COURSE DESCRIPTION

Course code	Volume in ECTS credits	Institution	Faculty	Department
AGR8001	8	VDU ŽŪA	Agronomy	Agroecosystems and Soil Science

Course title in Lithuanian

Agronominių tyrimų planavimas ir analizė

Course title in English

Agronomy Research Methodology

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

Short course annotation in Lithuanian (up to 500 characters)

Dalykas skirtas pirmųjų metų doktorantams. Dalyko tikslas - suteikti doktorantams agronominio mokslinio tyrimo savarankiško planavimo, atlikimo, duomenų statistinės analizės, rezultatų vertinimo ir interpretavimo žinių ir ugdyti gebėjimus, reikalingus rengiant daktaro disertaciją ir toliau savarankiškai dirbant mokslinį darbą. Dalyko studijų formos: paskaitos, pratybos, konsultacijos, pasirengimas kontroliniam darbui, individualiosios užduoties atlikimas, pasirengimas egzaminui.

Short course annotation in English (up to 500 characters)

The subject is delivered for the first year PhD students. The aim of the course is to provide PhD students with knowledge and abilities of autonomous agronomic research planning, statistical evaluation and interpretation of the research results. These knowledge and abilities are important in doing research and writing PhD degree theses and in future autonomous research work. The studies of the subject include lectures, practicums, consultations, preparation for intermediate test, completion of individual assignment, preparation for examination.

Relevance of the course

The course helps for PhD students to plan, conduct investigation, make statistical analyses of research data, compile conclusions, write publications and PhD theses.

Course aims

1. To develop knowledge and their application:
   - Theoretical and practical aspects of the general and specific agronomic research methods;
   - Theoretical and practical aspects of the experimental design, conducting of the experiments and experimental statistics;
   - Recommendations and requirements for writing scientific articles and doctoral theses.
2. To develop research abilities:
   - To formulate research problem, title, hypothesis, goal and objectives, choose the appropriate agronomic research methods;
   - To plan one and several factors experiments, to choose proper statistical methods for the analysis of the experimental data;
   - To develop research methodology, to choose and present statistical indicators in the scientific publications;
   - To prepare the data for statistical analysis, to choose computer programs for statistical data analyses according to the experiment design;
   - To formulate conclusions, consistent with the experimental data and the results of statistical analysis.
3. To develop social abilities:
   - To communicate with colleagues, the scientific community and the public providing innovative information in the field of research.
4. To develop personal abilities:

- To design own future learning perspective, to take responsibility, critically to evaluate his own strategic solutions;
- To develop creative intellectual personal competences.

Content (topics) and methods

Lectures

1. Introduction. Science and its role, unity of research planning and statistical analysis.
2. Agronomic Research Methods: advantages and disadvantages.
3. Research process and it's planning.
4. The scientific information sources and search possibilities.
5. Experiment planning: theoretical and practical aspects.
6. Planning and conducting of field experiment.
7. Specifics methods of agronomic research.
8. Data preparation for statistical analysis.
9. Population and sample: concepts and statistical indicators.
10. Statistical distributions and their application in experimental statistics.
11. Data grouping, population parameters and sampling statistics.
12. Mean and other measures of central tendency.
13. Testing of null hypothesis.
14. Assumptions of ANOVA and regression analysis.
15. The research data transformation.
16. ANOVA application for the assessment of agronomic research data.
17 Regression and correlation analysis application for the assessment of agronomic research data.
18. Presentation of statistical analysis results in the scientific publications.
19. Writing of research publications and theses.

Practicums

1. Sample statistical indicators, confident interval and t test.
2. Assumptions of statistical analysis and data transformation.
3. Single and multi-factor ANOVA.
4. Regression and correlation analysis.

Methods of learning

Lecture material is visualized using multimedia and blackboard. Students are involved in the debate, either individually or by groups. Groups are also given the task under the studied material, they prepare and present the tasks performed. After each presentation the discussion is organized. Each doctoral student gets individual task: to choose and describe research methods according to the dissertation topic. Students review each other's research methodologies developed. During the practicums the tasks are given using real research data. Doctoral students carry out tasks independently using software packages and in consultation with the teacher in the computer room. Doctoral students have to formulate conclusions drawn from the results of tasks performed. They present the results of practicums using computer programs. Doctoral students are additionally consulted in accordance with the agreed schedule and by IT means. In the absence of a minimum number of doctoral students the subject studies are organized through consultation.

Structure of cumulative score and value of its constituent parts

The final assessment consists of: practicums - 10%, individual task - 15%, interim assessment (colloquium) - 15%, exam - 60%.

Compulsory reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Hoshmand A. R. Design of experiments for agriculture and the natural sciences. – Chapman & Hall/CRC, USA, 2006
2.	Kardelis K. Mokslinių tyrimų metodologija ir metodai (penktasis leidimas), 2016
3.	Mokslinės metodikos inovatyviems žemės ir miškų mokslų tyrimams. Kaunas, Lututė, 2013
4.	Palaniswamy U. R., Palaniswamy K. M. Handbook of statistics for teaching and research in plant and crop science, USA, The Haworth Press, Inc., 2006

5.	Raudonius S. Mokslinių tyrimų planavimas ir analizė. – Akademija, 2008
6.	Rowena M. How to write a theses.-Great Britain, Open University Press, 2003
7.	Welham S. J., Gezan S. A., Clarks. J., Mead A. Statistical Methods in Biology: Design and analysis of Experiments and Regressions, CRC Press, 2015.
8.	Wu J. and Hamada M. S. Experiments: planning, analysis, and optimization. Wiley Series in Probability and Statistics, 2009

Supplementary reference materials

No.	**Authors of publication, title, publishing house, year of publication.**
1.	Box G. E. P., Hunter J. S., Hunter W. G. Statistics for experimenters: design, discovery, and inovation. John Wiley & Sons, USA, 2005
2.	Clewer Alan G., Scarisbrick David H. Practical statistics and experimental design for plant and crop science. – England, John Wiley and Sons, LTD, 2001
3.	Čekanavičius V., Murauskas G. Statistika ir jos taikymai I. – V., TEV, 2001
4.	Čekanavičius V., Murauskas G. Statistika ir jos taikymai II. – V., TEV, 2002
5.	Onofri A., Carbonell E. A., Piepho H-P., Mortimer A. M., Cousens R. D. Curent statistical issues in weed research. Weed Research, 2010, v. 50, No 1, p. 5-24
6.	Heath D. An Introduction to experimental design and statistics for biology. – Great Britain, UCL Press Ltd.,1988
7.	Larry B. Christensen. Experimental methodology. – USA, Allyn and Bacon, 1997
8.	Mann P. S. Introductory statistics. – John Wiley & Sons, Inc, USA, 2007
9.	Mead R., Curnow R.N. and Hasted A.M. Statistical methods in agriculture and experimental biology. Great Britain: T.J. Press Ltd., 1993
10.	Hoshmand A. Reza. Experimental research design and analysis: a practical approach for agricultural and natural sciences. – USA, CRC Press, 1994
11.	Mann P. S. Introductory statistics. John Wiley & Sons, Inc, USA, 2007
12.	Sokal Robert R. and Rohelf F. Biometry: the principles and practice of statistics in biological research. –New York: W.H. Freeman and Company, 1995
13.	Raudonius, Steponas. Application of statistics in plant and crop research: important issues // Žemdirbystė = Agriculture / Lietuvos agrarinių ir miškų mokslų centras, Aleksandro Stulginskio universitetas. Akademija, T. 104, Nr. 4 (2017), p. 377-382.
14.	Tarakanovas P., Raudonius S. Agronominių tyrimų duomenų statistinė analizė taikant kompiuterines programas ANOVA, STAT, SPLIT-PLOT iš paketo SELEKCIJA ir IRSTAT. – Akademija, 2003
15.	Velička R., Raudonius S., Marcinkevičienė A., Trečiokas K. Lauko bandymų planavimas ir atlikimas. Metodinė priemonė. – Akademija, 2004

Course programme designed by

No.	**Name, surname**	**Institution**	**Degree**	**E-mail address**
1.	Rita Pupalienė	VDU ŽŪA	Assoc. prof., dr.	rita.pupaliene@vdu.lt
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3.	Darija Jodaugienė	VDU ŽŪA	Assoc. prof., dr.	darija.jodaugiene@vdu.lt
4.	Daiva Rimkuvienė	VDU ŽŪA	Assoc. prof., dr.	daiva.rimkuviene@vdu.lt
5.	Kęstutis Romaneckas	VDU ŽŪA	Prof. dr.	kestutis.romaneckas@vdu.lt

Approved at the meeting of **VMU Faculty of Agronomy Institute of Agroecosystems and Soil Sciences on** 19 04 2019, protocol No. 6(6).

Approved in the meeting of the programme's Doctoral Studies Committee on 03 05 2019, protocol No. 138.

Description of the subject has been certified until 30 06 2023

COURSE DESCRIPTION

Course code	Volume in ECTS credits	Institution	Faculty	Department
AGR8002	8	VMU AA	Agronomy	Agroecosystems and Soil Sciences

Course title in Lithuanian

Žemės ūkio augalų produktyvumo biologija

Course title in English

The Biology of Crop Productivity

Study methods	Volume in ECTS credits
Lectures	4
Consultations	1
Individual work	3

Short course annotation in Lithuanian (up to 500 characters)

Dalykas skirtas pirmųjų metų doktorantams. Dalyko tikslas – suteikti doktorantams žinių apie naujausius augalų produktyvumo biologijos mokslo pasiekimus ir ugdyti gebėjimus interpretuoti agronominio mokslinio tyrimo rezultatus, modeliuoti augalų produktyvumą ir produkcijos kokybę, ugdyti gebėjimus, reikalingus rengiant daktaro disertaciją ir toliau savarankiškai dirbant mokslinį darbą. Dalyko studijų formos: paskaitos, pratybos, konsultacijos, seminarai, pasirengimas kontroliniam darbui, individualiosios užduoties atlikimas, pasirengimas egzaminui.

Short course annotation in English (up to 500 characters)

The subject is intended for first-year doctoral students. The aim of the subject is to provide doctoral students with knowledge about the latest achievements in plant productivity biology and to develop skills to interpret the results of agronomic research, model plant productivity and product quality, develop skills required for doctoral dissertation and further independent research. Forms of study of the subject: lectures, exercises, consultations, seminars, preparation for control work, performance of individual task, preparation for exam.

Relevance of the course

The subject helps doctoral students to plan, model and conduct research, select appropriate research methods to determine plant productivity, interpret and summarize the obtained research results, formulate conclusions, prepare scientific publications and doctoral dissertation.

Course aims

To provide knowledge of the latest achievements of biology of plant productivity and abilities to interpret the results of agronomic research, to model plant productivity and production quality; to identify morphogenetic, organogenetic, phenological and physiological parameters of plant ontogenesis associated with plant productivity.

Content (topics) and methods

Lectures:

1. Factors of plant productivity:

1.1. A general knowledge about the plant yield.
1.2. Botanical peculiarities of agricultural plants.
1.3. Ontogenesis of agricultural plants.
1.4. The genetic determination of the productivity.
1.5. Plant resistance to biotic and abiotic factors.
1.6. Biology of the whole plant.
1.7. Physiology of plant production.
1.8. The plant yield, harvest index, modelling.

2. Biological peculiarities of agricultural plants:

2.1. Biology of vegetable production.
2.2. Biology of garden plants production.
2.3. Biology of Poaceae crop production.
2.4. Biology of Fabaceae crops production.

2.5. Biology of rapeseed production.
2.6. Biology of sugar beet production.
2.7. Biology of potato production.

Study methods:
Lectures are given using a problematic, visualized teaching method, visualizing the material using multimedia and a whiteboard. If necessary, lectures are given remotely using remote meeting software (MS Teams, Zoom, etc.). During the lectures, the methods of case analysis and brainstorming are applied. Students participate in discussions individually or in groups. The groups are also given tasks based on the researched material, they prepare and present the completed tasks. A discussion is organized after each presentation. Each doctoral student receives an individual task: based on the acquired knowledge, agrobiological laws and regularities, the doctoral student biologically substantiates the hypothesis of his / her scientific dissertation topic, the provisions formulated in the goal and objectives and makes a public presentation in the group. Students review each other's individual tasks, assess the validity of the hypothesis and research tasks. During the practicums, doctoral students are introduced to plant productivity research methods, scientific laboratories and advanced research laboratory equipment. Doctoral students formulate conclusions drawn from the results of the tasks performed. They present the results of practicums using computer programs. Doctoral students are additionally consulted according to the agreed schedule and by IT tools. In the absence of a minimum number of doctoral students, subject studies are organized through consultations.

Structure of cumulative score and value of its constituent parts

A criterion ten-point scale and a cumulative assessment system are used to assess student achievement. Assessments are performed in accordance with the provided criteria for the assessment of the study results of the subject. The final assessment consists of: control work – 20%, individual task – 30%, exam – 50%.

Compulsory reference materials

No.	**Authors of publication, title, publishing house, year of publication.**
1.	Šlapakauskas V., Duchovskis P. Augalų produktyvumas. LŽŪU, 2007, 253 p.
2.	Šlapakauskas V. Augalų ekofiziologija. K.: Lututė, 2006, 430 p.
3.	Wallace D. H. Plant Breeding and Whole System Crop Physiology: improving crop maturity, adaptation and yield. New York: CAB, International, 1998, 390 p.
4.	Fageria N. K., Baligar V. C., Clark R. B. Physiology of crop production. USA, Food Product Press, 2006, 345.
5.	Fitter A. H., Hay R. Environmental Physiology of Plants. S. D., S. F., N. Y., B. L., S.T. Academic press, 2002, 367.
6.	Hay R., Porter J. The physiology of crop yield. Blackwell publishing, UK, USA, Australia, 2006, 314.
7.	Kuperman F.M. Morfofiziologija rastenii (Morfofiziologičeskij analiz etapov organogeneza različnych žiznenich form pokritosemenich rastenii). M.: Visšaja škola, 1984, 240 s. (in Russian).
8.	Duchovskis P. Flowering initiation of wintering plants. Sodininkystė ir daržininkystė, 23 (2): 2004, 3–11.
9.	Третьяков Н Н. Физиология и биохимия сельскохозяйственных растений. М.: Колос, 1998, 639.

Supplementary reference materials

No.	**Authors of publication, title, publishing house, year of publication.**
1.	Bluzmanas ir kt. Augalų fiziologija. V.: Mokslas, 1991, 420 p.
2.	Kopcewicz J., Lewak St. Podstawy fizjologii roslin. PWN, Warszawa, 1998, 725 s.
3.	Lietuvos mokslų akademija / Žemės ūkio mokslai (periodical scientific journal).
4.	Lietuvos mokslų akademija / Biologija (periodical scientific journal).
5.	Lietuvos mokslų akademija / Ekologija (periodical scientific journal).
6.	Sodininkystė ir daržininkystė (periodical scientific journal).
7.	Stašauskaitė S. Augalų vystymosi fiziologija. Vilnius: Debesija, 1995, 98 p.
8.	Taiz L., Zeiger E. Plant physiology. California: The Benjamin Cumings publ. Company, 2002. 690 p.

Course programme designed by

No.	**Name, surname**	**Institution**	**Degree**	**E-mail address**

1.	Zita Kriaučiūnienė	VMU AA	Assoc. Prof. Dr.	zita.kriauciuniene@vdu.lt
2.	Giedrė Samuolienė	LRCAF	Assoc. Prof. Dr.	giedre.samuoliene@lammc.lt
3.	Ilona Vagusevičienė	VMU AA	Assoc. Prof. Dr.	ilona.vaguseviciene@vdu.lt

Approval at the Institute: 17 04 2019 protocol Nr. 3.
Approval at the meeting of the PhD programme committee: 03 05 2019 protocol Nr. 138.
Course description valid until 30 06 2023

Faculty of Agronomy
Department of Agroecosystems and Soil Sciences
Vytautas Magnus University, Agriculture Academy

COURSE DESCRIPTION

Code of the study subject: AGR8003

Title of the study subject:
***in Lithuanian: Ag*roekologija**
***in English:* Agroecology**

Course volume:* 7 *credits,* 187 *hours, including* 46 *hours of contact work and 141 hours of independent work.

Dalyko anotacija lietuvių kalba
Agroekologijos samprata. Agroekosistemų principai, raida ir valdymas. Žemės ūkio augalų biocenozės ryšiai ir juos įtakojantys aplinkos veiksniai. Kintančio klimato ir dirvožemio agroekologinė reikšmė žemės ūkio gamybai. Pagrindinės industrinio žemės ūkio sąlygojamos agroekologinės problemos. Darnaus vystymosi koncepcija. Šiuolaikinių žemdirbystės sistemų vertinimas ilgalaikio ekologiškai stabilaus funkcionavimo požiūriu.

Dalyko anotacija anglų kalba
Agroecology concept. Fundamentals, development and management of agro-ecosystems. Relation of agricultural plant biocenosis and environmental factors affecting them. Agroecological significance of changing climate and soil for agricultural production. Major agroecological problems caused by industrial agriculture. The concept of sustainable development. Assessment of modern farming systems in terms of long-term ecologically stable functioning.

Forms and volume of work:

Forms of contact work	*Hours*	*Forms of independent work*	*Hours*
Lectures	42	Preparation for the test	26
Consultations	2	Preparation of an essay	35
Examination	2	Preparation for the exam	80

The purpose of the subject:

Study cycle	*Study programme*	*Subject type*
Third	Agronomy	Optional

Objective of the study subject: on the basis of the obtained knowledge, to assess the concepts, principles, development and biocenotic relationships of the ecosystems and agricultural systems as well as the effects of external conditions on the formation of these relationships.

Qualifications necessary for enrolment on the study programme: master's degree in agricultural sciences (preferably in agronomy (01 A) or a single-cycle higher education degree.

Outcomes of the study programme:

Knowledge and its application: a PhD student knows and is able to apply: the concept, structure and functioning of agro- and eco-systems and their management possibilities, the anthropogenic effect on

the formation of agroecological problems and solutions to these problems, the role of agricultural intensity in shaping general ecological status of the country, biosphere, water, air and soil resources, their pollution and protection, integrated application of the related fundamental and the latest knowledge of different branches of science.

Capacity to carry out research: to identify agroecological problems and their causes, to select the appropriate cause and effect assessment methods for the analysis of agroecological problems, to generate novel, original ideas, solutions and conclusions based on theoretical and practical data from agroecological experiments.

Special competences: to demonstrate agroecological understanding of the agricultural activity, to interpret agroenvironmental decisions, to understand the interface between man and environment, to scientifically assess the processes of the agroecosystem; to select rational, agricultural systems management practices/methods based on the original scientific research data, to describe energy cycling, biocenotic relationships and conditions for their control in the agroecosystem, to estimate the impact of changing climate on the agroecosystems and their adaptive capabilities, to plan sustainable use of genetic resources of agroecosystems and ecosystems.

Social skills: to be able to communicate with colleagues, scientific community and the public while developing and transferring innovations of their activity field; to perceive mankind as a factor which has the greatest environmental impacts; to foster technical, social and cultural progress favouring the development of society.

Personal skills: take responsibility to fully appraise, solve and creatively develop the problematic aspects of the subject area; be able to reveal and develop creative intellectual personal capabilities; be able to think creatively, critically and self-critically and to make use of various original concepts and information.

Assessment criteria of the subject study results:

1. Knowledge of the theoretical and practical aspects of the agroecology science and ability to apply them.
2. Understanding of social, ecological, and economic consequences of agricultural industrialization.
3. Ability to identify the demands and prospects of sustainable food production system; the role of different-intensity agriculture in the overall ecological status of the country and possibilities to improve it.
4. To summarize the agroecological significance of climate and soil for agricultural production on the global and local scale.
5. Ability to manage the complexity of environmental factors, to adapt the regularities of population processes in the agroecosystems.
6. Ability to evaluate biospheric resources, identify and rationally use genetic resources of the ecosystems and agroecosystems.
7. Ability to simulate energy flows of the agroecosystem.
8. Ability to combine, summarize and integrate the knowledge of different fields of science.
9. Ability to personally develop, project further prospects of learning, take responsibility to critically assess strategic decisions of his/her area of activity, ability to reveal and develop personal creative and intellectual competences.

Course content:

Lectures:

1. Introduction to the agroecology.
2. Evolution of the agroecology. Agroecology as a separate branch of science.
3. Agroecological problems.
4. Concept of agroecology.
5. Effects of climate and its change on the agroecosystems.
6. Soil and land assessment and protection.
7. System-level agroecological interactions.
8. Agricultural crops and environmental factors. External conditions for the formation of plant biocenotic relationships.
9. Agroecological role of animal husbandry.
10. Genetic resources of agroecosystems.
11. Energetics of agroecosystems.

Study methods: use of multimedia equipment and/or a graphic projector in lectures, the lecture material is illustrated by slides. Individual work. Each PhD student is given an individual task for systemic analysis on the basis of which essay is prepared.

The written essay is presented verbally in the form of a scientific discussion. The presentation is followed by a discussion. Control work/test is done in writing or verbally (when no group of PhD students is present). Control work is designed to check the student's knowledge and competences upon completion of the part of the study programme. Besides answering theoretical questions, a student describes agroecological problems and provides an analysis of problem solution methods and implementation possibilities, which show the PhD student's ability to creatively and independently apply the knowledge and formulate targeted solutions. At a scheduled time, PhD students are additionally consulted directly or in the cyberspace.

If there is no minimal number of students necessary for delivering a lecture, the studies are organized in the form of consultations. An individual timetable of consultations is made. A student individually studies the literature indicated by the lecturer. At a time scheduled for each subject's topic, a direct consultation is arranged to estimate the student's achievements and to explain the questions that need extra attention and to clarify the essential aspects of the topics under analysis.

Methods and structure of cumulative assessment of students' achievements: a ten-point scale criterion and cumulative assessment scheme are applied. Scientific discussions are encouraged. Tasks of independent work during the semester – essay (written and verbal presentation) and individual control work/test (in writing or verbally) – assessed by giving marks, final assessment is determined during the exam by multiplying the mid-term assessments by the weighting factor and by adding the products. The assessment point is determined according to the PhD student's ability to comprehensively and systematically analyse the given problematic questions and to participate in the interdisciplinary discussions. The assessment of student's knowledge and competences during the exam (oral examination) and the final assessment are done by the commission composed of three members: a lecturer coordinating the subject studies, a lecturer, and a supervisor or consultant of the student.

Structure of cumulative assessment

Work forms	*Weighting factor*	*Scheduled dates*
Test/control work	0.10	8^{th} week
Essay	0.20	10^{th} week
Exam	0.70	17^{th} -20^{th} week

Major sources of study:

1. Agroekosistemų komponentų valdymas. Sudaryt. Tripolskaja L. ir kt. Akademija, Kėdainių r., 2010. 568 p.
2. Brazauskienė D. Agroekologija ir chemija. K., Naujasis lankas, 2004. 207 p.
3. Dalgaard T., Hutchings N.J., Porter J.R. Agroecology, scaling and interdisciplinarity. Agriculture, Ecosystems and Environment, 100, 2003. 39–51 p.
4. Forskning G. Fate and biological effects of pesticides in soil and water ecosystems. The Norwegian Crop Research Institute. 2002. 216 p.
5. Gliessman S.R. Field and Laboratory Investigations in Agroecology. 2nd edition. CRC Press, 2007. 302 p.
6. Gliessman S.R. Agroecology: The Ecology of Sustainable Food System. CRC Press, New York, 2007. 384 p.
7. Lazauskas P., Pilipavičius V. Agroekologija. Mokomoji knyga. LŽŪU, Akademija. UAB „IDP Solutions“ 2008. 133 p.
8. Marozas V. Sausumos ekosistemų įvairovė ir apsauga. Vadovėlis. LŽŪU. UAB “IDP Soliutions”. 2008. 246 p.
9. Scientific journals – Agriculture, Ecosystems and Environment; Agricultural Systems; Journal of Applied Ecology; Agronomy for Sustainable Development; European Journal of Agronomy ir kt.
10. Newton P.C.D., Carran R.A., Edwards G.R., Niklaus P.A. Agroecosystems in a Changing Climate. CRC Press, USA. 2007. 364 p.
11. Wojtkowski P. A. Introduction to Agroecology: Principles and Practices. 2006. 403 p.

Additional sources of study:

1. Altieri M.A. Agroecology. Westview Pres, 1995. 431 p.
2. Baltrėnas P., Lygis D. ir kt. Aplinkos apsauga. Enciklopedija. V., 1996. 287 p.
3. Bučienė A. Žemdirbystės sistemų ekologiniai ryšiai (monografija). Klaipėda: LKU leidykla, 2003. 176 p.
4. Galminas Z. Melioracija ir aplinkosauga. V., 1999. 225 p.
5. Holmgren D. Permaculture: principles and pathways beyond sustainability. Holmgren design services. Australia. 2004. 286 p.
6. Jankauskas B. Dirvų apsauga nuo erozijos. Vilnius. 1990.
7. Kormondy J.E. Ekologijos sąvokos. Litera Universitati Vytauti Magni. 1992. 320 p.
8. Lietuvos žemės našumas. Sudarytojas Mažvila J. Akademija, Kėdainių r., 2011. 280 p.
9. Loomis R.S., Connor D.J. Crop ecology. Cambridge university press. 1992. 538 p.

10. Mokslinės duomenų bazės – Web of Science; Science direct; Agricola, ir kt.
11. Nadzeikienė J. Aplinkos apsaugos inžinerija. Mokomoji knyga. Aleksandro Stulginskio universitetas. Akademija, Kauno r., 2012. 120 p.
12. Ozolinčius R. Aplinkos ištekliai. Kaunas, VDU leidykla. 2005. 211 p.
13. Pilipavičius V., Navickas K. Atsinaujinantys agrariniai ištekliai ir atliekų perdirbimas. Mokomoji knyga. LŽŪU, Akademija. UAB „IDP Solutions“ 2008. 142 p.
14. Pilipavičius V., Pupalienė R., Marcinkevičienė A. Pasėlių bendrijos ir jų tyrimai. Mokomoji knyga. LŽŪU, Akademija. UAB „IDP Solutions“ 2008. 112 p.
15. Pleijelis H. Knyga apie ekologiją. Vilnius, 1994. 96 p.
16. Raškauskas A. Bendroji ekologija. V., 1991. 239 p.
17. SOER 2015 — The European environment — state and outlook 2015. [interaktyvus] [žiūrėta 2016 m. sausio 18 d.]. Prieiga per internetą: < http://www.eea.europa.eu/soer >
18. Stončius D. Gamtotvarkos vaidmuo saugant biologinę įvairovę. V., 2001. 85 p.
19. Stravinskienė V. Ekologijos įvadas. K., 2001. 155 p.
20. Stravinskienė V. Bendroji ekologija. K., 2003. 232 p.
21. Tausojamoji žemdirbystė našiuose dirvožemiuose. Sudarytoja Maikštėnienė S. Akademija, Kėdainių r., 2008. 327 p.
22. Tivy J. Agricultural Ecology. Longman Scientific and Technical. 1990. 374 p.
23. Tumas R. Vandenų ekologija. LŽŪU, VDU., K., 1999. 132 p.
24. Velička R., Pupalienė R. Demografinės padėties, klimato kaitos ir agroekologijos sąsajos. mokomoji knyga. LŽŪU, Akademija, 2010. 98 p.
25. Черникова В.А., Чекереса А.И. Агроэкология. Москва, Колос. 2000. 535 с.

Lecturer coordinating the studies of the subject: prof. habil. dr. Rimantas Velička, **VMU** Faculty of Agronomy, Institute of Agroecosystems and Soil Sciences.

Other lecturers of the subject: prof. habil. dr. Rimantas Velička, VMU Faculty of Agronomy, Institute of Agroecosystems and Soil Sciences; dr. Žydrė Kadžiulienė, Institute of Agriculture, LRCAF (LAMMC).

The description of the study programme has been prepared by: prof. habil. dr. Rimantas Velička; dr. Žydrė Kadžiulienė.

Reviewers:

Reviewer from VMU Faculty of Agronomy Institute of Agroecosystems and Soil Sciences: prof. dr. Kęstutis Romaneckas *Reviewer appointed by the Committee of PhD Studies in Agronomy:* assoc. professor, dr. Steponas Raudonius, prof. habil. dr. Pavelas Duchovskis, dr. Vita Tilvikienė.

Approved at the meeting of **VMU Faculty of Agronomy Institute of Agroecosystems and Soil Sciences on** 19 04 2019, protocol No. 6(6).

Approved in the meeting of the programme's Doctoral Studies Committee on 03 05 2019, protocol No. 138.

Description of the subject has been certified until 30 06 2023

COURSE DESCRIPTION

Course code	Volume in ECTS credits	Institution	Faculty	Institute
AGR8004	7	VMU AA	AF	Plant biology and food sciences

Course title in Lithuanian

Žemės ūkio augalų biotechnologija

Course title in English

Biotechnology of Crops

Study methods	**Volume in ECTS credits**
Lectures	2,0
Consultations	
Seminars	1,5
Individual work	3,5

Short course annotation in Lithuanian (up to 500 characters)

Perteikiamos bazinės ir naujausios žinios apie augalų biotechnologiją. Dalykas skirtas giliau suprasti augalų izoliuotų organų, audinių ir ląstelių auginimo savitumus *in vitro* sistemoje, didžiausią dėmesį skiriant naujausiems šio mokslo pasiekimams, žemės ūkio augalų biotechnologinių metodų panaudojimo praktikoje galimybėms bei jų reikšmei įvairių mokslų ir visuomenės vystymosi kontekste.

Short course annotation in English (up to 500 characters)

Basic and advanced knowledge on plant biotechnology are included. The subject intendent for a deeper understanding peculiarity of isolated organs, tissues and cells in *in vitro* system. The greatest attention is paid on the most recent achievements in plant biotechnology, agricultural plant biotechnological methods used in practice and their implications for the various sciences and social development.

Relevance of the course

Creation of plant genetic diversity by traditional breeding methods is a long and difficult process based on intervarietal hybridization and selection of the best plants. The development of genetic diversity all around the world progressively increase applying of *in vitro* technologies with leads to create varieties not only with new characteristics (improved quality parameters, resistance to diseases, herbicides, etc.), but also to reduce the period of time required to develop genetically stable lines. The theoretical knowledge and practical skills of plant biotechnology are very relevant for the research in the field of agronomy using biotechnological methods.

Course aims

Provide students with knowledge about the latest achievements in agricultural plant biotechnology, about importance of isolated organs, tissues and cell cultures in today's crop production and peculiarity in employment of biotechnological methods for breeding programs of different plant species in order to increase the efficiency of breeding work.

Content (topics) and methods

A plant biotechnology methods, directions and tasks. Conditions, principles and application possibilities of the higher plants isolated organs, tissues and cells cultures. Methods of micropropagation *in vitro*. Commercial aspects of micropropagation. *In vitro* technology in plant breeding. Creation of haploids and homozygous lines. Development of polypoid and mutants. Cell breeding. The secondary metabolic compounds *in vitro*. Storage of genetic plasma *in vitro*.
Gene engineering. Genetically modified plants. GMO risk assessment and legislation.
Methods.

Explanatory - demonstration method, discussion, self-learning using additional material, individual presentation of the assignment. If doctoral students studying the subject are less than three, lectures are not delivered. In this case, the doctoral students, in consultation with teachers, self-studying the latest scientific literature and prepared an individual assignment in the doctoral dissertation topic. Consultation arranged in accordance with a pre-arranged schedule.

Structure of cumulative score and value of its constituent parts

Individual work – 20 %, seminars – 30 %, exam – 50% of final knowledge assessment

Compulsory reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Chrispeels M. J., Sadava D. E. *Plants, genes and crop biotechnology*. Jones and Bartlett Publisher, 2002, 562 p.
2.	Christou P. *Handbook of Plant Biotechnology*. Wiley, 2004, 1488 p.
3.	Coleman J., Evans D., Kearns A. *Plant cell culture*. Garland science, 2003, 208 p.
4.	Plant biotechnology and agriculture [elektroninis išteklius]: prospects for the 21st century / edited by A. Altman, P. M. Hasegawa. Amsterdam; Boston: Academic Press, 2012, 586 p.
5.	Plant mutation breeding and biotechnology / edited by Q. Y. Shu, B. P. Forster, H. Nakagawa. Wallingford, Oxfordshire ; Cambridge, Mass. : CABI, 2012, 608 p.
6.	Transgenic crops IV / edited by E. C. Pua, M. R. Davey. Berlin : Springer, 2007. 476 p.
7.	From plant genomics to plant biotechnology / edited by P. Poltronieri, N. Burbulis, C. Fogher. Cambridge : Woodhead Publishing Limited, 2013, 242 p.
8.	Ratledge C., Kristiansen B. *Basic biotechnology*. Cambridge University Press, 2006, 666 p.
9.	Slater A., Scott N. W., Fowler M. R. *Plant biotechnology*. *The genetic manipulation of plants*. Oxford university Press, 2004, 346 p.
10.	Trigiano R. N., Gray D. J. *Plant development and biotechnology*. CRC Press, 2005, 359 p.

Supplementary reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Atherton K. *Genetically modified crops*. Taylor & Francis Ltd, 2002, 272 p.
2.	Cassells A. C., Gahan P. B. *Dictionary of plant tissue culture*. An Imprint of The Haworth Press, 2006, 265 p.

Course programme designed by

No.	Name, surname	Institution	Degree	E-mail address
1.	Natalija Burbulis	VMU AA	prof. dr.	natalija.burbulis@vdu.lt
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Approval at the Institute: 09 04 2019 protocol Nr. 22.
Approval at the meeting of the PhD programme committee: 03 05 2019 protocol Nr. 138.
Course description valid until 30 06 2023.

COURSE "SOIL SCIENCE" DESCRIPTION

Course code	Volume in ECTS credits	Institution	Faculty	Department
AGR8005	7	Vytautas Magnus University	Faculty of Agronomy	Agroecosystems and Soil Sciences

Course title in Lithuanian

Dirvotyra

Course title in English

Soil Science

Study methods	Volume in ECTS credits
Consultations	1.0
Individual project	2.0
Individual work	4.0

Short course annotation in Lithuanian (up to 500 characters)

Studijuodami dalyką „Dirvotyra" doktorantai įgyja žinių apie dirvožemio svarbą žemės ūkio ir miško ekosistemose, supranta geologinius ir mineralų dūlėjimo procesus bei dirvodaros veiksnius, adaptuoja ir taiko dirvožemio vertinimo metodus, nustato dirvožemio fizikines, chemines ir biologines savybe, žinoti tvaraus dirvožemio naudojimo principus, sprendžia agronomijos ir miškininkystės veiklos strateginio pobūdžio uždavinius.

Short course annotation in English (up to 500 characters)

Studying the course "Soil Science" PhD students obtaining knowledge on the consequences of soil in agricultural and forest ecosystems, getting to understand the geological and mineral weathering processes and soil formation principles, adapting and applying soil assessment methods, evaluating soil physical, chemical and biological properties, identifying the principles of sustainable soil principles, implementing soil sustainability in agronomy and forestry technologies.

Relevance of the course

The course helps PhD student to present, analyze, synthesize and critically evaluate new knowledge on soil science, to find out an original scientific solutions, to solve the complex of environmental problems in agronomy and forest practice, to plan fundamental and applied research.

Course aims

The aim of the course is to provide PhD student with knowledge on soil general science research in order to develop technologies to increase or sustain natural and efficient soil fertility, to model the soil ecosystem sustainability and preservation strategies.

Content (topics) and methods

Subject content:

Peculiarities of soil science. Soil science development in the world and in Lithuania. Soil mineral composition, origin, structure and consistence. Peculiarities of rock and mineral formation. Rock weathering and link to plant productivity. Soil parent material, geological classification and impact on weathering and soil formation. Soil formation theory. Soil formation factors and peculiarities for cultivation. Composition of soil phases. Soil granulometry and link to plant productivity. Soil mineral part and chemical composition. Soil organic part and sources from agriculture.

Soil status and properties. Soil colloids and sorption peculiarities. pH value, oxidation and reduction considerations in soil and methods to sustain the regimes. General soil physical properties. Soil moisture and air, warm conditions. Soil fertility status in agriculture and forestry.

Soil structure and morphology. Soil systematics, classification and diagnostic principles. Soil diagnostic materials, properties and horizons. Soil cover. Main patterns of soil distribution (latitude and

vertical zonality). The main soil groups in World and distribution properties. Lithuanian and international soil classification principles and soil valuation peculiarities in agriculture and forestry. Structure of soil cover and contrasting soil distribution. Research on soil cover evaluation. Theoretical and practical aspects of sustainable soil use.

Learning methods:
Lecture with discussion, report, individual task (analysis of scientific research data), brainstorming.

Structure of cumulative score and value of its constituent parts

A ten-point criterion-based scale and cumulative assessment system is applied.
Framework of cumulative assessment:
Individual project – 30 % (17-20 week; project presentation during an examination).
Examination – 70 % (17-20 week).

Compulsory reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Motuzas A., Buivydaitė V., Vaisvalavičius R., Šleinys R. Dirvotyra: 2-asis atnauj, papild. ir patais. leid. Vilnius: Enciklopedija, 2009. 335 p.
2.	Buivydaitė V., Butkus V., Motuzas A., Pečkytė A., Vaisvalavičius R., Vaišvila Z., Zakarauskaitė D. Geologijos pagrindų ir dirvotyros laboratorinių darbų aprašas: sąsiuvinis: studijų priemonė / Lietuvos žemės ūkio universitetas. Agronomijos fakultetas. Dirvotyros ir agrochemijos katedra. 3-iasis atnaujintas, papild. ir pataisytas leid. Akademija, 2009. 90 p.
3.	Eidukevičienė M. Lietuvos gamtinė geografija: [vadovėlis]. Klaipėda, 2009. 162 p.
4.	Mažvila J., Vaičys M., Buivydaitė V. Lietuvos dirvožemių makromorfologinė diagnostika: [monografija]. Akademija (Kėdainių r.): Lietuvos žemdirbystės institutas. 2006. 283 p.
5.	Miško augaviečių tipai: [metodinė priemonė] / Sudarytojas prof. habil. dr. M. Vaičys. Kaunas, Lututė, 2006. 95 p.
6.	Buivydaitė V., Motuzas A., Vaičys M. Naujoji Lietuvos dirvožemių klasifikacija (1999) / Metodinė priemonė laboratoriniams darbams atlikti. Akademija, 2001. 86 p.

Supplementary reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Baltrėnas P., Butkus D., Oškinis V., Vasarevičius S., Zigmontienė A. Aplinkos apsauga: [vadovėlis]. Vilnius: Technika, 2008. 576 p.
2.	Managing Soil Quality: challenges to modern agriculture / edited by P. Schjønning, S. Elmholt and B.T. Christensen. – 2004, 344 p.
3.	Huang P.M., Li Y., Sumner M.E. (Eds.). Handbook of soil sciences: resource management and environmental impacts. CRC Press, 2011, 2155 p.
4.	Mol G., Keesstra S.D., 2012. Soil sciences in a changing world. Current Opinion in Environmental Sustainability, 4(5), 473-477.
5.	Rowell D.L. Soil science: Methods & applications. Routledge, 2014, 368 p.
6.	Paul E.A. Soil microbiology, ecology and biochemistry. Academic press, 2014, 598 p.
7.	Keesstra S., Bouma J., Wallinga J., Tittonell P., Smith P., Cerda A. The significance of soils and soil science towards realization of the United Nations Sustainable Development Goals, 2017, 352 p.
8.	Simonson R.W., 2018. Soil Classification. In Handbook of Soils and Climate in Agriculture (pp. 103-130). CRC Press.

Course program designed by

No.	Name, surname	Institution	Degree	E-mail address

1.	Jūratė Aleinikovienė	Vytautas Magnus University	Assoc. Prof. Dr.	jurate.aleinikoviene@vdu.lt
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Approved at the meeting of **VMU Faculty of Agronomy Institute of Agroecosystems and Soil Sciences on** 19 04 2019, protocol No. 6(6).

Approved in the meeting of the programme's Doctoral Studies Committee on 03 05 2019, protocol No. 138.

Description of the subject has been certified until 30 06 2023

COURSE DESCRIPTION

Course code	Volume in ECTS credits	Institution	Faculty	Department
8006	7	VMU, Agriculture Academy	Agronomy	Agroecosystems and Soil Science

Course title in Lithuanian

Augalų mityba

Course title in English

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

Short course annotation in Lithuanian (up to 500 characters)

Dalyko paskirtis – supažindinti doktorantus su augalų mitybos mokslo perspektyvomis, augalų produktyvumo ir derliaus kokybės formavimo ypatumais natūralių ir antropogeninių veiksnių poveikyje, skirtingų tręšimo sistemų dėsningumais ir jų tobulinimo galimybėmis, augalų mitybos lygio bei pasekmių augalui ir aplinkai prognozavimo galimybėmis.

Short course annotation in English (up to 500 characters)

The aim of the subject is to introduce PhD students with perspectives of the plant nutrition science, peculiarities of plant productivity and yield quality formation with regard to natural and anthropogenic factors, regularities of the various fertilization systems and their development options, predictability possibilities of plant nutrition level and impact on plants as well as environment.

Relevance of the course

After the course students will have enough knowledge and skills to plant and perform the fundamental and applicable plant nutrition research, to process the obtained results and with regard to it to frame new knowledge and ideas; with reference to the results of novel carried fundamental and applicable scientific research to analyse the changes in soil properties and plant yield formation, to design and manage plant nutrition processes and to introduce strategic technological solutions for environmental pollution.

Course aims

To develop the system of knowledge, skills, abilities that assure complex assessment and management of plant nutrition processes.

Content (topics) and methods

Topic 1. Development of agrochemistry science (Greek philosophers, ancient Romans, medieval thinkers, development of agrochemistry in 18^{th} –19^{th}, 20^{th} and 21^{st} centuries.
Topic 2. Soil composition, characteristics (agrochemical, physical, biological), regimes (moisture, air, thermal). Soil fertility, its regulation.
Topic 3. Importance of soil fertility for plant nutrition, quality of soil, water and environment.
Topic 4. The regime of organic matter and mineral nutrition elements and transformation in soil. Role of oxygen in the transformation of plant organic matter.
Topic 5. Importance of macro, meso and micro elements in plant nutrition and their forms in plants.
Topic 6. Nitrogen fixation. Biological Nitrogen-Fixing Systems.
Topic 7. Organic and mineral fertilizers and their transformation in soil.
Topic 8. Plant stress. Nutritional regulation of plant productivity under regular and stress conditions.
Topic 9. Plant nutrition and diseases.
Topic 10. Spectrometric, morphobiometric and visual detection of plant nutrition.

Topic 11. Theoretical, biological and economic reasoning of forms, norms and time selection of fertilizers. Topic 12. Fertilizing systems (extensive, intensive, precision) and their impact on the environment.

Structure of cumulative score and value of its constituent parts

Homework - 40%; Final exam - 60 %.

Compulsory reference materials

No.	**Authors of publication, title, publishing house, year of publication.**
1.	Fernandez V., Sotiropoulos T., Brown P. Foliar fertilization. Scientific principles. International fertiliezer industry association, 2013. –144 p.
2.	Lawrence E. Datnoff, Wade H. Elmer, Don M. Huber (edit.) Mineral nutrition and plant disease. American Phytopathological Society, 2007. –278 p.
3.	Marschner's P. Mineral Nutrition of Higher Plants. Academic Press is an imprint of Elsevier, 2010. –642 p.
4.	Pessarakli M. Handbook of Plant and Crop Stress (third edition). Taylor and Francis group, London, 2011. – 713 p.
5.	Šlapakauskas V., Kučinskas J. Augalų mityba. Akademija, 2008. – 298 p.
6.	Tripolskaja L., Mašauskas V., Adomaitis T. ir kt. Agroekosistemų komponentų valdymas. Akademija, 2010. –567 p.

Supplementary reference materials

No.	**Authors of publication, title, publishing house, year of publication.**
1.	Dris R. Plant nutrition :growth and diagnosis. Science Publishers, 2002. –303 p.
2.	Kirkby E. A. Principles of plant nutrition. Dordrecht : Kluwer Academic, 2001. –849 p.
3.	Šlapakauskas V., Duchovskis P. Augalų produktyvumas: [vadovėlis]. Akademija, 2007. – 253 p.
4.	Šlapakauskas V. Augalų ekofiziologija. Mineralinė mityba. Kaunas-Akademija, 2001. –134 p.
5.	Tripolskaja L. Organinės trąšos ir jų poveikis aplinkai: [monografija]. Akademija, 2005. – 214 p.

Course programme designed by

No.	**Name, surname**	**Institution**	**Degree**	**E-mail address**
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Approved at the meeting of **VMU Faculty of Agronomy Institute of Agroecosystems and Soil Sciences on** 19 04 2019, protocol No. 6(6).

Approved in the meeting of the programme's Doctoral Studies Committee on 03 05 2019, protocol No. 138.

Description of the subject has been certified until 30 06 2023

COURSE DESCRIPTION

Course code	Volume in ECTS credits	Institution	Faculty	Department
AGR8007	7	VDU ŽŪA	Agronomy	Agroecosystem and soil sciences

Course title in Lithuanian

Herbologija

Course title in English

Weed science

Study methods	Volume in ECTS credits
Lectures	5
Consultations	0,5
Seminars/Practicum	0,5
Individual work	1

Short course annotation in Lithuanian (up to 500 characters)

Dalykas skirtas doktorantams. Dalyko tikslas - suteikti doktorantams piktžolių biologijos, ekologijos, jų kontrolės teorinių žinių ir gebėjimų jas panaudoti sprendžiant mokslines ir praktines pasėlių piktžolėtumo problemas. Dalyko studijų formos: paskaitos, pratybos, konsultacijos, pasirengimas kontroliniam darbui, individualiosios užduoties atlikimas, pasirengimas egzaminui.

Short course annotation in English (up to 500 characters)

The subject is delivered for the first year PhD students. The aim of the course is to provide PhD students with the knowledge on weed biology, weed ecology, weed control and with abilities to use them in solving research and practical weed population problems. The studies of the subject include lectures, practicums, consultations, preparation for intermediate test, completion of individual assignment, preparation for examination.

Relevance of the course

Conditions are created for the development of PhD students' knowledge and skills about weed biology, ecology, competition between weeds and cultivated plants, competition management by chemical and non-chemical methods, measures for solving scientific and production problems are analyzed.

Course aims

To provide PhD students with theoretical knowledge of weed biology, ecology, their control and the ability to use them in solving scientific and practical problems of crop weediness.

Content (topics) and methods

1. Introduction
2. Weed classifications.
3. Weed evolution and genetics.
4. Origin and prevalence of weeds.
5. Weed biology.
6. Ecology of weeds.
7. Prerequisites for successful weed control.
8. Weed prevention and control.
9. Physical control of weeds.
10. Methods of mechanical control of weeds.
11. Tillage and weediness: theoretical and practical aspects.
12. Biological control of weeds.
13. Chemical control of weeds.
14. Weed control and the social dimension.

Structure of cumulative score and value of its constituent parts

1. The concept of weed ecology is defined and the changes in weed evolution and genetics and their impact on weed spread are summarized,

2. The analysis of biological properties of various weeds has been performed, the possibilities of their spread have been defined, depending on the biological and soil properties, climatic conditions and plant growing technologies.
3. The interaction of weeds and soil environment is described, the factors determining the competition between weeds and agricultural plants are defined.
4. The weediness of the crops was assessed by different methods, the species composition of the weeds was identified and the weed control measures were selected in accordance with the principles of weed ecology.
5. Chemical and non-chemical means of competition management of weeds and cultivated plants are defined. The allelopathic effect of weeds on the germination of agricultural plants was evaluated.
6. The causes of weed resistance are described and measures to prevent it are analyzed.
7. The environmental impact of the use of chemical and non-chemical means has been assessed

Compulsory 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. – Springer, 2011.
2.	Booth B. D., Murphy S. D., Swanton C. J. Weed ecology in natural and agricultural systems. , UK ; Cambridge, 2003.
3.	Čiuberkis S., Vilkonis K. K. Piktžolės Lietuvos Agroekosistemose/Monorafija, 2013.
4.	Hakanson S. Weeds and Weed Management on Arable Land: an Ecological Aproach. U. K. CABI Publishing, 2003.
5.	Jodaugienė D., Raudonius S., Špokienė N. Piktžolių ekologija. - Akademija, 2008.
6.	Pilipavičius V. Piktžolių plitimo dėsningumai ir adaptyvumas abiotiniams veiksniams = Weed spreading regularity and adaptivity to abiotical factors : habilitacijos procedūrai teikiamų mokslo darbų apžvalga. Akademija, 2007.
7.	Radosevich S., R., Holt J.,S., Hoboken C., M., G. Ecology of weeds and invasive plants: relationship to agriculture and natural resource management, John Wiley & Sons, 2007.
8.	Zimdalh R.L. (editor) Integrated weed management for sustainable agriculture, Cambridge, UK : Burleigh Dodds Science Publishing, 2018
9.	Zimdalh R.L. Fundamentals of weed science, Academic Press inc, 2013.

Supplementary reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Singh H., P., Batish D., R., Kohli R., K. Handbook of sustainable weed management, New York, N.Y. etc. : Food products press, 2006
2.	Sirvydas, P., A., Terminis piktžolių naikinimas [Elektroninis išteklius, ASU Elektroninė talpykla] : monografija, 2012.
3.	Špokienė N., Povilionienė E. Piktžolės.- Kaunas, 2003.- 195 p.
4.	Upadhyaya M. K., Blackshaw R. E. Non-chemical weed management: principles, concepts and technology. Wallingford : CABI, 2007.
5.	Weber E. Invasive plant species of the world: a reference guide to environmental weeds. Cambridge, 2003.

Course programme designed by

No.	Name, surname	Institution	Degree	E-mail address
1.	Darija Jodaugienė	Vytautas Magnus University Agriculture Academy	Assoc. prof. dr.	Darija.Jodaugienė@vdu.lt

Approved at the meeting of **VMU Faculty of Agronomy Institute of Agroecosystems and Soil Sciences on** 19 04 2019, protocol No. 6(6).

Approved in the meeting of the programme's Doctoral Studies Committee on 03 05 2019, protocol No. 138.
Description of the subject has been certified until 30 06 2023

COURSE "CROP ECOLOGY" DESCRIPTION

Course code	Volume in ECTS credits	Institution	Faculty	Department
AGR8008	7	Vytautas Magnus University	Faculty of Agronomy	Agroecosystems and Soil Sciences

Course title in Lithuanian

Pasėlių ekologija

Course title in English

Crop ecology

Study methods	Volume in ECTS credits
Lectures	1.5
Consultations	0.2
Seminars	0.3
Individual work	5.0

Short course annotation in Lithuanian (up to 500 characters)

Studijuodami dalyką „Pasėlių ekologija" doktorantai įgyja žinių apie agrofitocenologijos raidos istorinius matmenis, laukų augalinės dangos ypatumus ir savybes, dirbamų žemių augalų bendrijų (agrofitocenozių) savybes, struktūrą, funkcionavimą, savitvarką, dinamiką, stabilumą, klasifikavimą ir pasiskirstymo dėsningumus, Lietuvos segetalinių ir ruderalinių bendrijų įvairovę.

Short course annotation in English (up to 500 characters)

PhD students studying the course "Crop ecology" acquire knowledge about the historical dimensions of the development of agrophytocenology, peculiarities and properties of the field plant cover, the arable land plant communities (agrophytocenoses) properties, structure, function, dynamics, classification, distribution patterns, the diversity of Lithuanian segetal and ruderal communities.

Relevance of the course

The course helps for PhD students to carry out research of plant communities (agrophytocenoses), to assess crop communities under the conditions of different farming systems and soil types, to compound field weed cartograms and maps of field plant cover (geobotanical maps).

Course aims

The aim of the course is to provide PhD students with knowledge about crop as part of the ecosystem and landscape, characteristics, structure, functioning, dynamics, classification and distribution patterns of plant communities (agrophytocenoses), human (anthropogenic) influence on the field plant cover, agricultural plant communities diversity.

Content (topics) and methods

Subject content:

Introduction to geobotany. Definition of geobotany. The concept of flora and vegetation. Spontaneous and sinantropic flora. The begining of agriculture. Cultural plants and weeds. Centres of origin of cultural plants. Geographical distribution of plants: ways, aerials and their grouping. Floral elements: geographic, genetic, historical and migratory. Human influence on plant cover or sinantropisation. Classification of sinantropic plants. The ability of plants to adapt to environmental conditions consists of many ecological factors. Concepts of place, habitat, ecotype, biotope. Complexes of ecological conditions: climate, edaphic, orographic and biotic. Definitions of modifications and ecotypes. Plant ecological groups. Plant life forms or bimorphs. Plants indices.

Fundamentals of general phytocenology. Understanding the plant community or phytocenosis. Continuity. Biocenosis, biogeocenosis, ecosystem. Organization of phytocenoses: species composition,

populations and cenopopulations, vertical, horizontal and temporal structures, synonyms. Classification of phytocenoses. Concept of syntax. Phytocenosis taxonomic categories. Association – the main unit of classification of communities. Science about community ecology or synecology. Phytosphere, rhizosphere. Phytocenosis change – succession, climax. Regular patterns of phytocenosis distribution in the land.

Agrophytocenology is a branch of special phytocenology. Definition of agrophytocenology. Historical dimensions of the development of agrophytocenology. The world's most famous agrophytocenologists and their works. Geobotanical concept of the field. Clasifying of field plant cover into crops and unusable plants – segetal and ruderal communities. Agroecosystem. Agrophytocenosis – integral part of the agroecosystem. Species composition of agrofitocenoses. Cenopopulations and their composition. Classification of agrophytocenosis cultural component individuals by age of maturity (ontogenesis). Abundance of species individuals (cenopopulations) and methods for its detection. Population density, its dependence on seed content and other agrotechnical tools. Density of weed populations and factors affecting it. Bank of diasporas. Vertical and horizontal structure of agrophytocenosis. Homogeneity of cenopopulations. Homogeneity indices and detection methods. Temporal structure of agrophytocenosis. Community phenological spectrum, phenological aspects. The concept of sinusia. Influence of ecological factors on agrophytocenosis. Ecological types of crop plants and their indicative value. Plant relationships in agrophytocenosis. Critical period of weed competition for cultural plants. Threshold of weed harmfulness (threshold). Productivity of agrophytocenoses. Functioning, self-regulation, dynamics and stability of agrophytocenosis. Agrophytocenology and agriculture. The importance of agrophytocenology for organic agriculture. Classification of agrophytocenoses: distinctive features of agrophytocenosis, classification systems and methods. Diversity of Lithuanian segetal and ruderal communities. Community indicative properties. Field weed cartograms. Maps of field plant cover (geobotanical maps).

Learning methods:

The lecture, lecture with discussion, report, individual task (analysis of x agrophytocenosis scientific research data), brainstorming.

Structure of cumulative score and value of its constituent parts

A ten-point criterion-based scale and cumulative assessment system is being applied.
Framework of cumulative assessment:
Report – 15 % (6-7 week after report theme performance);
Individual task – 15 % (10 week after individual task performance);
Examination – 70 % (17-20 week).

Compulsory reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Juknys R. Environment research: handbook. Kaunas, Publishing of VMU, 2005. 334 p.
2.	Loomis R. S., Connor D. J. Crop ecology. Productivity and management in the agricultural systems. Cambridge University Press, 1996. 538 p.
3.	Marozas V. Terrestrial ecosystems diversity and protection: handbook. Klaipėda, IDP Solutions, 2008. 112 p.
4.	Natkevičaitė-Ivanauskienė M. Botanical geography and basics of phytocoenology. Vilnius, Publishing of Science, 1983. 280 p.
5.	Pilipavičius V., Pupalienė R., Marcinkevičienė A. Crop communities and their investigations: study book. Klaipėda, IDP Solutions, 2008. 112 p.

Supplementary reference materials

No.	Authors of publication, title, publishing house, year of publication.

1.	Bučienė A. Ecological relationships of the farming systems: monograph. Klaipėda, Publishing of LKU, 2003. 176 p.
2.	Čiuberkis S., Vilkonis K. K. Weeds in the Lithuanian agroecosystems: monograph. Akademija, Kėdainių distr., 2013. 256 p.
3.	Gudžinskas Z. et al. Invasive organisms of Lithuanian and Latvian border region. Vilnius, Publishing of BMK, 2014. 181 p.
4.	Peart R. M., Shoup D. W. Agricultural systems management: optimizing efficiency and performance. New York, NY, Basel, Marcel Dekker, 2004. 280 p.
5.	Rašomavičius V. Inventory guide of EU importance natural habitats. Vilnius, 2012. 474 p.
6.	Sieglinde S., Pound B., Mass B. Agricultural systems: agroecology and rural innovation for development. Elsevier Academic Press, 2008. 386 p.
7.	Zacharenko A. V. Theoretical basics of agrophytocenoses weed control in the farming systems. Moscow, 2000. 466 p.

Course programme designed by

No.	Name, surname	Institution	Degree	E-mail address
1.	Aušra Marcinkevičienė	Vytautas Magnus University	Prof. dr.	ausra.marcinkeviciene@vdu.lt
2.	Danutė Karčauskienė	Lithuanian Research Centre for Agriculture and Forestry	Dr.	danute.karcauskiene@lammc.lt

Approved at the meeting of **VMU Faculty of Agronomy Institute of Agroecosystems and Soil Sciences on** 19 04 2019, protocol No. 6(6).

Approved in the meeting of the programme's Doctoral Studies Committee on 03 05 2019, protocol No. 138.

Description of the subject has been certified until 30 06 2023

COURSE DESCRIPTION

Course code	Volume in ECTS credits	Institution	Faculty	Department
8009	7	VMU, Agriculture Academy	Agronomy	Agroecosystems and Soil Sciences

Course title in Lithuanian

ŽEMDIRBYSTĖ

Course title in English

SOIL MANAGEMENT FOR SUSTAINABILITY

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

Short course annotation in Lithuanian (up to 500 characters)

Dalyko paskirtis - suteikti žinių apie tvaraus dirvožemio naudojimo ir su tuo susijusio įvairaus intensyvumo žemės dirbimo poveikį agroekosistemoms, sąsajas su biologiniais, cheminiais bei fizikiniais dirvožemio ekosistemų komponentais, agroekosistemų ekologinį intensyvinimą ir adaptaciją klimato kaitai.

Short course annotation in English (up to 500 characters)

This course will provide knowledge of the effects of sustainable soil management and related diverse soil tillage in agroecosystems, interrelations with the biological, chemical, and physical components of soil ecosystems, ecological intensification and adaptation to climate change of the agroecosystems.

Relevance of the course

After the course graduation students will have enough knowledge and abilities to plan and perform the fundamental and applicable research of soil management systems, to process the obtained results and with regard to it to create new knowledge and ideas; with reference to novel research results to analyze the effects of different intensity soil tillage on soil sustainability and environmental quality, considering changing climate conditions; to design strategic technological solutions for agroecosystem sustainability.

Course aims

To develop the system of knowledge, skills, abilities that assure complex assessment and management of soil management systems.

Content (topics) and methods

1. Introduction.
2. Environmental factors for crop growth and their management.
3. Soil degradation and erosion. Soil compaction.
4. Soil quality indicators and their management.
5. Management of crop rotation.
6. Catch cropping and green manure.
7. Straw and other crop residue management.
8. Weed ecology and weed control system.
9. Effect of soil tillage intensity on agroecosystem components.
   - 9.1. The role of soil tillage intensity on soil structure, water capacity and other physical properties.
   - 9.2. Soil tillage and soil microbial community.
   - 9.3. Soil tillage and sustainable nutrient management.
   - 9.4. Implications of soil tillage for crop, weed seeds and weed communities.

9.5. Influence of cultivation practices on arable crop diseases, earthworms and other fauna.
10. Peculiarities of organic, precision and conservation farming systems. Complex assessment and management of soil management systems.
11. Maintenance of ecosystem state, productivity and biodiversity, their integrity over time and in the context of human activity and intensity of use.
12. Sustainability of agroecosystems, ecological intensification and adaptation to climate change.

Structure of cumulative score and value of its constituent parts

Homework - 40%;
Final exam - 60 %.

Compulsory reference materials

No.	**Authors of publication, title, publishing house, year of publication.**
1.	Rattan Lal, B.A. Stewart. Principles of Sustainable Soil Management in Agroecosystems. - CRC Press, 2013. – 568 p.
2.	Rainer Horn, Heiner Fleiner, Stephan Peth, Xinhau Peng (Editor). Soil management for Sustainability. 2006. -497 p.
3.	Karl Heinrich Hartge, Rainer Horn. Essential Soil Physics: An introduction to soil processes, functions, structure and mechanics. Schweizerbart Science Publishers 2016. 389 p.
4.	C.J. Baker, K.E. Saxton, W.R. Ritchie, W.C.T. Chamen, D.C. Reicosky, M.F.S. Ribeiro, S.E. Justice, P.R. Hobs. No-tillage seeding in conservation agriculture. CAB International and FAO, 2007. - 326 p.
5.	Adel El Titi (Editor). Soil tillage in Agroecosystems. 2003. -367 p.
6.	Håkansson I. Machinery-induced compaction of arable soils. Inicidence – consequences – counter-measures. Swedish University of Agricultural Sciences. 2005. 153 p.
7.	Maren Oelbermann. Sustainable Agroecosystems in Climate Change Mitigation. - Wageningen Academic Publishers, 2014. – 164 p.
8.	Patrick J. Bohlen, Gar House. Sustainable Agroecosystem Management: Integrating Ecology, Economics, and Society. - CRC Press, 2009. – 328 p.
9.	Sven E. Jørgensen, Liu Xu, Robert Costanza. Handbook of Ecological Indicators for Assessment of Ecosystem Health. - CRC Press, 2010. – 498 p.
10.	Managing cover crops profitably. Editor Andy Clark. - Sustainable Agriculture Network, 2007. – 244 p.

Supplementary reference materials

No.	**Authors of publication, title, publishing house, year of publication.**
1.	Bučienė A. Žemdirbystės sistemų ekologiniai ryšiai. 2003. -180 p.
2.	Špokienė N., Povilionienė E. Piktžolės. Kaunas, 2003, 200 p.
3.	Michael A. Fullen, John A. Catt. Soil management: problems and solutions. 2004. -269 p.
4.	Benjaminas Kiburys. Dirvožemio mechaninė erozija. V.: Mokslas. 1989. 175 p.
5.	Jankauskas B. (1990). Dirvų apsauga nuo erozijos. V., 85 p.
6.	Soane B.D., C. van Onwerkerk (Editors). Soil Compaction in Crop Production. Elsevier, 1994. - 662 p.
7.	Soil biological fertility. Edited by Lynette Abbott, Daniel Murphy. – Springer, 2007. - 264 p.
8.	Lampkin N. (2002) Organic farming. Old Pond Publishing, 748 p.
9.	Noureddine Benkeblia. Agroecology, Ecosystems, and Sustainability. - CRC Press, 2014. – 393 p.
10.	John M. Kimble, Charles W. Rice, Debbie Reed, Sian Mooney, Ronald F. Follett, Rattan Lal. Soil Carbon Management: Economic, Environmental and Societal Benefits. - CRC

	Press, 2007. – 280 p.

Course programme designed by

No.	Name, surname	Institution	Degree	E-mail address
1.	Vaclovas Bogužas	VMU	prof., dr.	vaclovas.boguzas@vdu.lt
2.	Virginijus Feiza	Lithuanian Research Centre for Agriculture and Forestry	dr.	virginijus.feiza@lammc.lt

Approved at the meeting of **VMU Faculty of Agronomy Institute of Agroecosystems and Soil Sciences on** 19 04 2019, protocol No. 6(6).

Approved in the meeting of the programme's Doctoral Studies Committee on 03 05 2019, protocol No. 138.

Description of the subject has been certified until 30 06 2023

COURSE DESCRIPTION

Course code	Volume in ECTS credits	Institution	Faculty	Department
AGR8010	7	Vytautas Magnus University Agriculture Academy	Agronomy	Agroecosystems and Soil Sciences

Course title in Lithuanian

AUGALININKYSTĖ

Course title in English

CROP SCIENCES

Study methods	Volume in ECTS credits
Lectures	40
Consultations	3
Abstract	42
Individual work	100

Short course annotation in Lithuanian (up to 500 characters)

Dalykas apžvelgia tradicinę augalininkystę bei adaptuotą kintančio klimato sąlygoms. Pateikiamos naujausios inovatyvios žinios apie augalininkystės mokslinių ir eksperimentinių tyrimų bei mokslo raidą Lietuvoje bei pasaulyje, augalininkystės reikšmę žemės ūkiui, bendrąją žemės ūkio politiką, augalininkystės plėtros galimybes bei perspektyvas, pagrindinių augalų morfologines ir biologines savybes bei jų augimo ir vystymosi kritinius tarpsnius ir ciklus, augalų produktyvumo ir pasėlio struktūros formavimo principus.

Short course annotation in English (up to 500 characters)

Subject overview of traditional crop production and adapted the changing climatic conditions. Here are the latest innovative knowledge on crop research and development and scientific developments in Lithuania and the world, crop value for agriculture, the common agricultural policy, crop development opportunities and prospects for the main plant morphological and biological characteristics of the growth and development of the critical stages and cycles of plants crop productivity and structure formation principles.

Relevance of the course

Plant productivity can generally vary at climate change. According to the latest research provided the knowledge, it is important to understand the major field crop growth and development of the system, improve existing or create a new field of plant breeding techniques that improve crop production business stability, modeling of plants, taking into account the biological and technological field crop characteristics and evaluation of specific habitats adapts the most suitable plant Biopotential forming patterns.

Course aims

The acquired knowledge and skills will help to understand the systematic plant science. The ability of researchers in the field of crop production and crop production methods used Mastering. Gaining knowledge about the optimal field crop productivity formation patterns, be able to analyze and assess the environmental factors affecting the productivity of the plant, to be able to assess and manage crop growth and development of the system, the risk factors in crop production resulting from the changing climate and the environment.

Content (topics) and methods

Lectures:

1. Plant science: object, purpose, objectives, definition of the inclusive nature of the development of the most significant findings of research methods.
2. The crop science development opportunities and prospects. Crop research and experimental research developments in Lithuania. Crop development opportunities and prospects in the world.
3. The main outdoor crop growth and development of the control system.

4. Plant productivity concept, crop structure formation principles and patterns. Competition plant community, its impact on plant productivity. Productive crop density decrease causes their management.
5. Soil fertility influence, forecasting major field crop yield potential and nutritional intensity. The main field of biological plant requirements at different growth stages.
6. Combine the regularities of structural elements at different growth stages. Environmental factors influence physiological processes taking place in plants.
7. Outdoor plants and soil microorganisms interactions, their importance for plant growth and productivity.
8. Different field crop yield forecasting and modeling. Optimal stand density concept, its prognosis and different outdoor plant stand density affect plant productivity modeling.
9. Phytopathogens and pests affecting crop density, crop productivity and crop production in the technological properties.
10. Plant Nutrition assessment of the level of growth in different periods. Plant nutrition level on energy transformation plants, plant condition assessment.
11. Outdoor plant stress. Factors that cause stress. Plant stress on productivity. Plant Stress Management.
12. Winter crop resistance to adverse environmental factors increasing plant Winter Storage evaluation.
Study organized consultations by way consistent with the schedule of doctoral students. Individual and group counseling. At a minimum the number of doctoral students, the teaching process is carried out according to individual consultation mode doctoral needs.
Consultation beginning graduate students provided self-employment – abstract tasks, taking into account the doctoral dissertation topic.
During training, use of modern learning tools, apply problem training elements, conducted case studies, doctoral students involved in the discussion, part of the lecture material asks to study and introduce yourself.
Scientific literature, legal documents, theoretical – information materials analysis, knowledge and systematic, comparative and logical analysis methods.

Structure of cumulative score and value of its constituent parts

Evaluated using ten (10) points criteria - cumulative scoring system. Abstract - 0.1, Exam - 0.9 (weight coefficient.). Answering written and oral. Doctoral students' knowledge and skills assessment exam and a final assessment carried out by the commission formed.

Compulsory reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Agroekosistemų komponentų valdymas. Ilgalaikių agrocheminių tyrimų rezultatai: monografija / sudaryt. L. Tripolskaja ir kt. – Akademija, Kėdainių r., 2010. – 568 p.
2.	Jakienė, E.; Liakas, V. Cukrinių runkelių biologija ir jų auginimo technologijos / Aleksandro Stulginskio universitetas. Agronomijos fakultetas. Augalininkystės ir gyvulininkystės katedra. Akademija, 2012. 91 p.
3.	Lapinskas, E. Biologinio azoto fiksavimas ir nitraginas: Monografija. Akademija, 1998, 218 p.
4.	Maikštėnienė, S. (sudarytoja ir bendraautorė). 2008. Tausojamoji žemdirbystė našiuose dirvožemiuose. Monografija. Akademija, p. 568. ISBN 978-9955-650-31-7
5.	Šiuolaikinės augalininkystės technologijos. LŽŪU, Žemės ūkio mokslo ir technologijų parkas, Augalininkystės ir gyvulininkystės katedra. 1-7 tomai, Akademija, -2000-2005.
6.	Velička R. Rapsai. – Kaunas, 2002. – p. 319.
7.	Šlapakauskas, V.; Duchovskis, P. Augalų produktyvumas. K.: IDP Solutions. 2008. 253 p.
8.	Šlapakauskas, V., Kučinskas, J. 2008. Augalų mityba. Akademija. 298 p.
9.	Šiuliauskas, A.A. Praktinė augalininkystė. Javai ir rapsai. Vilnius, 2015. 630 p.

Supplementary reference materials

No.	**Authors of publication, title, publishing house, year of publication.**
1.	Agrios, G. N. Plant pathology. USA, San Diego, 1997. 635 p.
2.	Biologija // LMA periodinys leidinys.
3.	Scientific journal „Agricultural systems“ – paieška www.sciencedirect.com.
4.	Scientific journal „European Journal of Agronomy“ – paieška www.sciencedirect.com.
5.	Scientific journal „Journal of Agronomy and crop science“ – paieška www.blackwell-sygergy.com.
6.	Scientific journal „Russian Journal of Plant physiology“ – paieška www.maik.ru.
7.	Scientific journal „Agronomy Research“ – paieška www.agronomy.emu.ee.
8.	Scientific journal „Zemdirbyste – Agriculture“ – paieška www.zemdirbyste-agriculture.lt.
9.	„Žemės ūkio mokslai – Agricultural Sciences“ // LMA periodinis leidinys.

Course programme designed by

No.	**Name, surname**	**Institution**	**Degree**	**E-mail address**
1.	Vytautas Liakas	Vytautas Magnus University Agriculture Academy	Assoc. dr.	vytautas.liakas@vdu.lt
2.				

Approved at the meeting of VMU Faculty of Agronomy Institute of Agroecosystems and Soil Sciences on 19 04 2019, protocol No. 6(6).

Approved in the meeting of the programme’s Doctoral Studies Committee on 03 05 2019, protocol No. 138.

Description of the subject has been certified until 30 06 2023

COURSE DESCRIPTION

Course code	Volume in ECTS credits	Institution	Faculty	Department
AGR8011	7	VDU ŽŪA	Agronomy	Plant biology and food sciences

Course title in Lithuanian

Augalų genetika

Course title in English

Plant genetics

Study methods	**Volume in ECTS credits**
Lectures	46
Consultations	
Exam	2
Individual work	139

Short course annotation in Lithuanian (up to 500 characters)

Doktorantai, įgis naujausias sistemingas augalų genetikos mokslinių pasiekimų žinias, apie požymių paveldėjimo principus bei genetinės informacijos perdavimo sistemas, genų evoliucijos dėsningumus, funkcinę genomo sandarą ir genų raišką, genetinį kintamumą ir stabilumą, tikslingo genetinės informacijos keitimo metodus ir jų panaudojimo būdus.

Short course annotation in English (up to 500 characters)

The students will acquire the new systematic knowledge of the scientific achievements on plant genetics, the principles of inheritance of features and systems of transmission of genetic information, gene evolution, genome structure and gene expression, methods of investigation of genetic variability and stability and ways of using them.

Relevance of the course

PhD students will be able to identify specific phenomena of plant heredity and variability, evaluate gene expression management, analyze and explain genetic variability and stability issues; to plan and carry out research, to introduce genetic methods in the fields of biotechnology and breeding of agricultural plants, to solve the problems of plant genetics, to convey scientific innovations of plant genetics and prospects for further development

Course aims

To increase the knowledge of PhD student in plant genetics, and the ability to critically evaluate the current situation of plant genetics, the possibilities of gene expression management, to analyze and solve problems of genetic variability and stability, to apply genetic methods in agricultural plant breeding programs.

Content (topics) and methods

Lectures:
1. First hypotheses about heredity. Genetics Science Begins.
2. Cell Structure and Sharing. Types of reproduction. Cell cycle.
3. Generational transfer of inheritance.
4. Gene interaction.
5. Chromosomal inheritance theory.
6. Remote hybridization.
7. Population genetics.
8. Structure of chromosomes and genes.
9. Non-nuclear inheritance.
10. Modifications and mutations.
11. Mutagenesis.
12. Protein biosynthesis and recombinant DNA production technology.

Methods of study: lecture, problematic, visualized teaching method, theoretical knowledge combined with discussions. In the absence of a minimum number of doctoral students for lectures individual consultations will be provided.

Structure of cumulative score and value of its constituent parts

1. Ability to plan and carry out fundamental and applied research on plants genetics. 2. Ability to analyze, summarize and critically evaluate information and formulate alternatives scientific problem-solving strategies.

Compulsory reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Rančelis V. Genetika. Vilnius, 2000.- 662 p.
2.	Rančelis.V. Augalų genetika. Kaunas: Technologija. 2008.- 300 p.
3.	2. Acquaah G. Principles of Plant Genetics and Breeding. Oxford etc.: Blacwell publishing, 2007.-569 p.
4.	Babcock E. B. Genetics and plant breeding. Jodhpur : Agrobios, 2004. – 478 p.
5.	Howell S. H. Molecular genetics of plant development. 1998. - 384 p.
6.	Jackson J. F., Linskens H. F. Testing for Genetic Manipulation in Plants, 2002. - 194 p.
7.	Watson J. D. et all. Molecular Biology of the Gene. Singapure, 2004.- 681 p.
8.	Leister D. Plant functional genomics. Food Products Press. New York, London, Oxford. 2005. -
9.	677p. Генетика (под редакцией А.А.Жученко) Москва. Колос, 2003. – 479 с.

Supplementary reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Atherton K**.** Genetically Modified Crops. Taylor & Francis Ltd, 2002.- 272 p.
2.	Jeffrey C.**,** et all. Advances in genetics. Volume 62. San Diego, CA: Elsevier/Akademic Press, 2008.- 250 p.
3.	Snustad D. P., Simmons M. J,. Jenkins J. B. Principles of Genetics. New York, Toronto, 1997.- 829 p.
4.	Tęstiniai mokslo leidiniai: Biologija, Sodininkystė ir daržininkystė, Žemdirbystė-Agriculture ir kt.
5.	Journal of Plant Breeding and Genetics. eSci Journals Publishing
6.	Theoretical and Applied Genetics. Springer
7.	Molecular Plant Breeding. BioPublisher Platform
8.	8. Journal of Plant Genetics and Transgenics. A©ademy Journals Inc.

Course programme designed by

No.	Name, surname	Institution	Degree	E-mail address
1.	Vidmantas Stanys		Prof. habil. dr.	v.stanys@lsdi.lt
2.				

Approval at the Institute: 17 04 2019 protocol Nr. 3.
Approval at the meeting of the PhD programme committee: 03 05 2019 protocol Nr. 138.
Course description valid until 30 06 2023.

COURSE DESCRIPTION

Course code	Volume in ECTS credits	Institution	Faculty	Department
AGR8012	7	VMU AA	AF	Plant biology and food sciences

Course title in Lithuanian

Lauko augalų selekcija ir sėklininkystė

Course title in English

Breeding and seed production of crops

Study methods	Volume in ECTS credits
Lectures	2,0
Consultations	
Seminars	1,5
Individual work	3,5

Short course annotation in Lithuanian (up to 500 characters)

Perteikiamos bazinės ir naujausios žinios apie lauko augalų selekciją ir sėklininkystę. Dalykas skirtas giliau suprasti augalų selekcijos pagrindinius principus genetiniu aspektu, didžiausią dėmesį skiriant naujausiems šio mokslo pasiekimams, bei įvairių selekcijos metodų panaudojimo praktikoje galimybėms vertingų rekombinantų gavimui, įvertinimui bei atrankai.

Short course annotation in English (up to 500 characters)

Provides basic and up-to-date knowledge of crops breeding and seed production. The course is designed to provide a deeper understanding of the basic principles of plant breeding in the genetic aspect, focusing on the latest advances in this science, as well as the possibilities of using various breeding methods used in practice for obtaining, evaluating and selecting valuable recombinants.

Relevance of the course

In the context of a changing climate and in the context of the European Union's green course, the development of new plant varieties is becoming increasingly important. Theoretical knowledge and practical skills of plant breeding and seed production are very relevant in the design and implementation of breeding programs for creation of plant varieties resistant to biotic and abiotic factors.

Course aims

To develop students' theoretical knowledge, abilities and skills that ensure the integrated management of field plant breeding programs and the efficient process of new varieties developing.

Content (topics) and methods

Tasks, achievements and perspectives of crops breeding. Genetic basis of crops breeding. Directions of selection work and principles of variety development. Crops breeding methods: intergeneric hybridization, interspecific hybridization, heterosis, mutagenesis, biotechnological methods. Evaluation of the developed selection material and selection of valuable recombinants. Seed production. Legal acts regulating the legal protection of field plant varieties in Lithuania and the European Union.

Methods.

Explanatory - demonstration method, discussion, self-learning using additional material, individual presentation of the assignment. If PhD students studying the subject are less than three, lectures are not delivered. In this case, the doctoral students, in consultation with teachers, self-studying the latest scientific literature and prepared an individual assignment in the doctoral dissertation topic. Consultation arranged in accordance with a pre-arranged schedule.

Structure of cumulative score and value of its constituent parts

Individual work – 20 %, seminars – 30 %, exam – 50% of final knowledge assessment

Compulsory reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Acquaah, G. Principles of Plant Genetics and Breeding. Blackwell Publishing, 2nd. ed. 2012. http://gtu.ge/Agro-Lib/Principles%20of%20Plant%20Genetics%20and%20Breeding.pdf
2.	Bradshaw, J. E. Plant Breeding: Past, Present and Future. Springer International Publishing, 2016. https://www.springer.com/la/book/9783319232843
3.	Bos, I., Caligari, P. Selection Methods in Plant Breeding. Springer International Publishing, 2008. https://www.springer.com/la/book/9781402063695
4.	Céron-Rojas, J. J., Crossa, J. Linear Selection Indices in Modern Plant Breeding. Springer International Publishing, 2018. https://www.springer.com/la/book/9783319912226
5.	Hayward M.D., Bosemark M.O., Ramogosa I. Plant breeding principles and prospects. Champan Hall-London-Weinheim-Mew York-Tokyo-Melbourne-Madras. 1993.-550.

Supplementary reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Varshney, R.K., Roorkiwal, M., Sorrells, M.E. (Eds.). Genomic Selection for Crop Improvement. Springer International Publishing, 2017. https://www.springer.com/gp/book/9783319631684
2.	Journal of Plant Breeding and Genetics. eSci Journals Publishing https://esciencepress.net/journals/index.php/JPBG

Course programme designed by

Name, surname	Institution	Degree	E-mail address
Natalija Burbulis	VMU AA	prof. dr.	natalija.burbulis@vdu.lt
Vytautas Ruzgas	LAMMC	doc. dr.	vytautas.ruzgas@lammc.lt

Approval at the Institute: 09 04 2019 protocol Nr. 22.
Approval at the meeting of the PhD programme committee: 03 05 2019 protocol Nr. 138.
Course description valid until 30 06 2023

COURSE DESCRIPTION

Course code	Volume in ECTS credits	Institution	Faculty	Department
AGR8014	7	VDU ŽŪA	Agronomy	Plant biology and food sciences

Course title in Lithuanian

Sodo ir daržo augalų selekcija ir sėklininkystė

Course title in English

Breeding and Seed Growing of Horticultural Plants

Study methods	Volume in ECTS credits
Lectures	44
Consultations	2
Exam	2
Individual work	139

Short course annotation in Lithuanian (up to 500 characters)

Kursas skirtas doktorantams Gautų žinių pagrindu studentai suvoks kryžmadulkių, savidulkių ir vegetatyviniu būdu dauginamų augalų selekcijos ir sėklininkystės ypatumus. Sugebės parinkti pradinę medžiagą selekciniam darbui, sudaryti kryžminimo schemas, įvertinti hibridinius palikuonis įvairiose selekcijos grandyse, nustatyti strategiją, sudaryti selekcines programas ir kurti naujas veisles. Žinos heterozinių hibridų, kryžmadulkių ir savidulkių augalų sėklininkystės sistemas bei veislių identifikavimo metodus, susipažins su augalų veislių teisine apsauga Lietuvoje, ES valstybėse ir pasaulyje

Short course annotation in English (up to 500 characters)

The Course is designed for PhD Students. The students will understand the peculiarities of breeding of cross-, self-pollinating and vegetative propagating plants, and know seed production system. Will be able to select the material for the breeding, to define the breeding strategy and make programs to create new varieties. Will know the systems for creating of heterozygous hybrids, methods of identification of varieties, will get acquainted with the legal protection of plant varieties in Lithuania, EU countries and the world

Relevance of the course

After the course, students will have enough knowledge and skills to analyze and address the most relevant issues of plant breeding and seed production.

Course aims

The new systematic knowledge of plant genetics and breeding that can be applied interpreting the results of agronomic and biological research

Content (topics) and methods

Lectures:
1. Historical development of plant breeding in the world and Lithuania
2. Genetic Basics of Plant Breeding
3. Physiological and morphological basics of plant breeding
4. Starting material for selection
5. Plant selection methods and their use in practical selection
6. The main directions of plant breeding
7. Organization of selection work
8. Evaluation of breeding material
9. State examination of varieties in Lithuania
10. Seed production

Methods of study: lectures, consultations, self-study using additional

material. In the absence of a minimum number of doctoral students for lectures individual consultations will be provided.

Structure of cumulative score and value of its constituent parts

1. The mastery of the knowledge.
2. Ability to use the knowledge supporting multiplication techniques for different types of plants
4. Identification of practical problems of breeding and their solutions.

Compulsory reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Singh P.K., Dasgupta S.K., S.K. Tripathi. Hybrid Vegetable Development. Food Products Press.2004, 441 p.
2.	Hayward M.D., Bosemark M.O., Ramogosa I. Plant breeding principles and prospects. Champan Hall-London-Weinheim-Mew York-Tokyo-Melbourne-Madras. 1993.-550.
3.	Rančelis V. Genetika V.2000.-662
4.	*4.* Moore J.N. Janic J. Methods in fruit breeding.- West Lafayete (Indiana) Purdue University
5.	Press, 1983.-419p
6.	P.Lower. Seeds. The Definitive Guide to Growing, History, and Lore. Timber Press. Portland.
7.	Cambrige. 2005. 229 p. N.O. Andersen. Flower Breeding and Genetics. Issues, Challenges and Opportunities for the 21st Century. Springer.2005. 822 p. G.Acquaah. Principles of Plant Genetics and Breeding. Blackwell Publishing. 2007. 569 p.

Supplementary reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Nguyen H.T., Blum A. Physiology and biotechnology integration for plant breeding. Marsel
2.	Dekker Inc.2004, 626 p.
3.	Bowling B.L. The Berry grower's companion. Timber Press. 2000. 280 p.
4.	Балашова Н.Н. Селекция и семеноводство овощных и бобовых культур. Кишинев-1989.-279 с.
5.	Journal of Plant Breeding and Genetics. eSci Journals Publishing
6.	Theoretical and Applied Genetics. Springer
7.	Euphytica. Springer
8.	Acta Horticulturae. ISHS Žemdirbystė-Agriculture

Course programme designed by

No.	Name, surname	Institution	Degree	E-mail address
1.	Vidmantas Stanys,		prof. habil. dr.	v.stanys@lsdi.lt
2.				

Approval at the Institute: 17 04 2019 protocol Nr. 3.
Approval at the meeting of the PhD programme committee: 03 05 2019 protocol Nr. 138.
Course description valid until 30 06 2023.

DESCRIPTION OF THE DOCTORAL STUDY SUBJECT OF AGRONOMY SCIENCES FIELD

Administrator of doctoral study program: Vytautas Magnus University Agricultural Academy and Lithuanian research centre for Agriculture and forestry
The coordinator of study subject – Department of Plants Biology and Food Sciences
Course code: **AGR8015**
Name in English: Storage and processing of plant raw materials
Number of ECTS credits: 7, 187 h, of which for contact work 46 h., for shelf-study 141 h

Course workload structure and hours:

Type of contact work	*Hours*	*Self-study*	*Hours*
Lectures	42	Control works	-
Practical	-	Practical works	-
Consultations	2	Individual assignment	20
Examination	2	Preparation of report	21
		Preparation for examination	100

Subject belongs to:

Study Cycle	*Study program*	*Subject type*
Third	Agronomy	Optional

The aim of the course: to provide the latest knowledge on the storage and processing of plant raw material, to develop the skills in integrating interdisciplinary knowledge based on the results of the most advanced fundamental and applied research, to offer, analyse, systemize and critically evaluate new and complex ideas in the search of original scientific decisions that are of public interest and strategic significance in the field of storage and processing of plant raw material.

Prerequisites for entering the course:

Links between the study programme outcomes, course outcomes, study methods and criteria and methods for learning achievement evaluation

Type of study programme outcomes	*Course outcomes*	*Study methods*	*Criteria and methods for learning achievement evaluation*
Knowledge, its application	Will have the latest systematic research knowledge in solving the problems of improving the storage and processing of plant raw material	*Lecture, given in a problematic, visualized teaching method, case study, discussion*	Knowledge of the qualitative criteria for storing and processing plant raw material, ability to participate in the discussion and to answer the questions
			Ability to assess the

			influence of biotic and abiotic factors on the quality of stored and processed plant production; to rationally solve the problematic situation; interview, managed and assessed by the lecturer and/or practitioner
			Ability to plan and execute applied research or projects related to solving the problems of storing and processing the plant raw material (interview, managed and assessed by the lecturer and/or practitioner)
Skills for research implementation	Will propose, analyse, systematize and critically evaluate new and complex ideas in the search of original scientific solutions for storing and processing plant raw material	*Individual assignment, case study, brainstorming*	Knowledge of qualitative criteria for storing and processing the plant raw material, presentation of the report, ability to participate in the discussion and answer the questions
	Will plan and carry out scientific large-scale research or projects related to the relevance of solving the problems of processing and storing the crop production	*Report*	Ability to plan and execute applied research or projects related to solving the problems of storing and processing the plant raw material
Special skills	Will create original tools for scientific research	*Report*	Knowledge about the qualitative criteria for storing and processing the plant raw material, timely problems (presentation of the report)

	Will independently implement scientific research	*Individual assignment, case study*	Ability to plan and execute applied research or projects related to solving the problems of storing and processing the plant raw material (presentation of the report, ability to participate in the discussion and answer the questions)
Social skills	Will communicate with colleagues, scientific community and society	*Individual assignment, brainstorming*	Knowledge about the qualitative criteria for storing and processing the plant raw material, timely problems (interview, managed and assessed by the lecturer and/or practitioner)
	Will transfer the novelties and prospects for development, technical, social and cultural progress in its field of activity	*Report*	
	Will develop creative activities and culture, will promote the progress that is favourable to the society	*Individual assignment, case study*	Ability to plan and execute applied research or projects related to solving the problems of storing and processing the plant raw material (presentation of the report)
Personal skills	Will design a further learning perspective for himself and the team of experts. Will take responsibility to critically evaluate strategic decisions in the field of his activity; will quickly respond to dynamic changes in the social, economic, technological environment, reveal and develop personal creative intellectual skills	*Report*	Knowledge about the qualitative criteria for storing and processing the plant raw material, timely problems (presentation of the report)
			Ability to plan and execute applied research or projects related to solving the problems of storing and processing the plant raw material (interview, managed and assessed by the lecturer and/or practitioner)

Content of the course:

Lectures:

1. Management of the system for the analysis of risk factors - 9 hours.

1.1. The latest research achievements, perspectives and problems in Lithuania, the EU and the world on the issues of storage and processing of plant raw material (1 hour).

1.2. Risk assessment – scientific approach to the safety of plant raw material and food. Application of an important control point system for the analysis of risk factors. The benefits of the quality and safety management systems of plant food raw material in agribusiness (2 hours).

1.3. Advantages and disadvantages of the Hazard Analysis Critical Control Point (HACCP) system for the analysis of risk factors. Stages of the development of a plan for HACCP system for the analysis of risk factors. Risk factors: microbiological, chemical, physical factors. Typical control points (SVT) for quality management in the production of plant and other products (3 hours).

1.4. Food safety management systems: FSSC 22000, ISO 22000, BRC, IFS, Global G.A.P and other standards (3 hours).

2. Processing of plant raw materials – 18 hours.

2.1. Requirements for quality of plant raw materials and suitability for processing. Technological processes. Physical and biochemical changes occurring during the processing (2 hours).

2.2. Changes in the chemical composition of fruits, berries and vegetables during their processing (2 hours).

2.3. Microbiological bioconversion of plant raw materials. The use of enzymes when processing fruits, berries and vegetables (2 hours).

2.4. Methods for fruits and vegetables processing. Biochemical preservation. Processing methods that increase the dry matter content in the product. Drying: general characteristic of the process; Heat and mass exchange; Equilibrium humidity; Various drying methods. Quick freezing: the effect of freezing speed and temperature on product quality; Physical-chemical processes that occur during the freezing; Defrostation (6 hours).

2.5. Non-thermal technologies for food processing (2 hours).

2.6. Food additives: dyes. Chemical structure, properties and stability of plants raw materials pigments (carotenoids, anthocyanins, flavonoids, etc.) (2 hours).

2.7. Preservatives. Antioxidants. Their significance and utilization in the processing of fruits, berries and vegetables (1 hour).

2.8. Storage of the canned fruits, berries and vegetables. Processes, happening during the storage in the canned products. Causes of deterioration and the methods for preventing it (1 hour).

3. Storage of plant raw materials – 15 hours.

3.1. The effect of abiotic and biotic factors on the storing the plant raw material (1.5 hour);

3.2. Scientific principles of storage, the essence of biogenesis and the methods for its implementation (1.5 hours)

3.3. Theory and practice of storing the grain. Use of the principle of xero-anabiosis in the grain storage. Analysis of grain biological processes. Processes for moisture migration. Microbiological processes of grain mass in their warehouses. Mycotoxins. Grain pests. Progressive methods and techniques for drying. Application and the methods of the principle of thermo-anabiosis for storing the grain. Anoxic anabiosis principle and the airless (hermetic) method for grain storage. Advantages and issues of wet grain storage. Principles and methods for chemical preservation of grain. Types of grain storage losses and the reasons for their formation (4 hours).

3.4. Theory of potato, vegetable and fruit storage. The influence of biological factors and agro-products for the preservation of stored production. Processes occurring in plant raw material after the harvest. Control of storage conditions (4 hours);

3.5. Biological aspects of storage. The processes of breathing, maturation, microbiological processes and their effect on the preservation. Calm period. Germination of stored raw material and the possibilities for managing this process with chemical and natural means (2 hours);

3.6. Physical characteristics of juicy raw material. Physical processes of the raw material held in containers/crates. Their influence on the preservation of raw material. Changes in chemical composition of stored raw material, products in a modified atmosphere. The characteristic of stationary modern warehouses – naturally and artificially refrigerated warehouses and controlled atmosphere storage facilities (2 hours).

Preparation of the individual assignment:

Topic: The influence of storage and processing on the quality of plant raw material – 20 hours.

Preparation of the report:

Topic: Projects related to solving the storage and processing of plant raw material by using the EU funding – 21 hour.

Methods and structure of the cumulative assessment of students' achievements

Students' achievements are assessed in a 10-grade scale in the system of cumulative assessment. Assessment is carried out in accordance with the criteria for the assessment of the subject's study results.

Structure of the cumulative grade:

Assessment type	*Weighted score*	*Assessment deadline*
Report	0,2	
Individual assignment	0,3	
Examination	0,5	According to individual plan

Required reading:

1. Adeyeye Samuel A.O., Yildiz Fatih. Fungal mycotoxins in foods: A review. Cogent Food & Agriculture .2016, (2): doi.org/10.1080/23311932.2016.1213127.
2. Advances in fruit processing technologies / edited by Sueli Rodrigues and Fabiano Andre Narciso Fernandes. Boca Raton, London, New York: CRC Press, 2012, 458 p.
3. Blackburn Clive, J McClur Peter. Foodborne Pathogens, Second Edition: Hazards, Risk Analysis and Control (Woodhead Publishing Series in Food Science, Technology and Nutrition) 2nd Edition, 2009, 1193P.
4. Danilčenko, H. Maisto žaliavų kokybės ir saugos valdymas [elektroninis išteklius] : mokomoji knyga/ Akademija, 2012. 158 p.
5. Danilčenko H., Jarienė E., Rizikos veiksniai produkcijos gamyboje. Mokomoji knyga. Akademija, 2009. 57p.
6. Danilčenko, H.; Jarienė, E.; Paulauskienė, A. Augalinių maisto produktų kokybė ir apsauga : vadovėlis. Akademija, 2008. 247 p.
7. Danilčenko, H.; Kulaitienė, J.; Tarasevičienė, Ž.; Zaleckas, E. Instrumentinė ir juslinė maisto produktų analizė [elektroninis išteklius]: mokomoji knyga /Akademija, Kauno r.:, 2011. 101 p.

8. Fresh-cut fruits and vegetables: science, technology, and market. Ed. Lamikanra O. CRC Press. 2002. 452 p.
9. Fruit and Vegetable Processing. FAO. 2009. 93 p. Handbook of vegetable preservation and processing / edited by Y. H. Hui ... [et al.] Food science and technology; v. 130 New York: Marcel Dekker, 2004. 608 p.
10. Handbook of Vegetables and Vegetable Processing. Ed. Sinha N.K. Wiley-Blackwell. 2011. 788 p.
11. Handbook of postharvest technology: cereals, fruits, vegetables, tea, and spices / edited by Amalendu Chakraverty [et al.]. New York, NY Basel: Marcel Dekker, 2003. 884 p
12. Jarienė, E. Augalinių žaliavų cheminė sauga [elektroninis išteklius] : mokomoji knyga /. Akademija, 2012. 137 p.
13. Jarienė, Elvyra; Danilčenko, Honorata. Funkcionalusis maistas: produktų kūrimo sistemos [elektroninis išteklius]: praktinių darbų aprašas. Akademija, 2012. 39 p.
14. Jarienė E., Danilčenko H., Vaitkevičienė N. 2015 Augalinių žaliavų cheminė sauga. Laboratorinių ir praktinių darbų aprašas Akademija, 26 p.
15. Jeswal, P., Kumar, D. Mycobiota and natural incidence of aflatoxins, ochratoxin A, and citrinin in Indian spices confirmed by LC-MS/MS. *International Journal of Microbiology*. 2015: doi:10.1155/2015/242486
16. Mannaa Mohamed, Kim Ki Deok.Microbe-Mediated Control of Mycotoxigenic Grain Fungi in Stored Rice with Focus on Aflatoxin Biodegradation and Biosynthesis Inhibition. Mycobiology. 2016 Jun; 44(2): 67–78. doi: 10.5941/MYCO.2016.44.2.67
17. Moretti A, Susca A, Mulé G, Logrieco AF, Proctor RH. Molecular biodiversity of mycotoxigenic fungi that threaten food safety. Int J Food Microbiol. 2013 Oct 1;167(1):57-66. doi: 10.1016/j.ijfoodmicro.
18. Postharvest physiology and pathology of vegetables / edited by Jerry A. Bartz and Jeffrey K. Brecht. New York: Marcel Dekker, 2003. 733 p.
19. Satinder Ahuja, Neil D. Jespersen. Modern instrumental analysis. Elsevier, 2006. p. 864.
20. Singh N. P. Fruit and Vegetable Preservation. Oxford. 2007. 360 p.
21. Thompson, A. K. Fruit and vegetables: harvesting, handling and storage.3rd edition. Oxford: Wiley-Blackwell, 2015, 1035 p.

Recommended reading:

1. Carole A. Wallace. Intermediate HACCP. 2005. 231p.
2. Carmen Socaciu. Food Colorants: Chemical and Functional Properties, 2008. 633 p.
3. Chemistry and technology of soft drinks and fruit juices / edited by Philip R. Ashurst Oxford: Blackwell Publishing, 2005. 392 p.
4. Enzymes in Fruit and Vegetable Processing. Chemistry and Engineering Applications. Ed. Bayindirli A. CRC Press. 2010. 373 p.
5. Fruit and vegetable phytochemicals: chemistry, nutritional value and stability. Ed. De la Rosa L.A., Alvarez-Parrilla E., Gonz´alez-Aguilar G.A. Wiley-Blackwell. 2010.382 p.
6. Handbook of Food Analysis Instruments Edited by Semih Otles. *CRC Press*, 2008, p. 544.
7. Handbook of organic food safety and quality. Edited bei Cooper J., Niggli U. and Leifert C. Woodhead pub. Ltd, 2007. 353p.
8. Horticulture. Edited by Maldonado A.I.L. InTech. 2012. 182 p.
9. Sprenger R. A. The Foundation HACCP Handbook. 2nd Edition, Blackwell pub. 2007.
10. Zarządzanie jakością i bezpieczeństwem żywności. Pod.red. Trziszki T. Wydawn. Uniw. Przyrodn. we Wrocławiu. Wrocław. 2009. 354 s.

Subject teachers:

Role of teacher	***Academic title, scientific degree, name, surname***
Coordinating teacher	***Prof. (HP) dr. Elvyra Jarienė***
Other teachers	***prof. dr. Pranas Viškelis, assoc. prof. dr. Živilė Tarasevičienė***

Author of the course description: prof. dr. Honorata Danilčenko, prof. dr. Elvyra Jarienė, prof. dr. Pranas Viškelis.

Rewiever: *Agricultural and food science institute of VMU Agricultural Academy – asocc. prof. dr. Ž. Tarasevičienė*

Approval at the Institute: 17 04 2019 protocol Nr. 3.
Approval at the meeting of the PhD programme committee: 03 05 2019 protocol Nr. 138.
Course description valid until 30 06 2023

COURSE DESCRIPTION

Course code	Volume in ECTS credits	Institution	Faculty	Department
AGR8017	7		Agronomy	

Course title in Lithuanian

Sodininkystė

Course title in English

Horticulture

Study methods	Volume in ECTS credits
Lectures	40
Consultations	3
Exam	3
Individual work	141

Short course annotation in Lithuanian (up to 500 characters)

Studentai žinos sodininkystės mokslo ir gamybos vystymosi tendencijas ir perspektyvas pasaulyje, norminius aktus, reglamentuojančius uogų ir vaisių auginimo, kokybės ir realizavimo klausimus, aplinkos veiksnius ir klimatines sąlygas, sąlygojančias sodininkystės plėtrą, augalų sistematiką, biologiją, morfologiją, architektoniką, sodo augalų augimo, vystymosi, derėjimo dėsningumus, sodo augalų dauginimo, uogynų ir sodų įveisimo, priežiūros bei derliaus dorojimo ypatumus.

Short course annotation in English (up to 500 characters)

The students will know the tendencies and perspectives of the development of horticultural science and production in the world, normative acts regulating berry and fruit growing, quality and realization issues, environmental factors and climatic conditions, which determine the development of horticulture, plant systematics, biology, morphology, architectonics, regularities of garden plant growth and development , the peculiarities the propagation of plants, the maintenance and harvest.

Relevance of the course

Students will be able to analyze the changes in the growth, development, and coherence of garden plants under the influence of anthropogenic factors, model technologies based on the latest results of fundamental and applied research, propose strategic ways of solving issues related to the propagation, planting, care, yield and harvesting of garden plants, critically to assess the impact of horticultural development on the environment.

Course aims

Providing knowledge and skills for complex horticultural activities, gathering new knowledge about technologies, solutions, methods and processes; to help prepare for scientific activities.

Content (topics) and methods

Lectures: 1. Development and perspectives of horticulture. Trends in horticulture. Tribal composition of garden plants. 2. Horticultural production. Value and need of fruit in Lithuania, Europe, world. Fruit consumption rates. 3. Development of horticultural science. Research institutions in Lithuania, research directions. 4. Institutions and regulatory acts regulating horticultural production and scientific activities. 5. Conditions for the development of topographical and economic horticulture. 6. Environmental factors limiting gardening and climatic conditions. 7. Agrotechnical and environmental problems in horticulture. 8. Plant systematics, biology, morphology, architectonics. 9. Regularities of growth, development and consistency of garden plants. 10. Specific physiological, anatomical, morphological features of garden plants. 11. Peculiarities, techniques, technologies for propagation of garden plants. 12. Theoretical and technological solutions for gardening, planting and care. 13. Problems of quality assurance of growing material. 14. Nutrition of orchards and berry plants to preserve high quality harvest and plant potential. 15. Problems of young gardens. 16. Specificity of garden maintenance. 17.

Distinctive features of janitor care and harvesting. 18. Physiology of Fruit, Problems of Picking, Logistics and Trade. 19. Specifics of research and methodology in horticulture.
Study subject methods: lecture material visualized, problematic lectures focusing on critical plant development factors and scientific issues to be addressed by individual garden plants. During these, doctoral students are included in the discussion. Targeted readings and presentations are provided for analysis of normative documents regulating horticultural production and scientific activities. Approximately 10 minutes are given to discuss each lecture topic. In the absence of a minimum number of doctoral students, individual consultations will be provided.

Structure of cumulative score and value of its constituent parts

1. Description of the development, production and prospects of horticultural science. 2. Description of environmental factors and climatic conditions, plant systematics, biology, morphology, architectonics, garden plant growth, development and consistency patterns. 3. Acquisition of knowledge about the propagation, planting, care and harvesting of garden plants and their application to problem gardening. 4. Adaptation of knowledge about the peculiarities of gardening nutrition and its application in mineral nutrition issues. 5. Understanding and applying regulatory acts on horticultural production and research in the development of horticultural technology. 6. Ability to communicate. 7. Ability to analyze.

Compulsory reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Acquaah G. Horticulture principles and practices. Pearson Prentice Hall, 2009. - 760 p.
2.	Adams C. R., Early M.P. Principles of horticulture. Oxford: Elsevier Butterworth-Heinemann, 2004, Repr. 2006. - 230 p.
3.	Forshey C.G. Training and Pruning. Apple and Pear Trees.- Michigan, 1992.- 166 p.
4.	Uselis N. (sudarytojas). Intensyvios obelų ir kriaušių auginimo technologijos. Babtai, 2005.- 210 p.
5.	Uselis N. (sudarytojas). Intensyvios uoginių kultūrų auginimo technologijos. Babtai, 2002.- 190 p.
6.	Tromp J., Wertheim A.D., Wertheim S.J. Fundamentals of temperate zone tree fruit
7.	production.- Backhuys Publishers. 2005. - 400 p.

Supplementary reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Acta Horticulture. Mineral nutrition of deciduous fruit plants// Editors M. Tagliavini.G.H. Neilsen. P. Millard.- Trento, 1993. - 520 p.
2.	Bergmann W., Farbatlas. Ernarungsstorungen bei kulturpflanzen. -Jena, 1983. - 254 p.
3.	Brown L.V. Applied principles of horticultural science.- Butterworth Heinemann, 2002. - 322. Lind
4.	K., G.Lafer, K.Schloffer, G.Innerhofer,H.Meister. Organic fruit growing.- CABI publishing. 2003. 281p.
5.	Privalomieji kokybiniai reikalavimai šviežiems vaisiams ir daržovėms.- Babtai, 2001. 186p
6.	Tuinyla V., A. Lukoševičius (sudarytojai). Lietuvos pomologija. T.2. Vilnius, 1996. - 390 p.
7.	The Journal of Horticultural Science & Biotechnology
8.	Horticultural Science, Czech Academy of Agricultural Sciences
9.	Journal of the American Society for Horticultural Science
10.	Scientia Horticulturae. Elsevier
11.	European Journal of Horticultural Science. Verlag Eugen Ulmer.
12.	Acta Horticulturae. ISHS

Course programme designed by

No.	Name, surname	Institution	Degree	E-mail address
1.	Vidmantas Stanys,		prof. habil. dr.	v.stanys@lsadi.lt

Approval at the Institute: 17 04 2019 protocol Nr. 3.
Approval at the meeting of the PhD programme committee: 03 05 2019 protocol Nr. 138.
Course description valid until 30 06 2023.

COURSE DESCRIPTION

Course code	Volume in ECTS credits	Institution	Faculty	Department
AGR8019	7	VMU AA	AF	Plant Biology and Food Sciences

Course title in Lithuanian

Augalų fiziologija

Course title in English

Plant Physiology

Study methods	Volume in ECTS credits
Lectures	1
Consultations	1
Seminars	1,5
Individual work	3,5

Short course annotation in Lithuanian (up to 500 characters)

Kursas priklauso laisvai pasirenkamiesiems dalykams. Kurso metu nagrinėjama fiziologinių procesų sąveika įvairiuose augalo lygmenyse kintančio klimato sąlygose, išplečiamos žinias apie vykstančių procesų valdymo principus ir integravimo būdus. Tikslas – analizuoti įgytas teorines žinias augalų fiziologijos srityje ir jas interpretuoti sąsajose su tiriamuoju darbu. Studijų formos: paskaitos, seminarai, konsultacijos, individualus darbas ir pristatymas, baigiamasis egzaminas.

Short course annotation in English (up to 500 characters)

The course is owned free optional studies. The course examines the interaction of plant physiological processes at various levels of plant conditions of climate change, expands the boundaries of knowledge about governance processes and integration methods. The aim - to analyze the acquired theoretical knowledge in the field of plant physiology and their interfaces to interpret the research work. Study forms: lectures, seminars, consultations, individual work and presentation, the final exam.

Relevance of the course

After completing the course, students will have knowledge of scientific advances in plant physiology, plant vital functions, their mechanisms of expression, interactions and coordination at the cellular, plant and population levels. Will be able to evaluate plant processes in the context of environmental and growing technologies. The acquired knowledge will allow to search for scientific solutions in the fields of agricultural science and professional activities, will significantly expand the knowledge about the principles of plant processes management and integration methods.

Course aims

The main goal of the subject is to provide knowledge that at the level of physiological processes will allow to interpret fundamental knowledge, plan research and analyze it, systematize data and summarize research results, assessing their interaction with changing environmental, anthropogenic and technological factors.

Content (topics) and methods

1. **Topic.** Biochemical and physiological processes in plants and cells. Methods: literature analysis, discussion lecture.
2. **Topic.** Plant nutrition. Nutritional and symbiotic relationships of plants. Methods: discussion, case study.
3. **Topic.** Plant water metabolism physiology. Methods: literature analysis, discussion lecture, case study, individualized learning.

4. **Topic.** Physiology of carbon uptake and transformation. Effects of ecological (abiotic, biotic and anthropogenic) factors. Methods: literature analysis, consultation, discussion lecture. 5. **Topic.** Growth and development physiology. Physiology of stress and adaptation. Primary and secondary metabolites of plants (regulation and self - regulation). Plant hormones and primary and secondary metabolites of various stressors of tolerance. Methods: literature analysis, discussion lecture, case study, consultation, individual and collective work, individualized learning.

Structure of cumulative score and value of its constituent parts

Individual work and presentation - 50% of the final grade, Exam - 50% of the final grade

Compulsory reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Bhatla S.C., Lae M.A. *Plant Physiology. Development and Metabolism.* Springer, 2018.
2.	Hemsley A.R., Poole I. *The evolution of plant physiology: from whole plants to ecosystems*. London: Elsevier Academic Press, 2004.
3.	Hopkins W.G., Hüner N.P.A. *Introduction to Plant physiology.* Haboken (N.J.): J.Wiley&Sons, 2009.
4.	Nobel, Park S. *Physicochemical and Environmental plant physiology*. 4th Edit. Academic Press, 2009.
5.	Öpik H., Rolfe St.A. *The physiology of flowering plants*. New York: Cambridge University Press, 2005.
6.	*Physiology and molecular biology of stress tolerance in plants*. Ed. by K.V.Madhava Rao, A.S.Padhavendra, K. Janardhan Reddy. Springer, 2006.
7.	Tainz L., Zeiger E. *Plant Physiology*. Sunderland (mass):Sinauer Associates, 2010.
8.	Tainz L., Zeiger E., Møller I.M., Murphy A. *Plant Physiology and development.* Oxford University Press, 2018.

Supplementary reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	*Brassinosteroids in Plant Development Biology an Stress Tolerance*. Ed. by J. Yu, G. Ahammed, P. Krishna. 2019.
2.	*Cell physiology Source Book: Essentials of Membrane Biophysics*. Ed. by N. Sperelakes. 4the edition, 2011.
3.	Fagaria N.K., Baligar V.C., Clark R.B. *Physiology of crop production.* New York etc: Food products press., 2006.
4.	Kacienė G. *Skirtingų veiksnių sukeliamas oksidacinis stresas ir jo įtaka vasarinių miežių (Hordeum vulgare* L.) *atsparumui:* daktaro disertacija. Kaunas, VDU leidykla, 2014.
5.	Kutschera U. *Prinzipien der Pflanzenphysiologie*. 2. Auflage. Spektrum Akademischer Verlag, Heidelberg, Berlin, 2002.
6.	Schopfer P., Brennicke A. *Pflanzenphysiologie*. 6. Auflage. Elsevier, 2005.
7.	*Plant metabolism. Methods and Protocols*. Ed. by G.Sririam. Springer, 2014.

Course programme designed by

No.	Name, surname	Institution	Degree	E-mail address
1.	Regina Malinauskaitė	VMU A A	Ass.prof. dr.	regina.malinauskaite@vdu.lt
2.	Aušra Brazaitytė	LRC for Agriculture and Forestry	chief researcher	ausra.brazaityte@lammc.lt

Approval at the Institute: 09 04 2019 protocol Nr. 22.
Approval at the meeting of the PhD programme committee: 03 05 2019 protocol Nr. 138.
Course description valid until 30 06 2023.

COURSE DESCRIPTION

Course code	Volume in ECTS credits	Institution	Faculty	Department
AGR8019	7	VDU	AF	Agroecosystems and soil sciences

Course title in Lithuanian

Mikrobiologija

Course title in English

Microbiology

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

Short course annotation in Lithuanian (up to 500 characters)

Dalyko paskirtis – suteikti žinių apie mikroorganizmų grupes ir išaiškinti mikroorganizmų morfologinius ir fiziologinius skirtumus bei reikšmę gamtinėse ir antropogeninėse ekosistemose žemės ūkio ir miškininkystės sektoriuose. Skiriamas dėmesys mikrobiologinių procesų dirvožemyje bei mikroorganizmų maisto žaliavose pažinimui ir vertinimui. Mokoma metodų simbiontiniams ir patogeniniams mikroorganizmams tirti, vertinama mikrobiologinė tarša, supažindinama su profilaktinių priemonių taikymu.

Short course annotation in English (up to 500 characters)

Purpose of course - to provide knowledge about groups of microorganisms, to explain morphological and physiological differences in microorganism phylas, to identify the significance of microorganisms in natural and anthropogenic ecosystems in agricultural and forestry sectors. The experience in evaluation of microbiological processes in soil and microorganisms in food raw materials is amplified, methods for testing symbiotic and pathogenic microorganisms are taught, microbiological contamination is assessed, and application of preservation measures is introduced.

Relevance of the course

Doctoral students will be introduced with biological properties of microorganisms and development characteristics, impact on soil / plant / yield and crop quality. Students will be able to analyze, identify and assess microbiological processes in agriculture and forestry. The skills to plan and conduct fundamental and applied research on microbiology will be strengthen, the knowledge on the evaluation of various factors and methods on control the microorganisms will be developed.

Course aims

To develop students' knowledge and skills for implementing of student competencies to identify microorganisms in practice, to perform scientific research along with applying microbiology methods and evaluating of microbiological processes, to solve microbiological problems reflecting the society need, to plan scientific analyses for validation of innovative decisions for microbiology applied societies.

Content (topics) and methods

Lectures / discussions:

1. Objects of the microbiological research: eukaryotes, prokaryotes, non-cellular microorganisms.
2. Morphological and physiological similarities and differences of microorganisms.
3. Bacterial cell structure and features.
4. Structure and features of microscopic fungi.
5. Structure and features of non-cellular microorganisms: virus, viroid, prion.
6. Main aspects of environmental factors determining the development of microorganisms.
7. Microbial nutrient sources: importance of chemical elements and, particularly, carbon, nitrogen and phosphorus.
8. Metabolism of microorganisms: fermentation and application in biotechnology.
9. Metabolism of microorganisms: respiration and application in biotechnology.
10. Soil microorganisms and role in soil development, organic matter decomposition and stimulation for

formation of humic substances.
11. Plant raw material microbiology.

Individual activities or practical training:

1. Investigation of physical conditions impact on microorganisms
2. Investigation of chemical conditions impact on microorganisms
3. Identification of microorganisms using selective and chromogenic nutrient mediums (substrates)
4. Plant raw material and soil microbiological quality evaluation

Structure of cumulative score and value of its constituent parts

Doctoral students are scored on the ten-point cumulative assessment and is based on the described criteria for the assessment of the study results: individual activities or practical training - 50 percent of final evaluation; exam - 50 percent of final evaluation. The exam score is given based on student's ability to perform the analyses of individual questions and to discuss. Final examination score to evaluate students' knowledge and abilities are indicated by the examination committee consisting of two course program lecturers and student's supervisor or consultant.

Compulsory reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Pranaitis P., Mikrobiologijos pagrindai, Akademija, Kauno r.: LŽŪU Leidybos centras, 2009.
2.	Dabkevičius Z., Mikrobiologijos ir bakteriologijos pagrindai, Šiauliai: Šiaulių universiteto leidykla, 2008.
3.	Masteikienė R.R.;Maisto produktų mikrobiologija, Kaunas: Technologija, 2006.
4.	Dongyou Liu, Molecular food microbiology, Boca Raton, Fla.: CRC Press, Taylor & Francis Group, 2021.
5.	Wessner D.R., Dupont Ch., Charles T.C., Microbiology, Hoboken: Wiley, 2013.
6.	Strohl W.A., Rouse H., Fisher B.D., editors: Harvey R.A., Champe P.C., Microbiology, Philadelphia: Lippincott Williams & Wilkins, 2001.
7.	Buchovec I., Maisto patogenų inaktyvacija fotoaktyvuotu chlorofilinu: poveikio mechanizmas, optimizavimas ir pritaikymo galimybės, Vilniaus universitetas, Gamtos mokslų fakultetas, 2018.
8.	Snieškienė V., Stankevičienė A., Augalų grybinių ligų sukėlėjai Vytauto Didžiojo universiteto Kauno Botanikos sode, Vytauto Didžiojo universiteto botanikos sodo raštai, Kaunas: Vytauto Didžiojo universiteto leidykla, 2013 (T. 17, p. 165-176).

Supplementary reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Arzu Çelik Oğuz, Aziz Karakaya, Genetic diversity of barley foliar fungal pathogens, Agronomy, 2021 (Vol. 11(3), 434).
2.	Antwis R.E., Harrison X.A., Michael J., Microbiomes of soils, plants and animals: an integrated approach, Cambridge: Cambridge University Press, 2020.
3.	Thiele-Bruhn S., Schloter M., Wilke B.M. et al., Identification of new microbial functional standards for soil quality assessment, Soil, 2020 (Vol. 6, p. 17-34).
4.	Mendes R., Garbeva P.V., Raaijmakers j.M., The rhizosphere microbiome: significance of plant beneficial, plant pathogenic, and human pathogenic microorganisms, FEMS microbiology reviews, 2013 (Vol. 37 (5), p. 634-663).
5.	Philippot L., Ritz K., Pandard P., Hallin S., Martin-Laurent F., Standardisation of methods in soil microbiology: progress and challenges, FEMS microbiology ecology, 2012 (Vol. 82 (1)), p. 1-10).
6.	Gadd G., Sariaslani S., Advances in Applied Microbiology, Elsevier Science & Technology, 2009.
7.	Glazer A.N., Microbial biotechnology:fundamentals of applied microbiology, New York, N.Y.: Cambridge University Press, 2007.

Course programme designed by

No.	Name, surname	Institution	Degree	E-mail address
1.	Jūratė Aleinikovienė	VMU	Assoc. prof. dr.	jurate.aleinikoviene@vdu.lt
2.	Skaidrė Supronienė	LAMMC	dr.	skaidre.suproniene@lammc.lt

Approved at the meeting of **VMU Faculty of Agronomy Institute of Agroecosystems and Soil Sciences on** 19 04 2019, protocol No. 6(6).

Approved in the meeting of the programme's Doctoral Studies Committee on 03 05 2019, protocol No. 138.

Description of the subject has been certified until 30 06 2023

COURSE DESCRIPTION

Course code	Volume in ECTS credits	Institution	Faculty	Department
AGR8020	7	VMU	Agronomy	Agroecosystem and soil sciences

Course title in Lithuanian

Fitopatologija

Course title in English

Plant Pathology

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

Short course annotation in Lithuanian (up to 500 characters)

Studijose analizuojami biotiniai ir abiotiniai augalų ligotumo veiksniai. Nagrinėjamos neinfekcinių ligų priežastys, simptomai, diagnostika ir plitimo kontrolė. Studijuojama virusinių, bakterinių ir grybinių ligų sukėlėjai, jų sistematika, ekologija ir dinamika. Aptariami patogeniniai procesai augaluose, imunitetas ligoms. Analizuojami modernūs augalų ligų identifikavimo, apskaitos, plitimo prognozės ir kontrolės metodai. Susipažįstama su žemės ūkio, sodo ir daržo, miško ir dekoratyvinių augalų ir augalinių produktų ligomis, jų plitimo bei žalingumo kontrole.

Short course annotation in English (up to 500 characters)

The studies analyze biotic and abiotic factors affecting plant disease. The origin, symptoms, diagnosis and control of non-infectious diseases are analyzed. The causing organisms of viral, bacterial and fungal diseases, their systematics, ecology and dynamics are studied. Pathogenic processes in plants, immunity to diseases are discussed. Plant disease identification, accounting, prediction and control methods are analyzed. Get acquainted with diseases of agriculture, horticulture, forest and ornamental plants and plant products, disease incidence, severity, harmfulness and control of their.

Relevance of the course

Upon completion of the course the students will be able to identify the causes and origin of infectious and non-infectious plant diseases; to estimate the environmental effects on the development of diseases, to understand the interaction between pathogen and host plant; to know the principals of plant disease epidemiology. Students will be able to recognize and identify most important agricultural, horticultural, forest and ornamental plant diseases and will be able to select appropriate control measures.
Students will be able to choose adequate methods for fundamental and applied research on plant pathogens, disease epidemiology and control measures; will be able to critically evaluate the research results on plant pathology.

Course aims

Aim of studies course is to acquire new knowledge about infectious and non-infectious plant diseases, their causes, origin, interaction of environment, pathogens and plants, about pathogenic microorganisms; to explore plant disease epidemiology; to gain detailed knowledge of the main agricultural plant diseases, their identification and control.

Content (topics) and methods

Topic 1. Introduction to plant pathology.
Topic 2. Non-infectious plant diseases.
Topic 3. Infectious plant diseases.
Topic 4. Plant diseases caused by viruses.
Topic5. Plant diseases caused by bacteria.
Topic 6. Plant diseases caused by fungi.
Topic 7. Plant diseases caused by parasitic higher plants.
Topic 8. Parasitism and disease development. Epidemiology of plant diseases.

Topic 9. How the pathogens attack plants and plants defend themselves against pathogens. Topic 10. Identification, assessment and forecasting of plant diseases. Topic 11. The diseases of agricultural plants: incidence, severity, harmfulness and control methods. Topic 12. The diseases of plant-derived products: prevention and control. Topic 13. The diseases of horticultural and vegetable plants: incidence, severity, harmfulness and control methods. Topic14. The diseases of forest and ornamental plants: incidence, severity, harmfulness and control methods.

Structure of cumulative score and value of its constituent parts

Individual task -25 Practical training and seminars- 25, Final exam -50 .

Compulsory reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Agrios G.N. Plant Pathology – 5 th ed. – Elsevier Academic Press, 2005, 922 p.(1,2)[X]
2.	Biotic Interactions in Plant-pathogen Associations / edited for the British Society for Plant Pathology by M. J. Jeger, N. J. Spence. - New York, 2001, 353 p. (2)
3.	Lucas J. A. Plant Pathology and Plant Pathogens, 1998, -274 p. (1,2)
4.	Introduction to Plant Pathology / Strange Richard N. - New York: Wiley, 2003, 464 p. (2)
5.	Robert F. Nyval. Field Crop Diseases –Third edition. – Iowa State University Press/Ames, 1999.-1021p. (2)

[X] Note: the books are available in libraries: (1) Vytautas Magnus University, Academy of Agriculture
(2) Lithuanian Research Centre for Agriculture and Forestry

Supplementary reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Bacterial Plant Pathology: Cell and Molecular Aspects / David C. Sigee. - Cambridge, UK, 1993. 325 p. (1,2) [X]
2.	Carlile Bill. Pesticide Selectivity, Health and the Environment.- Cambrige University press, UK, 2006. 310 p. (1,2)
3.	Crop Protection Information. An International Perspective. Edited by K. M. Harris and P.R. Scott. – C.A.B. International, UK, 1989, 321 p. (2)
4.	Efficacy Evaluation of Plant Protection Products. Vol. 2 Fungicides & Bactericides: EPPO Standards.-Paris, France, 2004, 198 p. (1,2)
5.	Guidelines for the Efficacy Evaluation of Plant Protection Products. Vol. 1 Introduction, General & Miscellaneous Guidelines, New & Revised Guidelines: EPPO Standards.-Paris, France, 2004, 111 p. (2)
6.	Matthews G.A. Pesticide: Health, Safety and the Environment.-Blackwell Publishing, 2006. 235p. (1)
7.	Matthews' Plant Virology: 4nd ed. / Roger Hull, - Amsterdam, 2004, 1001 p. (2)
8.	Paul Holliday. A Dictionary of Plant Pathology – Second edition.- Cambrige University press, 1998. 536 p. (2)
9.	Plant-fungal Pathogen Interaction: a Classical and Molecular View / Hermann H. Prell, Peter R. Day, - Berlin, London, 2001, 214 p. (2)
10.	Viral Pathogenesis and Immunity / Neal Nathanson. - . New York, 2007, 266 p. (2)

[X] Note: the books are available in libraries: (1) Vytautas Magnus University, Academy of Agriculture
(2) Lithuanian Research Centre for Agriculture and Forestry

Course programme designed by

No.	Name, surname	Institution	Degree	E-mail address
1.	Zenonas Dabkevičius	VMU	Prof. Habil. Dr.	Zenonas.dabkevicius@lammc.lt
2.				

Approval at the Institute: 09 04 2019 protocol Nr. 22.
Approval at the meeting of the PhD programme committee: 03 05 2019 protocol Nr. 138.
Course description valid until 30 06 2023.

COURSE DESCRIPTION

Course code	Volume in ECTS credits	Institution	Faculty	Department
AGR8021	7	VMU	Agronomy	Agroecosystem and soil sciences

Course title in Lithuanian

Mikologija

Course title in English

Mycology

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

Short course annotation in Lithuanian (up to 500 characters)

Studijose analizuojama grybų ir panašių į grybus organizmų vieta gyvajame pasaulyje, jų biologija, paplitimas, poreikiai aplinkai. Studijuojama grybų sandara, mityba, dauginimasis, nomenklatūra, taksonomija ir sistematika, simbiontinių ir patogeninių grybų santykiai su augalu šeimininku. Susipažįstama su svarbiausiais augalų patogeniniais grybais, jų ekologiją, identifikavimo metodais, plitimo prevencijos ir kontrolės priemonėmis.

Short course annotation in English (up to 500 characters)

The studies analyse the place of fungi in the living world, their biology, prevalence, environmental needs. Fungi morphology, nutrition, reproduction, nomenclature, taxonomy and systematics, relationship between symbiotic and pathogenic fungi with the host are studying. The most important plant pathogenic fungi, their ecology, identification methods, disease incidence, severity and control are presented.

Relevance of the course

After mastering the course, students will know about the development of mycology science and the latest achievements, fungi in living organisms, biology, systematics and ecology of fungi, spread of pathogenic fungi and control measure; will be able to formulate research problem, goal and tasks in mycology science, to select research methods in fundamental and applied scientific mycology research, to critically evaluate the obtained research results in mycology; Based on the latest scientific knowledge, will be able to develop original methods of mycological research, studies, innovation, tools and tools for regulating fungal populations in the environment.

Course aims

Aim of the course: to acquire new knowledge about the location of fungi and similar fungi organisms in the living world, their biology, distribution, environmental needs. Essential to deepen knowledge about the structure, nutrition, reproduction, nomenclature, taxonomy and systematics of fungi, to get acquainted with the most important plant pathogenic fungi, to study the relationship between pathogenic fungi and plant host, ecology of pathogenic fungi, identification, preventive and control measures

Subject content, topics and study methods

Topic 1. History and development of mycology in the world and Lithuania.
Topic 2. Morphology of fungi.
Topic 3. Fungal reproductive organs, methods and processes of reproduction.
Topic 4. Fungi needs for environmental conditions, nutrition and metabolism.
Topic 5. Fungal genetics and variability.
Topic 6. Fungal nomenclature, systematics, taxonomy and classification.
Topic 7. Prevalence of fungi in nature, relationship with other organisms, pathogenesis of plants.
Topic 8. Pathogens of agriculture, garden, forest and ornamental plants, their ecology, symptoms.
Topic 9. Identification of fungi and methods of diagnosis of fungal diseases.
Topic 10. Principles and methods of prevention and control of fungal diseases.
Topic 11. Planning and carrying out mycological studies.
Subject study methods. Lecture material is visualized using multimedia equipment and smart auditorium board. Students are enrolled into discussions individually or by group of questions. In the absence of a minimum number of doctoral students, lectures are not counted and doctoral students, in consultation with the

lecturer, independently study topics and present knowledge during practical and control work. Doctoral students are discussing the most important topics, how much the doctoral student's work is closely related to plant pathology, possible methods of investigation of specific pathogens are discussed, where the latest research methodologies can be found and how to use them best in doctoral student work, advised with which scientists can be consulted in more detail. Doctoral students are consulted according to the agreed schedule and correspondence in electronic space.

Structure of cumulative score and value of its constituent parts

The achievements of doctoral students are evaluated using the ten-point cumulative assessment system and according to the envisaged criteria for assessment of the study outcomes of the subject: individual task, exercise, report - 40%. final evaluation; exam - 60 percent final evaluation. The examination score is determined by the ability of the doctoral student to analyze the questions submitted, to discuss with the examining teachers.

The evaluation of the knowledge and skills of the PhD students during the examination and the final assessment is carried out by a commission consisting of one or two subject teachers and the supervisor or consultant of the doctoral student.

Compulsory reference materials

No.	**Authors of publication, title, publishing house, year of publication.**
1.	Ainsworth & Bisby's dictionary of the fungi: 9th ed. / by P.M. Kirk [et al.]. - Wallingford. – 2001, 655 p.
2.	Hermann H. Prell, Peter R. Day. Plant-fungal pathogen interaction: a classical and molecular view, Berlin, London, 2001, 214 p.
3.	Carlile, M.J., Watkinson S., C. Gooday G., W. The fungi. Amsterdam. 2001. 588 p.
4.	Ramesh Maheshwari. Fungi experimental models in biology, Boca Raton, London, 2005, 204 p.

Supplementary reference materials

No.	**Authors of publication, title, publishing house, year of publication.**
1.	Butt T.M., Jackson C., Magan N. Fungi as biocontrol agents: progress, problems and potential. Cambrige, Mass.: CABI, -2001, 390 p.
2.	Dugan Frank M. The identification of fungi: an iliustrated introduction with keys, glossary and guide to literature. St. Paul, Minn., 2003, 176 p.
3.	Pitt J.I., Hocking D. Fungi and food spoilage. Gaithersburg, 1999, 539 p.
4.	Webster John. Introduction to fungi. Cambridge, 2011, 841 p.
5.	Watanabe, T. Pictorial atlas of soil and seed fungi: morphologies of cultured fungi and key to species. Boca Raton, 2002, 484 p.

Course programme designed by

Name, surname	**Institution**	**Degree**	**E-mail address**
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Approval at the Institute: 09 04 2019 protocol Nr. 22.
Approval at the meeting of the PhD programme committee: 03 05 2019 protocol Nr. 138.
Course description valid until 30 06 2023.

COURSE DESCRIPTION

Course code	Volume in ECTS credits	Institution	Faculty	Department
AGR8022	7	VDU-ŽŪA	Faculty of Agronomy	Agroecosystems and Soil Sciences

Course title in Lithuanian

Bestuburių zoologija ir entomologija

Course title in English

Invertebrate Zoology and Entomology

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

Short course annotation in Lithuanian (up to 500 characters)

Bestuburių zoologijos ir entomologijos kursas supažindina su bestuburių gyvūnų įvairove ir sistematika. Studijų metu analizuojami įvairūs vienaląsčiai organizmai, jų išorinė ir vidinė kūno sandara bei ekologija ir įvairovė. Tai pat ir daugialąsčiai bestuburiai gyvūnai, jų anatomija, morfologija ir ekologija. Nagrinėjama įvairių bestuburių grupių charakteristika, apžvelgiant pagrindinius biologinius aspektus: mitybą, elgsenos ypatumus, dauginimosi ir gyvenimo ciklus, pasiskirstymą ir adaptacijas tam tikrai aplinkai. Studijų metu apžvelgiama kiekvienos bestuburių grupės rūšinė įvairovė, ekonomiškai, mediciniškai ir ekologiškai svarbias bestuburių gyvūnų rūšys. Apžvelgiama bestuburių svarba vertinant aplinkos būklę. Aptariamos retosios ir nykstančios bestuburių rūšys, analizuojami faktoriai, nulemiantys šių rūšių išsaugojimą.

Short course annotation in English (up to 500 characters)

This course is designed to provide students with a basic understanding of biology, morphology, anatomy and physiology of the more common invertebrate phyla. This course is intended to introduce students with knowledge on structure, functional processes and diversity of protozoa and metazoa invertebrates. The characteristics (principles of feeding, behavior, reproduction, adaptations to various environments) of the main groups of invertebrates will be analyzed. The taxonomy, distribution, diversity and economical, medical and ecological importance of invertebrates will be presented. The rare species of invertebrates and factors important for the conservation invertebrate species will be observed.

Relevance of the course

Invertebrate Zoology is one of the most important natural science study subjects analysing the structure, biology, diversity and systematic structure of invertebrate animals and their relationship with other components of living and non-living nature. Invertebrates constitute for about 95 percent of the total number of species and individuals of wildlife of the Earth. They are common in all biocenoses and occupy a very important place in nature and human life. A variety of invertebrate animals ranging from unicellulars to molluscs and echinoderms are examined in the course. Students consistently examining systematic groups of invertebrate animals, understand the main directions of the evolutionary process and the structural and functional adaptations that have emerged during this process. While studying this subject, students will know the systematics of unicellular and multicellular invertebrates, the representatives of main types, their morphology, bioecology, the principles of their monitoring and protection, and forms of relationships between living organisms. Understanding of nature conservation problems and the necessity of biodiversity preservation will be indoctrinated. Ability to identify and characterize the main invertebrate animals, explain their biology peculiarities, performance of accounting, responsibility in making necessary decisions regarding the environmental factors and environmental protection requirements will be elevated.

Course aims

Preparation of theoretically qualified, capable of critical and creative thinking, broad-based students with knowledge and skills in the fields of biology, ecology, agronomy, and the environment, and capable in adapting this knowledge and skills in their professional activity under the altering environment conditions.
To construct the system of theoretical knowledge of living and non-living nature and cognition of ecosystems, to improve abilities of application of mathematical methods and information technologies, to develop skills in assessment and application of protection measures of individual components of nature.
To provide students with knowledge of evolution, systematics, morphology, their interrelations, significance, ecology of invertebrate animals; to study in detail the invertebrates living in Lithuania (protozoa, worms, arthropods, molluscs), their phylogeny, behavior, structure, ecology, methods of protection and control.

Content (topics) and methods

Content of the subject:

Lectures:

1. History of Zoology, taxonomy. Overview of living organisms. Animal Kingdom. Location and significance of invertebrates in ecosystems.
2. Structure, systematics of unicellular animals. The most important representatives, their ecology, significance.
3. Types of Sarcodina, Flagellata, Sporozoa, Cnidosporidia, Microsporidia, Ciliophora (structure, systematics, ecology, phylogeny).
4. Subkingdom of Multicellulars (structure, development, taxonomy).
5. Subsections of Phagocytelozoa, Parazoa (types of Placozoa, Spongia), key representatives, ecology, significance.
6. Eumetazoa (types of Coelenterata and Ctenophora), key representatives, ecology, significance.
7. Section of Bilateralia. Types of Plathelminthes, Nemathelminthes, and Annelida worms. Systematics, ecology, and significance.
8. The main representatives of the types of Nemertini, Rotatoria, Cephalorhyncha, Acanthocephala, Echiurida, Sipunculida. Their significance and ecology.
9. Types of Onychophora, Tardigrada, Tentaculata, Branchiopoda, Hemichordata, Pogonophora, Chaetognatha, Echinodermata. Their classification, morphology, ecology.
10. Type of Mollusca. Systematics, ecology, and significance.
11. Type of Arthropoda. Subtypes of Chelicerata, Trilobitomorpha, Pantopoda. Their systematics and ecology.
12. Class of Arachnida. Their systematics, ecology, and significance.
13. Subtype of Branchiata. Class of Crustacea. Systematics, ecology, and significance.
14. Subtype of Tracheata. Class of Myriapoda. Systematics, ecology, and significance.
15. Class of Insecta (morphology, behavior, reproduction and development, ecology).
16. Systematics and significance of insects.
17. Research methods, monitoring, and bioindication of invertebrate animals.
18. Control and protection problems of invertebrate animals.

Seminars:

1. Systematics and protection of unicellular animals.
2. Spongia, Coelenterata and their protection.
3. Worms.
4. Arthropoda. Subtype of Chelicerata.
5. Subtype of Branchiata.
6. Insect structure, larvae, pupae.
7. Insect systematics.
8. Mollusca, Echinodermata.
9. Coral reef protection.

Traditional and innovative study methods are used to convey the subject content. Traditional study methods are represented by a classical lecture (examination of various topics). Material of the lecture is visualized using multimedia equipment, video equipment. During the sessions, part of

the time is devoted to students' speeches and discussions. Practical tasks include assignments using animal samples, their preparations or pictures. Students perform tasks independently using exercise descriptions, identification keys, collections, and in consultation with the teacher. During the practical work each student has the opportunity to use the microscope individually. A video camera connected to a microscope and computer equipment is used for demonstration of particular work stages. Presentation (defence) of practical work results is mandatory.	

Structure of cumulative score and value of its constituent parts

The 10-point cumulative assessment structure is applied, following the criteria for assessing the subject's learning outcomes. The quality of laboratory work is evaluated according to the quality of individual work as well as the quality of the answers to the questions and the ability to discuss. During the control work, students respond to test questions by selecting one of the 3 answers given, recognizing 10 samples of animals or their paintings, indicating their taxonomy. The quality of practical work is assessed by the quality of individual work as well as the quality of the answers to the questions and the ability to discuss. During the exam, problematic questions requiring short answers are presented. Exam is the final assessment of the student's knowledge, and only those who have assessments of their independent work have the right to attend it.	

Compulsory reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Kazlauskas R. Bestuburių zoologija. Vilnius, 1988, 384 p.
2.	Žiogas A. Bestuburių zoologija ir apsauga. Mokomoji knyga. Akademija, 2009. 95 p.
3.	Edward E. Ruppert. Invertebrate Zoology: A Functional Evolutionary Approach Sinauer Associates, 2009.
4.	Hill R.W., Wyse G.A.,Anderson M. Animal Physiology Sinauer Associates, 2004.
5.	Ruppert E.E., Barnes R.D. Invertebrate zoology. Sixt edition. Saunders College Publishing 1991.112 p.
6.	Brusca R. C., Brusca G. J. Invertebrates. Sinauer Associates, 2003.
7.	Mažiulis D., Starodubaitė M. Zoologija.- Vilnius; Siveida, 2001. 296 p.
8.	Догель В. А. Зоология бензпозвоночных М. 1981.
9.	Thorp J. H., Covich A.P. Ecology and Classification of North American Freshwater Invertebrates, (Aquatic Ecology) The McDonald and Woodward Publishing Company Blacksburg, Virginia, 2002.
10.	Invertebrate zoology (CD-ROM). Mac/Win CD-ROM/2001/ 27AW2288
11.	Kingdom Animalia: The invertebrates. /DVD/ 2005/27AW2789
12.	Kingdom Animalia: The invertebrates. /DVD/ 2005/27AW2789

Supplementary reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Gecevičiūtė S., Bestuburių zoologijos laboratorinių darbų atlikimas. Vilnius, 1994.
2.	Invertebrate zoology. Peer-reviewed journal. KMK Scientific Press Ltd. Moscow. Volume 1 – 9, 2010, 2011, 2012.
3.	Kublickienė O. Parazitiniai pirmuonys. Mokomoji knyga aukštųjų mokyklų studentams. Vilniaus universiteto leidykla. 2000. 86 p. Lešinskas. A., Pileckis S. Vadovas lietuvos vabzdžiams pažinti. – V: Mintis, 1967.- 372 p.
4.	A. Žiogas.,D.Zakarauskaitė. Dirvožemio biologija. Mokomoji knyga. 2010. 136 p/
5.	A. Žiogas. Agriocenozių bioindikacija ir apsauga/ Mokomoji knyga, 2012, 191 p.
6.	Rašomavičius V., editor. Red data book of Lithuania (Lietuvos Raudonoji knyga). Kaunas:
7.	Lututė, 2007. 800 p. (in Lithuanian).
8.	Helsdingen van P.J Background information on invertebrates of the Habitats Directive and the Bern Convention. Strasbourg : Council of Europe Publishing, 1996.

9.	Haslett ,J. R. European strategy for the conservation of invertebrates : Convention on the
10.	Conservation of European Wildlife and Habitats (Bern Convention). Strasbourg : Council of Europe Publishing, 2007.
11.	Raudonikis L. Europos Sąjungos Buveinių direktyvos saugomos rūšys :vadovas Lututė, 2006.
12.	Lynn D. H. The ciliated protozoa. Springer, 2007.
13.	Šatkauskienė I. Gėlųjų vandenų bestuburiai. VDU leidykla, 2004.
14.	Жизнь животных. В 7 т. Том первый. Простейшие – щупальцевые. Москва. Просвещение,1987. – 448 с.
15.	Жизнь животных. В 7 т. Том второй. Молюски – ракообразные. Москва. Просвещение, 1988. – 447 с.
16.	Жизнь животных. В 7 т. Том третий. Членистоногие – онихофоры. Москва. Просвещение, 1984. – 463 с.

Supplementary reference materials

Course programme designed by

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Approved at the meeting of **VMU Faculty of Agronomy Institute of Agroecosystems and Soil Sciences on** 19 04 2019, protocol No. 6(6).

Approved in the meeting of the programme's Doctoral Studies Committee on 03 05 2019, protocol No. 138.

Description of the subject has been certified until 30 06 2023

COURSE DESCRIPTION

Course code	Volume in ECTS credits	Institution	Faculty	Department
AGR8023	7	VMU Agricultural Academy	Agronomy Faculty	Plant Biology and Food Sciences

Course title in Lithuanian

Bitininkystė

Course title in English

Apiculture

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

Short course annotation in Lithuanian (up to 500 characters)

Bitininkystės dalyko studijos skirtos Agronomijos mokslo krypties doktorantams. Studijuodami šį dalyką doktorantai susipažins su bitininkavimu Lietuvoje ir ES keliamais reikalavimais. Bičių šeimos biologija, bityno inventoriumi, pagrindiniais bičių ganyklų augalais, bičių priežiūra, ir selekcija. Gebės vertinti bites kaip agrotechninę žemės ūkio šaką. Žinos ir įvertins kompleksinį bitininkavimą, bičių produktų gamybą ir jų pritaikymą.

Short course annotation in English (up to 500 characters)

Studies in beekeeping subjects are aimed at doctoral students in the field of Agronomy. While studying this subject, doctoral students will get acquainted with the requirements of beekeeping in Lithuania and the EU. Bee family biology, apiary inventory, main bee pasture, bee care, and breeding. Will be able to evaluate bees as an agrotechnical branch of agriculture. Will know and appreciate the complex beekeeping, the production of bee products and their application.

Relevance of the course

There is a doctoral program in beekeeping at a single higher education institution. The module includes the mastery of general and specific competences, theoretical and scientific knowledge about beekeeping, the ability to analyse and evaluate research work.

Course aims

To transfer knowledge, payments, skills about beekeeping, to analyse theoretically and practically as a branch of agriculture, agrotechnical tool, biological whole. Expand general and special competences for students. At the following levels of the cognitive sphere: the mastery of theoretical and scientific knowledge of beekeeping, the ability to analyse and evaluate scientific research work.

Content (topics) and methods

1. INTRODUCTION
1.1 Beekeeping in other countries: industrial beekeeping in the US and Canada; Opportunity to bite in cold climates; beekeeping in European countries.
1.2 Bees in Lithuania: History; amateur beekeeping before World War I; beekeeping in interwar Lithuania; the importance of public beekeeping; the direction of today's beekeeping, science, education.
2. BIOLOGY OF BEES AND THEIR FAMILY
2.1 Bee family.
2.2. Bee's external structure
2.3. Bite's internal organs.
2.4. Types of food and its uptake.
2.5. Bee genotype.
2.6. Bee communication, age-based work.
2.7. Bee family members.

2.8. Bee genetics, systematics of domestic bees.
2.9. Bee nest.
3. APIARY AND EQUIPMENT
3.1. History of Beehive.
3.2. Classification of frame hives.
3.3. Beehives classification.
3.4. Beekeeping supplies: for bees, queens, products, protection.
3.5. Artificial honeycombs and their framing.
4. BEE PASTURE
4.1. Influence of weather on bee and blossom nectars.
4.2. Understanding and classification of pastures.
4.3. Available in the spring, summer and fall.
4.4. Evaluation of plant nectars.
4.5. Sticky jellyfish.
4.6. Ways of exploiting and improving bee pastures.
4.7. Available for crop rotation for bees.
4.8. Indicative calculation of pasture.
5. CARE AND BREEDING OF BEES
5.1. About the safe work of the apiary.
5.2. Carriage of bees.
5.3. Bee fly and their significance.
5.4. Spring bee inspection.
5.5. Slots expansion modes: gradual and single.
5.6. Use of magazines (hunts).
5.7. Works in the main honeycomb.
5.8. Means of mood suppression.
5.9. Possible medics: spring, main, autumn.
5.10. Family preparation for the winter: the best time; quantity and quality of food.
5.11. Bee wintering.
5.12. Genetic basics of bee selection: family relationships; sexual inheritance; mating, about diploid transients.
5.13. Selection methods.
5.14. Boning for bees and queens.
5.15. Techniques for breeding queen bees.
5.16. Techniques for marking and changing the nurses
5.17. Works with natural and artificial clusters.
5.18. Different beekeeping methods: Krikščiūnas method, multistorey and duplex beekeeping, beekeeping in various bits, availability of half frames.
5.19. Beekeeping for early ewes.
5.20. About packaging beekeeping possibilities.
6. BEE - AGROTECHNICAL MEASURE
6.1. Methods of pollination of blossoms.
6.2. Types of pollinators (wind, insects, birds).
6.3. The significance of bee families per hectare: garden plants, legumes.
6.4. Determination of bee sufficiency for pollination in red clover.
6.5. Ways to attract bees.
6.6. Bees in greenhouses.
6.7. Bee protection with pesticides.
7. BIRD CRAFT AND DISEASES
7.1. Characteristics of microorganisms.

7.2. Immunity. 7.3. Sanitary rules for bee care. 7.4. Protection of bees and their products. 7.5. Methods of disinfection. 7.6. Major bee pests: filant, bitlesis, varroa mites and others. 7.7. Bee nest pest. 7.8. The main diseases of the brood include rot, blight, fungal diseases and various deaths. 7.9. Adult bee diseases: nozenematosis, acaraphyosis, toxicosis, etc. 7.10. Treatments for bees. 8. COMPLEX BITCHING 8.1. Traditional honey production: family productivity, honey extraction, honey composition, methods of storage and use. 8.2. Wax, its raw material processing techniques, use 8.3. Pollen, its chemical composition, methods of collection and preservation, bread 8.4. Bee milk, its collection, storage and use 8.5. Poison poisoning, extraction and consumption. 8.6. Ways of picking bee pitch and potential for use them. 8.7. The economic importance of collecting bee products

Structure of cumulative score and value of its constituent parts

A ten-point Critical Scale and Cumulative Scoring Scheme are applied. The tasks of independent work of the semester are evaluated by grade, the final assessment is determined during the examinations, the intermediate evaluations are multiplied by the weighted factor and the product is summed up.

Compulsory reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Akadmikas Jonas Kriščiūnas / Sudaryt. P. Vasinauskas – V., 1979, 146 p.
2.	Balžekas J. Bitės ir raudonieji dobilai sėklai. – V., 1985, 128 p.
3.	Bitininkystė. – V., 1970, 447 p.
4.	Bitininko žinynas / sudaryt. J.Balžekas – V., 1987, 380 p.
5.	H. Clement, Y. Le Conte. Le Traite Rustica de l'Apiculture. – Rustica. 2003, – 1 – 528 p.
6.	L. Goodman. Form and Function in the Honey Bee. Ibra. 2003, – 1 – 221 p.
7.	Dadant and Sons. Inc. Mites of the Honey Bee. Printed in the U.S.A., by Book Masters, Inc.
8.	Mansfield, Ohio. 2001, 280 p.
9.	Lietuvos bitininkas. – V., nuo 1993 ..
10.	Gerlt – Seifert L. Bienenkrankheiten und Schadlige. – Berlin, 1982, – 159 p.
11.	Hodowla pszczol. – Warszawa, 1978, 528 s.
12.	A. Matheson. New perspectives on Varroa. International Bee Research Association, 1994, - 162 p.

Supplementary reference materials

No.	Authors of publication, title, publishing house, year of publication.
1.	Straigis J. Bitininkystė. – V., 1994, 208 p.
2.	Алпатов В.В. Породы меденосной пчелы. – М., 1948, 184 с.
3.	Батлер К. Дж. Мир медоносной пчелы. – М., 1980, 232 с.
4.	Малаю А. Итенсификация производства меда. – М., 1979, 176 с.
5.	Медоносная флора основа пчеловодства. – Бухарест, 1977, 249 с.
6.	Пчеловодство – малая энциклопедия /Редкол.: Г.Д. Билаш, А.Н. Бурмистров, В.Г. Гребцова и др. – М., 1991, 510 с.
7.	Скиркявичус А. Феромонная комуникация насекомых. – В., 1986, 291 с.

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Approval at the Institute: 09 04 2019 protocol Nr. 22.
Approval at the meeting of the PhD programme committee: 03 05 2019 protocol Nr. 138.
Course description valid until 30 06 2023.