirical) research methods; Methods of metatheoretical research; special research methods. Study methods: lectures, seminars, exam.
4. Topic Research process: experimental research process; types of experiments; formulation of research background; choice of research area and direction; evaluation of the research direction; the state and location of the study at the modern scientific stage; definition of research subject; assessment of the research subject by information sources; formulating the hypothesis of the problem and its solution; preparation of research methodology; preparation of an experimental program; determining the indicators and factors of the survey results; identification the type of an experiment; determination of the scope and number of tests and replications; data outliers and error estimation techniques; Creating an experimental plan; conducting an experiment: collecting, evaluating and processing data; presentation of results; analysis of results (interpretation, discussion) and generalization; formulation of conclusions and proposals. The process of theoretical research; choice of research area and definition of research subject; assessment of cognition of the research subject, generating the main idea of the problem and its solution; formation of concepts and assumptions, raising of the working hypothesis; selection of research methods; accumulation of scientific facts, their analysis, raising of scientific hypotheses; model development and testing, acceptance of hypotheses; Summarizing of the research results. Study methods: lectures, seminars, individual work, exam.
5. Topic Formalization of scientific works: production of scientific research; scientific article; scientific study; scientific monograph; scientific report; Bachelor's thesis; Master's thesis; doctoral dissertation; types of scientific presentation; annotation of scientific works; review of scientific works; publication of scientific works. Study methods: lectures, seminars, individual work, exam.
6. Topic Presentation of research results: forms of oral presentation of scientific information; preparation and presentation of scientific reports; preparation, presentation and defense of the dissertation. Study methods: lectures, seminars, independent work, exam.
7. Topic Organization of scientific work: hygiene of mental work; organization of the research workplace; Cluster of researchers, its formation and work organization; institutional structure of science organization in Lithuania; Evolution of science. Study methods: lectures, seminars, exam. Study methods: lectures, seminars, individual work, exam.
8. Topic Statistical methods: basic concepts; population, sample, variable, variable types and measurement scales, statistics and parameters; sample and sampling types; probabilistic distributions: Binomial, Poisson, Gauss, Student, Fisher (properties, density functions); the necessity and methods of variable transformations; descriptive statistics and errors: central tendency statistics and measures of variation; point estimates and confidence intervals; statistical tests. Study methods: lectures, practicums, individual work, exam.
9. Topic Analysis of variance (ANOVA): one and two factor cases; Background of ANOVA method, theoretical assumptions of ANOVA analysis, statistical criteria; multivariate ANOVA; fixed and random factors; interaction of factors; ANOVA of blocked data; task formulation, data preparation, interpretation of results; examples of use ANOVA in forest research. Study methods: lectures, practicums, individual work, exam.
10. Topic Regression analysis: linear, polynomial and nonlinear regression analysis; theoretical assumptions, checking the theoretical assumptions of the regression model; parameter estimates, their errors and significance; equality of parameters of two regression models; selection of regression model. Multiple regression analysis, assessment of multicollinearity and autocorrelation; applications of linear, nonlinear and logistic regression models in forest research. Study methods: lectures, practicums, individual work, exam.

11. Topic Time series models: time series transformations, smoothing; seasonal decomposition; autocorrelation, ARIMA model and evaluation of its parameters. Arima model application in forest research. Study methods: lectures, exercises, individual work, exam.
12. Topic Techniques of multi-dimensional analysis: multidimensional data; graphic presentation of multidimensional data; significance tests of multidimensional data; Tests of multidimensional distances; factor analysis; method of principal components, examples of factor analysis in forest research. Cluster analysis; distance and similarity measures, prototypes of clusters; methods of clustering, two step clustering, k-means clustering; hierarchical clustering; hierarchy index; significant number of clusters; applications of cluster analysis in forest research. Discriminant analysis; Fisher model; classification and discriminant functions; canonical discriminant functions; examples of discriminant analysis in forest research. Canonical correlation analysis; multidimensional scaling; ordination; spatial statistics; spatial layout data and it's graphical presentation; examples of canonical analysis in forest research. Study methods: lectures, exercises, individual work, exam.

Structure of cumulative score and value of its constituent parts

Practicums - 25% of the final grade; Individual work - 25% of the final grade; Seminars - 10% of the final grade, Exam - 40% of the final grade.

Compulsory reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Čekanavičius V., Murauskas G. Statistika ir jos taikymai Idalis. Vilnius Tev, 2001.
2.	Čekanavičius V., Murauskas G. Statistika ir jos taikymai II dalis. Vilnius Tev, 2002.
3.	Čekanavičius V., Murauskas G. Statistika ir jos taikymai III dalis. Vilnius Tev., 2009.
4.	Kardelis K. Mokslinių tyrimų metodologija ir metodai. Šiauliai, 2007.
5.	Rupšys P., Olson U., Engstrand U. Statistiniai metodai. Kaunas, Akademija, 2007.
6.	Tidikis. R. Socialinių mokslų tyrimų metodologija. Vilnius, 2003.
7.	Vencloviėnė. Statistiniai metodai aplinkotyroje. Kaunas, 2008.
8.	Vencloviėnė J. Statistiniai metodai medicinoje. VDU, 2010.
9.	Christensen R., Analysis of Variance and Regresion. Applied Statistical Method. N Y, Chapman & Hall, 1996.
10.	Rienecker L., Jorgeksen P.S. Kaip rašyti mokslinį darbą. Vilnius, 2003.
11.	Cochran W.G. Sampling Techniques. John Wiley & Sons, 1972.
12.	Crewson Ph. Applied Statistics Hanbook. AcaStat Software, 2006.
13.	Kanji G. 100 statistical tests. SAGE Publications Lt. , 2006.
15.	Smith M. Statistical Analysis Hadbook. The Winchelsea Press, Drumlin Security Ltd, Edinburgh, 2018.
16.	Sioptani M., Hayakawa T., Fujikoshi Y. Modern Multivariate Statistical Analysis: A Graduate Course. Handbook, American Sciences Press, Inc., 1985.

Supplementary reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Bartasevičienė V. Ekonominė statistika. Kaunas, 2005.
2.	Liutikas V., Šeštokas J., Zujus J. Mokslinių tyrimų pagrindai, Vilnius, 1987. 223 p.
3.	Mažeika J. Mokslinės ir technologinės kūrybos metodologiniai pagrindai. Akademija, 2007.
4.	Nekrašas E. Filosofijos įvadas. Vilnius, 2004.
5.	Plečkaitis R. Logikos įvadas. Vilnius, 2005.
6.	Sakalauskas V. Duomenų analizė su STATISTIKA. Vilnius, Margi raštai, 2003
7.	Songailienė A., Ženauskas K. Tyrimo duomenų biometrinis vertinimas. Vilnius, 1985.
8.	Day R. A. How to write and publish scientific paper. Philadalpha,1979.
9.	Manly B. F. J. Multivariate statistical methods. London, 1995.

Course programme designed by

No.	Name, surname	Institutio	Degree	E-mail address

1.	Edmundas Petrauskas	VMU-AA	Prof. Dr.	edmundas.petrauskas@vdu.lt
2.	Petras Rupšys	VMU-AA	Prof. Dr.	petras.rupsys@vdu.lt

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COURSE DESCRIPTION

Course code	Volume in ECTS credits	Institution	Faculty	Department
MIŠ8003	8	VMU-AA	Forest sciences and ecology	Environment and ecology

Course title in Lithuanian

Miško fitocenozijų tyrimo ir statistinės analizės metodai

Course title in English

Methods of research and statistical analyses of forest phythoseonoses

Study methods	Volume in ECTS credits
Lectures	2
Consultations	1
Seminars	2
Individual work	3

Short course annotation in Lithuanian (up to 500 characters)

Dalyko tikslas suteikti doktorantams žinių apie fitocenologinių tyrimų etapus ir terminologiją, duomenų tipus, rezultatų interpretavimo ypatumus ir galimas klaidas; regresinę analizę ir taikomus modelius, ordinavimo klasterinės analizės metodus; gebėjimų parinkti reikiamo tipo metodus, parengti tyrimo planą, pritaikyti regresijos, ordinavimo bei klasterinės analizės metodus fitocenologiniuose tyrimuose, interpretuoti gautus analizės rezultatus.

Short course annotation in English (up to 500 characters)

The aim of the subject is to provide the doctoral students with knowledge of terminology and phytocenological research stages, data types, interpretation of results and possible errors; regression analysis and applied models, methods of ordination, cluster analysis; abilities to select the required type of methods, to prepare a research plan, to apply regression, ordination and cluster analysis methods in phytocenological studies, to interpret the obtained results.

Relevance of the course

Knowledge of terminology and phytocenological research stages, data types, interpretation of results and possible errors; regression analysis and applied models, methods of ordination, cluster analysis; abilities to select the required type of methods, to prepare a research plan, to apply regression, ordination and cluster analysis methods in phytocenological studies, to interpret the obtained results.

Course aims

To provide the PhD student with knowledge of phytocenological research and analysis methods, ability to analyze phytocenological research data, to apply mathematical analysis methods, to select and apply them in case of specific research.

Content (topics) and methods

Introduction: types of phytocenological investigations, stages, application and terminology (*lectures, exercises, individual assignment*).

Data collection and analysis: Data collection objectives, data collection planning, data transformations: measurement scales, transformation, interpretation of results, interpretation mistakes, complexity of phytocenotic investigations (*lectures, exercises, individual assignment*).

Applications of regression in phytocenology: applied models and types of variables, regression methods using quantitative data, regression methods using qualitative data, application of multivariate regression in phytocenology, application of regression using indicative values of species (*lectures, exercises, individual task*).

Methods of ordination in phytocenology: ordination models and methods, correspondence analysis (CA), detrended correspondent analysis (DCA), principal component analysis (PCA), use of external data for ordination, result interpretation, canonical analysis (CA), multivariate analysis, presentation of results (*lectures, exercise, individual assignment*).

Cluster analysis in phytocenology: types of cluster analysis, agglomerative methods, dividing methods, TWINSpan, non-hierarchical gradient methods, interpretation of cluster analysis, presentation of cluster analysis results (*lectures, exercises, individual assignment*).

Structure of cumulative score and value of its constituent parts

Individual assignment 50%; Exams - 50 %

Compulsory reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Jongman R. H., Braak C. J. F. Ter, Tongeren O. F. R. Van. 1995. Data analysis in community and landscape ecology - Pudoc Wageningen
2.	Kent M., 2011: Vegetation description and analysis: a practical approach. Wiley-Blackwell, 428p.
3.	Lepš J., Šmileuer P. 2003. Multivariate Analyses of ecological data using CANOCO. Cambridge, 282 p. Maarel Eddy. 2004. Vegetation ecology, 408p.
4.	Wildi O. 2013. Data Analysis in Vegetation Ecology - Wiley-Blackwell, 320 p.
5.	

Supplementary reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Braak C. J. F., Šmileuer P. 2012. CANOCO 5 Wageningen, Česke Budejovice, 496 p.
2.	Fowler J., Cohen L., Jarvis, P. 1998. Practical statistics for field biology, 259p.
3.	Natkevičaitė-Ivanauskienė M., 1983. Botaninė geografija ir fitocenologijos pagrindai - Vilnius.
4.	Ženiauskas K., Songailienė A., 1989. Duomenų biometrinis vertinimas - Vilnius
5.	Mokslinės duomenų bazės – ScienceDirect; Agricola
6.	Tarptautiniai moksliniai žurnalai – Environmental Pollution, Journal of vegetation science, Applied vegetation science, Forest ecology and management, Ecological modeling
7.	Lietuvos moksliniai žurnalai – Ekologija, Botanica Lithuanica, Miškininkystė.

Course programme designed by

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COURSE DESCRIPTION

Course code	Volume in ECTS credits	Institution	Faculty	Department
MIŠ8004	7	VMU-AA	Forest sciences and ecology	Forest science

Course title in Lithuanian

Stuburinių gyvūnų tyrimo metodologija

Course title in English

Vertebrate research methodology

Study methods	Volume in ECTS credits
Lectures	2
Consultations	1
Seminars	1
Individual work	3

Short course annotation in Lithuanian (up to 500 characters)

Sausumos stuburinių gyvūnų tyrimo metodologijos tyrimai sudaro teorinį pagrindą sausumos stuburinių gyvūnų ekologijos ir apsaugos, medžioklėtyros ir kitų taikomųjų mokslų srityse. Stuburinių gyvūnų metodologijos mokymasis turėtų padėti doktorantui sistemingai ir sklandžiai vykdyti stuburinių gyvūnų tyrimus, bei minimaliomis pastangomis pasiekti optimalius rezultatus. Išklaušęs kursą doktorantas giliau įsisavins įvairius tyrimo metodus, sugebės apdoroti gautus duomenis.

Short course annotation in English (up to 500 characters)

Terrestrial vertebrate research methodology gives theoretical background for vertebrate biology, ecology and conservation, game management and other sciences. Vertebrate research methods give ability systematically and smooth develop analysis of vertebrate and by minimal efforts get optimal results. After completion of this course PhD student will be able to use various methods in practise, process and evaluate data.

Relevance of the course

The subject is important for optimal planning and implementation vertebrate animal research.

Course aims

The aim of the subject is provide knowledges on terrestrial vertebrate study methods and apply it in the field.

Content (topics) and methods

1. Vertebrate animals morphological description. Anatomical measurements, age determination.
2. Determination of population size and density:
Census for population estimation: observation and counting; stimulation; scaring; inventory of activity signs and marks, territory mapping;
Census for relative indices: One time and repeated capturing and marking; point counts; line transect counts, territory counts, registration of activity signs and marks, use of trained dogs.
3. Census methods on adaptation to species territoriality, abundance and spatial distribution; census of different species systematic and ecological groups; amphibian census, reptilian census, bird census, mammals census, migratory bird census, radiotelemetry, direct and indirect censuses, estimation of population size; research methods of terrestrial wildlife communities, general principles, longevity of communities, dependence between species number and habitat area/environmental factors, experimental comparison and statistical analysis.
4. Habitat selectivity research methods; habitat selection, geographical, ecological and local aspects of habitat selection.

5. Geographical distribution studies; endemics, distribution in continents, biomes, ecological and seasonal distribution, theory of island biogeography, study of fauna in the isolates and fragmented habitats, metapopulation studies, wildlife impact on environment studies;
6. Research methods of breeding biology and behaviour; territoriality and coloniality, study of breeding territory and home range, habitat selection studies, breeding terms and periodicity, parameters of breeding, local population size dynamics studies, ecological niche and its study methods, intraspecific and interspecific competition, acoustic analysis methods.

Structure of cumulative score and value of its constituent parts

Individual assignment 50%; Exams - 50 %

Compulsory reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Balčiauskas, L. 2004. Sausumos ekosistemų tyrimo metodai. Vilniaus universiteto leidykla.
2.	Linas Balčiauskas, Kazimieras Baranauskas, Romas Ferenca, Zigmantas Gudžinskas, Albertas Gurskas, Povilas Ivinskis, Vytautas Kesminas, Linas Ložys, Jolanta Rimšaitė, Zofija Sinkevičienė,
3.	Robertas Staponkus, Andrius Steponėnas, Giedrius Trakimas, Tomas Virbickas 2016. Europos Bendrijos svarbos rūšių monitoringo metodikos: žinduoliai, žuvis, varliagyviai, ropliai, moliuskai, vabzdžiai ir augalai. Vilnius : Aplinkos apsaugos agentūra, Valstybinė saugomų teritorijų tarnyba, 403 p.
4.	Bibby, C.J., Burges, N.D. Hill, D.A. 1992. Bird Census Technique. Academic press. 257 p.
5.	Braun C.E. (ed.) 2005. Techniques for wildlife investigation and management. The wildlife society USA. 974p.
6.	Briedermenn L. 1982. Der Wildbestand - die grobe Unbekannte (Methoden der ildbestandsermittlung). Berlin, VEB Deutsches Landwirtschaftsverlag, 212 p.
7.	Boitani, L., Fuller, T.K. 2000. Research techniques in animal technology. Columbia university press. 442 p.
8.	Padaiga P., Pėtelis K. 1995. Medžiojamųjų gyvūnų gausumo nustatymas bei sveikos gyvenamąja aplinka tyrimai. Kaunas.
9.	Liutauras Raudonikis, Gintaras Riauba, Gediminas Brazaitis, Arūnas Čerkauskas, Mindaugas Dagys, Julius Morkūnas, Eglė Pakštytė, Arūnas Pranaitis, Žydrūnas Preikša, Saulis Skuja, Vitas Stanevičius, Daiva Vaitkuvienė. 2016 Europos Bendrijos svarbos paukščių rūšių monitoringo metodikos Vilnius : Aplinkos apsaugos agentūra, Valstybinė saugomų teritorijų tarnyba prie Aplinkos ministerijos, 406 p. Sutherland, Williams J. 2006. Ecological census techniques. Cambridge Univ. press

Supplementary reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Drobelis E. 1989. Miško plėšriųjų paukščių tyrimai (Metodinės rekomendacijos). V., 92 p.
2.	Fowler, J., Cohen, L. 1988. Statistics for ornithologist. BTO Guide 22.
3.	Paltanavičius S. 1992. Pėdsekio vadovas. V., M., 110 p.
4.	Koskimas, P. Vaisanen, R.A. 1986. Monitoring bird populations. A manual of Methods applied in Finland. Univ. Of Helsinki, 143 p.
5.	Ulevičius, A., Juškaitis, R. 2005. Lietuvos žinduolių pėdsakai ir kitos žymės. Pridnieks, J., Kuresoo, A., Kurlavičius, P. 1986. Рекомендации к орнитологическому мониторингу в Прибалтике. Riga, Zinatine. 66p.

Course programme designed by

No.	Name, surname	Institution	Degree	E-mail address
1.	Gediminas Brazaitis	VMU-AA	dr.	gediminas.brazaitis@vdu.lt

Approved at the meeting of the doctoral committee of the program: 18 02 2022, Pr. No. 1 (124).

The description of the study subject is valid until 2026 February 28

COURSE DESCRIPTION

Course code	Volume in ECTS credits	Institution	Faculty	Department
MIS8005	7	VMU-AA	Forest Science and Ecology	Environment and Ecology

Course title in Lithuanian

Aplinkos tarša

Course title in English

Environmental pollution

Study methods	Volume in ECTS credits
Lectures	2,24
Consultations	0,56
Seminars	2,43
Individual work	2,77

Short course annotation in Lithuanian (up to 500 characters)

Suteikiamos žinios ir praktiniai įgūdžiai apie aplinkos taršą ir kontrolę, apie aplinkos taršos šaltinius, aplinkos taršos klasifikaciją, apie natūralią ir antropogeninę taršą, taškinę ir išsklaidytąją taršą. Supažindinama su teršalų migracija aplinkoje ir teršalų poveikiu ekosistemoms, atmosferos teršalų migracija aplinkoje, vandens teršalų migracija aplinkoje, dirvožemio teršalų migracija aplinkoje. Aplinkos taršos tyrimų ir kontrolės srityje gilinamasi į naujausius aplinkos taršos tyrimo metodus, aplinkos monitoringą, lauko eksperimentų planavimą ir vykdymą, matematinį aplinkos taršos procesų modeliavimą. Taršos prevencijos žinių įgilinimui studijuojama apie atliekų perdirbimo ir aplinkai draugiškų (žaliosios) naujausias technologijas, darnųjį vystymąsi, aplinkos taršos rizikos vertinimą, tarptautinės aplinkos taršos problemas ir jų sprendimo būdus bei aplinkos teisę.

Short course annotation in English (up to 500 characters)

Knowledge and practical skills on environmental pollution and control, sources of environmental pollution, environmental pollution classification, natural and anthropogenic pollution, point, and diffuse pollution are provided. Introduction of pollutant migration in the environment and impact of pollutants on ecosystems, migration of atmospheric pollutants in the environment, migration of water pollutants in the environment, migration of soil pollutants in the environment. In the field of environmental pollution research and control, the latest environmental pollution investigation methods, environmental monitoring, planning and execution of field experiments, and mathematical modeling of environmental pollution processes are being explored. Understanding of pollution prevention knowledge is studied on waste recycling and environmentally friendly (green) latest technologies, sustainable development, environmental pollution risk assessment, international environmental pollution problems and their solutions and environmental law

Relevance of the course

Students will acquire the latest systematic knowledge of environmental science related to environmental pollution, will be able to apply it to the development of new fundamental knowledge and ideas, solving strategic environmental pollution prevention tasks;

Course aims

On the basis of the knowledge acquired in the course, to be able to ecologically assess the impact of environmental pollution on the environment, ecosystems and humans, to see its problems, to have relevant scientific information, to apply modern methods of environmental pollution research, forecasting and prevention

Content (topics) and methods

Environmental pollution and control. The concept of the environment. Society development and environmental pollution. Impact of environmental pollution on ecosystems, public health and safety. Social, political, economic and technical pollution control measures.

Environmental pollution and its sources. Classification of environmental pollution. Natural and anthropogenic pollution, point and diffuse pollution, their extent, dispersion and impact. Physical, mechanical, visual,

chemical and biological pollution of the environment. Transport pollution. Car noise, vibration, electromagnetic fields. Formation and extent of transport pollutants. Transport waste formation. Improving the quality of consumables. Energy and industrial pollution.

Pollution from combustion processes: sulfur, nitrogen and carbon oxides, hydrocarbons, dioxins and furans, soot particles, thermal pollution. Chemical pollution: persistent organic and inorganic substances - heavy metals, PCBs, nanomaterials. Radiation pollution. Agricultural pollution. Utility pollution. The waste problem.

Migration of pollutants in the environment and their impact on ecosystems. Migration of atmospheric pollutants in the environment. Migration of water pollutants in the environment. Migration of soil pollutants in the environment. Accumulation of pollutants in biota and their impact on ecosystems.

Environmental pollution research and control. Environmental pollution research methods. Environmental monitoring. Field experiments. Laboratory tests. Mathematical modeling of environmental pollution processes. The evaluation of the effects on the environment. Environmental pollution risk assessment. International environmental pollution problems and their solutions. Environmental law. Measures for the decontamination and pollution control of the technical and technological environment. Industrial ecology. Life cycle assessment.

Inexhaustible and renewable energy sources. Waste recycling and environmentally friendly (green) technologies. Sustainable development and environmental pollution, its assessment, systematic approach to management.

Individual task: The individual task is performed according to the doctoral student's research topics.

Study methods: lectures, consultations, basic knowledge, explanations of concepts, research tendencies, discussions during lectures, student presentations on the topic

During the lectures, individual work analyzes the data of the most important foreign and domestic research, the development of current and historical problem situations, solutions and strategies on problematic issues.

Structure of cumulative score and value of its constituent parts

Knowledge of the subject is assessed by a 10-point cumulative assessment system separately for the individual task and theoretical knowledge, which is tested during the exam. The results obtained are multiplied by the weighting factor and summed. The main evaluation criteria for the acquired knowledge and skills are quality, formulation of conclusions and summaries. The exam provides questions that require short answers and problematic questions. The final grade consists of individual assignment and exam grades. Assessments are performed in accordance with the prescribed criteria for the assessment of the study results of the subject.

Compulsory reference materials

No	Authors of publication, title, publishing house, year of publication.
1.	M.Rutkoviėnė, N.Sabienė. Aplinkos tarša. Mokomoji elektroninė knyga. http://www.asu.lt/nm/lprojekta/-Aplinkos_tarsa/titlas.htm
2.	Dunnivant F.M., Anders E. (2006) A basic introduction to pollutant fate and transport: an integrated approach with chemistry, modeling, risk assessment, and environmental legislation. John Wiley & Sons., 504 p.
3.	Environmental science (2003) Ed. by Ryden L., Migula P. and Andersson M. The Baltic University Press, Uppsala, 824 p.
4.	Hill M.K. (2004) Understanding environmental pollution. Cambridge University Press, UK, 484 p.
5.	Pepper I.L., Gerba Ch.P., Bruseeau M. L (2006) Environmental and pollution science. Academic Press, Elsevier, 552 p.
6.	Wright J. (2003) Environmental chemistry. London New York : Routledge, 419 p
7.	Wright R.T. (2008) Environmental science: Towards sustainable future, 9-th edition http://wps.prenhall.com/esm_wright_envisci_9/

8.	Ian L. Pepper, Charles P. Gerba, Mark L. Brusseau (2006). Environmental and Pollution Science. Academic Press, p.532.
9.	Marquita K. Hill. (2010) Understanding Environmental Pollution. Cambridge university press, 585 p.
10.	Gerard Kiely (2007) Environmental Engineering. The Mc Graw Hill Companies, 890 p.
11.	Environmental Science and Technology: Concepts and Applications. By Frank R. Spellman, Nancy E. Whiting. Oxford, 2006, 630 p.
12.	Air, Water and Soil Quality Modelling for Risk and Impact Assessment. By Adolf Ebel, Teimuraz Davitashvili, Springer, 2007, 370 p.
13.	Nanotechnology: Environmental Implications and Solutions. By Louis Theodore, Robert G. Kunz. John Wiley & sons, 370 p.
14.	Municipal Solid Waste Management: Processing - Energy Recovery - Global Examples (2011). By P. Jayarama Reddy, BS publications, 425 p

Supplementary reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Geo-spatial technologies in urban environments (2005) Ed. by Jensen R.R., Gat-rell J.D., McLean D. Berlin, Springer, 176 p.
2.	Landner L., Reuther R. (2004) Metals in society and in the environment: a critical review of current knowledge on fluxes, speciation, bioavailability and risk for adverse effects of copper, chromium, nickel and zinc. Dordrecht etc., Kluwer academic publishers, 406 p.
3.	Landscape simulation modeling: a spatially explicit, dynamic approach (2004) Series: modeling dynamic systems. Ed. by Costanza R., Voinov A. New York : Springer, 2004, 330 p.
4.	Ludwig C., Hellweg S., Stucki S. (2003) Municipal Solid Waste Management. Strategies and Technologies for Sustainable Solutions. Springer Verlag, 534 p.
5.	Staniškis J.K., Stasiškienė Ž., Kliopova I.. (2002) Švaresnė gamyba: sisteminis požiūris. Monografija. Kaunas, 366 p.
6.	Staniškis J. K., Stasiškienė Ž., Kliopova I. (2004) Subalansuotos pramonės plėtros strategija: teorija ir praktika. Monografija. Kaunas, 506 p
7.	The European environment – state and Outlook. EEA. http://www.eea.europa.eu/soer OECD Environmental Outlook to 2050: The Consequences of Inaction. http://www.oecd.org/environment/oecdenvironmentaloutlookto2050theconsequencesofinaction.htm
8.	Costanza R., Voinov A (2004) Landscape Simulation Modeling. USA, 330 p.
9.	Reible DD. (1999) Fundamentals of Environmental Engineering. CRS Press, 526 p. Kammen DM
10.	Hassenzahl DM (2001) Should we risk it? Princeton university press. 405 p. PRISM (Partnership for Regulatory Innovation and Sustainable Manufacturing). An alternative regulatory system, Model for vehicle manufacturing, 52 p.
11.	Industry ecology. US/Japan perspectives. National academy press, Washington, 1994, 55p. Corporate environmental practices. Climbing learning curve. National academy press, Washington, 1994, 28p.
12.	Principles for better environmental management. Management practices in industry: examples from French industry. Nollet P. (ed), WICE, 191 p.
13.	Clayton AMH, Radcliffe NJ (1996) Sustainability. A system approach. Westview press, 258 p. Industrial ecology and global change. R.Socolow, C.Andrews, F. Berkhout, V.Thomas (eds.), Cambridge university press, 500 p

Course programme designed by

No.	Name, surname	Institution	Degree	E-mail address
1.	Laima Česonienė	VMU-AA	Prof.dr.	Laima.cesoniene1@vdu.lt
2.				

Approved at the meeting of the doctoral committee of the program: 18 02 2022, Pr. No. 1 (124).

The description of the study subject is valid until 2026 February 28

COURSE DESCRIPTION

Course code	Volume in ECTS credits	Institution	Faculty	Department
MIS8006	7	VMU-AA	Forest sciences and ecology	Environment and ecology

Course title in Lithuanian

Augalų ekologija ir fitocenologija

Course title in English

Plant ecology and phytoceonology

Study methods	Volume in ECTS credits
Lectures	2
Consultations	1
Seminars	1
Individual work	3

Short course annotation in Lithuanian (up to 500 characters)

Dalyko tikslas suteikti doktoratams žinių apie aplinkos veiksnių poveikio augalams tyrimo metodus, pagrindinius aplinkos veiksnius veikiančius augalus, biogeocheminius svarbiausių elementų ciklus, augalų bendrijų kaitą, žemės ūkio augalų poveikio negyvajai gamtai įvairius aspektus, kitų žemynų specifiskas augalų ekologijos problemas; gebėjimų įvertinti sudėtingą natūraliosios ir žmogiškosios aplinkos poveikį augaliniams įvairiuose doktorantūros darbų tarpsniuose - pasirenkant tyrimo vietas, objektus, metodus bei nagrinėjant savo mokslinio darbo rezultatus.

Short course annotation in English (up to 500 characters)

The aim of the subject is to provide the doctoral students with knowledge of methods of studying the impact of environmental factors on plants, the main environmental factors affecting plants, the biogeochemical cycles of the most important elements, the change of plant communities, various aspects of the impact of agricultural plants on abiotic environment, and other ecological problems of plants on other continents; the ability to assess the complex impact of the natural and human environment on vegetation at various stages of preparation of doctoral thesis - selecting study sites, objects, methods and analyzing the results of scientific work.

Relevance of the course

The subject of plant ecology and phytocenology provides the theoretical basis for comprehensive and deep research in the fields of crop production, horticulture, forestry and other applied sciences.

Course aims

The aim of the subject is to provide the doctoral students with knowledge of methods of studying the impact of environmental factors on plants, the main environmental factors affecting plants, the biogeochemical cycles of the most important elements, the change of plant communities, various aspects of the impact of agricultural plants on abiotic environment, and other ecological problems of plants on other continents; the ability to assess the complex impact of the natural and human environment on vegetation at various stages of preparation of doctoral thesis - selecting study sites, objects, methods and analyzing the results of scientific work.

Content (topics) and methods

Concept of plant ecology: Factors causing plant stress (stress): concept of plant ecology, environment as tension factor, light, temperature, oxygen deficiency, water shortage, salts, heavy metals, aluminum, xenobiotics, stress induced by the living environment (*lecture, individual assignment*).

Plant ecology - autecology: plant heat, water in plants, plant nutrition, carbon metabolism.

Communities Ecology (Phytocenology): Ecosystem concept, phenomena occurring in forests and other ecosystems, biogeochemical cycles, research of some ecosystems (*lecture, individual assignment*).

Plant changes in time, space, interaction with the environment: historical process and change of plant communities (syndynamics), spatial distribution of plants (synchorology), vegetation ecology - synecology (*lecture, individual assignment*).

Earth plant ecology: global change, earth material transformation, water, carbon, nitrogen, sulfur cycles, human impact on carbon cycle and global climate, the importance of land use change for carbon cycle, disturbances, pollution, impact of human activity on biodiversity (*lecture, individual assignment*).

Structure of cumulative score and value of its constituent parts

Individual assignment 50%; Exams - 50 %

Compulsory reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Begon M., Harper J.L., Townsend C.R. Ecology. Individuals, Populations and Communities, Blackwell Scientific publications, 2006, 945 p.
2.	Crawley M.J. Plant Ecology. Blackwell Science, Oxford, 2nd ed., 1997, 717 p.
3.	Kupčinskienė E. Aplinkos fitoindikacija. – Kaunas, 2011, - 752 p.
4.	Skuodienė L. Medžių stresas ir jo fiziologinė indikacija
5.	Šlapakauskas V. Augalų ekofiziologija. Kaunas - Lututė, 2005. - 402 p.
6.	Maarel Eddy. Vegetation ecology, 2004, 408
7.	Taiz L., Zeiger E. Plant Physiology. – California: The Benjamin Cumings publ. Company, - 2010.

Supplementary reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Stravinskienė V. Bendorji ekologija. K., 2003. – 232 p.
2.	Mokslinės duomenų bazės – ScienceDirect; Agricola
3.	Tarptautiniai moksliniai žurnalai – Environmental Pollution, Journal of vegetation science, Applied vegetation science, Forest ecology and management, Ecological modeling
5.	Lietuvos moksliniai žurnalai – Ekologija, Botanica Lithuanica, Miškininkystė

Course programme designed by

No.	Name, surname	Institution	Degree	E-mail address
1.	Vitas Marozas	VMU-AA	Professor, dr.	vitas.marozas@vdu.lt
2.	Eugenija Kupčinskienė	VDU	Professor, habil. dr.	eugenija.kupcinskiene@vdu.lt

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The description of the study subject is valid until 2026 February 28

COURSE DESCRIPTION

Course code	Volume in ECTS credits	Institution	Faculty	Department
MIŠ8007	7	VMU-AA	Forest sciences and ecology	Environment and ecology

Course title in Lithuanian

Biologinės įvairovės apsauga

Course title in English

Biodiversity conservation

Study methods	Volume in ECTS credits
Lectures	2
Consultations	1
Seminars	1
Individual work	3

Short course annotation in Lithuanian (up to 500 characters)

Dalyko tikslas suteikti doktorantams žinių apie biologinės įvairovės lygius, globalius pokyčius, biologinės įvairovės nykimo priežastis, per didelio biologinių išteklių naudojimo, egzotinių rūšių poveikio ekosistemoms pasekmes; biologinės įvairovės ekonominę ir socialinę reikšmę, tarptautinius susitarimus dėl biologinės įvairovės apsaugos, gebėjimų analizuoti biologinės įvairovės apsaugos būdus ir metodus, parinkti biologinės įvairovės apsaugos sistemas konkrečiais atvejais.

Short course annotation in English (up to 500 characters)

The aim of the subject is to provide doctoral students with knowledge of biodiversity levels, global changes, the causes of biodiversity loss, the consequences of excessive use of biological resources, the impact of exotic species on ecosystems; the economic and social importance of biodiversity, international agreements on the protection of biodiversity, the abilities to analyze measures and methods of biodiversity protection, and to select biodiversity protection systems in specific cases.

Relevance of the course

Knowledge of biodiversity levels, global changes, the causes of biodiversity loss, the consequences of excessive use of biological resources, the impact of exotic species on ecosystems; the economic and social importance of biodiversity, international agreements on the protection of biodiversity, the abilities to analyze measures and methods of biodiversity protection, and to select biodiversity protection systems in specific cases.

Course aims

The aim of the subject is to provide doctoral students with knowledge of biodiversity levels, global changes, the causes of biodiversity loss, the consequences of excessive use of biological resources, the impact of exotic species on ecosystems; the economic and social importance of biodiversity, international agreements on the protection of biodiversity, the abilities to analyze measures and methods of biodiversity protection, and to select biodiversity protection systems in specific cases.

Content (topics) and methods

Biodiversity and its importance: the concept of biodiversity, biodiversity levels, biodiversity change, biodiversity assessment, peculiarities of Lithuanian biodiversity (*lectures, individual assignment*).

Biodiversity loss: biodiversity and global change, causes of biodiversity loss, ecosystem degradation, depletion of biological resources, exotic species (*lectures, individual assignment*).

Biodiversity and human: the economic importance of biodiversity, the social significance of biodiversity, international agreements on the protection of biodiversity, the Convention on Biological Diversity (Rio de Janeiro, 1992), the biodiversity conservation strategy and action plan of the Republic of Lithuania (*lectures, individual assignment*).

Protection of biodiversity: protected areas, red book, ex-situ protection, habitats of European interest, protection of key forest habitats, biodiversity in forests and agriculture (*lectures, individual assignment*).

Structure of cumulative score and value of its constituent parts

Individual assignment 50%; Exams - 50 %

Compulsory reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Gaston K.J., Spicer J.I. 2004. Biodiversity: an introduction. Blackwell Publishing, 208p.
2.	Jeffries M.J. 2006. Biodiversity and conservation. Raoutledge: Taylor and Francis group, 256p. Kurlavičius P. 2005. Biologinės įvairovės apsauga žemės ūkyje. – Kaunas: Lututė, 64p.
3.	Kurlavičius P. 2006. Biologinės įvairovės apsauga valstybiniuose miškuose. – Kaunas: Lututė, 151p.
4.	Lietuvos gamta. Saugomos teritorijos (sud. M. Kirstukas), Lututė, 2004 Malcolm L., Hunter J. 2002. Fundaments of Conservation Biology – Blackwell Science, 547p.
5.	Rašomavičius V. (red.). 2001. Europinės svarbos buveinės Lietuvoje. Vinius: Botanikos institutas,
6.	Aplinkos ministerija, 138p. Stončius D., Treinys R., Mierauskas P. 2001. Gamtotvarkos vaidmuo saugant biologinę įvairovę.
7.	Vilnius: Daigai, 87 p.
8.	Sutherland W. 2000. The Conservation Handbook: Research, Management and Policy. Blackwell Science, 278 p.

Supplementary reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Andersson L., Kriukelis R. Kertinės miško buveinės – Vilnius, 2004.
2.	Interpretation manual of European Union habitats. 2006. EUR 15/2. ETCNC.
3.	Lietuvos raudonoji knyga - Vilnius, 2007.
4.	Lietuvos raudonoji knyga. Augalų bendrijos – Vilnius, 2000.
5.	Ozolinčius R. (sud.). 2006. Biologinės įvairovės išsaugojimas miškanaudoje.- Kaunas:Lututė, 28p. Mokslinės duomenų bazės – ScienceDirect; Agricola
6.	Tarptautiniai moksliniai žurnalai – Environmental Pollution, Journal of vegetation science, Applied
7.	vegetation science, Forest ecology and management, Ecological modeling
8.	Lietuvos moksliniai žurnalai – Ekologija, Botanica Lithuanica, Miškininkystė

Course programme designed by

No.	Name, surname	Institution	Degree	E-mail address
1.	Vitas Marozas	VMU-AA	Professor, dr.	vitas.marozas@vdu.lt
2.				

Approved at the meeting of the doctoral committee of the program: 18 02 2022, Pr. No. 1 (124).

The description of the study subject is valid until 2026 February 28

COURSE DESCRIPTION

Course code	Volume in ECTS credits	Institution	Faculty	Department
MIŠ8008	7	VMU-AA	Forest Science and Ecology	Forest Science

Course title in Lithuanian

Dendroklimatochronologija

Course title in English

Dendroclimatchronology

Study methods	Volume in ECTS credits
Lectures	1
Consultations	2
Practice	1
Individual work	3

Short course annotation in Lithuanian (up to 500 characters)

Studijų dalykas skirtas Miškotyros mokslo krypties doktorantams. Dendroklimatochronologijos studijų dalykas apima baigtinę visumą, kurią sudaro tokie klausimai: 1) studijų objekto ir dalyko samprata; 2) medžių rėvių struktūra ir sezoninis formavimasis; 3) dendroklimatologija; 4) medžių rėvių analizės metodai.

Short course annotation in English (up to 500 characters)

The study subject is designed for PhD students of Forest Sciences. Dendroclimatchronology includes a finite whole: 1) conception of study object and subject matter; 2) structure and seasonal dynamics of the tree's growth; 3) dendroclimatology; (4) methods of tree ring analysis.

Relevance of the course

The course helps the PhD students to understand the processes of tree ring formation and assessment of the integrated effect of environmental factors on tree stem radial increment with special attention on the effect of climate change. Chronological approach of different environmental processes is presented for the detection of the effect of environmental changes on tree ring formation. Having completed this course, the students will know how to apply their theoretical and methodological knowledge and skills in research.

Course aims

The aim of the course - to gain knowledge, understanding and practical skills in the area of chronology of environmental processes and their integrated effect on tree ring formation at different time scale: diurnal, weekly, monthly or annual; synergies between environmental factors which enhance or inhibit their effect on increment, main attention is paid at climate warming.

Content (topics) and methods

<p>Lectures:</p> <ol style="list-style-type: none"> 1. Conception of Dendroclimatchronology science; 2. History of the development of Dendroclimatchronology science; 3. Dendrochronological and Dendroclimatchronological research in Europe and Lithuania; 4. Tree ring formation: hourly, diurnal, weekly, monthly and annual increment; 5. Tree ring structure: early growth timber, late growth timber; 6. Annual tree ring increment of prevailing in Lithuania forest tree species, its variation; 7. Lost tree rings; 8. Integrated effect of environmental factors on tree ring formation; 9. Abiotic factors and their effect on tree ring formation; 10. Biotic factors and their effect on tree ring formation; 11. Climate, extreme conditions and their effect on tree ring formation; 12. Activity of sun radiation and tree rings;

<p>13. Tree development classes and their reactions to climate conditions</p> <p>14. Antropogenical factors and their effect on tree increment: local and regional pollution load;</p> <p>15. Radioactive pollution and its effect on dendroindication;</p> <p>16. Apply of dendroindication methods for assessment of the effect of climate change on tree increment: control stand and tree methods;</p> <p>17. Principle of dendroscale;</p> <p>18. Date of increment scores; synchronisation of long term tree increment data sets;</p> <p>19. Indices of tree radial increment and their calculation;</p> <p>20. Collection of experimental materials for dendrochronological indication;</p> <p>21. Instrument for tree stem bores;</p> <p>22. Selection of trees for dendrochronological analysis; time of the collection material, amount of bores at a site;</p> <p>23. Preparation of bore for transportation and storage;</p> <p>24. Preparation of bores for measurement and measurement, LINTAB;</p> <p>Field trip: Aukštaitija Integrated monitoring station;</p> <p>Data base of ICP IM Aukštaitija station, measurements and equipment;</p> <p>Air chemistry, precipitation chemistry, climatic parameters and their changes;</p> <p>Soil chemistry, main tendencies; Soil, ground and surface water, their chemical composition,</p> <p>Tree condition – crown defoliation. Radial increment of tree stem. Measure and methods. Electronical and manual stem circumference meters; Dendrochronology and increment analysis.</p> <p>Individual tasks:</p> <p>Dendrochronological analysis of the tree ring width series. Detection of key environmental factors which have the most significant effect on tree ring formation.</p> <p>Methods of the study:</p> <p>Lectures, consultations and practical tasks at Aukštaitija Integrated Monitoring Station.</p> <p>State of knowledge based on references analysis, publications and presentation of the recommendations for review preparation.</p>
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Structure of cumulative score and value of its constituent parts

Practical task at Aukštaitija IMS 20%, Individual tasks - 30%; final exam - 50 %.

Compulsory reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Bitvinskas T. 1989. Prognosis of tree growth by cycles of Solar activity. Methods of dendrology. Applications in the environmental science (eds. E. Cook and L. Kairiūkštis). Dordrecht, Boston, London: Kluwer Academic Publishers, p. 9-11.
2.	Bitvinskas T. 1997. Centrinės Lietuvos klimatas ir medynų prieaugiai. Rūšių tyrimai areale (1). Ekologinio optimumo zonos. Vilnius: Mokslo labdaros fondas, p. 9-11.
3.	Bomdietti E.A., Baes C.F., Mclaughlin S.B. 1989. Radial trends in cation ratios in tree rings as indicators of the impact of atmospheric depositions on forest. Canadian Journal of Forest Research, 19, 5, p.589.
4.	Cook E.R., Johnson A.R., Blasing T.J. 1987. Forest decline: modeling the effect of climate on tree rings. Tree Physiol, 3, p. 27-40.
5.	Ecstein D. 1989. Qualitative assessment of past environmental changes.// Methods of dendrochronology. Applications in the environmental sciences. Kluwer Academic Publishers, Dordrecht, p. 220-223.
6.	Fletcher J. 1978. Dendrochronology in Europe. (Based on the Symposium held at the National Maritime Museum, Greenwich), No. 4, p 1.
7.	Fritts H. C. 1987. Tree rings and climate (Reprinted by courtesy of academic press). // Warsaw, Vol. 2, p. 567.
8.	Jacobson M.Z. 2002. Atmospheric pollution: history, science, and regulation. Cambridge University Press, p 399
9.	Lundua report. 1992. Tree rings and environment. // Lund University, Dep. Of Quaternary Geology. Lund, Nr. 34, p. 159.
10.	Norkūnienė S. 1998. Dendroklimatochronologija: bibliografija 1971-1980. Vilnius, p. 329.

11.	Schweingruber F. H. 1988. Tree rings: basics and applications of dendrochronology. Dordrecht / Boston / Lancaster / Tokyo, p. 276.
12.	Stravinskienė V., Juknys R. 1998. Dendrochronology and environmental trends. Kaunas, p. 229.
13.	Stravinskienė V. 2002. Klimato veiksnių ir antropogeninių aplinkos pokyčių dendrochronologinė indikacija. Kaunas, p. 172.
14.	Wimmer R., Vetter R. E. 2003. Tree-ring analysis: biological, methodological and environmental aspects. United Kingdom, p. 302.
15.	Augustaitis, A. 2021. Intra-Annual Variation of Stem Circumference of Tree Species Prevailing in Hemi-Boreal Forest on Hourly Scale in Relation to Meteorology, Solar Radiation and Surface Ozone Fluxes. Atmosphere 12 (8), 1017.
16.	Augustaitis, A. et al. 2018. Tree-ring formation as an indicator of forest capacity to adapt to the main threats of environmental changes in Lithuania // Science of the total environment. Amsterdam: Elsevier Science BV. ISSN 0048-9697. Vol. 615 (2018), p. 1247-1261.
17.	Augustaitis, Algirdas; Augustaitienė, Ingrida; Mozgeris, Gintautas; Juknys, Romualdas; Vitas, Adomas; Jasinevičienė, Dalia. Growth patterns of Scots pine (<i>Pinus sylvestris</i> L.) under the current regional pollution load in Lithuania // iForest-Biogeosciences and Forestry. Potenza: Societa Italiana di Selvicoltura ed Ecologia Forestale. ISSN 1971-7458. 2015, vol. 8, p. 509-516.

Supplementary reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Science Direct. https://www.sciencedirect.com/
2.	Dendrochronology: https://www.sciencedirect.com/topics/earth-and-planetary-sciences/dendrochronology
3.	Dendrochronology: What tree rings tell us about past and present. https://www.environmentalscience.org/dendrochronology-tree-rings-tell-us
4.	TREX Tree-Ring Expedition https://serc.carleton.edu/trex/students/labs/lab1_1.html
5.	Special Issue "Dendrochronology: An Interdisciplinary Approach to Assess Wooden Cultural Heritage Worldwide" https://www.mdpi.com/journal/forests/special_issues/Dendrochronology
6.	Mikalajūnas, M., Pretzsch, H., Mozgeris, G., Linkevičius, E., Augustaitienė, I., Augustaitis, A. 2021. Scots pine's capacity to adapt to climate change in hemi-boreal forests in relation to dominating tree increment and site condition. iForest, doi: 10.3832/ifor3703-014
7.	Kulbokas, G., Jurevičienė, V., Kuliešis, A., Augustaitis, A., Petrauskas, E., Mikalajūnas, M., Vitas, A., Mozgeris, G. 2019. Fluctuations in gross volume increment estimated by the Lithuanian National Forest Inventory compared with annual variations in single tree increment. Baltic Forestry, 25: 273-280. http://orcid.org/0000-0002-8480-6006
8.	Augustaitis, A. et al. 2016. Sensitivity of European beech trees to unfavorable environmental factors on the edge and outside of their distribution range in northeastern Europe // iForest-Biogeosciences and Forestry. Potenza: Societa Italiana di Selvicoltura ed Ecologia Forestale. ISSN 1971-7458. 2016, vol. 9, no. 2, p. 259-269.
9.	Juknys, R., Augustaitis, A. et al. 2014. Dynamic response of tree growth to changing environmental pollution // European Journal of Forest Research. ISSN 1612-4669. 2014, Vol. 133, iss. 4, p. 713-724.
10.	Augustaitis, A. et al. 2010. The seasonal variability of air pollution effects on pine conditions under changing climates // European Journal of Forest Research. ISSN 1612-4669. 2010, Vol. 129, N 3, p. 431-441.
11.	Juknys, R., Stravinskienė, V., Augustaitis, A. et al 2003. Scots pine (<i>Pinus sylvestris</i> L.) growth and condition in a polluted environment: from decline to recovery / Romualdas Juknys, Jone Vencloviene, Vida Stravinskiene, Algirdas Augustaitis, Edmundas Bartkevičius // Environmental Pollution. ISSN 0269-7491. Vol. 125, Iss. 2 (2003), p. 205-212.
12.	Vitas A. Tree-ring chronology of Scots Pine (<i>Pinus sylvestris</i> L.) for Lithuania. Baltic forestry, Vol. 14, No. 2, p. 110-114.
13.	Ozolinčius R. 1994. Diagnostiniai testai miškų monitoringe. Kaunas: Girionys, p. 31.
14.	Stravinskienė V. 1994. Medžių gręžinių paėmimas ir radialinio prieaugio matavimas, atliekant dendrochronologinius ir dendroindikacinius tyrimus. Kaunas-Girionys, p. 24.

Course programme designed by

No.	Name, surname	Institution	Degree	E-mail address
1.	Algirdas Augustaitis	VMU-AA	Prof. dr.	algirdas.augustaitis@vdu.lt
2.	Ekaterina Makrickienė	VMU-AA	Doc. dr.	Ekaterina.makrickiene@vdu.lt

Approved at the meeting of the doctoral committee of the program: 18 02 2022, Pr. No. 1 (124).

The description of the study subject is valid until 2026 February 28

COURSE DESCRIPTION

Course code	Volume in ECTS credits	Institution	Faculty	Department
MIS8009	7	VMU-AA	Forest Science and Ecology	Forest Science

Course title in Lithuanian

Dendrologija

Course title in English

Dendrology

Study methods	Volume in ECTS credits
Lectures	3
Consultations	2
Seminars	1
Individual work	1

Short course annotation in Lithuanian (up to 500 characters)

Dendrologijos studijos padės doktorantui įsigilinti į mokslinius tyrimus, vykdomus su įvairiomis sumedėjusių augalų rūšimis. Po praktinių užduočių įvykdymo, doktorantas bus įgudęs atlikti tyrimus, susijusius su dendrologija. Atlikęs individualią užduotį doktorantas įgis metodinių žinių, reikalingų tyrimų vykdymui.

Short course annotation in English (up to 500 characters)

Studies will help the PhD student to deepen his knowledge into research about various woody plants. After completing the practical tasks, PhD student will be proficient in conducting research related to dendrology. After completing the individual task, the doctoral student will acquire the methodological knowledge necessary for conducting the research.

Relevance of the course

The doctoral student will master the science of dendrology and apply it in his / her scientific work. During the practicum, PhD student will learn to take samples for research.

Course aims

On the basis of the acquired knowledge of the subject, to evaluate the development of dendrology as a branch of botanical science, to determine the endurance and vitality of individual woody species and smaller taxa in our climatic conditions and their suitability for different types of greenery.

Content (topics) and methods

Development of dendrology science.
 Morphological features, biological and decorative properties of woody plants.
 Taxonomic diversity of woody plants grown in urban areas
 Maintenance of urban greenery.
 Review of Dendroflora Research .
 Methods - lecture, seminar.
 Practicum: tree identification, inventory, monitoring of phenological phases, Collection of samples for laboratory testing.

Structure of cumulative score and value of its constituent parts

Compulsory reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Coombes A.J. Trees. London: Dorling Kindersley handbooks, 2000.- 320 p.
2.	Januškevičius L., Baronienė V., Liagienė D. Sumedėjusių augalų introdukcija ir aklimatizacija bei jų rezultatai ir perspektyvos Lietuvoje. Kaunas: 2006, 388 p.
3.	Krussmann G. Handbuch der Laubgehölze. I.-Berlin & Hamburg:Parey, 1976, 486 p.
4.	Krussmann G. Handbuch der Laubgehölze. II.-Berlin & Hamburg:Parey, 1977, 466 p.
5.	Krussmann G. Handbuch der Laubgehölze. III.-Berlin & Hamburg:Parey, 1978, 496 p.
6.	Krussmann G. Handbuch der Nadelgehölze. Berlin & Hamburg:Parey, 1983, 396 p.

7.	Navasaitis M., Ozolinčius R., Smaliukas D., Balevičienė J. Lietuvos dendroflora. Kaunas: Lututė, 2003, 576 p.
8.	Navasaitis M. Dendrologija. Vilnius: Margi raštai, 2004, 856 p.
9.	Van Gelderen C.J., Van Gelderen D.M. Maples for Garten. Timber Press, 2000, 294 p.

Supplementary reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Dagys J. Augalų ekologija. Vilnius: Mokslas, 1980, 240 p.
2.	Danusevičius J. Pušies selekcija: kilmių atranka, introdukcija, hibridizacija, selekcinė sėklininkystė. Kaunas: Lututė, 2000, 352 p.
3.	Dendrologia Lithuaniae. Lietuvos dendrologų draugijos periodinis leidinys. 1993 ir vėliau.
4.	Gabrilavičius R., Danusevičius D. Eglės genetiniai tyrimai ir selekcija Lietuvoje. Vilnius: 2003, 364 p.
5.	Jankauskas M. Maumedžiai Lietuvos TSR miškuose ir parkuose ir jiems auginti perspektyvos. Vilnius: Valst.pol. ir moksl. lit. I-kla, 1954, 258 p.
6.	Jurkevičienė G. Lianos. Vilnius: 1997, 134 p.
7.	Kapustinskaitė T. Juodalksnynai. Vilnius: Mokslas, 1983, 227 p.
8.	Lietuvos TSR flora, 1-6 t., Vilnius: 1959-1980.
9.	Navasaitis M.(sud.), Straigyte L. Skinderišio dendroparkas. Kaunas: 2006, 200 p.

Course programme designed by

No.	Name, surname	Institution	Degree	E-mail address
1.	Lina Straigyte	VMU-AA	Dr.	lina.straigyte@vdu.lt

Approved at the meeting of the doctoral committee of the program: 18 02 2022, Pr. No. 1 (124).

The description of the study subject is valid until 2026 February 28

COURSE DESCRIPTION

Course code	Volume in ECTS credits	Institution	Faculty	Department
MIS8010	7	VMU-AA	Forest Science and Ecology	Environment And Ecology

Course title in Lithuanian

Ekosistemų evoliucija ir ekologija

Course title in English

Ecosystems evolution and ecology

Study methods	Volume in ECTS credits
Lectures	1
Consultations	4
Seminars	1
Individual work	1

Short course annotation in Lithuanian (up to 500 characters)

Ekosistemų evoliucija ir ekologija dalyko studijos skirtos Aplinkos ir ekologijos mokslo krypties doktorantams. Studijuodami šį dalyką doktorantai pagilins žinias apie ekosistemas, jų evoliuciją bei bioįvairovę, regionine lokalizacija, ekologinių sąlygų specifika bei keliamomis aplinkosauginėmis problemomis globaliu ir lokaliu mastu; ekosistemų gamtosaugos prasmę ir perspektyvas kintant klimatui; geokosminių ir antropogeninių veiksnių įtaką ekosistemų homeostazei bei išlikimui; pritaikyti ekosistemų ekologijos žinias natūralių ir žmogaus sukurtų ekosistemų valdymui; tausoti gamtinius resursus bei bioįvairovę kaip vieningą sistemą.

Short course annotation in English (up to 500 characters)

Course Ecosystems evolution and ecology assigned for PhD studies of Environment and ecology scientific direction. The studies of this subject will provide PhD students with deeper knowledge of ecosystems, their evolution and biodiversity, regional localization, specifics of ecological conditions and environmental problems on a global and local scale; the meaning and prospects of ecosystem conservation in climate change; influence of geocosmic and anthropogenic factors on homeostasis and survival of ecosystems; to adapt ecosystem knowledge for the management of natural and man-made ecosystems; to conserve natural resources and biodiversity as a unified system.

Relevance of the course

Evolution and ecology of ecosystems is relevant for PhD students in the field of Environment and Ecology to achieve their deeper competitions and knowledge about ecosystems and their formation.

Course aims

To assess of the state of ecosystems in a globally changing biosphere; to evaluate the conditions of origin and basic structures of the different ecosystems; to evaluate the impact of various environmental reasons on the stability of the environment - vegetation system; to define the value of ecosystem homeostasis and its changes; to evaluate energy metabolism and influence of anthropogenic factors on ecosystem survival; to adapt ecosystem knowledge for the management of natural and man-made ecosystems; to conserve natural resources (soil, water, air) and their biodiversity as a integrated system.

Content (topics) and methods

Introduction to Ecosystem Evolution and Ecology. Geological time scale. Methods of Reconstruction. Dating methods. Genetic identification of the development of organisms and ecosystems. DNA potential in evolution research. DNA capture, storage and extraction. Other fossil biomolecules and chemical constituents; stable carbon isotope (¹³C) method for fossil analysis.

Geological evidence of the evolution and evolution of ecosystems and organisms. Environmental and climate change in geological stages of ecosystem development. Evolution of ecosystems and biogeographical distribution. Five historical mass extinctions, the reasons and the survival of populations. The sixth mass extinction, its reasons.

First forms of life in the primary environment. Early Environment on the Earth. Accumulation of organic matter and the emergence of a cell. First prokaryotes, their geological evidence. Eukaryotes evolution.

Colonisation of land. Changes in the environment during Cambrian and Ordovician (543-443 MY). Fossil evidence of the first terrestrial plants. Organizational adaptations. Evolution directions: from green algae to terrestrial plants; biogeographic distribution of first terrestrial plants in late Silurian-Early Devon (approx. 430-390 MY)

First forests. The major changes in the environment lasted from the middle Devon to the late Carbon (~ 395-290 million). Land conditions for plant adaptation between Middle Devon and Late Carbon (~ 395-290 MY). The oldest tree fossils. Biogeographic distribution of vegetation in Carboniferous (354-290 MY).

The emergence of seed plants. Changes in environment in Permian (290-248 MY). Biogeographic distribution of vegetation in Permian (267-264 MY). Coniferous expansion. Biogeographic distribution of vegetation in the Jura (206-180 MY).

Origin of flowering plants. First colonies of the Angiosperm. The environment and spread of the first colonies. Why so late? Direction of Evolution: From Gymnosperm to Angiosperm? Biogeographic distribution of vegetation in late Cretaceous (~ 84-65 MY).

Cenozoic (65 MY). environmental changes in the last 65 MY (Tertiary and Quaternary). Biogeographic distribution of vegetation 60 - 50 MY (late Palaeocene-Early Eocene). Evolution of herbaceous species. Deforestation and spread of arid vegetation. Biogeographic distribution of vegetation between 34-25 MY (Oligocene). Type C4 and CAM photosynthesis and plant evolution. Biogeographic spread of vegetation before 11.2-5.3 MY (late Miocene).

- reading lectures;

- consultations (lectures can be read in case of sufficient number of PhD students)

Structure of cumulative score and value of its constituent parts

A ten-point scale and cumulative scoring scheme are applied. Self-study assignments (report on selected topic) are graded, final assessment is determined by examinations, multiplication of intermediate evaluations by weighting and product summing.

Compulsory reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Begon M., Townsend C. R., Harper J. L. 2005. Ecology – From Individuals to Ecosystems, 4th ed., Blackwell Publishing, Oxford, 738.
2.	Behrensmeyer AK., Damuth J, DiMichele W, Potts R, Sues H, Wing S. 1993. Terrestrial Ecosystems Through Time: Evolutionary Paleoecology of Terrestrial Plants and Animals. University of Chicago Press. 568.
3.	Brandon R. N. 1996. Concepts and Methods in Evolutionary Biology. Cambridge: Cambridge University Press, 458.
4.	Grime JPh., Pierce FRS S. 2012. The Evolutionary Strategies that Shape Ecosystems. Wiley-Blackwell, 263.
5.	Ingrouille M., Eddie W. 2006. Plants: Evolution and Diversity. Cambridge University Press. 458.
6.	Rauchfuss H. 2008. Chemical Evolution and the Origin of Life. Springer-Verlag Berlin Heidelberg. 354.
7.	Willis KJ, McElwain. 2002. The evolution of plants. Oxford university press, 195.

Supplementary reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Allison S. K. 2012. Ecological Restoration and Environmental Change: Renewing Damaged Ecosystems., Routledge, 252.
2.	Archibold, O.W. 1995. Ecology of World Vegetation. Springer Netherlands, 510.

3.	Bissonette J.A., Storch I. 2003. Landscape ecology and resource management: linking theory with practice. 463.
4.	Goldammer, Johann G. Fire in Ecosystems of Boreal Eurasia Forestry sciences. Dordrecht a.o. : Kluwer Academic Publishers, 1996. 528.
5.	Sinclair, Anthony Ronald Entrican. 2006. Wildlife ecology, conservation, and management. Oxford. 469.
6.	Kabailienė M., Radzevičius S. 2011. Paleontologija. Vilniaus Un. 530.

Course programme designed by

No.	Name, surname	Institution	Degree	E-mail address
1.	Ligita Baležentienė	VMU-AA	dr.	ligita.balezentiene@vdu.lt

Approved at the meeting of the doctoral committee of the program: 18 02 2022, Pr. No. 1 (124).

The description of the study subject is valid until 2026 February 28

COURSE DESCRIPTION

Course code	Volume in ECTS credits	Institution	Faculty	Department
MIŠ8011	7	VMU-AA	Forest sciences and ecology	Forest science

Course title in Lithuanian

Geografinės informacinės sistemos aplinkos tyrimuose

Course title in English

Geographic Information Systems in Environmental Research

Study methods	Volume in ECTS credits
Lectures	2
Consultations	1
Practicums	1
Individual work	3

Short course annotation in Lithuanian (up to 500 characters)

Šiame kurse formuojamas požiūris į geografines informacines sistemas kaip mokslą, todėl didžiausias dėmesys skiriamas tokiems klausimams, kaip geografinių duomenų analizė, mokslu grindžiamas kartografavimas, erdvinė statistika ir geostatistika. Pateikiamas nuotolinių tyrimų įvadas. Akcentuojamas GIS naudojimas moksliniuose tyrimuose bei praktiniuose projektuose.

Short course annotation in English (up to 500 characters)

Geographic information systems are considered in this course as geoinformation science, thus underlining methodological aspects of GIS, such as geographic data analyses, science-driven mapping, spatial statistics and geostatistics. Remote sensing techniques for capturing geographic data are introduced. Special focus is on using GIS in research and applied projects.

Relevance of the course

After having passed this course the PhD students will acquire systematic knowledge on conducting research in geomatics. The students will develop abilities of using geographic information science in their specific fields of research, particularly related to environmental sciences, in order to generate new fundamental knowledge and ideas, as well as solve relevant practical tasks.

Course aims

To develop a system of scientific knowledge and practical abilities in the area of geographic information science, namely relevant to fundamental tasks in such fields as geographic information systems, digital mapping, geostatistics and remote sensing, aiming for abilities to use geographic information systems for environmental research.

Content (topics) and methods

Lectures:
Lecture 1. Geographic information systems (GIS) and science: GIS as geoinformation science, geoinformation technology and geoinformation studies. History of GIS worldwide and in the country.
Lecture 2. Geographic data: structuring geographic objects of the real world to represent them using digital models, accuracy of geographic data, management of GIS data quality, modern methods and tools for collecting geographic data.
Lecture 3. Geo-reference and thematic GIS databases in Lithuania and abroad: the role of geo-referenced and thematic GIS databases, some available databases, adopting of geo-reference data for specific thematic tasks, development and use of GIS metadata.
Lecture 4. GIS software and hardware: types of GIS software architecture, some currently used GIS packages, specifications of GIS hardware, distributed GIS, the choice of GIS software and hardware to conduct the research, main potential directions of GIS evolution.

Lecture 5. Spatial analysis and its role in environmental research: key functionality of GIS analysis and modelling (queries and selection procedures, data summarizing, overlays, buffering, clipping, etc. using vector and raster tools), similarities and differences of spatial analysis and conventional statistical treatment of research data, planning GIS analysis, examples of GIS analysis used in environmental research.

Lecture 6. Spatial statistics and their role in environmental research: spatial autocorrelation and location quotient, modifiable areal unit problem, analysing spatial patterns, edge effects, density estimations, hot-spot mapping, local indicators of spatial association, examples of using spatial statistics for environmental research.

Lecture 7. Geostatistics and its role in environmental research: assessment of geographic phenomena geo-statistically and spatial interpolation, the 1st law of geography and its practical importance, main spatial interpolation algorithms: inverse distance weighting, polynomials, splines, kriging, interpretation and assessment of interpolation results, examples of using geostatistics for environmental research.

Lecture 8. Spatial modelling and its role in environmental research: spatial questions and why the physical modelling of some phenomena and processes is problematic, spatial modelling tools, suitability assessment of spatial models, limitations of spatial modelling, examples of using spatial modelling for environmental research.

Lecture 9. Special techniques of spatial analysis and modelling: working with terrain data, address geo-coding, network analysis, linear referencing and dynamic segmentation, decision support using spatial modelling.

Lecture 10. Main principles of GIS data representation (digital mapping): digital mapping and GIS, scientific representation of spatial analysis outputs, how to prepare professionally-looking map using GIS.

Lecture 11. Digital remote sensing information, its role in environmental research and integration with GIS: methods of digital remote sensing, available and planned remote sensing systems, available sources of remote sensing data and its integration in research, acquisition/acquiring remote sensing information.

Lecture 12. GIS on the internet and for the internet: web-GIS and distributed GIS, sources of GIS data on the web, specialised GIS tools for internet.

Lecture 13. Planning the use of GIS: development of project for GIS application, managing GIS project, potential of GIS in scientific research of PhD students.

Lecture 14. Examples of using GIS in specific research and applied projects: application of GIS in forestry, agriculture and environmental sciences, GIS for specific field of application, depending on research interests of PhD student, additional information sources on specific GIS applications.

Practicums:

Planning GIS data collection.

Adopting of GIS database to fit specific research requirements, depending on the research tasks of PhD students.

Development of GIS database.

Conducting spatial analysis and modelling (depending on research interests of PhD student).

Sources of remote sensing information and integration of remote sensing in specific research, conducted by PhD student.

Individual assignment:

Individual assignment depending on specific PhD student's research interests.

Structure of cumulative score and value of its constituent parts

Practicums – 20%, individual assignment - 20%; final exam - 60 %

Compulsory reference materials

No.	Authors of publication, title, publishing house, year of publication.
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1.	P.A. Longley, M.F. Goodchild, D.J. Maguire, D.W. Rhind, 2011, Geographic Information Systems and Science, 3rd edition, Wiley, 539 p.
2.	Lillesand T.M., Kiefer R.W., Chipman J.W., 2008, Remote Sensing and Image Interpretation, Sixth Edition, John Wiley & Sons, Inc., 756 p.
3.	Isaaks E. H., Srivastava R. M. Applied Geostatistics, 1989.
4.	Mozgeris G., Dumbrasuskas A., Geoinformacinių sistemų pagrindai. Mokomoji knyga, Lietuvos žemės ūkio universitetas, Kaunas, 2008, 186 p.
5.	D.J. Maguire, M. Batty, M.F. Goodchild (eds.), 2005, GIS, Spatial Analysis, and Modeling, ESRI Press, 480 p.
6.	M. Zeiler, Modeling Our World. THE ESRI Guide to Geodatabase Design, ESRI Press, 199 p.
7.	A. Mitchell, The ESRI Guide to GIS Analysis Volume 1: Geographic Patterns & Relationships, 186 p. [http://www.amazon.com/ESRI-Guide-GIS-Analysis-Relationships/dp/1879102064#reader_1879102064]
8.	A. Mitchell, (2005), The ESRI Guide to GIS Analysis, Volume 2: Spatial Measurements and Statistics, ESRI Press, 252 p.
9.	A. Mitchell, (2012), The Esri Guide to GIS Analysis, Volume 3: Modeling Suitability, Movement, and Interaction, ESRI Press, 432 p.

Supplementary reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	G.Mozgeris, Geoinformatika aplinkotyroje, Vytauto Didžiojo universitetas, Kaunas, 2008, 228 p.
2.	G.Mozgeris, Ekologijoje ir aplinkotyroje naudojami šiuolaikiški erdvinės analizės metodai ir jų praktinis panaudojimas, Vytauto Didžiojo universitetas, Kaunas, 2008, 104 p.
3.	Mozgeris G., Augustaitis A., Jonikavičius D., Bosas G., Darbo ArcGIS 10 programine įranga pagrindai. Praktinių darbų aprašas, Lietuvos žemės ūkio universitetas, Aplinkos institutas, Miškų ir ekologijos fakultetas, 2011, 159 p.
4.	Scientific publications from Science Direct, EBSCOhost Web

Course programme designed by

No.	Name, surname	Institution	Degree	E-mail address
1.	Gintautas Mozgeris	VMU-AA	Dr.	gintautas.mozgeris@vdu.lt
2.	Donatas Jonikavičius	VMU-AA	Dr.	donatas.jonikavicius@vdu.lt

Approved at the meeting of the doctoral committee of the program: 18 02 2022, Pr. No. 1 (124).

The description of the study subject is valid until 2026 February 28

COURSE DESCRIPTION

Course code	Volume in ECTS credits	Institution	Faculty	Department
MIŠ8012	7	VMU-AA	Forest sciences and ecology	Forest science

Course title in Lithuanian

Gyvūnų ekologija

Course title in English

Wildlife ecology

Study methods	Volume in ECTS credits
Lectures	2
Consultations	1
Seminars	1
Individual work	3

Short course annotation in Lithuanian (up to 500 characters)

Gyvūnų ekologijos dalykas sudaro teorinį pagrindą visapusiškiems ir giliems tiriamiesiems darbams gyvūnijos apsaugos, medžioklėtyros, miškininkystės ir kitų taikomųjų mokslų srityse. Gyvūnų ekologijos mokymasis turėtų padėti doktorantui nagrinėti savo mokslinio darbo rezultatus šiuolaikinės gyvūnų ekologijos mokslo šviesoje. Iš klausęs kursą doktorantas giliau supras gyvūnų ryšių su aplinka sudėtingumą įvairiais lygmenimis, sugebės įsivaizduoti žmogaus ūkinės veiklos galimas pasekmes klimatui, rūšių gyvybingumui ir įvairovei. Susipažinęs su ekosistemų funkcionavimu ir įvairių veiksnių įtaka gyvūnijos gausai doktorantas turėtų mokėti prognozuoti nepalankių aplinkos veiksnių pasekmes augalams, darbe pasirinkti aplinką tausojančią taktiką ir strategiją.

Short course annotation in English (up to 500 characters)

Wildlife research give theoretical background for miscellaneous and deep studies within wildlife conservation, game management, forestry and other applied and fundamental sciences. Wildlife ecology gives ability to interpret own study results within concept of modern science. After completion of this course PhD student better understand wildlife relation with surrounding environment on various levels, will be able to forecast the relations between human activities and unfavourable environmental factors for wildlife, to select environmentally friendly methods and strategies.

Relevance of the course

The subject is important for proper evaluation of collected research material within current global situation.

Course aims

The aim of the subject is to provide knowledges on wildlife interaction with surrounding environment, populations and communities functioning. Learn manage populations by affecting its populations and its environment.

Content (topics) and methods

1. Wildlife ecology as a science. Definition of wildlife ecology. Wildlife ecology terms, concept and historical development; relation with other sciences; wildlife ecology in Lithuania.
2. Species ecology - autecology.
Interactions with environment; nutrition ecology; importance of water and minerals; oxygen cycles; sun and light significance for wildlife; environmental and body temperature; wind; substrates; biological cycles; orientation and sensitivity;
3. Ecology of populations.

Ecological structure of bird species; structure of populations; spatial distribution; population dynamics;

4. Ecology of communities:
Flora and fauna; interactions; predators, parasites; description of communities; biogeography and biomes.

Structure of cumulative score and value of its constituent parts

Individual assignment 50%; Exams - 50 %

Compulsory reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Sinclair, A.R.E., Fryxell, J.M., Caughley, G. 2006. Wildlife ecology, conservation and management. Blackwell publishing. 469 p.
2.	Bolen E.G., Robins W.L. 2003. Wildlife ecology and management. Prentice Hall 634 p.
3.	Braun C.E. (ed.) 2005. Techniques for wildlife investigation and management. The wildlife society USA. 974p.
4.	Elton, C.S. 2001. Animal Ecology. Univ. Of Chicago Press, 209 p.
5.	Krausman P.R. 2002. Introduction to wildlife management. Prentice Hall. 478 p.
6.	Patton, D.R. 1992. Wildlife habitat relationships in forested ecosystems. Timber Press 1992.
7.	Feldhamer G., Dritchamers L., Vessey, S.H., Merritt, J.F. 2002. Mammology: adaptation, diversity and ecology. McGraw-Hill.
8.	Raškauskas, V. 1991. Bendroji ekologija. – Vilnius, 239p.
9.	Heirich D., Hergt M. 2000. Ekologijos atlasas. – Vilnius, 279 p.

Supplementary reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Malcolm L. Hunter. 2002. Fundamentals of Conservation Biology. Blackwell publishing. 547 p.
2.	D. Linzey. 2001. Vertebrate Biology. McGraw-Hill. 530 p.
3.	Kormondy E.J. Ekologijos sąvokos. Litera Universitatis Vytauti Magni, 1992.
4.	Stravinskienė V. Bendroji ekologija. K., 2003. – 232 p.
5.	Naumov, N. 1963. Ekologija žvotnich. Maskva, 618p. (Rusų k.)
6.	Riklėfs, R. 1975. Osnovi obščiej ekologiji. Maskva, 424 p.
7.	Makfedlen, E. 1965. Ekologija žvotnich. Maskva, 375p. (Rusų k.)

Course programme designed by

No.	Name, surname	Institution	Degree	E-mail address
1.	Gediminas Brazaitis	VMU-AA	dr.	gediminas.brazaitis@vdu.lt
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Approved at the meeting of the doctoral committee of the program: 18 02 2022, Pr. No. 1 (124).

The description of the study subject is valid until 2026 February 28

COURSE DESCRIPTION

Course code	Volume in ECTS credits	Institution	Faculty	Department
MIŠ8013	7	VMU-AA	Forest sciences and ecology	Forest science

Course title in Lithuanian

Miško ekonomika

Course title in English

Forest economics

Study methods	Volume in ECTS credits
Lectures	2
Consultations	1
Seminars	-
Individual work	4

Short course annotation in Lithuanian (up to 500 characters)

Kursas skirtas pagilinti žinias apie Lietuvos, Europos bei pasaulio miškų išteklius, valstybinius ir privačius miškus, miško ūkio ekonominius ir finansinius pagrindus, miško ūkio gamybos procesus, gamybos veiksnius, gamybos išlaidas, miško productų kainodarą, mokesčius, miškų ekonominių vertinimą, šiuolaikinius miško ūkinių sprendimų priėmimo metodus.

Short course annotation in English (up to 500 characters)

The course is designed to provide knowledge about the forest resources in Lithuania, Europe and all over the world, public and private forest resources, economic and financial principles of forestry, production processes in forestry, factors of production, costs of production, pricing of forest products, taxes, economic valuation of forests, modern methods of decision making in forestry.
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Relevance of the course

When strategical or tactical forestry decisions are being made, the need for economic justification of the choice is important, especially in market economy. After completion of the course, PhD students will have knowledge and skills to understand and evaluate possibilities to use economic methods for forestry decision making.
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Course aims

Provide the knowledge about economic methods as well as about their use and adaptation in forestry, ability to systemize and assess economic methods that are used in forestry.

Content (topics) and methods

- | |
|---|
| <ol style="list-style-type: none"> 1. Introduction to forest economics. 2. Forestry organization. 3. Economic-financial regulation of forestry. 4. Planning in forestry. 5. Accounting in forestry. 6. Factors of production in forestry. 7. Forest products market research. 8. Costs of production in forestry. 9. Pricing of forest products. 10. Economic valuation of forest resources. 11. Economic aspects of multi-purpose forestry. 12. Economics of sustainable forestry. 13. Economic analysis of forestry. |
|---|

Structure of cumulative score and value of its constituent parts

Individual assignment - 30%; final exam - 70 %
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Compulsory reference materials

No.	Authors of publication, title, publishing house, year of publication.
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1.	Buongiorno J., Gilles J. 2003. Decision methods for forest resource management. San Diego: Elsevier Science. 440 p.
2.	Duerr W. 1993. Introduction to Forest resource Economics. New York: McGraw–Hill. 486 p. Klemperer W. 1996. Forest Resource Economics and Finance. New York: McGraw–Hill. 552 p.
3.	Price C. 1989 The Theory and Application of Forest Economics. Oxford. 402 p. Zhang D., Pearse P.H. 2011. Forest Economics. Canada: Vancouver, Toronto. 380 p.
3.	G. Činga, R. Deltuvas, A. Kuliešis, R. Mankus, J.A. Mažeika, G. Mozgeris, M. Puodžiūnas, A.
4.	Rutkauskas, A. Tebėra, D. Vitunskas; sudarytojas Juozapas Algirdas Mažeika. Miško naudojimas ir
5.	logistika: vadovėlis, Lietuvos žemės ūkio universitetas. Miškų fakultetas. Miškotvarkos katedra. Akademija (Kauno r.): Lietuvos žemės ūkio universitetas, 2008. 399 p.

Supplementary reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Adamowicz W., Boxall P., Luckert M., Phillips W., White W. 1996. Forestry, Economics and the Environment. Guildford: Biddles Ltd. 276 p.
2.	Čiegis. R. 2009. Gamtos išteklių ir aplinkos ekonomika. Klaipėda: Klaipėdos universiteto leidykla. 772 p.
3.	Martinkus B., Žilinskas V. 2008. Ekonomikos pagrindai. K.: Technologija. 790 p.
4.	Miško žemių ekonominis vertinimas. 1975. V.: LMA EI. 192 p.
5.	Mizaras S. 2002. Ekonominiai metodai miškų ūkyje. K.: Lututė. 114 p.
6.	Mizaras S. 2012. Miškininkavimo ekonominė analizė. Akademija. 112 p.
7.	Moksliniai žurnalai: Miškininkystė, Baltic forestry, Žemės ūkio mokslai, Forest Policy and Economics, Forest Science, Scandinavian Journal of Forest Research, Journal of Forest Economics. Statistikos metraščiai: Miškų urėdijų veiklos rodikliai, Lietuvos miškų ūkio statistika.
8.	Duomenų bazės: FAO, Eurostat.

Course programme designed by

No.	Name, surname	Institution	Degree	E-mail address
1.	Marius Kavaliauskas	VMU-AA	Dr.	marius.kavaliauskas@vdu.lt

Approved at the meeting of the doctoral committee of the program: 18 02 2022, Pr. No. 1 (124).

The description of the study subject is valid until 2026 February 28

COURSE DESCRIPTION

Course code	Course group	Volume in ECTS credits	Course valid from	Course valid to
MIS8014	Doctoral studies	7	2019	2023

Course title in Lithuanian

Miško hidrologija

Course title in English

Forest hydrology

Short course annotation in Lithuanian (up to 500 characters)

Globali klimato kaita reikšmingai keičia miškų augaviečių hidrologinį režimą. Tinkamam miško ekosistemų hidrologiam režmui palaikyti būtina gilesnė, moksliniais tyrimais pagrįsta samprata. Šio kurso tikslas yra suteikti gilesnias mokslines žinias apie miško hidrologiją, dirvožemio ir augalų sąveiką ir tyrimo metodus fokusuojant žinias į miško ūkio ir vandens ūkio tvaraus suderinamumo principus.

Short course annotation in English (up to 500 characters)

Global climate change markedly affects the hydrology regime of forest ecosystems. To maintain a sound hydrologic regime in forest ecosystems, a deeper insight is required based on up-to-date scientific knowledge. This course aims to provide a deeper knowledge of forest hydrology science and amelioration methods on forest land, with particular focus on the compatibility between forest and water management.

Distribution of workload

Study forms	Volume in ETC credits	
Lectures	4	
Seminars	1	
Consultations	1	
Individual students work	1	
Total:	7 credits	

The demand and relevance of the course

Global climate changes significantly the hydrological regime of forest habitats. Precipitation is getting high in the short term, often followed by a long-term period of moisture deficit. Therefore, a deeper research-based approach is needed to maintain the proper hydrological status of forest ecosystems.

Course aim

The objective of the course is to provide deeper knowledge about the concept, evolution, preconditions, and research methods in forest hydrology.

The content of the course

1. An Introduction to forest hydrology. The concept of ecohydrology, its connection with other disciplines. The main methodology principles of the interaction between forest vegetation, soils, and moisture. Equipment and methods for studying hydrological processes in a forest. Principles of compatibility between forestry and water management. European perspectives on forest hydrology.
2. Water potential. Soil moisture potential. Soil moisture content. Water in the aeration zone and its movement. Optimal moisture for the growth of the tree. Wilting point. Productive soil moisture. Transpiration and evapotranspiration. The optimal water supply of stands during the growing season. Tolerance of trees to excess moisture and drought. Plant competition in the forest for moisture. Forest runoff processes. Tropical forest hydrology. Hydrology of flooded and wetland forests.
3. Interaction between soil oxygen, groundwater level, and tree roots. Types of tree root formation depend

on groundwater depth. Growth of tree and shrub roots in the presence of permanent and temporary excess moisture in the soil. Regeneration of woody plant root systems. Influence of soil moisture and cold on seedling roots. Impact of soil moisture on reforestation.

4. Groundwater formation and depths in Lithuania. Influence of groundwater depth on stand height. Regularities of groundwater regime and balance formation in individual habitats. Effects of evapotranspiration on groundwater level and soil moisture. Influence of clear-cutting on groundwater regime and soil moisture. Influence of occasional tree felling on groundwater regime and soil moisture.
5. The impact of high water levels in rivers and lakes for stand vitality. Effects of temporary, long-term, and permanent flooding on grass vegetation. Significance of ponding for the microclimate in surrounding forests. Changes in stand growth and forest types in the area due to hydrological impact of ponds.
6. Effect of soil preparation methods on soil moisture. The demand for irrigation. Regulation of soil moisture in open ground nurseries by irrigation. Wastewater irrigation of energy plantations. Quality of water used for irrigation. Forest drainage. Humidity regulation in the forest by redistribution of water reserves between individual sites. Effectiveness of soil moisture control in forest. Hydrologic effects of forest management. Hydrology of forests after wildfire.
7. Concept and theory of mathematical modeling in forest hydrology. Conceptual and empirical models. Input parameterization for water balance modeling in the forest. Interface between hydrological models and stand growth, soil nutrient regime, and soil erosion models. Forest water balance models. Geospatial technology applications in forest hydrology. Advantages of the application of mathematical models to assess the ecological effect of forests. Future directions in forest hydrology research.

Structure of cumulative score and value of its constituent parts

Individual work - 30%. Case studies - 20%. Exam - 50%.
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Recommended reference materials

No	Publication year	Authors and title of publication (e-source)	Number of copies in University libraries or link to e-source
<i>Basic materials</i>			
1	2016	Amatya, D., Williams, T., Bren, L. and De Jong, C. eds., 2016. <i>Forest Hydrology: Processes, Management and Assessment</i> . CABI.	2
2	2011	Levia, D.F., Carlyle-Moses, D. and Tanaka, T. eds., 2011. <i>Forest hydrology and biogeochemistry: synthesis of past research and future directions</i> (Vol. 216). Springer Science & Business Media.	2
3	2019	Gann G.D. et. International principles and standards for the practice of ecological restoration. <i>Restoration Ecology</i> Vol. 27, No. S1, 2019. S1–S46 p.	https://onlinelibrary.wiley.com/doi/pdf/10.1111/rec.13035
4	2011	Amatya, D.M., Douglas-Mankin, K.R., Williams, T.M., Skaggs, R.W. and Nettles, J.E., 2011. Advances in forest hydrology: challenges and opportunities. <i>Transactions of the ASABE</i> , 54(6), pp.2049-2056.	1
5	2002	Ruseckas J. Miško ir drėgnės sąveika. "Lututė". Kaunas. 2002, p. 175.	10
6	2011	Buttle, J.M., 2011. The effects of forest harvesting on forest hydrology and biogeochemistry. In <i>Forest Hydrology and Biogeochemistry</i> (pp. 659-677). Springer, Dordrecht.	1
7	2007	Wood P., Hannah D-M., Sadler P-S. Hydroecology and ecohydrology: past, present and future. J.Wiley & Sons Ltd. 2007. - 436p.	2
<i>Supplementary materials</i>			
1	2000	Goudie A. The human impact on the environment. Blackwell publ., Bodmin. 2000.- 512 p.	

	2004	Yusheng, Y., Bin, D., Jinsheng, X., Guangshui, C., Ren, G., Ling, L., Xiaoguo, W. and Jianfen, G., 2004. Soil respiration of forest ecosystems and its response to global change. <i>Acta Ecologica Sinica</i> , 24(3), pp.583-591.
2	2000	Karaziņa S. Vaičiūnas V. Ekologinis miškų vaidmuo Lietuvoje. "Lututė", Kaunas, 2000, p.150.
3	1982	Pauliukevičius G. Miškų ekologinis vaidmuo. Vilnius, Mokslas, 1982. 191 p.
4	2010	Schwinning, S., 2010. The ecohydrology of roots in rocks. <i>Ecohydrology: Ecosystems, Land and Water Process Interactions, Ecohydrogeomorphology</i> , 3(2), pp.238-245.
5	2004	Falkenmark, M., Rockstrom, J. and Rockström, J., 2004. <i>Balancing water for humans and nature: the new approach in ecohydrology</i> . Earthscan.

Course description designed by

Prof. Dr. (HP) Arvydas Povilaitis e-mail: arvydas.povilaitis@vdu.lt

COURSE DESCRIPTION

Course code	Volume in ECTS credits	Institution	Faculty	Department
MIŠ8015	7	VMU-AA	Forest Science and Ecology	Forest Science

Course title in Lithuanian

Miško medžių genetika, selekcija ir sėklininkystė

Course title in English

Genetics, breeding and seed management of forest trees

Study methods	Volume in ECTS credits
Paskaitos	4
Konsultacijos	1
Seminarai	1
Individualus darbas	1

Short course annotation in Lithuanian (up to 500 characters)

Miško medžių, augalų ir gyvūnų genetinė įvairovė yra viena iš pagrindinių miško ekosistemų tvarumo komponentų. Miškas veikia kaip vienalytė ekosistema, todėl ją būtina suprasti kompleksiskai kaip tęstinės veiksmų tarpusavio sąveikos sistemą. Vienas šių veiksmų ir yra genetinis veiksnys. Todėl atliekant tyrimus miškuose būtina suprasti rūšių populiacijų genetinę struktūrą, genetinės įvairovės pasiskirstymo dėsningumus, jų priežastis ir pasekmes, rūšių populiacijų adaptacijos procesą, adaptabilumą, adaptyvumą, adaptacinius požymius, kas formuoja jų genetinę struktūrą ir kaip moderniais metodais ją ištirti, koks yra Darvinistinis tinkamumas, kaip vykdomas miško medžių genetinis pagerinimas ir kaip yra saugomi jų genetiniai ištekliai, koks yra evoliucinių jėgų poveikis ir ką sako nauji miško ekosistemų genetiniai tyrimai.

Short course annotation in English (up to 500 characters)

Genetic diversity of forest trees, plants and animals is one of the major components of sustainable development of forest ecosystems. Forest acts as a compound ecosystem to be understood as complex interaction of the components such as genetics. Therefore, when studying forests in any field, it is important to understand the population genetic structure, pattern of spatial and temporal distribution of genetic diversity, the process of adaptation, adaptability and adaptedness, the forces affecting the genetic structure and diversity, what are the methods for assessing genetic diversity, what is Darwinian fitness, what are the effects and methods of forest tree breeding and gene conservation, and finally what are the current achievements of forest genetic research.

Relevance of the course

Sustainable development of very single species within a forest ecosystem largely depends on its genetic properties such as evolutionary origin, adaptability, adaptedness, diversity and mode of trait inheritance. For a scientist or qualified professional dealing with forests, it is essential to comprehend the basic principles of genetic functioning of the species in forest ecosystem as well as advantages and risks with the novel genetic technologies. Such knowledge would markedly improve the efficiency of research in own field of forest science as well as professional activity.

Course aims

This course is aimed to reveal the complex principles of sound genetic functioning of species in a forest ecosystem and on how to genetically improve their adaptability and economical values. We will focus on forest trees and novel genetic technologies by basing the lecture materials on own research projects and relevant scientific papers.

Content (topics) and methods

1. Specific features of forest genetics: vast genetic diversity in the wide range wild populations.

2. Basics of molecular genetics of forest trees: Genomics, genome and its organization, genetic diversity sources within individuals, DNA markers, bioinformatics, genetic structure and diversity of forest tree populations at molecular level, neutral and functional diversity.
3. Epigenetics of forest trees. Tree and a stationary biosystem. Epigenetic control mechanisms. DNA methylation, histone code, RNAi, paramutations and genomic imprints. Effects of environment on epigenetic control of forest trees.
4. Quantitative inheritance in forest trees. Genetic units, genetic and phenotypic variance, qualitative and quantitative traits, heritability, GxE interaction, inbreeding and heterosis, selection indexes, genetic correlations.
5. Evolution of forest tree populations. Evolutionary forces, species differentiation, phenotypic and epigenetic plasticity, definition of population and adaptive environment, fitness-adaptation-adaptability-adaptedness, adaptive traits, population structure of trees and game in forests, is local population best adapted? (Darwinian and domestic fitness), is perfect adaptedness ever achieved under changing environment, risks with climate warming and need for diversity, genetic characteristics of populations (among population structure and within population diversity, allelic frequencies, differentiation, and diversity indexes, HW equilibrium), how population structure is diversity is assessed (morphology and DNA markers), types of genetic structuring among populations.
6. Gene conservation of forest trees. What is and why gene conservation is needed, conservation strategy and methods, dynamic-static conservation, in situ, ex situ conservation, coordination between breeding and conservation, genetic pollution, gene conservation Lithuania.
7. Forestry biotechnology. Genetic engineering, micropropagation, mycorrhization.
8. Forest tree breeding: main principles. Aims and benefits, traits, breeding populations and genetic entries, testing and assessment methods.
9. Forest tree breeding: exotic species, categories of exotic, risks and advantages, modes of introduction, projects in Lithuania.
10. Forest tree breeding: sequence of breeding programme, species selection, provenance testing, geographical patterns of variation in adaptive traits, stand selection, individual selection, plus trees.
11. Breeding programs, types and principles. Understanding need for planning. Short-term vs. long-term, high vs. low input breeding, ecology-economic priorities in breeding, which program for which species, organising breeding operations.
12. Long term breeding. Main factors: gain vs. diversity, time and costs of breeding cycle. Importance of diversity (coancestry and inbreeding), how to maintain diversity effectively in a long run, cycles of recombination-testing-and-selection, understanding the recombination, selection methods to maintain diversity in long run, optimum selection age, MAS, example of a breeding program.
13. Short term high intensity breeding. Emphasis on genetic gain, genetic diversity matters as long as inbreeding depression is avoided, short-rotation species, examples.
14. Long-term low intensity breeding. For species with high ecological values, methods of breeding and maintaining the genetic diversity.
15. Short term low intensity breeding, stand selection, selective thinning, see collection stands.
16. Seed orchards as multilocation populations. Types, establishment and maintenance.
17. Forest breeding in Lithuania.
18. Forest seed. Flowering biology. Establishment of seed collection network, seed collection, storage, and control of origin and quality of FRM.

Structure of cumulative score and value of its constituent parts

Personal assignment (0.3) and exam (0.7).

Compulsory reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	White ir kt. 2007. Introduction to Forest Genetics. CABI; 1 edition (June 15, 2002) 500 p.
2.	Danusevičius, D. 2010. Biotechnologija miškų ūkyje. Paskaitų konspektai. Elektroniniai 120 p.
3.	http://www.lzuu.lt/me/lt/
4.	Eriksson G., Ekberg, I., Clapham, D. 2006. An Introduction to Forest Genetics. ISBN 91576-7190-7, SLU, Švedija (http://vaxt.vbbsg.slu.se/forgen/index.html Anglų klb)

Supplementary reference materials

No.	Authors of publication, title, publishing house, year of publication.
1	Gabrilavičius, R. ir Danusevičius, D. 2003. Eglės genetiniai tyrimai ir selekcija Lietuvoje. Lietuvos miškų institutas. "Petro ofsetas", Vilnius.
2	Danusevičius, J. 2001. Pušų selekcija. Lietuvos miškų institutas. "Lututė", Kaunas.
3	Danusevičius ir kt. 2006-2010. Internetinis mokomasis puslapis „Miško medžių genetika ir biotechnologijos“ http://www.lzuu.lt/me/lt/12718 .
4	Danusevičius, D. 2008. Miško medžių bandomųjų želdinių vadovas VĮ Kazlų Rūdos mokomojoje miškų urėdijoje. VĮ Kazlų Rūdos miškų urėdija, Lietuvos miškų institutas. Lututė, ISBN 978-9955-37-016-1, 103 p.
5	Danusevičius D., Pliūra A., Baliuckas V., Aučina, A., Kuusienė, S. 2006. Mokomoji priemonė magistrantams “Biotechnologija miškų ūkyje” (projektas ESF/2004/2.5.0-K02-VS05/Sut159, veiklos kodas: MF-2), Girionys, LMI, I-II dalys, 402 p

Course programme designed by

No.	Name, surname	Institution	Degree	
	Darius Danusevičius	VMU-AA	dr.	darius.danusevicius@vdu.lt
	Virgilijus Baliuckas	LAMMC	dr.	v.baliuckas@mi.lt

Approved at the meeting of the doctoral committee of the program: 18 02 2022, Pr. No. 1 (124).

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COURSE DESCRIPTION

Course code	Volume in ECTS credits	Institution	Faculty	Department
MIS8016	7	VMU-AA	Forest Science and Ecology	Forest Science

Course title in Lithuanian

Miško našumas

Course title in English

Forest growth and yield

Study methods	Volume in ECTS credits
Lectures	40
Consultations	10
Seminars	
Individual work	65

Short course annotation in Lithuanian (up to 500 characters)

Kursas skirtas įgyti žinių apie medžių augimą laisvai, jų konkurencinius santykius medyne, medynų formavimąsi, retinimąsi, našumą, jo santykį su aplinkos faktoriais, reguliavimą ūkiniu priemonių pagalba, apie medynų našumo modeliavimo metodus, jų taikymą praktikoje, medynų našumo apskaitos metodus.

Short course annotation in English (up to 500 characters)

This course provides knowledge to the participants regarding forest growth and yield of the stands. It focuses to the different relations existing between trees and their impact to the growth and productivity. For example, there is a difference when trees grow in competitive situation or grow freely. It has direct impact to natural mortality of trees as well as diameter increment. Also the attention is given to the environmental factors that influence forest growth. Further attention is given to the silvicultural treatments and the possibility to regulate productivity of the stands by cuttings. A special part in this course takes the modelling growth of forest stands by using single tree level simulator BWINPro.

Relevance of the course

The course takes a comparative approach in understanding by various theories and methodology of Forest growth and yield science. The aim of this course is to introduce the main conceptions of forest growth and yield modelling, as well as the main tendencies on the climate and human impact to forest growth. The first year doctoral students acquire competence in defining assessing and discussing various forest growth and yield issues and main regularities of forest growth. This course of the program is evaluated through the examinations, which includes lectures, consultations, student's homework, and final exam.

Course aims

To learn the main peculiarities on forest growth, competitive relationship in the stand, stand formation, dynamics, experimental planning, collection of research data, systematization, methods of modeling of stand productivity, get familiar with forest inventory methods.

Content (topics) and methods

1. Introduction. History of forest productivity science development, change of forest productivity and its regulation, development of research methods, importance of forest productivity and its regulation in the conditions of sustainable development.
2. Tree growth in open space and in the stand, competition between trees and formation of the stand: basic concepts, growth space and its variation, management, competition and thinning, patterns of growth and formation of stands, types of productivity formation.
3. Forest growth and yield modeling: evolution of stand productivity modeling methods, relations of main stand indicators, growth and change patterns and their modeling, structure of stands,

- growth tension, thinning and modeling. Modeling of parameters of interconnection between the growing and falling parts of stands. Modeling of tree growth and thinning by evaluating the influence of competition between trees.
4. Productivity of Lithuanian and European forests, division of Lithuanian forests according to different areas of forest productivity.
 5. Inventory systems of forest resources

Structure of cumulative score and value of its constituent parts

Personal task 30%, Exam 70%.

Compulsory reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Antanaitis V. Miško naudojimas. Vilnius, 1981, 200 p.
2.	Kairiūkštis L., Juodvalkis A. Etaloniniai medynai ir jų formavimas. Vilnius, 1985.
3.	Kuliešis A. medynų našumas ir jo panaudojimas. Vilnius, Lietuvos agroleidykla, 1989, 141 p.
4.	Kuliešis A. Lietuvos medynų prieaugio ir jo panaudojimo normatyvai. Kaunas, Girios aidų leidykla, 1993, 384 p.
5.	Kuliešis A. Lietuvos miškų rajonavimas pagal medynų našumą. Lietuvos mokslas, V t., 1997, p. 54-63.
6.	Kuliešis A., Petrauskas E., 2000. Lietuvos miškų naudojimo XXI amžiuje prognozė. Kaunas, Naujasis lankas, 146 p.
7.	Kuliešis A., Kasperavičius A., Kulbokas G., Kvalkauskienė M., 2009. Lietuvos nacionalinė miškų inventorizacija. Kaunas, Naujasis lankas, 284 p.
8.	Oliver C.D., Larson B.C. Forest stand Dynamics. Jons Wiley and Sons, 1996, 521 p.
9.	Pretzsch H., 2010. Forest Dynamics, Growth and Yield., Springer, 664 p.
10.	Gadow von K, Hui GY, 1999. Modelling Forest development. Kluwer, Dordrecht, 213 p.
11.	Gadow von K, 2005. Forsteinrichtung. Analyse und Entwurf der Waldentwicklung. Univ-Verlag Gottingen, Gottingen, 342 p.
12.	Антанайтис В.В., Загреев В.В. Прирост леса. Москва, Лесная промышленность, 1979, 251 с.
	Антанайтис В.В., Тябера А.П., Шпятеня Я.А. Законы, закономерности роста и строения древостоев. Каунас, 1986, 157 с.
	Кофман Г.Б. Рост и форма деревьев. Новосибирск, Наука, 1986, 211 с.
	Кузмичев В. Закономерности роста древостоев. Новосибирск, Наука, 1977, 160 с.
	Лиєпа И.Я. Динамика древесных запасов. Рига, Зинатне, 1980, 139 с.
	Полубояринов О. Плотность древесины. Москва, Лесная промышленность, 1976, 160

Supplementary reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Wenk G., Antanaitis V., Šmelko Š. Waldertragslehre. Deutscher Landwirtschaftsverlag, Berlin GmbH, 1990, 448 s.
2.	Буш К., Иевинь И. Экологические и технологические основы рубок ухода. Рига, 1984, 175 с.
3.	Загреев В.В. Географические закономерности роста и продуктивности древостоев. Москва, Лесная промышленность, 1978, 240 с.
4.	Moksliniai žurnalai – <i>Forest Science, Forestry, Baltic Forestry, Journal of Environmental Management</i>
5.	Кивисте А. Функции роста леса. Тарту, 1986, 172 с.

Course programme designed by

No.	Name, surname	Institution	Degree	E-mail address
1.	Edgaras, Linkevičius	VMU-AA	assoc. prof., dr.	Edgaras.Linkevicius@vdu.lt

Approved at the meeting of the doctoral committee of the program: 18 02 2022, Pr. No. 1 (124).

The description of the study subject is valid until 2026 February 28

COURSE DESCRIPTION

Course code	Volume in ECTS credits	Institution	Faculty	Department
MIS8017	7	VMU-AA	Forest sciences and ecology	Forest science

Course title in Lithuanian

Miško žėlimas ir želdinimas

Course title in English

Natural and artificial forest establishment and regeneration

Study methods	Volume in ECTS credits
Lectures	4
Consultations	1
Seminars	1
Individual work	1

Short course annotation in Lithuanian (up to 500 characters)

Pagilinti ir išplėsti magistro studijų žinias bei gebėjimus miško atkūrimo ir įveisimo problemų tyrimo, planavimo, projektavimo, žėlimo skatinimo ir želdinimo technologijų taikymo, žėlinių ir želdinių priežiūros bei apsaugos klausimais.

Short course annotation in English (up to 500 characters)

The course is aimed to provide a deeper insight into the main forest establishment methods for each forest tree species. Especially we focus on understating on the effects of changing environment on choice of species and forest regeneration methods.

Relevance of the course

Reforestation is an essential guarantee of forest continuity. With the change in the climate and the development of technologies, the spread of new species of plants and animals, the change in the hydrological regime, the species composition of the habitat, many new challenges arise for afforestation. Often the old rules do not meet the environmental conditions. Research and highly qualified professionals are needed.

Course aims

The aim of the subject is to deepen and expand the knowledge and skills of master's studies in the issues of research, planning, design, application of natural regeneration and planting technologies, maintenance and protection of forest plantations and naturally regenerated forests.

Content (topics) and methods

1. Peculiarities of application of forestry methodology in research of natural forest regeneration and afforestation problems
2. Methods of reforestation, their development, possible application results.
3. Environmental factors determining the natural forest regeneration of the main forest tree species, their ecological niche, interaction, etc.
4. Peculiarities of the natural forest regeneration of main forest tree species under the stand cover, in shelterwood and clear-cut areas.
5. Measures to promote natural forest regeneration, topical issues of care and protection of naturally regenerated forests,
6. Comparative efficiency of naturally regenerated forests and forest plantations (in ecological, economic and other aspects).
7. Comparative efficiency of pure and mixed forest plantations in ecological, economic and other aspects.
8. Peculiarities of modern technologies of afforestation of the main forest tree species.
9. Motivation for genetic improvement of forest plantations.
10. Theoretical bases of modeling of forest plantations types.

11. Optimization of forest plant species composition, mixing methods and schemes.
12. Peculiarities of different purpose and multi-purpose forest plantations.
13. Quality assessment of naturally regenerated forests and forest plantations.

Structure of cumulative score and value of its constituent parts

Individual assignment 30%; Exams - 70 %

Compulsory reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Miško želdintojo žinynas (Sudarytojas E Riepšas) Vilnius, „Eugrimas“, 2017. - 598 p.
2.	Gradeckas A., Malinauskas A. Miško želdynų veisimo biologiniai ir ekologiniai veiksniai bei patirtis Lietuvoje. – Kaunas : Lututė, 2005. – 404 p.
3.	Szymanski S. Ekologiczne podstawy hodowli lasu. – Warszawa : Państwowe Wydawnictwo Rolnicze i Lesne. 2000. – 479 p.
4.	Mangalis I. Meža atjaunošana un ieaudzešana. – Rīga : Et Cetera, SIA, 2004. – 453 p.
5.	Ackzell L. Forest regeneration by nature and man. Umea, 1994.-148 p.
6.	Dengber A. Waldbau auf ökologischer Grundlage. Hamburg und Berlin, -1990. -447 p.
7.	Miško atkūrimas ir įveisimas (teisės aktų rinkinys). LR Aplinkos ministerija Miškų departamentas. Vilnius, 2011. - 128 p.

Supplementary reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Malinauskas A. Miško želdinių pradinis tankumas. – Kaunas : Lututė, 2008. - 232 p.
2.	Afforestation in Europe. Experiences and prospects / red. S. Zajaca, W. Gila. – Warszawa, 2003. – 281 p.
3.	Riepšas E. Miško želdinimo ir želimo skatinimo technologiniai modeliai žemės ūkiui nenaudojamose žemėse. – Vilnius, 2005. – 37 p. Miško ekologija (sudar. S. Karazija). – Vilnius : Enciklopedija, 2008. – 296 p.
4.	Lietuvos ažuolynai : išsaugojimo ir atkūrimo problemos (sudar. S. Karazija). – Kaunas : Lututė, 1997. – 234 p.
5.	Kapustinskaitė T. Juodalksnynai. Vilnius: Mokslas, 1977.-231 p.
6.	Orlander G., Gemmel P., Hunt J. Site preparation, a Swedish Overview. FRDA report, ISSN 0835-0752; 105. Alnarp, 1990.- 61 p.
7.	Eglynų auginimas (kompleksinės rekomendacijos). Vilnius, 1993.- 32 p.
8.	Pušynų auginimas (kompleksinės rekomendacijos). Vilnius, 1994. -32 p.
9.	Beržynų auginimas (kompleksinės rekomendacijos). Kaunas, 1999. -28 p.
10.	Leibundgut H. Die naturliche Waldverjungung. 1981. Verlag Paul Haupt Bern und Stuttgart. 108 p. Leibundgut H. Die Aufforstung. 1982. Verlag Paul Haupt Bern und Stuttgart. 92 p.
11.	Smith, D.M. The Practice of Silviculture. 1986. John Wiley and Sons, New York. 527 p.
12.	Wiersum K.F. (Editor) Strategies and design for afforestation, reforestation and tree planting. 1984.
13.	Pudoc, Wageningen, 432 p. Kenneth Pickett Davis, McGraw-Hill. Forest Fire: Control and Use. 1959 - 584 psl.
14.	Zobel B., Talbert J. Tree Improvement . 1984. John Wiley and Sons. New York, 502 p.
15.	Капустинская Т., Создание лесных насаждений на болотных почвах в Литовской ССР. 1968. Каунас. 189 p.
16.	

Course programme designed by

No.	Name, surname	Institution	Degree	E-mail address
1	Vytautas Suchockas	VMU-AA	dr.	Vytautas.Suchockas@vdu.lt

Approved at the meeting of the doctoral committee of the program: 18 02 2022, Pr. No. 1 (124).

The description of the study subject is valid until 2026 February 28

COURSE DESCRIPTION

Course code	Volume in ECTS credits	Institution	Faculty	Department
MIS8018	7	VMU-AA	Forest Science and Ecology	Forest Science

Course title in Lithuanian

Miškotvarka

Course title in English

Forest management planning

Study methods	Volume in ECTS credits
Lectures	2
Consultations	1
Seminars	-
Individual work	4

Short course annotation in Lithuanian (up to 500 characters)

Kursas skirtas pagilinti mokslines žinias bei suvokimą apie mišką, jo tvaraus ir atsakingo naudojimo organizavimą bei susijusius iššūkius ir perspektyvas. Formuojamas sisteminis požiūris į miško naudojimą dabar ir ateityje, siekiant balanso tarp visų miško teikiamų ekosisteminių paslaugų. Pristatomi miškotvarkos teoriniai pagrindai ir praktiniai metodai, miškotvarkos sprendimų priėmimo technologija ir priemonės

Short course annotation in English (up to 500 characters)

The course is designed to provide scientific facts and enhance the knowledge about the forest, sustainable and responsible forest use and associated challenges and opportunities. The course is based on the concept of systematic current and future forest use which is aimed to keep the balance between all forest ecosystem services. Fundamentals and implementation principles of forest management planning are introduced together with the techniques and tools for supporting forest management decisions

Relevance of the course

Having completed this course, the PhD students will acquire the knowledge and skills to aim for a specific forest condition, as well as practical methods to implement them. They will also be able to systemize and critically assess the methods and models of sustainable forest use and improvement.

Course aims

Provide the knowledge about organizing sustainable and responsible forestry under conditions of modern forest policy

Content (topics) and methods

1. Understanding of forest management planning, aim and objectives. Historical glimpse on global and national forest management planning
2. Forestry concepts shaping the forest management planning: principle of sustainable forest use (preconditions to start sustainable forestry, concept, historical types of sustainable forestry, relationship of human and nature and the role of understanding this principle in forest management planning; understanding sustainable forestry, criteria and indicators; sustainability of forest ecosystem services; responsible forestry). Theory of normal forest. Close to nature forestry and its peculiarities under Lithuanian conditions.
3. Methods to implement the forest management planning, format of forest management planning. Forest rotations and cutting ages. Cutting age. Segregative vs integrative forestry
4. Modern forest inventory methods. The role of remote sensing and IT techniques.
5. Principles of planning forest management currently. Internal forest management project in Lithuania and globally.
6. Participation in forest management planning.

7. Decision support in forest management planning. Modelling forest policy and forest management planning scenarios.
8. Alternative forest management models and forest management planning. The influence of command & control forest governance on forest management planning.
9. Forest management planning in other countries.
10. Future vision of Lithuanian forest management and the real world.
11. Individual assignment depending on the research interests of PhD student.

Structure of cumulative score and value of its constituent parts

Individual assignment - 50%; final exam - 50 %

Compulsory reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	L. S. Davis, K.N. Johnson, P.S. Bettinger, T.E. Howard. Forest Management. To Sustain Ecological, Economic and Social Values. Waveland Press, Inc., Long Grove, Illinois, 2001, 804 p.
2.	G. Činga, R. Deltuvas, A. Kuliešis, R. Mankus, J.A. Mažeika, G. Mozgeris, M. Puodžiūnas, A. Rutkauskas, A. Tebėra, D. Vitunskas; sudarytojas Juozapas Algirdas Mažeika. Miško naudojimas ir logistika: vadovėlis, Lietuvos žemės ūkio universitetas. Miškų fakultetas. Miškotvarkos katedra. Akademija (Kauno r.): Lietuvos žemės ūkio universitetas, 2008. 399 p.
3.	Lietuvos miškotvarka ir jos raida. Kaunas, 2002, 188 psl. S. Mizaras, V. Brukas, D. Mizaraitė, Miškų tvarkymo darnumo vertinimas: ekonominiai ir socialiniai aspektai, Kaunas, 2015, 256 psl.

Supplementary reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Legal acts specifying Lithuanian forest management planning (e-tar.lt)
2.	Lietuvos miškų metraštis XX amžius, Vilnius, 2004, 632 psl.

Course programme designed by

No.	Name, surname	Institution	Degree	E-mail address
1.	Gintautas Mozgeris	VMU-AA	Dr.	gintautas.mozgeris@vdu.lt
2.	Edmundas Petrauskas	VMU-AA	Dr.	edmundas.petrauskas@vdu.lt

Approved at the meeting of the doctoral committee of the program: 18 02 2022, Pr. No. 1 (124).

The description of the study subject is valid until 2026 February 28

COURSE DESCRIPTION

Course code	Volume in ECTS credits	Institution	Faculty	Department
MIŠ8019	7	VMU-AA	Forest sciences and ecology	Forest science

Course title in Lithuanian

Ornitologija

Course title in English

Ornithology

Study methods	Volume in ECTS credits
Lectures	2
Consultations	1
Seminars	1
Individual work	3

Short course annotation in Lithuanian (up to 500 characters)

Ornitologijos dalykas suteikia teorines žinias apie paukščius ir sudaro teorinį pagrindą visapusiškiems ir giliems tiriamiesiems darbams. Suteikiamos detalios žinios apie paukščio sandarą, geografinį paplitimą, judėjimo fiziologiją, kūno energetiką, mitybą, termoreguliaciją, teritoriškumo elgseną, veisimąsi, šėrimąsi, populiacijų gausos dinamiką, paukščių bendrijas, ūkinę naudą, paukščių bendrijas, populiacijų valdymą ir retų bei nykstančių rūšių išsaugojimą. Ornitologijos mokymasis turėtų padėti doktorantui nagrinėti savo mokslinio darbo rezultatus šiuolaikinio mokslo šviesoje. Išklauses kursą doktorantas giliau supras paukščių ryšių su aplinka sudėtingumą įvairiais lygmenimis, sugebės interpretuoti gautus ornitologinių tyrimų rezultatus.

Short course annotation in English (up to 500 characters)

Ornithology gives theoretical knowledges about birds and makes background deep and versatile studies. Student will get information about anatomy, geographical distribution, movement physiology, moulting, populations dynamics, bird communities, usefulness, population management and rare and exticnted species conservation; Learning of Ornithology will help analyse own study results on the modern science. PhD student better uncerstand bird relations with surrounding world and complexity of various levels factors and be able to interpret outcoms of its ornithological research.

Relevance of the course

The subject is important for proper evaluation of collected research material within current global situation.

Course aims

The aim of the subject is to provide knowledges on birds, its anatomy, biology and ecology on individual, population and community levels.

Content (topics) and methods

1. Introduction to ornithology. Historical development of ornithology, global findings, ornithology in Lithuania and the world, scientific journals and other sources of information;
2. General characteristics of the class Aves. Feathers and skin; muscular system; skeletal system; digestive system; nervous system; senses; circulatory system; respiratory system; digestive system; urogenital system; systematics of Aves; bird evolution; phylogenetic tree of Aves.
3. Geographical distribution of birds, distribution in the continents, ecological distribution, distribution in biomes, effect of ecotones, edge and interior species, seasonal distribution, endemics, endemic species.
4. Bird movement physiology. Movement in terrestrial, swimming, diving, flying and hovering (static and dynamic);
5. Bird nutrition. Nutritive specialization, polyphagia, oligophaga and stenophagia, ecological groups by feeding specialization, nutrition physiology.

6. Body energetics. Daily and seasonal rhythmic, respiratory and gas circulation, respiratory system and its functions, adaptation to diving; body thermoregulation.
7. Behavioural aspects. Territorial and not territorial species; territorial behaviour; breeding territory, nesting territory; habitat selection; species habitat distribution; isolated and fragmented habitat selection; coloniality; demonstrative behaviour;
8. Reproduction physiology. Breeding periodicity; interaction in couple; sexual dimorphism; mating behaviour; pair creation and sustainability; monogamy; polygyny, polyandry and promiscuity; brood parasitism; interspecific and intraspecific parasitism; adoption of birds for parasitic and host life type; nutrition impact for breeding; breeding terms and cycles; nesting behaviour; site tenancy; eggs and its structure; clutch size; embryogenesis; hatching; types of juveniles; maturity and life longevity;
9. Bird population and its dynamics. Factors influencing population size. Self regulation of population size; rare species; dynamics of local population; ecological features of bird communities; interspecific interaction in community, longevity of communities, bird guilds.
10. Bird migration. Migration as adaptive behaviour; migration routes; diurnal and nocturnal migration; migration in Lithuania – studies and results; bird orientation; orientation concepts.
11. Bird moulting. Feathers oogenesis; nestling feathers; post nesting and juvenile feathers, feather seasonal coats of matured birds; full and partial moulting;
12. Practical aspects of birds; bird and aviation; birds and medicine, birds and agriculture, birds as a hunting object; management of populations; human impact on population size and abundance dynamics; pest species and its regulation.
13. Rare and threatened species; historical aspects of bird protection; extincted species; main reasons of population decline; habitat protection; habitat management for conservation; bird protection strategy; international bird protection; bird protection organizations, international conventions.

Structure of cumulative score and value of its constituent parts

Individual assignment 50%; Exams - 50 %

Compulsory reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	The Birds of the Western Palearctic. Vol.I-IX
2.	Cody, M.L. 1985. Habitat selection in Birds. Academic press
3.	Iljičiov, V.D., Kartašov, N.N., Šilov, I.A. 1982. Obščiaja ornitologija. Vysšaja škola.
4.	Gill, Frank B. 2007. Ornithology. New York; Basingstoke: Freeman, 2007, 758 p.
5.	Marzluff, J.M., Sallabanks, R. 1998. Avian conservation Research and Management. Island Press.
6.	Podulka, S., Rohrbaugh, R.W., Bonney, R. (eds.) 2004. Handbook of bird biology. Cornell Labo f Ornithology
7.	Perrins, C.M., Birkhead, T.R. 1983. Avian Ecology. Chapman & Hall, New York
8.	Perrins, C. 2004. The new encyclopedia of birds. Oxford University Press.
9.	Proctor, N.S., Lynch, P.J. 1993. Manual of ornithology, Avian Structure and Function. Yale Univ. Press.
10.	
11.	Wiens, J.A. 1989. The ecology of bird communities. Vol. 1-2. Cambridge University Press. Whittaker, R.J., Fernandez-Palacios J.M. 2007. Island Biogeography Ecology, Evolution and Conservation. Oxford Univ. Press.

Supplementary reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Malcolm L. Hunter. 2002. Fundamentals of Conservation Biology. Blackwell publishing. 547 p.
2.	D. Linzey. 2001. Vertebrate Biology. McGraw-Hill. 530 p.
3.	Stravinskienė V. Bendorji ekologija. K., 2003. – 232 p.
4.	Lietuvos moksliniai žurnalai – Ekologija, Botanica Lithuanica, Miškininkystė
5.	Lietuvos fauna. Paukščiai. 1 ir 2 t. V.: Mokslas, 1990, 1991.
6.	Riklefs, R. 1975. Osnovi obščiej ekologiji. Maskva, 424 p.
7.	Raudonikis, L. 2004. Europos Sąjungos reikšmės paukščiams svarbios teritorijos Lietuvoje. K.: - Lututė.
8.	Žalakevičius M. Paukščių migravimas. V.: Mokslas, 1986.

9.	Ivanauskas T. Lietuvos paukščiai 1-3 T. V.: Mintis, 1957, 1959, 1964.
10.	Tucker, G.M., Evans, M.I. Habitats for birds in Europe. A conservation strategy for wider environment, Birdlife, 1997.

Course programme designed by

No.	Name, surname	Institution	Degree	E-mail address
1.	Gediminas Brazaitis	VMU-AA	dr.	gediminas.brazaitis@vdu.lt

Approved at the meeting of the doctoral committee of the program: 18 02 2022, Pr. No. 1 (124).

The description of the study subject is valid until 2026 February 28

COURSE DESCRIPTION

Course code	Volume in ECTS credits	Institution	Faculty	Department
MIŠ8007	7	VMU-AA	Forest Science and Ecology	Forest Science

Course title in Lithuanian

Rekreacinė miškininkystė

Course title in English

Forest Recreation

Study methods	Volume in ECTS credits
Lectures	4
Consultations	1
Seminars	1
Individual work	1

Short course annotation in Lithuanian (up to 500 characters)

Miško rekreacinės aplinkos ir jos rekreacinio naudojimo tyrimo, planavimo, darnaus tvarkymo bei apsaugos klausimai svarbūs šalies aplinkos strateginių siekinių įgyvendinimui. Kursas skirtas suteikti rekreacinės miškininkystės pagrindus fokusuojant studijas į antropogeninių tyrimų metodologijos ypatumus rekreacijos gamtoje klausimais, rekreacijos plėtros gamtoje sąlygas, gyventojų ir atvykstančių turistų rekreacinės reikmės bei veiklą miškuose; rekreacinių apkrovų nustatymą ir prognozavimą, medynų atsparumo rekreacinei apkrovai užtikrinimą ir kt.

Short course annotation in English (up to 500 characters)

To efficiently implement the national environmental strategy, it is important to gain knowledge on recent advance in recreational science, especially in forests being the most suitable environment for resilience and recreation. The course is aimed to provide the basis of forest recreation focusing on anthropological research methods in recreation in nature, recreational development conditions, regulation of recreational pressure and etc.

Relevance of the course

Recreation is one of the main ecosystem services provided by the forest. Recreational, urban forestry knowledge is essential to forming a network of future forest ecosystem services.

Course aims

To deepen and expand the knowledge and skills of master's studies in the field of research, planning, sustainable management and protection of the recreational environment of the forest and its recreational use.

Content (topics) and methods

1. Terminology, meaning, development, experience of forest recreation and concept in the context of multi-purpose forest use.
2. Peculiarities of anthropogenic research methodology in the field of recreation in nature; general methodological research system of recreational natural resources and their use.
3. Conditions for the development of recreation in nature (legal, cultural, socio-economic, etc.).
4. Recreational needs of residents and incoming tourists and activities in forests; identification and forecasting of recreational loads.
5. The concept of the system of territorial organization of recreation.
6. Evaluation of recreational resources in nature (forests, waters, relief, natural and cultural values, means of communication, etc.) (methodologies, scales, etc.).
7. Influence of holidaymakers and tourists on forest ecosystems.
8. Possibilities of forest spatial structure and tree species composition optimization and anthropoclimatic modeling.
9. Principles and experience of landscape architecture and planning of recreational areas.

10. System of organizational and economic measures for recreational areas.
11. Organizational arrangements.
12. Forest management measures.
13. Recreational equipment (infrastructure) facilities.

Structure of cumulative score and value of its constituent parts

Individual assignment 50%; Exams - 50 %

Compulsory reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Riepšas E. Rekreacinė miškininkystė (bendrasis vadovėlis aukštosios mokykloms), Kaunas : Lututė, 2012. – 2 p.
2.	Bell, S. Design for Outdoor recreation. – New York: Taylor & Francis, 2008. – 232 p. Hammit, W.E., Cole, D.N. Wildland recreation: Ecology and management, Second Edition. New York, etc., N.Y.: Wiley, 1998... xii. - 361 p. ISBN 0471194611
3.	Dahl, B., Molnar, D. Anatomy of a park (Essentials of Recreation Area Planning and Design). – Long Grove Illinois: Waveland press, INC, 2003.- 188 p.
4.	Russ, T. H. Site planning and design handbook. – London, 2009. – 215 p.

Supplementary reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Barth D. L. Parks and Recreation System Planning : A New Approach for Creating Sustainable, Resilient Communities. Washington, DC : Island Press. 2020 eBook.
2.	Forests and sustainable cities. Inspiring stories from around the world. Food and Agriculture Organization of the United Nations 2018. Forests and Sustainable Cities (fao.org) .
3.	Rekomendacijos rekreaciniams miškams tvarkyti (sudarytojas E. Riepšas). Vilnius : 2013. - p.
4.	Chavez, D. J. Adaptive Management in Outdoor Recreation // Serving Hispanic in Southern California Western Journal of Applied Forestry, Vol. 17, No. 3, 2002. - 129-133 p.
5.	Problemy turystyki i rekreacji w lasach Polski: Krajowa konferencja naukowa. Warszawa: Polskie towarzystwa lesne ..., 2000. - 270 p. ISBN 83-914188-20.
6.	Репшас, Э. Оптимизация рекреационного лесопользования: на примере Литвы. Москва: Наука, 1994. - 240 с. ISBN 5-02-004396-6.
7.	
8.	Douglass, R.W. Forest recreation. 2 nd ed. N.Y.:Pergamon press INC. New York, 1975. - 336 p. Turizmas : vadovėlis (autorių kolektyvo moksl. vadovas P. Grecevičius. Kaunas, 2002. – 240 p.
9.	Kaimo turizmo organizavimas: mokymo priemonė. Sudarė I.Vainienė. Vilnius: Eugrimas, 2001. - 400 p. ISBN 9986-752-99-x.
10.	Daujotaitė I. Kraštovaizdžio architektūros pagrindai. Vilnius : Technika, 1998. – 91 p.

Course programme designed by

No.	Name, surname	Institution	Degree	E-mail address
1.	Gediniminas Brazaitis,	VMU AA	dr.	gediniminas.brazaitis@vdu.lt
2.	Remigijus Žalkauskas	VMU AA	dr.	remigijus.zalkauskas@vdu.lt

Approved at the meeting of the doctoral committee of the program: 18 02 2022, Pr. No. 1 (124).

The description of the study subject is valid until 2026 February 28

COURSE DESCRIPTION

Course code	Volume in ECTS credits	Institution	Faculty	Department
MIŠ8021	7	VDU, ŽŪA	Forest Science and Ecology	Forest Science

Course title in Lithuanian

Sumedėjusių augalų ekologija

Course title in English

Ecology of woody plants

Study methods	Volume in ECTS credits
Lectures	3
Consultations	2
Seminars	1
Individual work	1

Short course annotation in Lithuanian (up to 500 characters)

Analizuojami sumedėjusių augalų ekologiniai ypatumai skirtingose augimo sąlygose. Supažindinama su atvirose vietose ir bendrijose augančių sumedėjusių augalų priežiūros metodais. Aiškinamasi svetimų rūšių augalų plitimą lemiantys veiksniai. Studijose doktorantai susipažins su naujausiais moksliniais tyrimų metodais, gautais rezultatais sumedėjusių augalų ekologijoje. Praktinių užsiėmimų metu bus lavinami įgūdžiai rinkti supančio dirvožemio, nuokritų mėginius, juos paruošti laboratoriniams tyrimams.

Short course annotation in English (up to 500 characters)

Ecological peculiarities of woody plants in different growth sites are analyzed. Introducing with methods for growing of woody plants in open spaces and communities. Factors determining the spread of alien species are explained. During the studies, the doctoral students will get acquainted with the latest scientific research methods, research results. In practicum PhD student will develop skills to collect soil samples, drop samples, and prepare them for laboratory testing.

Relevance of the course

The doctoral student will be able to apply new research methods and results in shaping new basic knowledge and ideas of forest science, urban forestry, landscaping.

Course aims

Will help doctoral students learn to assess the ecological characteristics of woody plants under different growth conditions.

Content (topics) and methods

The concept of ecology of woody plants.
 Review of research on ecology of woody plants.
 Geographical, climatic and edaphic factors.
 The influence of urbanization on the diversity, spread and health of woody plants.
 Practicum: Determination of the spread of invasive woody plants; Estimation of pruning effects on the quality of tree condition in an urbanized area; Sampling for laboratory testing.
 Lab works: Preparation of samples of different tree species- leaves, soil samples.
 Individual task; Preparation of the report.

Structure of cumulative score and value of its constituent parts

The 10-point cumulative rating system is applied according to the weighting coefficients. (0.1 - teaching practice and laboratory work; 0.4 - self-study; 0.5 - exam).

Compulsory reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Cadotte W., McMahon S. M. and Fukami T. Conceptual ecology and invasion biology: reciprocal approaches to nature. Springer, 2006, 505 p.

2.	Januškevičius L., Baronienė V., Liagienė D. Sumedėjusių augalų introdukcija ir aklimatizacija bei jų rezultatai ir perspektyvos Lietuvoje. Kaunas: 2006, 388 p.
3.	Lockwood J. L., Hoopes M. F., Martchetti M. P. Invasion Ecology. Blackwell, 2007, 304 p. Navasaitis M., Ozolinčius R., Smaliukas D., Balevičienė J. Lietuvos dendroflora. Kaunas: Lututė, 2003, 576 p.
4.	Navasaitis M. Dendrologija. Vilnius: Margi raštai, 2004, 856 p.
5.	Ruseckas J. 2002. Miško ir drėgmės sąveika. Kaunas. „Lututė“, 200 p.
6.	Stravinskienė V. 2003. Bendroji ekologija.-Kaunas: Šviesa, 232 p.
7.	Navasaitis M., Ozolinčius R., Smaliukas D., Balevičienė J. Lietuvos dendroflora. Kaunas: Lututė, 2003, 576 p.

Supplementary reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Dagys J. Augalų ekologija. Vilnius: Mokslas, 1980, 240 p.
2.	Danusevičius J. Pušies selekcija: kilmių atranka, introdukcija, hibridizacija, selekcinė sėklininkystė. Kaunas: Lututė, 2000, 352 p.
3.	Hodge, S.J. Urban Trees - A survey of street trees in England. London : HMSO, 1991.
4.	Hasenauer H., Glazda A., Konnert M., Lapin K., Mohren G., Spiecker H., Loo M., Potzelsberger E. Non-native tree species for European forests: experiences, risks and opportunities. BOKU: 2016, 419 p.
5.	Jankauskas M. Maumedžiai Lietuvos TSR miškuose ir parkuose ir jiems auginti perspektyvos. Vilnius: Valst.pol. ir moksl. lit. I-kla, 1954, 258 p.
6.	Jurkevičienė G. Lianos. Vilnius: 1997, 134 p.
7.	Kapustinskaitė T. Juodalksnynai. Vilnius: Mokslas, 1983, 227 p.
8.	Smaliukas D. Lietuvos gluosniai (Salix L.). Taksonomija, biologija, fitocenologija, biocheminės savybės ir išteklių. Vilnius: VPI I-kla, 1996, 254 p.
9.	Navasaitis M.(sud.), Straigyte L. Skinderiško dendroparkas. Kaunas: 2006, 200 p.
10.	Mokslinės duomenų bazės – Science Direct., Tylor & Francis, Springel LINK.
11.	Lietuvos moksliniai žurnalai – Miškininkystė, Žemės ūkio mokslai, Ekologija; Tarptautiniai žurnalai – Forest Ecology and Management, Dendrobiology, Baltic forestry, Urban Forestry and Urban Greening.

Course programme designed by

No.	Name, surname	Institution	Degree	E-mail address
1.	Lina Straigyte	VMU	Dr.	lina.straigyte@vdu.lt

COURSE DESCRIPTION

Course code	Volume in ECTS credits	Institution	Faculty	Department
MIŠ8022	7	VMU-AA	Forest Science and Ecology	Environment and Ecology

Course title in Lithuanian

Invazijų ekologija

Course title in English

Invasions Ecology

Study methods	Volume in ECTS credits
Lectures	1
Consultations	4
Seminars	1
Individual work	1

Short course annotation in Lithuanian (up to 500 characters)

Strateginis globalių antropogeninių ir klimato kaitos poveikio sukulto rūšių invazijos žalos ekologinis ir ekonominis vertinimas; invazijų teorijos; rūšių invazijos problemų ekosistemose sprendimas, ekosistemų būklės vertinimas pagal svetimžemių rūšių poveikį; invazinių rūšių poveikio bioįvairovei ir ekosistemų funkcionavimui vertinimas ir valdymas stabilizuojant ekosistemų bioįvairovę; sisteminių ir fundamentalių žinių apie invazinių rūšių plitimą, žalą bioįvairovei ir ekosistemoms; kompetencijos naujų ekologinių idėjų ir technologijų kūrimui ir vystymui

Short course annotation in English (up to 500 characters)

Strategic and economic assessment of the damage caused by global anthropogenic and climate change-induced invasions; theories of invasions; solving of species invasion problems in ecosystems, assessment of ecosystem status by alien species; assessing and managing the impact of invasive species on biodiversity and ecosystem functioning by stabilizing biodiversity in ecosystems; systemic and fundamental knowledge about the spread of invasive species, damage to biodiversity and ecosystems; competences for the development of new eco-ideas and technologies

Relevance of the course

Invasions ecology is relevant for PhD students in the field of Environment and Ecology to achieve their deeper competences and knowledge about ecosystems and their formation.

Course aims

Assessing the importance of species invasion phenomena for biodiversity of native species and ecosystems in a globally changing biosphere of the Earth, based on new fundamental knowledge; to identify causes, conditions and levels of species migration in different ecosystems; to assess the impact of various environmental factors on species invasion and ecosystem stability; to assess the influence of anthropogenic factors on biodiversity of alien species migration and local, natural, semi-natural and anthropogenic ecosystems; to adapt ecosystem knowledge for species invasion management; biological, ecological and economic assessment of the impact of alien species in order to preserve the biodiversity of ecosystems.

Content (topics) and methods

Reasons, effects, consequences and response of biological invasion. Coexistence of species. Alien species - landscape weeds. The significance of specific ecological conditions for coexistence of herbaceous and wood species. Models describing species diversity. Quantitative indicators of the control mechanisms regulating species diversity in communities. The connection of spatial environment with the coexistence of species. The relationship of species coexistence with the duration of environmental change. Classification systems of invasive species. The most important barriers of biological invasion. Naturalization and establishing levels of alien species.

Geographical-historical classification of invasive species. Division of anthropophytes by biotopes and naturalization level. Types of naturalized aliens. The direct economic impact of invasions. The impact of invasive species and problems caused by various sectors of practical human activity; the contribution of anthropogenic activities to the diversity and spread of alien species; ecology and control of introduced species. Invasive species regulation. International species invasion regulatory organizations. Regulation of international conventions, treaties, directives and codes. Regional and national regulation. Invasive and harmful databases. Involving the public in the management of invasive species. Invasive species in Europe. Alien species in Lithuania.

-Lectures, consultations, discussions during lectures, individual work
 - consultations (lectures can be read in case of sufficient number of PhD students)

Structure of cumulative score and value of its constituent parts

A ten-point scale and cumulative scoring scheme are applied. Self-study assignments (report on selected topic) are graded, final assessment is determined by examinations, multiplication of intermediate evaluations by weighting and product summing.

Compulsory reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Pimentel D. 2011. Biological Invasions. Economic and Environmental Costs of Alien Plant, Animal, and Microbe Species. 2nd ed., CRC Press, Taylor & Francis Group. 446.
2.	Cronk Q.C.B., Fuller J.L. (2001) Plant invaders: the threat to natural ecosystems. Island Press, Washington DC
3.	Davis M. A. Invasion biology. Oxford University Press, Oxford, 2009, 244 p.
4.	Handbook of Alien Species in Europe. Ed. J. A. Drake. 2009 Springer Science + Business Media B.V.
5.	McNeeley J. A., Mooney H. A., Neville L. E., Schei P. and Waage J. K. A Global Strategy on Invasive Alien Species, IUCN, Gland, Switzerland, 2001.
6.	Weber E (2003) Invasive plant species of the world: a reference guide to environmental weeds. CABI, Cambridge

Supplementary reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Colonisation, Succession and Stability. M. J. Crawley, P. J. Edwards and A. J. Gray (eds), Blackwell Scientific Publications, Oxford, 1987, 429.
2.	Invasive Species and Biodiversity Management, O. T.Sandlund, P. J. Schei, A. Viken (eds), Kluwer Academic Publishers, Dordrecht, 1999, 79.
3.	Clutton-Brock J. A Natural History of Domesticated Mammals, Cambridge University Press, Cambridge, 1999.
4.	Radosevich, S. R. , Holt, J. S., Ghera, C. M. Ecology of weeds and invasive plants : relationship to agriculture and natural resource management. 3rd ed. Hoboken [N.J.] : John Wiley & Sons, 2007.
5.	Heywood V. Global Biodiversity Assessment, Cambridge University Press, Cambridge, 1995

Course programme designed by

No.	Name, surname	Institution	Degree	E-mail address
1.	Ligita Baležentienė	VMU-AA	dr.	ligita.balezentiene@vdu.lt

Approved at the meeting of the doctoral committee of the program: 18 02 2022, Pr. No. 1 (124).

The description of the study subject is valid until 2026 February 28

COURSE DESCRIPTION

Course code	Volume in ECTS credits	Institution	Faculty	Department
MIS8023	7	VMU-AA	Forest Science and Ecology	Environment and Ecology

Course title in Lithuanian

Alelopatija

Course title in English

Allelopathy

Study methods	Volume in ECTS credits
Lectures	
Consultations	
Seminars	
Individual work	

Short course annotation in Lithuanian (up to 500 characters)

Biocheminių medžiagų svarbą organizmų komunikavime; biocheminės organizmų sąveikos teoriniai pagrindai; augalų ir kitų organizmų cheminė sąveika; alelopatinės sąveikos ekosistemose; cheminės alelopatinių medžiagų grupės ir jų formos; natūralios ir kultūrinės floros rūšių biocheminė sąveika; alelopatijos reikšmė ekofiziologiniams procesams ir ekosistemų tyrime ir valdyme; organizmų cheminė sąveiką - biologines kontrolės priemonė; biocheminės sąveikos laboratoriniai ir lauko tyrimai; naujų ekologinių idėjų ir technologijų vystymas ir taikymas praktikoje.

Short course annotation in English (up to 500 characters)

Importance of biochemicals in communication between organisms; theoretical fundamentals of biochemical interaction between organisms; chemical interaction between plants and other organisms; allelopathic interactions in ecosystems; chemical groups of allelopathic substances and their forms; biochemical interaction between natural and cultural flora species; significance of allelopathy in ecophysiological processes and ecosystem research and management; the chemical interaction of organisms - a biological control tool; biochemical interaction laboratory and field studies; development and application of new eco-ideas and technologies in practice.

Relevance of the course

Allelopathy knowledge is relevant for PhD students in the field of Environment and Ecology to achieve their deeper competences and knowledge about ecosystems and their formation.

Course aims

new fundamental knowledge of biochemical interaction between organisms in ecosystems; an assessment of the importance of biochemical interactions of organisms in biodiversity and regeneration of indigenous species and ecosystems; to know the causes, conditions and levels of species migration in different ecosystems; to evaluate the impact of various environmental factors on the phenomenon of allelopathy, ecophysiology of species, establishment and biodiversity, ecosystem stability; to evaluate the influence of anthropogenic factors on biochemical interaction in natural and anthropogenic ecosystems; to adapt the ecological knowledge of biochemical interactions to the management of biodiversity in different communities in order to preserve the biodiversity of ecosystems

Content (topics) and methods

Biochemical Interactions in Ecosystems. Biochemical Interactions of Organisms in Ecosystems. Allelopathy is an obstacle to competition. Infochemicals - Mediators of biochemical interaction. Types of Allelochemicals. The main groups of allelochemicals. Allelopathic Plant Interaction Plant Allelopathic Sensitivity. Chemical nature and function of plant allelopathic substances. Effects of the environment on the formation of secondary metabolites. Autotoxicity. Allelopathic interaction

between plants and microorganisms. Dynamics of Alchemicals in Plants. Laboratory and field studies. Mechanisms of action and ecological significance of allelochemicals. Mechanism of chemical protection. Detoxification of xenobiotics by plants: fitoremediation. Chemical interaction between plants and insects. Insect pheromones. Phenocenos phenomenon of allelopathy. Alelopathic effects of plant residues. Biochemical Interaction of Moners, Protists, Mushrooms, Mosses in Ecosystems Biochemical Interaction of Taxa of Different Organisms and Its Importance for Ecosystems. The role of allelopathy in the process of invading alien plants in terrestrial ecosystems. Interaction between allelopathy and abiotic and biotic stress; effect on ecophysiological processes. Consequences of ecological allelopathy.

- lectures;
- consultations (lectures can be read in case of sufficient number of PhD students)

Structure of cumulative score and value of its constituent parts

A ten-point scale and cumulative scoring scheme are applied. Self-study assignments (report on selected topic) are graded, final assessment is determined by examinations, multiplication of intermediate evaluations by weighting and product summing.

Compulsory reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Müller-Schwarze D. 2009. Hands-On Chemical Ecology. Simple Field and Laboratory Exercises. Springer-Verlag New York. 150.
2.	Cheema Z. A., M. Farooq, A. Wahid. Allelopathy. Current Trends and Future Applications. Springer -Verlag Berlin Heidelberg, 2013.
3.	Inderjit and Mallik A.U., Eds. 2002. Chemical Ecology of Plants: Allelopathy in Aquatic and Terrestrial Ecosystems. Springer Basel AG. 273.
4.	Harborne J. B. Introduction to Ecological Biochemistry, Academic Press, 2002, 318..
5.	Lambers H., F. S. Chapin, T. L. Pons. 2008. Plant Physiological Ecology. 2008, 2nd ed. Cambridge University Press, 610.
6.	Reigosa MJ, Pedrol N, González L., eds. 2006. Allelopathy: a physiological process with ecological implications. Kluwer Academic Publishers, Netherlands, 634.
7.	Reigosa M J, Pedrol N, eds. Allelopathy from Molecules to Ecosystems. 2002. Plymouth, UK: Science Publishers, Inc.
8.	Callaway R.M. 2007. Positive Interactions and Interdependence in Plant Communities. Springer, 419.

Supplementary reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Blum, U. Plant-plant allelopathic interactions: phenolic acids, cover crops and weed emergence. Dordrecht : Springer, 2011, 200 p.
2.	Fujii, Y. and Hiradate S. ed., 2007. Allelopathy, New Concepts and Methodology. Science Publisher, Enfield.
3.	Cardé R. T., Millar J.G. Advances in Insect Chemical Ecology. 2011, 352.
4.	Chapin, III, F. Stuart, Matson, P. A., Vitousek, P.M. Principles of Terrestrial Ecosystem Ecology. 2nd ed. Cambridge University Press, 2012, 2012, 529 p.
5.	Molisch H (1937) Der Einfluss einer Pflanze auf die andere—allelopathie. Fischer, Jena, Germany.
6.	Principles and Practices in Plant Ecology: Allelochemical Interactions. ed. K.M.M. Dakshini, C.L. Foy. Boca Raton : CRC Press, 1999. 589 p.

Course programme designed by

No.	Name, surname	Institution	Degree	E-mail address
1.	Ligita Baležentienė	VMU-AA	dr.	ligita.balezentiene@vdu.lt

Approved at the meeting of the doctoral committee of the program: 18 02 2022, Pr. No. 1 (124).

The description of the study subject is valid until 2026 Februa

COURSE DESCRIPTION

Course code	Volume in ECTS credits	Institution	Faculty	Department
MIS8024	7	VMU-AA	Forest Science and Ecology	Forest Science

Course title in Lithuanian

Tarptautinė miškų politika

Course title in English

International Forest Policy

Study methods	Volume in ECTS credits
Lectures	2
Consultations	1
Seminars	-
Individual work	4

Short course annotation in Lithuanian (up to 500 characters)

Kursas skirtas ugdyti miškų politikos, kaip sistemos, suvokimą, pagilinti žinias apie nacionalines, regionines bei globalias prielaidas bei ypatumus, turinčius įtakos miškų politikos formavimui, pagrindines nacionalines bei tarptautines institucijas, organizacijas ir susitarimus bei jų vaidmenį miško politikos formavime bei įgyvendinime.

Short course annotation in English (up to 500 characters)

The course is designed to improve understanding of forest policy as a system, provide knowledge about national, regional and global assumptions and peculiarities influencing formation of forest policy, the main national and international institutions, organisations and agreements as well as their role in formation and implementation of forest policy.

Relevance of the course

As the ecological, social and economic role of forests in Lithuania, Europe and the world grows, it is necessary to understand the context of forest policy environment and the essence of forest policy formulation and implementation, to be able to formulate forest policy models and tasks, to analyze factors affecting forest policy.

Course aims

To provide knowledge about the use and improvement of forests to meet societal needs in the world and in the European Union.

Content (topics) and methods

1. Concept of forest policy as system, subject, specificity, directions, process of formulation.
2. Characteristics of EU forest policy.
3. Characteristics of European forests, forest concept in international forest statistics, European forests in a global context.
4. The political context of European forestry and the characteristic changes in forest policy.
5. Forms of forest ownership, their advantages and disadvantages.
6. Problems of small-scale private forestry and measures to solve them.
7. International forest policy agreements.
8. Ministerial Conference on Forest Protection in Europe (MCPFE).
9. Public participation in forest policy decisions.
10. Concept, criteria and indicators of sustainable forestry.
11. National forestry programs.
12. Forest certification.
13. EU forestry strategy.
14. Forest legal acts, administration, financing and taxation models.

Structure of cumulative score and value of its constituent parts

Individual assignment - 30%; final exam - 70 %

Compulsory reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	The European Forest Sector Outlook Study II. 2010-2030. UNECE, FAO, Geneva, 2011. F. Schmithuesen, F. Hirsch. Private Forest Ownership in Europe. Geneva Timber and Forest Study Paper. ECE/TIM/SP/26. Geneva, 2010.
2.	European Forest Sector Outlook Study: 1960-2000-2020 Main Report. Geneva Timber and Forest Study Paper 20. -UNECE, Geneva, 2005. 235 p.
3.	The EU Forest Action Plan 2007-2011. EC, 2006.
4.	People, Forests and Sustainability. Social Elements of Sustainable Forest Management in Europe. ILO, Geneva, 1997
5.	Public Participation in Forestry in Europe and North America. ILO. WP.163. Geneva, 2000. MCPFE. Vienna Declaration and Vienna Resolutions. Vienna, 2003.
6.	I. Tikkanen, B. Pajari. Future Forest Policies in Europe – Balancing Economic and Ecological Demands. EFI Proceedings No. 22. Joensuu, 1998.
7.	Krott M. Forest Policy Analysis. - 2010. 323 p.

Supplementary reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	P.V. Ellefson. Forest Resources Policy. Process, Participants and Programs. NY, 1992.
2.	European Forest Sector Outlook Study: 1960-2000-2020 Main Report. Geneva Timber and Forest Study Paper 20. -UNECE, Geneva, 2005.
3.	Thoroé C., Peck T., Corredor H.G. and Schmithüsen F. The Policy Context of the European Forest Sector. Geneva Timber and Forest Discussion Paper 34. -UNECE, Geneva, 2006.
4.	Sustainable Forestry and the European Union: Initiatives of the European Commission. -Luxembourg, 2003.
5.	Forestry and our cultural heritage. Proceedings of the seminar, 13-15 June, 2005, Sunne, Sweden. Warsaw, 2006.

Course programme designed by

No.	Name, surname	Institution	Degree	E-mail address
1.	Marius Kavaliauskas	VDU-AA	Dr.	marius.kavaliauskas@vdu.lt

Approved at the meeting of the doctoral committee of the program: 18 02 2022, Pr. No. 1 (124).

The description of the study subject is valid until 2026 February 28

COURSE DESCRIPTION

Course code	Volume in ECTS credits	Institution	Faculty	Department
MIS8025	7	VMU-AA	Forest Science and Ecology	Forest Science

Course title in Lithuanian

Globali kaita ir miškų būklė

Course title in English

Global changes and forest condition

Study methods	Volume in ECTS credits
Lectures	2
Consultations	1
Practice	1
Individual work	3

Short course annotation in Lithuanian (up to 500 characters)

Kurso metu analizuojamas aplinkos globalios kaitos, įskaitant klimata, oro taršą ir rūgščiąsias iškritas bei pažemio ozoną, poveikis miško ekosistemų pagrindiniams komponentams: medžių būklei ir prieaugiui, epifitinių kerpių ir žaliųjų oro dumblių gausai, bei dirvožemio pedobiontams ir upelio makrobentosui. Praktinių užsiėmimų metu supažindinama su Aukštaitijos kompleksiško monitoringo stoties veikla bei ES šalių inicijuota kompleksiško monitoringo programa. Įsigilinama į medžių būklės ir produktyvumo tyrimus bei remiantis medžių momentinėmis ekofiziologinėmis reakcijomis, nagrinėjami veiksniai turintys reikšmingos įtakos jų kaitai.

Short course annotation in English (up to 500 characters)

The course is designed to overview and analyse the effect of environmental global changes on forest ecosystems. The course covers forest tree health, productivity and their relationships with environmental factors as well as interrelationships between biotic and abiotic components of the forest ecosystem. Based on the results of the ecophysiological reactions of different tree species causation between environmental factors and changes in tree condition and increment are presented. The field trip to Aukštaitija Integrated monitoring station is intended to acquaint the students related to the aim of the UN ECE ICP programme and research conducted in the station.

Relevance of the course

The course helps the PhD students to understand processes of environmental global changes, key factors and main equipment and procedures applied for monitoring their tendencies and trends. The students will acquire competence in defining, assessing, analyzing and discussing various problems related to climate warming, changes in air pollution and acid deposition as well as interaction and synergies among VOC emitted by stressed trees, surface ozone and CO₂ air concentrations and use this knowledge in practice, suggesting environmental protection measure and assessing the effect environmental changes on different components of forest biota, including forest health and productivity. Dendrochronological approach is presented for the detection of the effect of environmental changes on tree rings formation. Having completed this course the students will know how to apply their theoretical and methodological knowledge and skills in research.

Course aims

The aim of the course - to gain knowledge, understanding and practical skills in the area of global changes, synergies between environmental factors which enhance or inhibit their effect on different components of forest ecosystem main attention paying on climate warming, air pollutants, acid deposition, surface ozone and their integrated effect on tree condition, increment epiphytic lichens, green algae and soil pedobionts diversity and abundance.

Content (topics) and methods

Lectures:

Topic 1. Environmental factors: climate change, global, regional and local pollution level, long range transboundary air pollution; their interrelationships.

Topic 2. Emissions: international legislation and conventions aimed at reduction of the environmental pollution level, new threats for forest ecosystem.

Topic 3. Air pollution: acid components, acid deposition and base cation; effect of meteorology on scattering of pollutants; effect of acid deposition on geochemical processes in soil; direct and indirect effect of acidifying compounds on different biotic components of forest ecosystems; critical concentrations and load; tree condition, crown defoliation, tree stem radial increment.

Topic 4. Surface ozone, its formation and main tendencies, interrelationships between VOC emitted by stressed trees, nitrogen oxide and CO₂; effect of climate warming on enhancing of formation of surface ozone; its phytotoxic effect on plant and trees; ozone flux content; transpiration rate and changes in increment; critical ozone flux, AOT40 and AOT80; effect of surface ozone on different biotic components of forest ecosystem. Experiences from Aukštaitija Integrated monitoring station.

Topic 5. Tree transpiration rate. Radial increment of tree stem. Hourly, diurnal, weekly and seasonal variation in tree stem circumference. Interrelationships between transpiration rate and tree stem increment. Increment of prevailing in Lithuania tree species. Water use efficiency – bioindicator of tree capacity to adapt to global environmental changes and mitigate their new threats.

Topic 6. Climate change: most significant changed meteorological parameters, their integrated effect on environmental processes and forest sustainability, including tree condition and their capacity to adapt to climate changes and mitigate their new threats. The significance of the gradual increase in CO₂ concentration and their sequestration in forest ecosystem.

Field trip: Aukštaitija Integrated monitoring station;

ICP Integrated monitoring of forest ecosystem, its conception, aim, and objectives, key methodological approach, measures and equipment;

Air chemistry, precipitation chemistry, climatic parameters and their changes;

Soil chemistry, main tendencies and key factors resulting them;

Soil, ground and surface water, their chemical composition, key factors resulting them;

Mass balance of the main nutrition and pollutants components;

Tree condition – crown defoliation. Radial increment of tree stem. Measure and methods.

Dendrochronology and increment analysis.

Bioindicators of forest condition: epiphytic lichens, green algae, herbs – species diversity and abundance, key factors.

Individual tasks:

Search of the main tendencies in environmental factors.

Dendrochronological analysis of the tree ring width series. Detection of key environmental factors which have the most significant effect on tree ring formation.

Study methods:

Lectures, consultations and practical tasks at Aukštaitija Integrated Monitoring Station.

State of knowledge based on references analysis, publication and presentation of the recommendations for review preparation.

Structure of cumulative score and value of its constituent parts

Practical task at Aukštaitija IMS 20%, Individual tasks - 30%; final exam - 50 %.

Compulsory reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Forest Condition in Europe: 2018 Technical Report of ICP Forests. https://www.researchgate.net/publication/328956391_Forest_Condition_in_Europe_2018_Technical_Report_of_ICP_Forests_Report_under_the_UNECE_Convention_on_Long-Range_Transboundary_Air_Pollution_Air_Convention
2.	Miško ekologija. 2008. Sudarytojas S.Karazija. Vilnius, Enciklopedija, 296 p.
3.	V.A.Šlapakauskas. 2006. Augalų ekofiziologija. Lututė, 412 p.
4.	R.Ozolinčius. 1998. Lietuvos spygliuočiai: morfologinės struktūros transformacijos bei jas

	indikuojantys veiksniai. Kaunas, Lututė, 300 p.
5.	V.Marozas. 2008. Sausumos ekosistemų įvairovė ir apsauga. Lietuvos žemės ūkio universitetas, 246 p.
6.	Sąlygiškai natūralių ekosistemų kompleksiškas monitoringas. 2006. Sudarytojas A.Augustaitis. Aplinkos apsaugos agentūra, 112 p.
7.	Lietuvos miškų būklė ir ją sąlygojantys veiksniai. Monografija. Redakcinė kolegija: R.Ozolinčius, K.Armolaitis, A.Augustaitis, L.Kairiūkštis, V.Stakėnas, M.Vaičys. Kaunas 1999, 308 p.
8.	Study on impacts of climate change on European forests. http://ec.europa.eu/agriculture/analysis/external/euro_forests/factsheets_en.pdf .

Supplementary reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Publication on internet. Key words: <i>forest ecosystem, climate change, acid rain, acid deposition, surface ozone, forest health</i> . http://www.sciencedirect.com/
2.	Forest health and global change. S. Trumbore, P. Brando, H. Hartmann. <i>Science</i> 21 Aug 2015: Vol. 349, Issue 6250, pp. 814-818. DOI: 10.1126/science.aac6759
3.	Forest health in a changing world: Effects of globalization and climate change on forest insect and pathogen impacts. T. D. Ramsfield; Barbara Bentz https://doi.org/10.1093/forestry/cpw018
4.	"Forests, health and climate change" is now ready to be downloaded at https://www.eea.europa.eu/downloads/3578ec8a-c6a2-40ab-8b21-e468a52b5b60/1500283255/forests-health-and-climate-change.pdf

Course programme designed by

No.	Name, surname	Institution	Degree	E-mail address
1.	Algirdas Augustaitis	VMU-AA	prof. dr.	algirdas.augustaitis@vdu.lt

Approved at the meeting of the doctoral committee of the program: 18 02 2022, Pr. No. 1 (124).

The description of the study subject is valid until 2026 February 28

COURSE DESCRIPTION

Course code	Volume in ECTS credits	Institution	Faculty	Department
MIS8026	5	VMU-AA	Forest Science and Ecology	Forest Science

Course title in Lithuanian

Mokslinių straipsnių rašymas ir leidyba

Course title in English

Writing and publishing scientific articles

Study methods	Volume in ECTS credits
Lectures	2
Consultations	1
Seminars	1
Individual work	1

Short course annotation in Lithuanian (up to 500 characters)

Daugiausia dėmesio bus skiriama pagrindiniams mokslinių tyrimų projektavimo, planavimo ir rašymo įgūdžiams, ypač apie tai, kaip rašyti loginius ir glaustus sakinius, pastraipas ir skyrius naudojant IMRAD. Kursas studentams suteiks praktinių įrankių rinkinį esminiam teksto analizės ir redagavimo darbui, kurio reikia norint paruošti parengtą rankraštį. Rašymo modeliai ir požiūris į rašymą bus išsamiai aptarti, pabrėžiant, kad mokslinis rašymas yra įgytas įgūdis, kurį galima tobulinti sąmoningai ir struktūrizuotomis pastangomis.

Short course annotation in English (up to 500 characters)

Major focus will be placed on basic research design, planning and writing skills, particularly on how to write logic and concise sentences, paragraphs and sections using IMRAD. The course will provide the students with a set of hands-on tools for the essential text analysis and editing needed to produce a submission ready manuscript. Writing models and attitude toward writing will be discussed in depth, emphasizing that scientific writing is an acquired skill that can be refined by conscious and structured efforts.

Relevance of the course

The doctoral student should be able to write and publish a scientific paper, presents the results in scientific meetings and be able to find relevant information in the science data bases

Course aims

The overall objective of the course is to provide training for the doctoral students to write scientific manuscripts for publication in international peer-review journals, find relevant information in scientific data bases and present the results in scientific meetings.

Content (topics) and methods

- Lectures about how a suite of published papers developed from study design to publication in high impact factor journals
- Lectures on type, structure of scientific papers and the processes of revision prior to submission, submitting of the manuscript, the peer-review process, as well as acceptance, revision and rejection, including presentation of review of arguments to the editors.
- Practical lessons about how to design a scientific presentation, where students will make own presentations based on the content of their manuscripts.
- Practical lessons about scientific data bases and how to find relevant information for citing in own scientific papers
- Group discussions and activities where students present their work and the class actively discuss the presentations and lists of content.
- Assignment on manuscript submission for a high impact factor journal

Structure of cumulative score and value of its constituent parts

Practicums (0.5), Individual assignment (0.5)

Compulsory reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Gastel, B., & Day, R. A. (2016). How to write and publish a scientific paper. ABC-CLIO.
2.	Lichtfouse, E. (2013). Scientific writing for impact factor journals. Nova Science Publishers.
3.	Ecological Applications (2017). Author Guidelines. Wiley. https://esajournals.onlinelibrary.wiley.com/hub/journal/19395582/resources/author-guidelines-eap
4.	Journal of Environmental management. (2017). Author Guidelines. Elsevier https://www.journals.elsevier.com/journal-of-environmental-management

Supplementary reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Fox, N. (2011). Little Book of Scientific Writing. New Street Communications, LLC.
2.	Hyldgard, H., Ebdrup, E., Andersen, MM. & Petersen, IB. (2014). Share your research: a hands on guide to successful Science communication. Ajour and Science Nordic, Denmark.

Course programme designed by

No.	Name, surname	Institution	Degree	E-mail address
1.	Michael Manton	VMU-AA	Dr.	michael.manton@vdu.lt
2.	Darius Danusevičius	VMU-AA	Prof. dr.	Darius.danusevicius@vdu.lt

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COURSE DESCRIPTION

Course code	Volume in ECTS credits	Institution	Faculty	Department
MIS8027	7	VMU-AA	Forest Science and Ecology	Forest Science

Course title in Lithuanian

Nuotoliniai metodai

Course title in English

Remote sensing

Study methods	Volume in ECTS credits
Lectures	2
Consultations	1
Practicums	1
Individual work	3

Short course annotation in Lithuanian (up to 500 characters)

Šiame kurse nagrinėjami nuotolinių tyrimų – vienos iš geomatikos disciplinų – teoriniai bei taikymų miškotyroje ir aplinkos tyrimuose praktiniai pagrindai. Nagrinėjamos šiuolaikinės nuotolinių tyrimų sistemos, jų veikimo principai, nuotolinių tyrimų duomenų rinkimo būdai, jų apdorojimo metodiniai sprendimai ir gautos informacijos integravimas į GIS. Taip pat nagrinėjami specifiniai nuotolinių tyrimų duomenų rinkimo bei apdorojimo sprendimai, susiję su doktoranto moksliniais interesais.

Short course annotation in English (up to 500 characters)

This course deal with fundamentals and application of remote sensing, considering the subject as one of key disciplines in geomatics, with specific focus on forestry and environmental applications. Modern remote sensing systems are introduced, discussing the principles they are based on, followed by the the principles of remotely sensed data collection, methodological solutions of extracting information from the data and its integration into geographic information systems. Depending on specific research interests of PhD students, specific data collection and processing solutions are analysed.

Relevance of the course

Remote sensing is one of the key techniques for collecting geographic data. Numerous monitoring systems in forestry and environmental research are built on use of remote sensing. This course is assumed for PhD students with research interests requiring more deep knowledge and skills in collecting and processing geographic data.

Course aims

To improve the understanding of fundamental concepts and operational solutions of remote sensing, as of one of disciplines in geomatics, to be able to use such techniques for forestry and environmental research.

Content (topics) and methods

Lectures:
Lecture 1. Remote sensing as one of disciplines of geoinformation science. Fundamentals of remote sensing.
Lecture 2. Remote sensing systems based on aerial photography. Digital aerial imaging, parameters of platforms and sensors.
Lecture 3. Photogrammetry. Characteristics of aerial images, parallaxes, why one needs for orthophotos, production of orthophotos.
Lecture 4. Visual interpretation of remotely sensed images. Stereo-photogrammetric measurements on aerial images.
Lecture 5. Multi-spectral, hyper-spectral and thermal sensors.

Lecture 6. Space-borne remote sensing platforms. Acquisition of satellite image.
 Lecture 7. Principles of processing of digital images.
 Lecture 8. Peculiarities of processing digital multi-spectral remotely sensed images in forestry (or other fields of application, depending on research interests of PhD student).
 Lecture 9. Peculiarities of processing digital hyper-spectral remotely sensed images in forestry (or other fields of application, depending on research interests of PhD student).
 Lecture 10. Laser scanning. Peculiarities of processing digital laser scanning data in forestry (or other fields of application, depending on research interests of PhD student).
 Lecture 11. Integration of remote sensing and geographic information systems.
 Lecture 12. Planning project based on remote sensing: data acquisition and processing planning, monitoring remote sensing project, sources of remote sensing data.
 Lecture 13. Examples of remote sensing application in Lithuanian (global) forestry (or other fields of application, depending on research interests of PhD student).
 Lecture 14. Future perspectives of remote sensing in the fields, relevant for PhD student.

Practicums:

Acquisition of remotely sensed data (mission planning for imaging, data search on geographic data warehouses or special data ordering systems).
 Pre-processing of remotely sensed data 1 (orthophoto production).
 Pre-processing of remotely sensed data 2 (radiometric and geometric corrections, enhancement and transformations).
 Processing of remotely sensed data using numerical approaches (depending on specific needs of PhD student, the focus may be on visual or computer interpretation of aerial images, processing multi- or hyper-spectral images, processing of laser point clouds, etc.).
 Integration of achieved information into further research.

Individual assignment

Individual assignment is given depending on specific needs of PhD student. Individual assignment could be combined with the practicums.

Structure of cumulative score and value of its constituent parts

Practicums – 20%, individual assignment - 20%; final exam - 60 %

Compulsory reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Lillesand T.M., Kiefer R.W., Chipman J.W., 2015, Remote Sensing and Image Interpretation, Seventh Edition, John Wiley & Sons, Inc., 756 p.
2.	Mozgeris G., Dumbrasukas A., Jonikavičius D., 2014, Geoinformacinių sistemų pagrindai. Mokomoji knyga, Aleksandro Stulginskio universitetas.
3.	Mozgeris, G., 2010, Nuotoliniai metodai. Laboratorinių darbų aprašas, Lietuvos žemės ūkio universitetas, Aplinkos institutas, Miškų ir ekologijos fakultetas.

Supplementary reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Daniulis J. Aerofotometodai: aerofotonuotraukų dešifravimas. Vadovėlis aukštųjų mokyklų studentams.- Vilnius: Enciklopedija, 1998. - 248 p.
2.	Сухих В.И., 2005, Аэрокосмические методы в лесном хозяйстве и ландшафтном строительстве. Учебник, 390 с.
3.	Činga G., Deltuvas R., Kuliešis A., Mankus R., Mažeika J.A., Mozgeris G., Puodžiūnas M., Rutkauskas A., Tebėra A., Vitunskas D., Miško naudojimas ir logistika. Vadovėlis, Akademija (Kauno raj.), 2008, 400 p.
4.	P.A. Longley, M.F. Goodchild, D.J. Maguire, D.W. Rhind, 2011, Geographic Information Systems and Science, 3rd edition, Wiley, 539 p.
5.	Scientific publications from Science Direct, EBSCOhost Web

Course programme designed by

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1.	Gintautas Mozgeris	VMU-AA	Dr.	gintautas.mozgeris@vdu.lt
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