Table 5.1. Specification of subjects in the doctoral studies study program

Name of the subject:	**Research design**
Teacher(s):	**Mentor(s) / supervisor(s)**
Status of the subject:	**Mandatory**
Number of ECIIБ points:	**10**
Condition: none	

Goal of the subject
This course should enable students to gain theoretical and practical knowledge how to develop a PhD thesisapplication.

Outcome of the subject
After completing the course, students will be able to:

- Develop working hypothesis related to planned research;
- Develop main objectives and deployed goals of research:
- Develop a research protocol related to planned research;
- Outline materials and methods needed for the research;
- Understand time efforts needed to conduct the research;
- Develop a PhD thesis application.

Content of the subject
Theoretical lectures
Within this course the following segments will be covered: (i) what are scientific hypothesis and how todevelop working hypothesis; (ii) role of literature review in developing goals and objectives of a research;
(iii) time management in performing successful research; (iv) what does ―Materials and methods‖ mean and importance of understanding resource management in performing research; (v) sampling, data collection and data analysis (vi) route to PhD (application and its public defense, literature review, research, data processing, publication, public defense of a completed PhD); (vii) potential failure risks related to successful completion of research and mitigation measures.

Practical lectures
Depending on the PhD topic, mentor(s) will identify practical lectures and elective courses needed for thestudent.

Recommended literature
Herrington, J., Mc Kenney, S., Reeves, T., & Oliver, R. (2011). Design-based research and doctoral students:Guidelines for preparing a dissertation proposal. Edith Cowan University. ECU Publications.

Number of active classes	Theory: 5	Practice: 2

Methods of delivering lectures
Lectures combined with interactive teaching, seminars, consultations and mentoring work with students.

Evaluation of knowledge (maximum number of points 100)
Writing the PhD thesis application and its public defense.

Table 5.1. Specification of subjects in the doctoral studies study program

Name of the subject: Writing scientific papers and research dissemination			
Teacher(s): Igor Tomašević			
Status of the subject: Mandatory			
Number of ESPB points: 5			
Condition: none			
Goal of the subject Learn how the scientific publishing cycle works from writingto submission and peer review through to decision time.			
Outcome of the subject The student should demonstrate the knowledge of the fundamentals of manuscript preparation, submissionand promotion after publication. At the end of the study, the student should demonstrate • ability to write and submit a research manuscript; • ability to write and submit a review manuscript; • ability to write and submit a book chapter			
Content of the subject *Theoretical lectures* The Scientific Literature and Elements of Scientometrics;What Is ―Peer-Review‖?; Decisions to Take Before You Begin Writing; How to Compose the Title; The Delicate Art of Deciding about Authorship; Abstract and Keywords;How to Write the Introduction; How to Write the Material and Methods Section; How to Write the Results, How to Write the Discussion; Acknowledgements and Appendices; How to Cite References; Constructing Figures: A Tricky Art?; Analysis of Sample Graphs; How to Design Tables; The Writing Process:How to Write the First Version; Putting It All Together: Preparing the Final Version; How to Submit a Manuscript; The Manuscript Handling Process (Scientific Editing); On Receipt of theEditor's Report; How to Write Revisions; Submitting the Final Version; What Happens to the Manuscript After Acceptance?; What to Do with aPublished Paper? *Practical lectures:* Practical teaching includes IT laboratory work based on the application of modern software packages used to write the manuscript, search the scientific literature, review relevant literature and cite the work of other researchers.			
Recommended literature 1. Kate L. Turabian, Wayne C., Booth Gregory, G. Colomb (2018) A Manual for Writers of Research Papers, Theses, and Dissertations, Ninth Edition. (Chicago Guides to Writing, Editing, and Publishing) 2. Joshua Schimel (2023). Writing Science: How to Write Papers That Get Cited and Proposals ThatGet Funded. Oxford University Press. 3. Jari Saramäki (2018). How to Write a Scientific Paper: An Academic Self-Help Guide for PhD Students. 4. Stephen B. Heard (2016) The Scientist's Guide to Writing: How to Write More Easily andEffectively throughout Your Scientific Career. Princeton University Press.			
Number of active classes	Theory:4	Practice:1	
Methods of delivering lectures Theoretical and practical lectures will be conducted as active teaching methods through consultations or theoretical lectures, laboratory work, processing and analysis of scientific literature.It is mandatory to write an exemplaryscientific paper or a review of literature in the chosen field, as well as the work on the doctoral dissertation.During the performance, students will present part of the acquired knowledge in the oral presentation of the seminar work.			
Evaluation of knowledge (maximum number of points 100)			
Pre-exam	**Points 60**	**Final exam**	**Points 40**
Practical classes	20	Oral exam	40

Table 5.1. Specification of subjects in the doctoral studies study program

Seminar	40		

Name of the subject: Data Sciences, Mathematical modeling and „R“ programming

Teacher(s): Nataša Milosavljević

Status of the subject: optional

Number of ECIIБ points:5

Condition: None

Goal of the subject

The goal of the course is to enable the student to acquire theoretical and practical knowledge in terms of:

- Understanding data relationships and using data collected for decision making.
- Working with databases in the R programming language.
- Understanding the basics of machine learning and its practical application in the R programminglanguage.
- Understanding and working with supervised and unsupervised learning algorithms

Outcome of the subject

After completing the course and taking the exam, the student should be able to:

- Develop a good understanding of current machine learning algorithms and their application to various data sets.
- Use the R programming language for data analysis and presentation.
- Analyzes and evaluates the performance of learning algorithms and model selection.
- Compare the strengths and weaknesses of many popular machine learning approaches

Content of the subject

Theoretical lectures

- Difference between two main types of machine learning methods: supervised and unsupervised.
- Supervised learning algorithms, including classification and regression.
- Unsupervised learning algorithms, including clustering and dimensionality reduction.
- How mathematical modeling is used in the R programming language.
- How to use databases in the programming language R.

Practical lectures

The use of the programming language R in the analysis of food and agricultural data, connection to the database and interpretation of the results obtained using machine learning techniques.

Recommended literature

1. Lantz, Brett. *Machine learning with R: expert techniques for predictive modeling*. Packt publishing ltd, 2019.
2. Dulhare, Uma N., Khaleel Ahmad, and Khairol Amali Bin Ahmad, eds. *Machine learning and big data: concepts, algorithms, tools and applications*. John Wiley & sons, 2020.
3. Vuppalapati, Chandrasekar. *Machine Learning and Artificial Intelligence for Agricultural Economics: Prognostic Data Analytics to Serve Small Scale Farmers Worldwide*. Vol. 314. Springer Nature, 2021.
4. Kassambara, Alboukadel. *Machine learning essentials: Practical guide in R*. Sthda, 2018.

Number of active classes	Theory:3	Practice:2

Methods of delivering lectures

Combination of theoretical and practical teaching on the computer, interactive teaching, literature search, writing a seminar paper, consultations, interpretation of results.

Evaluation of knowledge (maximum number of points 100)

Pre-exam	**Points 30**	**Final exam**	**Points 70**
Activity during the lecture		Written test	40
Practical classes	10	Oral exam	30
Colloquiums			
Seminars	20		
Project presentation			

Table 5.1. Specification of subjects in the doctoral studies study program

Table 5.1. Specification of subjects in the doctoral studies study program

Name of the subject: Mathematical programming and optimization in food technology

Teacher(s): Nataša Milosavljević

Status of the subject: optional

Number of ECIIБ points:5

Condition: None

Goal of the subject

The goal of the course is to enable the student to acquire theoretical and practical knowledge in terms of:

- Understanding and application of mathematical programming.
- Determining the optimal solution.
- Understanding and application of dynamic programming based on food technology problems.
- Using multicriteria optimization.
- Understanding and application to food technology problems.

Outcome of the subject

After completing the course and taking the exam, the student should be able to:

- Develop a good understanding and use of the methods mastered through this course in application tofood technology problems.
- Uses software tools to solve mathematical programming and optimization problems.
- Analyzes and evaluates the application of different methods and their selection

Content of the subject

Theoretical lectures: Introduction to Mathematical Programming; Method of minimum angles; Application of game theory; Direct heuristic algorithm; Use of GEOM, MarPlex, RevMarPlex, Lingo programs; Parametric programming; Transport problem; Classic problems of dynamic programming; Multi-criteria optimization.

Practical lectures: The use of mathematical programming and optimization methods in the analysis of food and agricultural dataand their interpretation using different software.

Recommended literature

1. Krassadaki, Evangelia, et al. *Operational Research in Agriculture and Tourism*. SpringerInternational Publishing, 2020.
2. Bertsekas, Dimitri. *Nonlinear programming*. Vol. 4. Athena scientific, 2016.
3. Williams, H. P. (2013). *Model building in mathematical programming*. John Wiley & Sons.
4. Lingo- User Manuals, LINDO systems INC, 2018
5. D. Dentcheva and G. Martinez. Regularization methods for optimization problems with probabilisticconstraints. Mathemathical Programming, Series A, 138:223–251, 2013.
6. L. Ding, S. Ahmed, and A. Shapiro. A Python package for multi-stage stochastic programming.Optimization Online, 2019.
7. Walk, M. (2022). *Theory of duality in mathematical programming* (Vol. 72). Walter de GruyterGmbH & Co KG.
8. Chong, E. K., Lu, W. S., & Zak, S. H. (2023). *An Introduction to Optimization: With Applications toMachine Learning*. John Wiley & Sons.
9. Diwekar, U. M. (2020). *Introduction to applied optimization* (Vol. 22). Springer Nature.

Number of active classes	Theory:3	Practice:2

Methods of delivering lectures

Combination of theoretical and practical teaching on the computer, interactive teaching, literature search,writing a seminar paper, consultations, interpretation of results.

Evaluation of knowledge (maximum number of points 100)

Pre-exam	**Points 30**	**Final exam**	**Points 70**
Activity during the lecture		Written test	40
Practical classes	10	Oral exam	30
Colloquiums			
Seminars	20		

Table 5.1. Specification of subjects in the doctoral studies study program

Project presentation			

Name of the subject: Python programming for Machine Learning

Teacher(s):Nataša Milosavljević

Status of the subject: optional

Number of ECIIБ points: 5

Condition: None

Goal of the subject

The goal of the course is to enable the student to acquire theoretical and practical knowledge in terms of:

- To understand the relationship of the data collected for decision making.
- To know the concept of principle components, factor analysis and cluster analysis for profiling and interpreting the data collected.
- To lay the foundation of machine learning and its practical applications.
- To develop self-learning algorithms using training data to classify or predict the outcome of futuredatasets.
- To prepare for real-time problem-solving in data science and machine learning

Outcome of the subject

After completing the course and taking the exam, the student should be able to:

- Develop a sound understanding of current, modern computational statistical approaches and their application to a Variety of datasets.
- Use appropriate packages for analysing and representing data.
- Analyze and performance evaluation of learning algorithms and model selection.
- Compare the strengths and weaknesses of many popular machine learning approaches.

Content of the subject

Theoretical lectures

- The difference between the two main types of machine learning methods: supervised andunsupervised
- Supervised learning algorithms, including classification and regression
- Unsupervised learning algorithms, including Clustering and Dimensionality Reduction
- How statistical modeling relates to machine learning and how to compare them.

Practical lectures

The use of the Python programming language in the analysis of agricultural data, interpretation of the resultsobtained through the application of machine learning techniques.

Recommended literature

1. Aurélien Géron, Hands-On Machine Learning with Scikit Learn, Keras, and TensorFlow, 2nd Edition, O'ReillyMedia Inc, 2019.
2. Wes McKinney, Python for Data Analysis - Data wrangling with pandas, Numpy, and ipython,Second Edition, O'ReillyMediaInc, 2017.
3. Andreas C.Müller and Sarah Guido, Introduction to Machine Learning with Python-A Guide forData Scientists, First Edition, O'ReillyMediaInc, 2016.

Number of active classes	Theory: 3	Practice: 2

Methods of delivering lectures

Combination of theoretical and practical teaching on the computer, interactive teaching, literature search,writing a seminar paper, consultations, interpretation of results.

Evaluation of knowledge (maximum number of points 100)

Pre-exam	**Points 50**	**Final exam**	**Points 50**
Seminars	30	Written test	50

Table 5.1. Specification of subjects in the doctoral studies study program

Project presentation	20		

Name of the subject: Computer aided design			
Teacher(s): Olivera Ećim-Đurić, Nataša Milosavljević			
Status of the subject: optional			
Number of ECПБ points: 5			
Condition: None			
Goal of the subject Introducing the student to numerical methods for solving partial differential equations in engineering. The student should become familiar with the theoretical foundations of calculation techniques for solving partial differential equations, as well as gain experience through practical application on a computer using the Python programming language			
Outcome of the subject The student should be able to independently solve problems by applying numerical methods to solving partial differential equations, using the finite difference method. By connecting the basic knowledge, the student should pose a problem, choose a solution method and apply programming knowledge in order to obtain a solution.			
Content of the subject *Theoretical teaching* Introduction to Finite Difference Methods Solving elliptic differential equations Solving parabolic differential equations Solving hyperbolic differential equations Introduction to finite element methods Advanced NumPy and SciPy module techniques Solving equations using a computer *Practical teaching* The use of the Python programming language in the analysis and creation of models for solving partial differential equations. Application to concrete problems in agriculture. Using the advanced techniques of the NumPy and SciPy modules. Observations of differences and similarities.			
Recommended literature Ioannis Koutromanos,(2018): Fundamentals of Finite Element Analysis, Linear Finite Element Analysis, John Wiley & Sons Ltd Zhilin Li, Zhonghua Qiao, Tao Tang (2018): Numerical Solution Of Differential Equations,Introduction to Finite Difference and Finite Element Methods, Cambridge University Press Francisco J. Blanco-Silva (2013): Learning SciPy for Numerical and Scientific Computing, Packt Publishing Hemant Kumar Mehta (2015): Mastering Python Scientific Computing, Packt Publishing			
Number of active classes	Theory:3	Practice:2	
Methods of delivering lectures Combination of theoretical and practical teaching on the computer, interactive teaching, literature search, writing a seminar paper, consultations, interpretation of results.			

Evaluation of knowledge (maximum number of points 100)			
Pre-exam	**Points 50**	**Final exam**	**Points 50**
Activity during the lecture		Written test	
Practical classes	30	Oral exam	50
Colloquiums			
Seminars	20		
Project presentation			

Table 5.1. Specification of subjects in the doctoral studies study program

Name of the subject: Modeling technical-technological processes in food engineering			
Teacher(s): Olivera Ećim-Đurić			
Status of the subject: optional			
Number of ECIIБ points: 5			
Condition: None			
Goal of the subject The goal of the course is to expand the student's knowledge in theoretical and practical terms: • Understanding of the basic influencing variables in the process • Heat and mass transfer phenomenon • Principles of functioning various technical and technological systems • Describing the process and creating a physical and mathematical model • Applications of numerical methods in process simulation			
Outcome of the subject After successfully completing the course, student should be able to independently: • Recognizes the basic influencing parameters of a certain process • Create a physical and mathematical model • Simulates the model behavior with given functional parameters • Defines methods to improve efficiency and process automation			
Content of the subject *Theoretical lectures* Familiarity with the basic influencing parameters, principles and laws thermotehnical systems are based: hydraulic and hydrodynamic systems, pneumatic systems, process systems, thermotechnical and thermoenergetic systems, systems for controlling microclimatic conditions and automated systems. Analysis of processes in which they are based on the laws of mass, impulse and energy transfer. Modeling of heat processes and phenomena. Modeling of the mass transfer process. Creation of one-dimensional and multi-dimensional models. Numerical solution of the system of model equations. Parametric and error magnitude analysis of the model. Visualization of the obtained results. *Practical lectures* Independent project: Modeling of chosen process in food engineering, analysis and presentation of the project			
Recommended literature Harry Silla (2003): Chemical Process Engineering, Taylor & Francis Group LLC Nayef Ghasem, Redhouane Henda (2015): Principles of Chemical Engineering Processes, Taylor & Francis Group LLC Theodoros Varzakas, Constantina Tzia (2015): Food Engineering Handbook , Taylor & Francis Group LLC Zeki Berk (2009): Food Process Engineering and Technology, Elsevier Inc P. Fellows (2000): Food Processing Technology, Woodhead Publishing Limited			
Number of active classes	Theory:3	Practice:2	
Methods of delivering lectures Combination of theoretical and practical teaching on computer, interactive teaching, e-learning, mentoring work with students. Preparation and development of the project.			
Evaluation of knowledge (maximum number of points 100)			
Pre-exam	**Points 50**	**Final exam**	**Points 50**
Activity during the lecture		Written test	
Practical classes	30	Oral exam	50
Colloquiums			

Table 5.1. Specification of subjects in the doctoral studies study program

Seminars	20		
Project presentation			

Name of the subject: Advanced engineering software - artificial neural networks

Teacher(s): Olivera Ećim-Đurić

Status of the subject: optional

Number of ECIIБ points: 5

Condition: None

Goal of the subject

The goal of the course is to expand the student's knowledge in theoretical and practical terms:
• Preparation of data sets for analysis
• Formation of artificial neural networks (ANN) for Deep Learning
• VNM optimization by adjusting hyperparameters
• Software packages for data processing using ANN methods

Outcome of the subject

Students should be able to independently:
• Prepare data for analysis
• Defines the ANN model depending on the problem
• Perform ANN model optimization
In accordance with the chosen topic of the doctoral dissertation, the student should form a VNM based on the data obtained from the experiments.

Content of the subject

Theoretical lectures

Analysis of frameworks, models and techniques for Deep Learning from data. Data preprocessing - normalization and standardization. Basics of artificial neural networks. Linear regression and classification methods using ANN models. Implementing an ANN network "from scratch". ANN model improvements by hyperparameter fine-tuning. Classification of images and texts using convolution neural networks. Work in Tensorflow, Scikit-Learn and PyTorch modules.

Practical lectures

Independent project: Modeling of chosen process in food engineering, analysis and presentation of the project

Recommended literature

Peters Morgan (2016): Data Analysis From Scratch With Python, AI Sciences LLC
Sebastian Raschka, Yuxi ŽLiu, Vahid Mirjalili (2022): Machine Learning with PyTorch and Scikit-Learn, Pact Publishing
Aurélien Géron (2017): Hands-On Machine Learning with Scikit-Learn and TensorFlow, O"Reilly

Number of active classes	Theory: 3	Practice: 2

Methods of delivering lectures

Combination of theoretical and practical teaching on computer, interactive teaching, e-learning, mentoring work with students. Preparation and development of the project.

Evaluation of knowledge (maximum number of points 100)

Pre-exam	**Points 50**	**Final exam**	**Points 50**
Activity during the lecture		Written test	
Practical classes	30	Oral exam	50
Colloquiums			
Seminars	20		
Project presentation			

Table 5.1. Specification of subjects in the doctoral studies study program

Course: Advanced Microscopic Techniques			
Teacher or teachers: Milica M. Fotirić Akšić, Rančić V. Dragana, Vladimir B. Pavlović			
Course status: Elective			
Number of ECTS credits: 5			
Admission requirement: None			
Course aim The goal of the course is to enable students to become familiar with modern methods and techniques in the field of microscopic analysis, which are related to optical (light) microscopy, as well as to transmission (TEM) and scanning electron microscopy (SEM). Students will gain a theoretical understanding of, and practical experience in working with state-of-the-art equipment used in qualitative and quantitative microscopy. Also, the goal is to introduce students with the possibilities of using software that can be used in processing and measuring the obtained images (imaging).			
Course outcome After successfully completing the course, the student is expected to demonstrate an understanding of the working principles of light, fluorescent and electron microscopes, to be able to independently make temporary and permanent microscopic slides using selected microscopic techniques, as well as to be able to independently interpret the obtained results and to present them in written form, in the form of a presentation of scientific results. In addition, the student should be versed with programs/software that he can use in processing and measuring the obtained photos.			
Course content *Theory:* Both types of microscopy, optical (light) and electron, are used to magnify objects in the field of cell and tissue biology, microbiology, and materials science, and each technique has its advantages and disadvantages. This course will provide the knowledge necessary for choosing the appropriate technique in accordance with the research objectives, as well as the knowledge necessary for obtaining images and the interpretation and analysis of photomicrographs, including anatomical measurements and quantitative assessment. This course will provide an overview of the most commonly used methods for preparation of microslides, the principles of staining in light microscopy and contrast in electron microscopy. *Research practice:* Lectures dealing with the theory, mechanics, and application of varoous microscopic methods will be combined and complemented with extended laboratory exercises in which students will be encouraged to use their own specimens in order to increase the practical/use value of the knowledge gained in this course. Our goal is to provide students with the knowledge and expertise to be able to implement state-of-the-art microscopic methods in research related to their PhD works. Depending on the specificity of the research topic of each individual doctoral dissertation, the requirements related to the preparation of essays, processing, analysis and presentation of the obtained results will be adjusted.			
Recommended literature 1. Pekić Quarrie, S., Rančić, D. *Methods in Plant Anatomy* (in Serbian). Poljoprivredni fakultet i WUS Austria, 2007. 2. Hayat MA 2000 Principles and Techniques of Electron Microscopy: Biological Applications 4th Edition. Cambridge University Press; 4 edition 3. Terry A 2008 Introduction to Electron Microscopy for Biologists, Volume 88. 1st Edition. Academic Press 4. Kubitscheck U, Peters R 2013. Fluorescence Microscopy From Principles to Biological Applications. John Wiley & Sons.			
Number of classes of active teaching	Lectures: 3	Study research work: 2	
Methods of teaching Theory and student research practice including measurement, processing and data analysing, presentation of results. Writing of essay with elements of scientific-research paper is planned.			
Evaluation of knowledge (maximum number of points 100)			
Pre-exam	**Points 70**	**Final exam**	**Points 30**
Activity during the lecture		Written test	
Practical classes	20	Oral exam	30
Colloquiums	30		
Seminars	20		

Table 5.1. Specification of subjects in the doctoral studies study program

Name of the subject: Food chemistry			
Teacher(s): Vesna Antić, Mališa Antić, Nebojša Pantelić			
Status of the subject: Elective			
Number of ECIIБ points: 5			
Condition: none			
Goal of the subject The course should enable students to acquire theoretical knowledge about chemical compounds that are mostoften present in food (meat and meat products, milk and dairy products, bakery products, etc.), as well as about additives in food products.			
Outcome of the subject Upon completion of the course, the student shall be able to: • Describe and explain the structure and chemical properties of proteins, lipids and carbohydrates. • Describe the relationship between the chemical composition of food and food quality. • Describe the chemical properties of the additive in the broader sense. • Define the role of additives in food. Apply knowledge of food chemistry and present it through written and oral forms of presentation.			
Content of the subject *Theoretical lectures* Proteins, carbohydrates and lipids in food: a brief overview of these compounds' most important chemical and physical properties. Chemical and physical changes of these compounds during food processing, storage and preparation. Water in food: water activity and methods for its activity. The role of water in foods. Additives: definitions and classification of additives. Chemical properties of the additive. Artificial sweeteners, flavoring compounds, emulsifiers. Vitamins and mineral in food. Overview of the chemical composition of particular type of food and food products (meat, milk, dairy, bakery, etc.). *Practical lectures* Theoretical exercises related to the examination of the chemical composition of a particular food product, according to the topic of the doctoral dissertation.			
Recommended literature 1. V. Antić i M. Antic, Food Chemistry – lectures, IFC-WBG. 2. John M. deMan (1999): Principles of Food Chemistry—3rd, Aspen Publishers, Inc.			
Number of active classes	Theory: 3	Practice: 2	
Methods of delivering lectures Theoretical teaching, theoretical exercises and interactive teaching. Preparation of a seminar work.			
Evaluation of knowledge (maximum number of points 100)			
Pre-exam	**Points 30**	**Final exam**	**Points 70**
Activity during the lecture	/	Written test	/
Practical classes	/	Oral exam	70
Colloquiums	/		
Seminars	30		
Project presentation	/		

Table 5.1. Specification of subjects in the doctoral studies study program

Name of the subject: Instrumental Methods of Analysis			
Teacher(s): VesnaAntić, Vladslav Rac			
Status of the subject: Elective			
Number of ECIIБ points: 5			
Condition: none			
Goal of the subject: The course should enable students to acquire fundamental knowledge of the principles and instrumentation of spectroscopic and chromatographic techniques for analyzing food, agricultural and environmental samples. Emphasis will be placed on particular instrumental methods, according to requirements of a specific PhD dissertation.			
Outcome of the subject Upon completion of the course, the student shall be able to: -Understand the fundamental chemical and physical properties important for the instrumental techniques discussed (molecular spectroscopies, chromatography and mass spectrometry). -Understand, describe and apply the operating principles of the instruments discussed in the course (tools for measuring UV/visible, IR and Raman spectroscopy, mass spectrometry and separations based on liquid- and gas-chromatography). -Evaluate and use data obtained using the instrumental methods and techniques discussed.			
Content of the subject *Theoretical lectures* Fundamentals and application of methods based on phenomena related to electromagnetic radiation (UV/Vis, IR and Raman spectroscopy). Fundamentals and application of mass spectrometry. Introduction to chromatography. Adsorption and partition column chromatography. Thin layer and paper chromatography. Gas chromatography (GC). Detectors in gas chromatography. Mass spectrometer as a detector for GC. Derivatization in GC. Qualitative and quantitative determination in GC and GC-MS. High-performance liquid chromatography (HPLC). Ionic chromatography, gel-permeation chromatography (GPC), and affinity chromatography. Methodology, advantages, disadvantages and application of each technique. *Practical lectures* Practical training and data interpretation exercises will be available for PhD students, in line with specific requirements of their research. Theoretical exercises related to choosing the appropriate method for separation and analysis are foreseen. Getting acquainted with qualitative and quantitative chromatographic analysis methods—constructing calibration curves and method validation.			
Recommended literature 1. V. Antić, M. Antić, Chromatography in Food Analysis, Presentations. 2. F. Rouessac, A. Rouessac (2007), Chemical Analysis, Modern Instrumentation Methods and Techniques; 2th edition, John Wiley&Sons. 3. D.A. Skoog, F.J. Holler, S.R. Crouch, (2017), Principles of Instrumental Analysis, 7th Edition, Cengage Learning.			
Number of active classes	Theory:3	Practice: 2	
Methods of delivering lectures Theoretical lectures, practical lectures. Preparation of a seminar work.			
Evaluation of knowledge (maximum number of points 100)			
Pre-exam	**Points 30**	**Final exam**	**Points 70**
Activity during the lecture	/	Written test	/
Practical classes	/	Oral exam	70
Colloquiums	/		
Seminars	30		
Project presentation	/		

Table 5.1. Specification of subjects in the doctoral studies study program

Name of the subject: High Performance Liquid Chromatography in food analysis			
Teacher(s): Miroljub B. Barać, Mirjana B. Pešić			
Status of the subject: elective			
Number of ECTS points: 5			
Condition: none			
Goal of the subject The course aims to provide students with the knowledge and skills they need to understand the principles of high performance liquid chromatography methods and the application of the appropriate method in the analysis of food products. At the end of the course, students will be able to: choose the appropriate HPLC method, apply it in the analysis of food product compounds, adequately choose the appropriate sample preparation procedures, adequately choose the conditions of HPLC analysis, analyze and interpret the obtained results.			
Content of the subject *Theoretical lectures* Basic principles of HPLC methods. HPLC methods of food analysis: chromatography on "normal" and reverse phase, ion exchange chromatography, size-exclusion chomatography. The HPLC system components. *Practical lectures* Laboratory exercises: extraction and preparation of samples, analysis and interpretation of the results.			
Recommended literature Corradini, D., Phillips, T.M. (2010). Handbook of HPLC, CRC Press, London, UK.ISBN9780429222047			
Number of active classes		Theory: 3	Practice: 2
Methods of delivering lectures Lectures, Laboratory exercises			
Evaluation of knowledge (maximum number of points 100)			
Pre-exam	**Points 30**	**Final exam**	**Points 70**
Seminar	30	Oral exam	70

Table 5.1. Specification of subjects in the doctoral studies study program

Name of the subject: Electrophoretic methods in food analysis			
Teacher(s): Miroljub B. Barać, Mirjana B. Pešić			
Status of the subject: elective			
Number of ECTS points: 5			
Condition: none			
Goal of the subject The course aims to provide students with the knowledge and skills needed to understand the principles of electrophoretic methods and the application of appropriate methods in food protein analysis. At the end of the course, students will be able to: choose the appropriate electrophoretic technique, apply it in the analysis of food products, adequately choose the appropriate sample preparation procedures, adequately choose the conditions of electrophoretic analysis, analyze and interpret the obtained results.			
Content of the subject *Theoretical lectures* Basic principles of electrophoretic methods of analysis. Gel electrophoresis methods: "quantitative" and preparative gel electrophoresis in food analysis (native, electrophoresis in denaturing and reducing conditions), isoelectric focusing, isotachophoresis, two-dimensional gel electrophoresis. Basic principles of capillaryelectrophoresis. *Practical lectures* Laboratory exercises: Extraction and preparation of protein samples, analysis of protein content and composition.			
Recommended literature Kurien, B.J., Scofield R.H. (2012): Protein electrophoresis. Methods and Protocols. Kurien B.J and Scofield R.H. eds, Humana Totowa, NJ, doi.org/10.1007/978-1-61779-821-4ISBN 978-1-61779-820-7			
Number of active classes	Theory: 3	Practice: 2	
Methods of delivering lectures Lectures, Laboratory exercises			
Evaluation of knowledge (maximum number of points 100)			
Pre-exam	**Points 30**	**Final exam**	**Points 70**
Seminar	30	Oral exam	70

Table 5.1. Specification of subjects in the doctoral studies study program

Name of the subject: Food authentication- chemical and molecular-genetic methods			
Teacher(s): Aleksandar Ž. Kostić,Gordana R. Branković			
Status of the subject: Elective			
Number of ЕСПБ points: 5			
Condition:none			
Goal of the subjectis to enable the student to acquire knowledge: a) about the use of modern molecular-genetic and physical-chemical analytical methods for checking the authenticity of food, i.e. variety and species, geographical origin, quality determination, detection of allergens and genetically modified organisms (GMO); b) skills related to the application and mastery of: 1) techniques of molecular genetic methods, selection of a suitable method for checking the authenticity of food, use of bioinformation technologies and databases in designing primers; 2) physical and chemical analyzes to determine the authenticity of the geographical or botanical origin of the food product; and the development of competences to determine whether a certain food product has been adulterated by the addition of supplements instead of the main component.			
Outcome of the subject: Upon completion of the course from this subject, the student should be able to: 1) choose and apply one of the molecular-genetic and physico-chemical methods for verifying the authenticity of various food products and for qualitative and quantitative detection of GMOs; 2) statistically process and analyze the obtained data using chemometrics; 3) uses bioinformation technologies in working with databases in designing primers; 4) integrates knowledge and skills, develops critical thinking and a systemic approach in the field of food authentication and detection of counterfeit food products; 5) participates individually and in a team in solving problems that may arise in the field of sustainable food authenticity.			
Content of the subject: *Theoretical lectures:*1. The concept of food authenticity and its importance for the consumer; 2. Principles and techniques of molecular genetic methods used for food authenticity testing (DNA extraction and purity verification; DNA copy number and genome coverage; selection of nuclear or organelle genomes for analysis; primer design; End-Point and Real-Time PCR; melting curve); 3. DNA mini-barcodes, mini- and microsatellites, single nucleotide polymorphism, randomly amplified polymorphic DNA, inter-microsatellite repeats, sequence of the characterized amplified region of DNA, single-stranded DNA conformation polymorphism, restriction fragments length polymorphism, amplified fragments length polymorphism; 4. Detection of allergens in food; 5. Detection of the presence of GMOs in food; 6. Verification of the authenticity of food of plant and animal origin; 7. Determining the geographical/botanical origin of the product using various physico-chemical methods, elemental and isotopic analysis; 8. Chemometric data processing. *Practical lectures:*research work of the student related to one of the methodological units covered.The possibility of applying in the laboratory some of the physico-chemical methods for assessing the authenticity of a certain food stuff prepared as model.			
Recommended literature: 1. Branković, G. (2024): Food authentication-molecular-genetic methods. University of Belgrade, Faculty of Agriculture, Belgrade, Serbia, pp. 389. ISBN 978-86-7834-433-6. COBISS.SR-ID 143347721.; 2. Food authentication management: analysis and regulation (2017) edited by Georgiou C.A. and Danezis G.P., Wiley Blackwell, West Sussex, UK. 3. Cajka, T., Showalter, M. R., Riddellova, K., Fiehn, O. (2016): Advances in mass spectrometry for food authenticity testing: an Omics perspective, In Advances in Food Authenticity Testing. Chapter 7: 171-195. Elsevier Ltd., Amsterdam, The Netherlands.; 4. Danezis, G. P., Tsagkaris, A. S., Camin, F., Brusic, V. (2016): Food authentication: Techniques, trends & emerging approaches. Trends in Analytical Chemistry, 85: 123-132.			
Number of active classes	**Theory: 3**	**Practice: 2**	
Methods of delivering lectures: Theoretical teaching and the research work of the student-SRW. Lectures, modern methods of interactive teaching, seminar papers, case studies. Preparation of a seminar paper with elements of scientific and research work: choice of method, use of databases and design of primers, measurements, processing and analysis of results, presentation of results.			
Evaluation of knowledge (maximum number of points 100):			
Pre-examination obligations	**Points 50**	**Final exam**	**Points 50**
activity during classes	5	written exam	
practical classes	20	oral exam	50
colloquiums			
seminars	25		

Table 5.1. Specification of subjects in the doctoral studies study program

Course: Microbiological methods of analysis			
Teacher or teachers: Klaus Anita, Mirković Nemanja			
Course status: elective			
Number of ECTS credits: 5			
Admission requirement: none			
Course aim The subject should enable the student to acquire: a) knowledge / understanding of the method of analysis in microbiological scientific research and novel microbiological detection techniques microorganisms b) the skill of applying modern microbiological methods to scientific research, in microbiological control of food quality and food production processes.			
Course outcome At the end of the module the student should: differentiates and defines the theoretical basis of certain contemporary microbiological methods of analysis; recognize their advantages and disadvantages and their applicability in specific cases; develop an analytical and flexible approach to solving microbiological problems methodologies in food analysis; creatively and critically gives opinions and makes conclusions; critically testing scientific hypotheses; design an experiment, analyze the results and present the acquired knowledge.			
Course content *Theoretical teaching*: Analysis and comparison of classical microbiological methods; application of molecular methods for the identification of bacteria and yeasts; application and significance of ATP determination as a hygienic safety indicator; application of immunological methods for the detection of pathogenic microorganisms;determination of bioactivity of bacteria and yeasts using classical and molecular methods, conductometric methods *Practical teaching*: Experimental work (demonstration or work of a student) with modern whales for the detection of microorganisms and work on available apparatus in order to master other analytical methods relevant to PhD students of food technology studies.			
Recommended literature 1.Ralph Rapley, The Nucleic Acid Protocols, Edited by University of Hertfordshire, Hatfield, UK, 2000 2.Bacteriological analytical manual, FDA 2001 3.Abhishek Chauhan, Tanu Jandal. Microbiological Methods for Environment, Food and Pharmaceutical Analysis. Springer Cham, 2020.			
Number of classes of active teaching	Lectures: 3	Study research work: 2	
Methods of teaching Theoretical work: lectures, interactive teaching, literature search, writing seminar work, consultations; Practical classes: performing experiments on specific instruments, or interpreting results / spectra / signal.			
Knowledge assessment (maximum number of points 100)			
Pre-exam	**Points**	**Final exam**	**Points**
Seminars	40	Oral exam	40
Practical classes	20		

Table 5.1. Specification of subjects in the doctoral studies study program

Course: Research methods in environmental microbiology

Teacher or teachers (surname, middle letter, name)**:** Blazo T. Lalević, Jelena Jovičić-Petrović

Course status: Elective

Number of ECTS credits: 5

Admission requirement: none

Course aim

Is to provide knowledge of

- methodics and technique of scientific and research work
- methods in environmental microbiology and microbiological analyses of soil and water
- principles of work in microbiological laboratory
- standards of soil and water sampling
- methods of isolation of microorganisms from environment, isolation of pure microbial cultures, identification of microorganisms
- biopotential of microorganisms as biocontrol agents
- bioremediation techniques and promoting of plant growth

Course outcome

At the end of course, student must be able for

- work in microbiological laboratory
- to connect the knowledge about the microbial communities with research methods in environmental microbiology
- selection the methods for isolation and identification of microorganisms from environment, apply methods for isolation of pure cultures of microorganisms
- determination of potential of microorganisms in remediation of contaminated environments, stimulation of plant growth and biocontrol, to be able of application of molecular methods inidentification of microorganisms

Course outcome

Theoretical lectures

Methodics and technique of scientific and experimental work
Principles of work in microbiological laboratory
Sampling in microbiological research Identification of pure cultures of microorganisms
Microbiological methods for research of soil and water

Practical lectures

Methods for determination of microbiological activity of soil and agro-industrial waste
Microorganisms as contaminants of fresh fruits and vegetables
Microorganisms in bioremediation and stimulation of plant growth
Microorganisms as biocontrol agents

Recommended literature

1. Karnwal, A., Al-Tawaha, A.R.M.S. (2022). Environmental microbiology: advanced research and multidisciplinary applications. Bentham books.
2. Chauhan, A., Jindal, T. (2020). Microbiological methods for environment, food andpharmaceutical analysis. Springer.
3. Madigan, M., Bender, K., Buckley, D., Sattley, W., Stahl, D. (2019). Brock biology of microorganisms. Pearson.

Number of classes of active teaching	Lectures: 3	Study research work: 2

Methods of teaching

Theoretical and practical lessons, interactive classes, mentoring program, case study, e-learning.
Oral presentations of seminar work is obligate. An original scientific full paper presented on Conference and/or included in Conference Proceeding may be prepared instead of seminar work.

Knowledge assessment (maximum number of points = 100)

Pre-exam	**Points 60**	**Final exam**	**Points 40**
Seminar	60	Final exam	40

Table 5.1. Specification of subjects in the doctoral studies study program

Course: Microbiological monitoring

Teacher or teachers (surname, middle letter, name)**:** Jelena P. Jovičić-Petrović, Igor S. Kljujev

Course status: Elective

Number of ECTS credits: 5

Admission requirements: none

Course aim

The aim of the course is to

- inform students about concept of microbial indicators and their inportance in the environment monitoring
- explain methods for detection of microbial indicators
- get acquainted with standards and criteria for specific indicator species and risk assessment

Course outcome

At the end of the course student should be able to

- distinguish microbial indicators in diverent ecosystems
- define all the necessary stages of the experiment
- describe, compare, and apply different methods for microbial indicators detection
- integrate theoretical knowledge and practical methods in monitoring process with the aim to evaluate the environment
- make a risk assessment, to use software models in microbial monitoring

Course content

Theoretical lectures

Groups of microbial indicators
Microbial metabolites as indicators
Monitoring of microbial indicators in natural and agro-ecosystems
Monitoring of microbial quality of water ecosystems
Risk assessment and application of software models in the monitoring

Practical lectures

Sampling with the aim of detection and identification of microbial indicators from different environments
Methods for detection of groups of microbial indicators, standard and rapid methods for identification of indicator groups

Recommended literature

1. Hurst, C.J. (2019). The structure and function of aquatic microbial communities. Springer International Publishing.
2. Tate, R.L. III, Tate, R. L. (2020). Soil microbiology. Wiley.
3. Madigan, M., Bender, K., Buckley, D., Sattley, W., Stahl, D. (2019). Brock biology of microorganisms. Pearson.
4. Pepper, I.L., Bgerba, C.P. (2004). Environmental microbiology. Elsevier.

Number of classes of active teaching	Lectures: 3	Study research work: 2

Methods of teaching

Lectures in combination with mentoring, eLearning and case-study. Student should make a written report on performed experiments, and present obtained results in written and oral form. Student should evaluate experimental results individually and in a group.

Knowledge assesment (maximum of 100 points)

Pre-exam	**Points 60**	**Final exam**	**Points 40**
Written report on performed experiments, and presentation of obtained results	60	Final exam	40

Table 5.1. Specification of subjects in the doctoral studies study program

Name of the subject: Research Methods in Plant Pathology			
Teacher(s):Bulajić, A., Duduk, N., Ivanović, M., Obradović, A., Stanković, I., Vico, I.			
Status of the subject: Elective			
Number of ECIIБ points:5			
Condition: passed exam in Research design			
Goal of the subject The course will provide knowledge/understanding of: protocols and procedures tools and methods used for timely and accurate detection and isolation of plant pathogens (fungi and pseudofungi, bacteria, viruses, phytoplasmas, etc.), their identification and characterization based on pathogenic, morphological, metabolic, serological and molecular characteristics. The skills in:designing and setting up the experiments, selecting appropriate experimental methods (conventional and genome-based) to obtain reliable results in identification and characterization of plant pathogens. The ability to: use lab tools and equipment and apply appropriate research methods for identification and characterization of plant pathogens; understanding of the obtained results, their analysis and interpretation.			
Outcome of the subject A student should be able to demonstrate theoretical and practical knowledge and understanding of particular methods for the detection, identification and characterization of plant pathogens, and to be able to independently perform complex experimental methods, and correctly interpret the obtained results.			
Content of the subject *Theoretical lectures* Understanding of importance of good timing, sensitivity and precision of the detection, identification and characterization of various plant pathogens; the pathogen isolation techniques, growth and preservation of plant pathogens, significance of macroscopic and microscopic features of plant pathogens; Koch's postulates, *in vitro* and *in vivo* pathogenicity tests; detection of seed- and soil-borne plant pathogens; serological detection and identification (DAS ELISA, pocket serology devices, LFD), polymerase chain reaction based tests (RT-PCR, Multiplex PCR, Touchdown PCR, Real time PCR, Nested PCR), scanning electron microscopy, Singer-sequencing, sequence analyses, phylogeny, barcoding, data analyses. *Practical lectures* Implementation of protocols of methods for detection and identification of specific plant pathogens. Interpretation of the results obtained by different methods.			
Recommended literature Suarez Casanova, V. M. and Shumskaya, M. (2021) Exploring DNA in biochemistry lab courses: DNA barcoding and phylogenetic analyses. Biochemistry and Molecular Biology education, 49: 789-799. Crous, P.W., Rossman, A.Y.,Aime, M.C., Allen, W.C., Burgess, T., Groenewald, J.Z., and Castlebury, L.A. (2021): Names of Phytopathogenic Fungi: A Practical Guide. Phytopathology, 111: 1500-1508. Matthews, R.E.F. (1993): Diagnosis of Plant Virus Diseases. CRC Press, Inc. Klement, Z., Rudolph, K., Sands, D.C. (1990): Methods in Phytobacteriology. Akademiai Kiado, Budapest. Schaad, N.W., Jones, J.B., Chun, W. (2001): Laboratory Guide for Identification of Plant Pathogenic Bacteria. The American Phytopathological Society, St. Paul, USA. Dhingra, O.D., and Sinclair, J.B. (1985). Basic plant pathology methods. CRC Press, Inc. Lévesque, C.A. (2001). Molecular methods for detection of plant pathogens - What is the future? Canadian Journal of Plant Pathology, 23(4), 333-336.			
Number of active classes	Theory:3	Practice:2	
Methods of delivering lectures Lectures and practical lab work in combination with interactive lectures. Online teaching and consultations. Participation in group projects and exchange of knowledge with the experianced team members.			

Evaluation of knowledge (maximum number of points 100)			
Pre-exam	**Points 60**	**Final exam**	**Points 40**
Seminar and oral examination	**60**	oral exam	**40**

Table 5.1. Specification of subjects in the doctoral studies study program

Name of the subject: Sensory analysis of food, oral processing and consumer behavior			
Teacher(s): Nikola S. Tomić, Ilija V. Djekić			
Status of the subject: Elective course			
Number of ESPB points: 5 ESPB			
Condition: No specific conditions			
Goal of the subject Depending on the specialization within the doctoral program, this course is designed to provide students with theoretical and practical knowledge related to the following: - Planning experimental sensory programs and interpreting and reporting sensory data; - Understanding oral processing behavior and the dynamic perception of texture and taste of food; - Qualitative and quantitative consumer research, including design, application, execution and reporting; Relating different types of data (sensory, mechanical, consumer etc.).			
Outcome of the subject Learning outcome (depending on the area of specialization within the PhD program): - Fundamentals of sensory/consumer/oral mechanical processingmeasurements and evaluation methods; - Ability to design sensory/consumer/oral mechanical processing experiments, analyze and interpret the results; - Relationship between sensory data and other analytical measurements or consumer data; Critically evaluate the literature in the field of sensory and consumer research.			
Content of the subject *Theoretical lectures* Depending on the specialization within the PhD program, the following topics are covered: (1) Physiological and psychological basis of sensory analysis and principles of good laboratory practices; (2) Discrimination theory (similarity and equivalence testing); (3) Classical and flexible methods of descriptive sensory analysis; (4) Oral management of food and effects of oral processing on consumer choice and preferences; (5) Qualitative and quantitative consumer research and multisensory processes; (6) Relationship between the sensory characteristics of a product and consumer response (preference mapping, emotion mapping etc.); (7) Experimental design and problem solving (univariate and multivariate approaches). *Practical lectures* The practical lectures offered in this course are closely linked to the topics of each PhD thesis to ensure that students receive practical training and application of sensory analysis concepts that are directly relevant to their specific areas of study in food science.			
Recommended literature Lawless, H. T., Heymann, H. (2010). *Sensory Evaluation of Food: Principles and Practices*. New York: Springer Science+Business Media, LLC. Meilgaard, M. C., Civille, G. V., Carr, T. B. (2016). *Sensory Evaluation Techniques*. Boca Raton: CRC Press, Taylor & Francis Group, LLC. Varela, P., Ares, G. (Eds.) (2014). *Novel Techniques in Sensory Characterization and Consumer Profiling*. Edited book. Boca Raton, FL: CRC Press, Taylor & Francis Group. Chen, J., Engelen, L. (Eds.) (2012). *Food Oral Processing: Fundamentals of Eating and Sensory Perception*. Edited book. Chichester, West Sussex: Blackwell Publishing Ltd., John Wiley & Sons, Ltd. Varela, P., Ares, G. (Eds.) (2018). *Methods in Consumer Research*. Volume 1: *New Approaches to Classic Methods*, & Volume 2: *Alternative Approaches and Special Applications*. Edited books. Duxford: Elsevier Ltd.			
Number of active classes	Theory: 3	Practice: 2	
Methods of delivering lectures Oral and visual presentation and interaction during class. Consultation – directly, by e-mail or via internet platforms.			
Evaluation of knowledge (maximum number of points 100)			
Pre-exam	**Points 60**	**Final exam**	**Points 40**
Seminars	60	Oral exam	40

Table 5.1. Specification of subjects in the doctoral studies study program

Name of the subject: Intelectual property and Patents			
Teacher(s): Mirjana B. Pešić			
Status of the subject: Mandatory			
Number of ECTS points: 7			
Condition: /			
Goal of the subject The course aims to provide students with the knowledge and skills they need to recognize and protect variousforms of intellectual property, to prepare a patent application and use a patent.			
Outcome of the subject At the end of the course, students will be able to: recognize different forms of intellectual property, know the forms of intellectual property protection, recognize the patentability of their scientific research, draft a patent application,search patent databases and to use a patent.			
Content of the subject *Theoretical lectures* Overview of various forms of intellectual property, importance of intellectual property, protection of intellectual property, trademarks, industrial designs, indication of geographical origin, plant variety protection, copyright, invention, patent, small patent, patent recognition procedure, patent application, patent database search, termination of a patent, limitation of rights, exclusion of patentability, use of patent, international protection, advantages and disadvantages of patenting, alternatives to patenting. *Practical lectures* In the computer workshop, students practice searching in the patent databases Mimoza and Espacenet. The skills, knowledge and abilities acquiring in searching databases and writing a patent application are assessed on the basis of individual tasks.			
Recommended literature Mukherjee, S. (2023). Patent Exhaustion and International Trade Regulation: Brill | Nijhoff. Netherland ISBN: 9789004542815 Michelson, G.K. (2021). Introduction to Intellectual Property, OpenStax, Rice University, Houston, Texas, USA,ISBN: 978-1-951693-34-3 Word Intelectual Property Organization (WIPO) (2020): What is intelectual property rights? Geneve,WIPO, WIPO publication No. 450E/20 ISBN 978-92-805-3176-3 Word Intelectual Property Organization (WIPO) (2023): WIPO patent drafting manual, second edition, Geneve,WIPO DOI: 10.34667/tind.44657, ISBN: 978-92-805-3579-2 (online)			
Number of active classes	Theory: 5	Practice: 2	
Methods of delivering lectures Lectures, assignments			
Evaluation of knowledge (maximum number of points 100)			
Pre-exam	**Points 30**	**Final exam**	**Points 70**
Seminar	30	Oral exam	70

Table 5.1. Specification of subjects in the doctoral studies study program

Name of the subject: Communication and presentation skills			
Teacher(s): Mirjana B. Pešić. Vesna V. Antić			
Status of the subject: mandatory			
Number of ECTS points: 7			
Condition: none			
Goal of the subject The subject aims to provide students with the tools and techniques they need to communicate research ideas andfindings to different audiences and to create effective, clear and audience-appropriate presentations using a variety of presentation methods.			
Outcome of the subject By the end of the course, the student will be able to: understand principles of effective communication, select relevant communication types, uderstand how storytelling techniques can build a compelling scientific story to communicate scientific research, prepare PowerPoint slides for effective oral and poster presentations, avoid diminishing audience attention and effectively conclude the presentation with a „take-home message–.			
Content of the subject *Theoretical lectures* Principles of scientific communication, types of scientific communication, presentation tools and techniques, tailoring communication to audience requirements, preparing a power point presentation for oral or poster communication e.g. background selection, pptx templates, designing text, tables and figure, summarizing conclusions, preparing presenters to communicate effectively with scientific and non -scientific audiences through public speaking and presentations, social media and media interviews. *Practical lectures* As a part of computer workshop, students practice presenting relevant information from a scientific research, interpreting scientific data using figures and tables and presenting the most important results and conclusions using Microsoft Office Power Point. The skills and knowledge acquired and the ability to present and communicate the results of a scientific research are assessed through individual presentation assignments.			
Recommended literature Bowater, L., Yeoman, K. (2012). Scientific communication: A practical guide for scientists, Wiley-Blackwell,ISBN: 978-1-118-40666-3 Dionne, J.P. (2022): Presentation skills for scientist and engineers: The slide master. Springer Nature, Berlin, Germany ISBN 978-3030660710			
Number of active classes	Theory: 5	Practice: 2	
Methods of delivering lectures Lecture, assignment			
Evaluation of knowledge (maximum number of points 100)			
Pre-exam	**Points 30**	**Final exam**	**Points 70**
Seminar	30	Oral exam	70

Table 5.1. Specification of subjects in the doctoral studies study program

Name of the subject: Agroecology			
Teacher(s): Dolijanović, K. Željko			
Status of the subject: elected			
Number of ECIIБ points: 8			
Condition: no condition			
Goal of the subject The course should enable the student to acquire: a) knowledge of the principles of natural resource management in agriculture, the formation and functioning of a sustainable agroecosystem, ecological concepts that will benefit farmers on farms; b) skills for proper management of agro-ecosystems, assessment of productivity and state of agro-ecosystems, avoidance of harmful effects of certain technologies in agriculture on the environment			
Outcome of the subject At the end of the course, the student should demonstrate knowledge (understanding) of: principles of agroecology, the influence of environmental factors on cultivated plants and accompanying elements of agroecosystems, functioning and management of agroecosystems. He should be able to: apply ecological technologies in growing crops, recognize the negative effects of agrotechnical measures on natural resources and the environment, change and adapt the methods applied on the farm in order to protect and preserve the environment, apply instruments for measuring microclimatic parameters and interpreting the climate for the needs of agriculture, the application of teamwork methods, the presentation of acquired knowledge within the course, oral and written assessment of learning outcomes and assessment of the development of the teaching process during the implementation of the course.			
Content of the subject *Theoretical lectures:* Significance of climate and assessment of climate for the needs of agriculture; Variability of climate and weather; Light, Temperature and Water, the influence and adaptations of plants to light, temperature and water; Air and air movements (wind); Edaphic and orographic factors (importance of soil for plants and their distribution); Biotic factors: mutual relations between organisms (symbiosis, competition, epiphytism, biochemical relations, allelopathy) and the use of natural mechanisms in improving the production capabilities of cultivated plants; Concept of biocenosis, ecological niche and application to agriculture; Agroecosystems; Stability in the agroecosystem; Types of agriculture in the world. Conventional, conservation and organic plant growing systems. Sustainable agriculture; The anthropogenic factor and its contribution to mitigating the consequences of climate change. Biodiversity. GMOs. Preventive measures (crop rotation, cover and combined crops). Importance of modification of direct agrotechnical measures. Integral approach to growing plants. *Practical lectures (Study research):* It will be organized individually depending on the topic of the doctoral dissertation, it will take place in the experimental field, and it will include the preparation and writing of seminar and scientific papers.			
Recommended literature Stephen R. Gliessman, V. Ernesto Méndez, Victor M. Izzo, Eric W. Engles (2022): Agroecology: Leading the Transformation to a Just and Sustainable Food System. 4th edition. ISBN 9781003304043. CRC Press. Dolijanović, Ž., Simić Milena (2015): Chapter: Intercropping Systems: Principles, Production Practices and Agronomic Benefits, pp 1-43. In: Agricultural Research Updates pp 180. Volume 12, Editors: Prathamesh Gorawala and Srushti Mandhatri ISBN: 978-1-63483-967-9. ISSN: 2160-1739. Published by Nova Science Publishers, Inc., New York.			
Number of active classes	Theory: 3	Practice: 3	
Methods of delivering lectures Lectures combined with interactive teaching, seminars, consultations and mentoring work with students.			
Evaluation of knowledge (maximum number of points 100)			
Pre-exam	**Points 70**	**Final exam**	**Points 30**
Activity during the lecture	10	Written test	
Practical classes	10	Oral exam	30
Colloquiums	30		
Seminars	20		
Project presentation	-		

Table 5.1. Specification of subjects in the doctoral studies study program

Name of the subject: Multifunctional tasks and importance of grassland and lawns			
Teacher(s): Aleksandar Simić			
Status of the subject: Elective			
Number of ECПБ points: 8			
Condition:			
Goal of the subject The course is designed to enable students to acquire the following knowledge: Knowledge of the main processes in the structure of grassland and turf, environmental influences and their interaction with applied agriculturaltechniques in grassland and turf management			
Outcome of the subject Upon completion of the course, the student should: know the basics of grassland and turf science, the effects of environmental factors on grasses, production systems of the main forage and ornamental species, the basicprinciples of turf establishment, the effects of environmental factors on established turf, the additional elements of the turfgrass agroecosystem, and the functioning and management of turfgrass agroecosystems, technical and agrotechnical measures on meadows and pastures, natural and sown medows and pastures, utilisation of meadows and pastures, conservation and roughage production, grass seed production. After completing the course, the student should be able to: plan the establishment of grassland, apply technical and agrotechnical measures to grassland and lawns, organise the management of grassland professionally, organise the continuous production of green fodder professionally, prepare, conserve and store roughage. Upon completion of the course, a student should be able to: apply the technique of establishing and maintaining lawns, determine positive and negative effects of lawns, importance and role of lawns in land planting; classification of lawns. Relationship between lawns and environmental conditions. Important morphological and biological characteristics of grasses. Creation and maintenance of lawns for specific purposes. Mechanisation and equipment for lawn care. Calendar of lawn activities. Grassland and its role in erosion control and forage production. Production of grass species seeds. Current global research on grasslands			
Content of the subject *Theoretical lectures:* Relationship between grassland and environmental conditions; production on natural and sown meadows and pastures. Evaluation of the quality of meadows and pastures. Current worldwide research on grassland and turf; importance of turf in land cultivation. Classification of turf. Relationship between turf and the environment. Important morphological and biological characteristics of grasses. Creation and maintenance of lawns for specific purposes. Mechanisation and equipment for lawn maintenance. Organisation of lawn maintenance activities. Grasses for sports fields. Turfgrasses for erosion control and surface protection. Current research on turf grasses and lawns in the world. *Practical lectures:* Planning and conducting a study/experiment. Analysing the research results and presenting the results.			
Recommended literature Alibegović-Grbić, S., Bezdrob, M., Eich-Greatorex, S., Klaus, A., Krogstad, T., Matijašević, D., Milenković, I., Milovanović, J., Nikšić, M., Pavlović, J., Rac, V., Rajić, N., Rakić, V., Randjelović, M., Simić, A., Sogn, T., Vunduk, J., Živanović, I. (2016): The use of natural zeolite (clinoptilolite) for the treatment of farm slurry and as a fertilizer carrier Monograph based on results from the HERD program for the period 2012-2015, Editors: Tore Krogstad and Vesna Rakić. Simić A. (2020): Pasture systems and forage production in agro-ecological conditions of the Republic of Srpska. In: Pržulj N, Trkulja V (eds) From genetics and environment to food. Academy of Sciences and Arts of the Republic of Srpska, Banja Luka, Monograph XLI: 439-487. Licina, V., Krogstad, T., Simić, A., Akšić, M. F., Meland, M. (2021): Nutrition and fertilizer application to apple trees-a review. Monograph - NIBIO Rapport, Vol. 7, No. 59, 2021			
Number of active classes	Theory:3	Practice:3	
Methods of delivering lectures In this course, different teaching methods are used to teach students about these different aspects of grasses both in grasslands and in lawns. Through lectures, practicals, excursions and case studies, in-depth knowledge is gained on botanical, physiological and nutritional aspects of grasses. Also skills are developed relating to problem identification and solving in grassland science. In the course chapters, lectures are used to varying degrees in combination with interactive activities			
Evaluation of knowledge (maximum number of points 100)			
Pre-exam	**Points:60**	**Final exam**	**Points:40**
Seminar and oral discussion on seminar topic	60	Written exam	40

Table 5.1. Specification of subjects in the doctoral studies study program

Name of the subject: Irrigation

Teacher(s): Stričević J. Ružica

Status of the subject: elective

Number of ECIIБ points: 8

Condition: Principles of Agricultural water use

Goal of the subject

Students should gain the comprehensive knowledge related to the soil-plant-water-air continuum, to learn new diagnostic methods of crop water needs prior to irrigation, to apply new indices and methods for irrigation scheduling, to compare different methods and form the critical opinion. The aim of this course is to enable students to establish experimental research based on scientific principles, to apply appropriate equipments, techniques and methods to evaluate irrigation system performance, to use informatic technology and scientific literature.

Outcome of the subject

Student should independently establish scientific research in the realm of irrigaiton, evapotranspiration, water use efficiency, crop growth modeling in rainfed and irrigated farming, use of continual meteorological measurement, soil water content and plant water status measurement. Students should be able to interpret and scientificly support results, to discuss and to prepare poster and oral presentation.

Content of the subject

Theoretical lectures

Plant and microclimate; Crop water requirement in full irrigation and stress condition; dual kc, land cover, shadowing and impact of soil wetting on evaporation, evapotranspiration; Plant reaction on water stress, yield reduction coefficients, crop water stress index; Use of remote sensing and various indices for irrigation scheduling; Irrigation and sustainable agriculture. Contemporary principles of irrigation managenemt.

Practical lectures

Practical analysis of scientific research, training and demonstration of skills in measurement of soil and plant water status, crop growth modeling, demonstration of usage information tools and techniques.

Recommended literature

1. López-Pérez, E., Sanchis-Ibor, C., Jiménez-Bello, M. Á., & Pulido-Velazquez, M. (2024). Mapping of irrigated vineyard areas through the use of machine learning techniques and remote sensing. Agricultural Water Management, 302, 108988..
2. Evapotranspiration, An Overview. (2013). InTech, Chapters. Ed. Alexandris S.G., Stričević R.J. https://www.intechopen.com/books/evapotranspiration-an-overview
3. Knipper, K.R., Kustas, W.P., Anderson, M.C., Alfieri, J.G., Prueger, J.H., Hain, C.R., ... Hipps, L.E. (2018). Evapotranspiration estimates derived using thermal-based satellite remote sensing and data fusion for irrigation management in California vineyards. *Irrigation Science*, 1-19.
4. Vlotman, W., Smedema, L., & Rycroft, D. (2020). Modern land drainage: Planning, design and management of agricultural drainage systems. CRC Press.

Steduto, P., Hsiao, T.C., Fereres, E. Raes, D. (2012). Crop yield response to water. FAO, Rome.

Number of active classes	Theory: 3	Practice: 3

Methods of delivering lectures

Interactive lecturing and project oriented work on chosen topic.

Evaluation of knowledge (maximum number of points 100)

Pre-exam	**Points 40**	**Final exam 60**	**Points 100**
Activity during the lecture		Written test	
Practical classes		Oral exam	60
Colloquiums			
Seminars	40		
Project presentation			

Table 5.1. Specification of subjects in the doctoral studies study program

Name of the subject: Plant Genetics			
Teacher(s): **Vladan Pesic**			
Status of the subject: Election			
Number of ECIIБ points: 8			
Condition: none			
Goal of the subject The course aims to provide the student with new and deepen previously acquired knowledge and skills in genetics. The student gets to know in detail: elements of genetic analysis of traits; structure, functioning and regulation of gene activity, types of variations in the number of chromosomes, as well as methods of obtaining transgenic plants. Particular attention will be paid to the specificities of agriculturally important plants.			
Outcome of the subject The student should master research methods; be able to describe and analyze in detail different sources of genetic variability such as hybridization, mutations, somaclonal variation and somatic hybridization; explain the processes of realization of hereditary information; knows the procedures for obtaining GMOs; know the state of science and be capable of improving new projects in this area.			
Content of the subject *Theoretical lectures* Genetic analysis of qualitative and quantitative traits of plants. Molecular genetics. Genetic variability. Polyploidy and aneuploidy in higher plants. Recombinant DNA technology and genetic modifications of plants. *Practical lectures* It will be organized individually depending on the topic of the doctoral dissertation, and will include the preparation and writing of a seminar or scientific paper			
Recommended literature • Russell, P.J. 2003. Essential i Genetics. Benjamin Cumings, San Francisco. • Hartwell, H.L., Hood, L., Goldberg, L.M., Reynolds, E.A., Silver, M.L., Veres, C.R. 2004. Genetics: From Genes to Genomes. McGrow Hill, New York • Pierce, B.A. 2005. Genetics A Conceptual Approach, 2nd ed. W. H. Freeman and Company, New Yorк			
Number of active classes	Theory: 3	Practice: 3	
Methods of delivering lectures Theoretical teaching, methods of interactive teaching and learning, preparation of seminar papers and consultations.			
Evaluation of knowledge (maximum number of points 100)			
Pre-exam	**Points 40**	**Final exam**	**Points 60**
Activity during the lecture	5	Written test	
Practical classes		Oral exam	60
Colloquiums	15		
Seminars	20		
Project presentation			

Table 5.1. Specification of subjects in the doctoral studies study program

Name of the subject: Precision Agriculture			
Teacher(s): Milos Pajic			
Status of the subject: Elective course			
Number of ECIIБ points: 8			
Condition: completed bachelor or master's studies in the field of agriculture/agronomy			
Goal of the subject Acquiring knowledge in the field of application of Precision Agriculture (PA) in production systems: Detection (sensors and sensor systems), structure and analysis of agricultural data;Applications of GIS (Geographic Information System), GNSS (Global Navigation Satellite System), VRT (Variable Rate Technologies) in agriculture;Application of unmanned aerial vehicles in agriculture;Economic evaluation of the application of PA technologies.			
Outcome of the subject The student is qualified for the practical application of acquired knowledge in the field of remote sensing and data analysis, optimization of input application in agricultural production, management of production systemsbased on available PA technologies.			
Content of the subject *Theoretical lectures* Basic principles of PA.Description of the spatial heterogeneity of soil and plants.Database structure, GIS, GNSS, VRT, applied PA technologies.Unmanned aerial vehicles in agriculture.Processing and interpretation of images of plots.Decision-making and economic evaluation of PA technologies. *Practical lectures* Practical exercises that encourage active learning/understanding of the basic principles and technologies ofPA. Analysis of production processes using case studies from PA area. Training for learning basic design, analysis and optimization in applied PA technologies.			
Recommended literature 1. Davide Cammarano, Frits K. Van Evert, Corne Kempenaar (2023): Precision Agriculture. Springer. 2. Avital Bechar (2021): Innovation in Agricultural Robotocs for precision Agriculture. Springer. 3. Qin Zhang (2016): Precision Agriculture Technology for Crop Farming. CRC Press, Taylor and Francis Group. 4. Stafford, J.V. (2013): Precision Agriculture ed. 13. Wageningen Academic Publishers.			
Number of active classes	Theory: 3	Practice: 3	
Methods of delivering lectures Combination of theoretical, practical and interactive teaching. Oral lectures, video presentations and public presentations, solving case studies, interactive communication (team collaborative and cooperative methodsof active learning).			
Evaluation of knowledge (maximum number of points 100)			
Pre-exam	**Points 60**	**Final exam**	**Points 40**
Activity during the lecture	10	Written test	40
Practical classes	/	Oral exam	/
Colloquiums	/		
Seminars	/		
Project presentation	50		

Table 5.1. Specification of subjects in the doctoral studies study program

Name of the subject: Agricultural entomology			
Teacher(s): Andja Radonjić			
Status of the subject: Elective (Topic specific courses)			
Number of ECПБ points: 8			
Condition: none			
Goal of the subject The objective of the module is to enable students to acquire knowledge of external and internal structure of insects, the function of insect organs as well as to understand all life processes that occur in certain organs of the insect body and in the organism in general. Acquire knowledge of the biology of the most important insect pests and beneficial insects in agricultural production.			
Outcome of the subject Students are expected to demonstrate knowledge and understanding of the morphological and anatomical characteristics of insects and the physiological processes in the insect organism. They should be able to identify the major insect pests and recognise the damage they cause to plants. Students are also expected to understand the life cycles of certain insect species.			
Content of the subject *Theoretical lectures* Morphological characteristics of insects. The importance of morphological characteristics for the identification of insects and the use of specific keys for the identification and classification of insects. Anatomical characteristics of insects. Physiology of insects. Reproduction and development. Physiology of diapause. Behaviour of insects. The most important pest and beneficial insect species in agricultural production. *Practical lectures* Examination and preparation of microscopic specimens to familiarize students with the morphological and anatomical characteristics of the insect group that is the subject of his research as part of his doctoral studies. Identification of insect species with specific insect identification keys.			
Recommended literature Beutel, R.G., Friedrich, F., Ge,SQ, Yang, XK (2014): Insect Morphology and Phylogeny. Walter de Gruyter GmbH, Berlin/Boston Chapman, R. F. (2013): The Insects: Structure and Function. 5th edn (Eds Simpson S. J. and Douglas, A. E.). Cambridge University Press, Cambridge Van Emden, H.F. (2012): Handbook of Agricultural Entomology. Wiley-Blackwel Insect identification keys. Scientific literature available on the Internet			
Number of active classes	Theory: 3	Practice: 3	
Methods of delivering lectures Lectures combined with interactive classes shall be implemented throughout all teaching practice. A student is obliged to prepare one paper with respect to any of the chapters mentioned in the contents.			
Evaluation of knowledge (maximum number of points 100)			
Pre-exam	**Points 60**	**Final exam**	**Points 40**
Activity during the lecture		Written test	
Practical classes		Oral exam	40
Colloquiums	30		
Seminars	30		
Project presentation			

Table 5.1. Specification of subjects in the doctoral studies study program

Name of the subject: Soil conservation			
Teacher(s): Marija D. Ćosić			
Status of the subject: optional			
Number of ECIIБ points: 8			
Condition: none			
Goal of the subject The acquisition of theoretical and practical knowledge enabling students to thoroughly understand the principles, techniques, and approaches to soil conservation for the preservation of soil fertility, reduction of erosion, and sustainable management of agricultural resources.			
Outcome of the subject By the end of the course, the student should demonstrate an understanding of water and wind erosion processes,acquire the skill of applying appropriate methodologies to assess soil loss amidst erosion processes, and understand procedures for measuring erosion intensity. Additionally, students should gain skills in applying suitable methodologies in the development and execution of projects for soil erosion management. The student should be competent to participate in the development of project programs, revision of investment-technical documentation, creation of studies and projects in the field of erosion and soil protection, as well as supervisingtheir construction. Upon completion of the course, students are expected to express proficiency in individualand teamwork, critical thinking, and utilization of professional literature.			
Content of the subject *Theoretical lectures*:Soil erosion - concept and definition, types of erosion processes; Water erosion of soil; Wind erosion of soil: mechanism and agents; Forms of wind-induced soil erosion. Methods of studying and measuring soil erosion by water and wind; Measures for erosion control: preventive measures, direct measures, anti-erosion agrotechnical measures, biological measures, measures based on nature-based solutions (NBS), technical measures. *Practical lectures:*Prediction and measurement of runoff: surface water runoff, underground water flow; Methods of studying and measuring soil erosion by water and wind; Application of Geographic Information System (GIS) for monitoring and analyzing soil erosion; Project development including methodology and calculation of soil erosion intensity, and proposing solutions for soil erosion protection; Fieldwork (visiting eroded areas and areas where specific erosion protection measures have been applide)			
Recommended literature Blanco, Humberto., Lal, Rattan. (2023). Soil Conservation and Management (Second Edition). The Editor(s) (ifapplicable) and The Author(s) under exclusive license to Springer Nature Switzerland AG 2008, 2023. ISBN 978-3-031-30340-1 ISBN 978-3-031-30341-8 (e Book) https://doi.org/10.1007/978-3-03-30341-8 (https://books.google.rs/books?hl=en&lr=&id=g1DXEAAAQBAJ&oi=fnd&pg=PR5&dq=soil+conservation+book&ots=m13LUSW4kC&sig=kURp_XOgX4nqUG82433CSd4iqxk&redir_esc=y#v=onepage&q=soil%20conservation%20book&f=false) Scientific and technical literature available on the Internet Materials from lectures and research papers as part of the course			
Number of active classes	Theory: 3	Practice: 3	
Methods of delivering lectures Theoretical and practical teaching, organization of field lessons for students and familiarization with practical problems and solutions. Training in the application and use of appropriate computer techniques (software packages) for the creation of erosion and soil conservation projects. Development of a project that follows the whole problem of the teaching discipline.			
Evaluation of knowledge (maximum number of points 100)			
Pre-exam	**Points 60**	**Final exam**	**Points 40**
Activity during the lecture		Written test	40
Practical classes	30	Oral exam	
Colloquiums			
Seminars	30		
Project presentation			

Table 5.1. Specification of subjects in the doctoral studies study program

Name of the subject: Crop growth modelling			
Teacher(s): Marija D. Ćosić			
Status of the subject: optional			
Number of ECIIБ points: 8			
Condition: none			
Goal of the subject The subject aims to enable students to understand the concepts of existing models for simulating the growth and development of crops in agricultural production, as well as to differentiate approaches and methodologies in the field of crop modeling. Subsequently, it aims to develop students' ability to choose and apply models to specific examples through independent modeling, calibration, and validation of simulations of the growth and development of various crops. Students will be trained to assess the growth and development of crops under future climate conditions. The subject directs students towards developing critical thinking and analytical skills related to the application of models in agriculture.			
Outcome of the subject At the end of the course, the student should understand key concepts and terms in the application of models in crop production. They should critically apply the appropriate model to specific examples in agriculture. Additionally, they will master the procedures of model calibration, validation, and sensitivity analysis. The student will also be trained to analyze and interpret model results, with a focus on making informed decisions regarding practical implementation, all while understanding its advantages and limitations. In addition to the mentioned skills, the student should be trained and encouraged to apply models in their future scientific research work.			
Content of the subject *Theoretical lectures:* Introduction to models in crop production; Analysis and preparation of input data (climate, soil, plant, agro technique); Calibration; Validation; Analysis and Interpretation. *Practical lectures*: Conducted on a computer within selected models. Exercises follow the theoretical part of the lectures. Gathering, analysis, and input of necessary data into the corresponding model; Model calibration and validation; Interpretation of results; Forecast of crop growth and development using an appropriate model.			
Recommended literature Jeffers, J.N.R. (1982). Modelling. Chapman and Hall, London, New York Raes, D., Van Gaelen, H. (2016). Running AquaCrop – Training handbook II.FAO, Rome, Italy APSIM training manuals – available online (https://www.apsim.info/support/apsim-training-manuals/)			
Number of active classes	Theory:3	Practice: 3	
Methods of delivering lectures Lectures: Presentation of the material, familiarization with the material through discussion with students, demonstration examples and video presentations. Practice: working on the computer with the softwarepackage for appropriate models, creation of projects using appropriate models for crop production, field data collection as inputsfor the models, project presentations (results and reports of the model).			
Evaluation of knowledge (maximum number of points 100)			
Pre-exam	**Points 50**	**Final exam**	**Points 50**
Activity during the lecture		Written test	50
Practical classes	30	Oral exam	
Colloquiums			
Seminars	20		
Project presentation			

Table 5.1. Specification of subjects in the doctoral studies study program

Name of the subject: TOXICOLOGY AND ECOTOXICOLOGY OF PESTICIDES			
Teacher: Dragica V. Brkić			
Status of the subject: elective			
Number of ECПБ points: 8			
Condition: none			
Goal of the subject: Describe specific target organs and molecular mechanisms of toxicity of pesticides. Apply different toxicological and ecotoxicological frameworks within the professional disciplines and have awareness about different risk assessment criteria. Critically evaluate toxicological information from different sources (EFSA, EC, IPCS, ATSRD etc. databases). Develop a critical attitude towards new OECD test guidelines in toxicology and ecotoxicology. Independently carry out and recommend risk assessment of pesticides for different organisms. Estimate the risk for adverse effects of a chemical on different biological organisation levels.			
Outcome of the subject: Ability to work in a multidisciplinary team dealing with problems of risk assessment of pesticides for different organisms. Ability to apply the standards and regulations concerning placing of PPP on the market as well as pesticide residues and food safety. Independently carry out classification and labelling of pesticides according to GHS system for classification and labelling.			
Content of the subject *Theoretical lectures:* Pesticides and specific target organs; molecular mechanisms of toxicity of pesticides: covalent binding to endogenous substrates, inhibition of enzymes and other proteins, oxidative stress, mechanisms of apoptosis and necrosis, effect of toxins on ion channels and specific receptors, etc. Effects of pesticides on human health and the environment. Toxicity of mixtures. New approaches in toxicological and ecotoxicological testing. Bioconcentration, bioaccumulation and biomagnification of pesticides and entering the food chain. The need for standards and regulations in toxicology and ecotoxicology. Regulations concerning the placing of PPP on the market in EU. Human and ecological risk assessment. Direct and indirect effects of pesticides important for risk assessment. Principles in hazard and risk assessment based on dose-response and exposure assessment. *Practical lectures:* Methods to study toxic and ecotoxic effects of pesticides (in vivo, in vitro, in silico). Determination of Hazard Quotient (HQ) for different organisms, Toxicity Exposure Ratio (TER), Regulatory Acceptable Concentration (RAC), etc. and interpretation of results. EFSA OpEx model for the assessment of exposure of operators, workers, residents and bystanders in risk assessment for PPP. EFSA residue intake model (EFSA PRIMo). Laboratory work and individual research. Classification and labelling of pesticides in relation to toxicological and ecotoxicological properties (health and environmental hazard) according to GHS system for classification and labeling.			
Recommended literature: 1. Kreiger, R. (Ed). Hayes' Handbook of Pesticide Toxicology. Academic Press, London, UK, 2010. 2. Casarett & Doull's Essentials of Toxicology, Klaassen, D.C, Watkins, B.J. (Eds). Mc Graw Hill Medical, New York, USA, 2022. 3. Newman, C.M. Fundamental of Ecotoxicology, The Science of Pollution. CRC Press, Boca Raton, FL, USA, 2015. 4. OECD test guidelines for the chemicals. 5. EFSA Guidance on the assessment of exposure of operators, workers, residents and bystanders in risk assessment for PPP. 6. EFSA pesticide residue intake model (EFSA PRIMo revision 3). 7. Vučinić, S., Antonijević, B., Brkić, D. (2014). Occupational and Environmental Aspects of Organophosphorus Compounds. In: Basic and Clinical Toxicology of Organophosphorus Compounds (Balali-Mood, M. and Abdollahi, M., eds.). Springer-Verlag, London.			
Number of active classes	Theory: 3	Practice: 3	
Methods of delivering lectures: Lectures combined with interactive teaching methods; practical group work			
Evaluation of knowledge (maximum number of points 100)			
Pre-exam	**Points 40**	**Final exam**	**Points 60**
Activity during the lecture		written test	30
Practical classes		oral test	30
Colloquiums	20		
Seminars	20		

Table 5.1. Specification of subjects in the doctoral studies study program

Name of the subject: Weed Science			
Teacher(s): Sava Vrbničanin, Dragana Božić			
Status of the subject: elective			
Number of ECIIБ points: 8			
Condition: none			
Goal of the subject Giving knowledge about: weed classification, fundamental biological and ecological characteristics of weed species, genetic and phenotipic variability, reproduction, invasive processes of adventive weed species, structure and changes in weed communities, crop-weed interactions, environment-weed interactions, resistance/tolerance of weeds/crops to herbicides, diagnostic methods and the impact of climate change on weed spread and weed control strategies in conventional and organic production.			
Outcome of the subject The student should be able to monitor and to assess the abundance of weeds, their interaction with crops, the weeds resistanceto herbicides and to plan an integrated weed management focused to the sustainability of the agroecosystems. Should be trained to apply team work methods, develop critical thinking about the course content and be able to present the knowledge acquired in this course.			
Content of the subject *Theoretical lectures* Weed classification. Weed biology: reproduction, dormancy, time and space spreading, germination and emergence, seed-bank estimation. Weed ecology: population dynamics, effects of abiotic and biotic factorson the weed populations, alian invasive weed species. Crop-weed interaction: inter- and intraspecific competition, physiological aspect of competition, allelopathy. Parasitic weed species. Diagnosis and applied biotechnology in weed control: monitoring and sampling procedures, weed seed, seedlings and plants identification, diagnosis of weeds abundance, weed thresholds and critical time for weed control, application of biotechnology in weed science. Weed control: prevention, tools used for weed control, physical, cultural, biological and chemical method of weed control. Herbicide-resistance weeds and antiresistant strategy. Management strategies for herbicide-resistant weeds. IWM in conventional and organic crop production. *Practical lectures* Getting to know with evolutionary processes in weeds, methods od weed reproduction, invasive processes of alian weed species, crop-weed-environment interactions, resistance/tolerance of weeds/crops to herbicides, strategy of weed management in conventional and organic crop production.			
Recommended literature 1. Jugulam, M.: Biology, Physiology and Molecular Biology of Weeds. CRC Press, 2017. 2. Pacanoski, Z.: Herbicide Resistance in Weeds and Crops. BoD – Books on Demand, 2017. 3. Zimdahl, R.L.: Fundamentals of Weed Science. 5th ed., Academic Press, New York, 2018. 4. Jabran, K., Chauhan, B.S.: Non-Chemical Weed Control. Academic Press, 2018. 5. Korres, N.E., Burgos, N.R., Duke, S.O.: Weed Control: Sustainability, Hazards, and Risks in Cropping SystemsWorldwide. 1st ed., CRC Press, 2021. 6. Mendes, K.F., da Silva, A.A.: Applied Weed and Herbicide Science. Springer, 2022.			
Number of active classes	Theory:3	Practice: 3	
Methods of delivering lectures Interactive lectures, practical work.			
Evaluation of knowledge (maximum number of points 100)			
Pre-exam	**Points 70**	**Final exam**	**Points 30**
Activity during the lecture		Written test	
Practical classes		Oral exam	30
Colloquiums	40		
Seminars	30		
Project presentation			

Table 5.1. Specification of subjects in the doctoral studies study program

<table>
<tr><td colspan="4">Name of the subject: Advanced Phytopathology</td></tr>
<tr><td colspan="4">Teacher(s): Obradović, A., Vico, I., Duduk, N., Bulajić, A., Ivanović, M., Stanković, I.</td></tr>
<tr><td colspan="4">Status of the subject: Elective</td></tr>
<tr><td colspan="4">Number of ECIIБ points: 8</td></tr>
<tr><td colspan="4">Condition: passed exam in Research Methods in Plant Pathology</td></tr>
<tr><td colspan="4">Goal of the subject is to provide state of the art knowledge and expertise in phytopathology, throughout theoretical and practical classes of: plant pathogens' biology, variability and dynamics of the pathogen populations, distribution and spread of the pathogens, epidemiology, pathogenesis of plant diseases, symptomatology, structural and physiological changes in diseased plants, plant resistance mechanisms, plant disease and epidemics forecasting, general prophylaxis and therapy, and biological control of plant pathogens.</td></tr>
<tr><td colspan="4">Outcome of the subject
A student is expected to demonstrate the knowledge of: plant pathogens' biology, distribution and spread of plant pathogens, epidemiology, plant disease pathogenesis, symptomatology, structural and physiological changes in diseased plants, plant resistance mechanisms, plant disease and epidemics forecasting, general prophylaxis and therapy, and biological control of plant pathogens.</td></tr>
<tr><td colspan="4">Content of the subject
Theoretical lectures. Biological characteristics of plant pathogens; Population structure and dinamics; Pathogen distribution and spread; Epidemiology; Pathogenesis of plant diseases, Symptomatology; Structural and physiological changes in diseased plants; Plant resistance mechanisms; Plant disease and epidemics forecasting; General prophylaxis and therapy; Biological approach in plant pathogen control.
Practical lectures. Application of current protocols and schemes for analysis of diseased and latently infected plant material; Conventional and genome-based identification and characterisation of plant pathogens; Plant – pathogen interactions; Determination of sensitivity-resistance of plants and the pathogen virulence factors; Processing, analysis and presentation of the results; Critical thinking; Practice of independent and/or teamwork; Writing and presentation of the scientific work.</td></tr>
<tr><td colspan="4">Recommended literature
Agrios (2005): Plant pathology 5th edn. Academic Press, California
Whindham, M.T., and Whindham, A.S. (2003): What is disease? In Plant Pathology: concepts and laboratory exercises, ed. By Trigiano, R.N., Windham, M. T. and Windham, A. S. CRC Press, Florida.
Lucas, J., 1998: Plant pathology and plant pathogens, third edition, Blackwell Publishing,UK
The Terminology Sub-Committee of the Federation of British Plant Pathologists (1973): A guide to the use of terms in Plant Pathology, CMI, Kew, England, UK
D'Arcy, C.J. , D.M. Eastburn, and G.L. Schumann. 2001. Illustrated Glossary of Plant Pathology. The Plant Health Instructor http: http://www.apsnet.org/Education/IllustratedGlossary/
Trigiano, R.N., Windham, M.T., and Windham, A.S. 2003: Plant Pathology: Concepts and Laboratory Exercises. CRC Press, Boca Raton, Florida.
Schuman, G.L., D'Arcy, C.J. (2006): Essential Plant Pathology. APS Press, St Paul, Minn. USA
Dyakov, Y.T., Dzhavakhiya, V.G., Korpela, T. (2007): Comprehensive and Molecular Phytopathology. Elsevier.
Klement, Z., Rudolph, K., Sands, D.C. (1990): Methods in Phytobacteriology. Akademiai Kiado, Budapest.
Lelliott, R.A., Stead, D.E. (1987): Methods for the Diagnosis of Bacterial Diseases of Plants. Blackwell Scientific Publications, Oxford, London.
Schaad, N.W., Jones, J.B., Chun, W. (2001): Laboratory Guide for Identification of Plant Pathogenic Bacteria. The American Phytopathological Society, St. Paul, USA.</td></tr>
<tr><td>Number of active classes</td><td>Theory: 3</td><td colspan="2">Practice: 3</td></tr>
<tr><td colspan="4">Methods of delivering lectures
Lectures and practical lab and field work in combination with interactive lectures. Online teaching and consultations. Participation in a group projects and exchange of expertise with the team members.</td></tr>
<tr><td colspan="4">Evaluation of knowledge (maximum number of points 100)</td></tr>
<tr><td>Pre-exam</td><td>Points 60</td><td>Final exam</td><td>Points 40</td></tr>
<tr><td>Seminar and oral examination</td><td>60</td><td>Oral exam</td><td>40</td></tr>
</table>

Table 5.1. Specification of subjects in the doctoral studies study program

Course: Soil microbiology
Teacher or teachers (surname, middle letter, name)**:** Blažo T. Lalević, Igor S. Kljujev
Course status: Elective
Number of ECTS credits: 8
Admission requirement: none
Course aim: Course should enable students to understand the • role of microorganisms in processes of formation and maintenance of soil fertility • importance of microorganisms in cycling of macro- and micronutrients and supplying of plants withnecessary nutrients • complex interactions between plants and microorganisms • influence of agrotechnique and agromeliorative processes on soil microbial activity
Course outcome At the end of course, student should • establish the knowledge about the role and importance of microorganisms in formation and maintenance of soil fertility, as well as elements cycling in the frame of complex plant-soil- microorganism interactions • establish the importance and practical application of methods for estimation of soil biological activity as an indicator of influence of agrotechnique processes on soil fertility • be capable of critical analyse, presentatation of acquired knowledge's and professional transfer of knowledge's, teaching evaluation and course outcomes
Course outcome *Theoretical lectures* The role of microorganisms in soil, abundance of microorganisms in soilInfluence of abiotic and biotic factors on microorganisms in soil Role of microorganisms in humification and dehumification processes *Practical lectures* Role of microorganisms in transformation of nitrogen, phosphorus, sulfur and metals Influence of agrotechnique on microbiological processes in soil Microorganisms as an indicators of soil fertility
Recommended literature 1. Tate, R.L. III, Tate, R. L. (2020). Soil microbiology. Wiley. 2. Mohapatra, B., Lal, B., Paul, D., Das, S., Adhya, T.K. (2018). Advances in soil microbiology:recent trends and future prospects. Springer Nature Singapore. 3. Madigan, M., Bender, K., Buckley, D., Sattley, W., Stahl, D. (2019). Brock biology ofmicroorganisms. Pearson.

Number of classes of active teaching	Lectures: 3	Study research work: 3

Methods of teaching Theory: oral presentation coupled with interactive teaching. Laboratory researches coupled withinteractive teaching.

Knowledge assessment (maximum number of points = 100)			
Pre-exam	**Points 60**	**Final exam**	**Points 40**
Seminar	60	Oral exam	40

Table 5.1. Specification of subjects in the doctoral studies study program

Course: Water microbiology

Teacher or teachers (surname, middle letter, name)**:** Igor S. Kljujev, Blažo T. Lalević

Course status: Elective

Number of ECTS credits: 8

Admission requirement:none

Course aim

Course should enable students to understand

- the microbial diversity and role of microorganisms in water ecosystems
- understanding of autopurification process and eutrophication in water ecosystems
- estimation of microbial quality of surface, subsurface and wastewaters
- role of microorganisms in biological systems for wastewaters purification
- connection of application of good agricultural practice and importance of microbial quality ofirrigation water with productivity of safe fruits and vegetables

Course outcome

At the end of course, student should be able to

- estimate the microbiological quality of surface, subsurface, wastewaters, waters for irrigationpurpose
- find and recognize factors having influence on eutrophication of water ecosystems
- select suitable method for wastewater treatment
- predict and analyze key points connected with microbiological contamination of irrigation water andto apply principles of good agricultural practice for microbial quality of water

Course outcome

Theoretical lectures

Biodiversity of microbial populations in water ecosystems
Autopurification in water ecosystems
Microbiological quality of surface, subsurface and wastewaters.
Human pathogen microorganisms in waters
Methods of biological treatment of wastewaters
Principles of good agricultural practice and microbiological quality of irrigation water

Practical lectures

Isolation and identification of microorganisms from water ecosystems
Determination of microorganisms by membrane filtration method
Bacteria as an indicator of water quality and ecological aspects
Analyze of activated sludge quality.

Recommended literature

1. Suyal, D.C., Chauhan, J.S., Morales-Oyervides, L., Soni, R. (2023). Current status of freshwater microbiology. Springer Nature Singapore.
2. Hurst, C.J. (2019). The structure and function of aquatic microbial communities. Springer International Publishing.
3. Madigan, M., Bender, K., Buckley, D., Sattley, W., Stahl, D. (2019). Brock biology of microorganisms. Pearson.

Number of classes of active teaching	Lectures: 3	Study research work: 3

Methods of teaching

Theoretical teaching in combination with eLearning and case-study. Presentation of seminar, which may be replaced with publishing of scientific paper or presentation of paper in conference.

Knowledge assessment (maximum number of points = 100)			
Pre-exam	**Points 50**	**Final exam**	**Points 50**
Seminar	50	Final exam	50

Table 5.1. Specification of subjects in the doctoral studies study program

Course: Soil and water bioremediation

Teacher or teachers (surname, middle letter, name)**:** Blažo T. Lalević, Igor S. Kljujev

Course status: Elective

Number of ECTS credits: 8

Admission requirement:none

Course aim

Course should enable students to understand the

- importance of bioremediation in destructed soils and waters
- role of microorganisms in removal of organic pollutants from destructed environments and transformation of heavy metals from polluted soils
- principles and techniques of bioremediation and theirs application in contemporary agricultural productions and environmental protection
- interactions and role of plant-growth-promoting bacteria in bioremediation processes

Course outcome

At the end of cours, student should to be able to

- select appropriate bioremediation technique depending on locations
- estimate the role of microorganisms in degradation of organic pollutants in environment
- describe the role of microorganisms in metal transformation
- design bioremediation experiments
- connect theoretical knowledge with practical usage of bioremediation
- use methods of fast studying and team work

Course content

Theoretical lectures

Diversity, physiological and genetic characteristics of soil microorganisms in bioremediation. Environmental factors and bioremediation. Principles and techniques of bioremediation. Bioremediationof soil polluted by oil and oil hydrocarbons. Bioremediation of soil contaminated by agrochemicals. Microorganisms in the removal of heavy metals.

Practical lectures

Usage of biofilters in remediation of soil and water. Interaction between microorganisms and plants in bioremediation. Legislative and regulations.

Recommended literature

1. Shiomi, N. (2018). Advances in bioremediation and phytoremediation. IntechOpen.
2. Koul, B., Taak, P. (2018). Biotechnological strategies for effective remediation of polluted soils. Springer.
3. Madigan, M., Bender, K., Buckley, D., Sattley, W., Stahl, D. (2019). Brock biology of microorganisms. Pearson.

Number of classes of active teaching	Lectures: 3	Study research work: 3

Methods of teaching

Theoretical teaching in combination with eLearning and case-study. Presentation of seminar, whichmay be replaced with publishing of scientific paper or presentation of paper in conference.

Knowledge assessment (maximum number of points = 100)

Pre-exam	**Points 50**	**Final exam**	**Points 50**
Seminar	50	Final exam	50

Table 5.1. Specification of subjects in the doctoral studies study program

<table>
<tr><td colspan="4">Course name: Biochemistry and Physiology of Microorganisms</td></tr>
<tr><td colspan="4">Teacher (Name, middle letter, surname): Igor S. Kljujev, Jelena P. Jovičić-Petrović</td></tr>
<tr><td colspan="4">Course status: Elective</td></tr>
<tr><td colspan="4">Number of ECTS credits: 8</td></tr>
<tr><td colspan="4">Requirement:</td></tr>
<tr><td colspan="4">Course aim
The subject should enable acquiring knowledge about
• catabolic and anabolic processes in the microbial cell
• the mechanism of biological nitrogen fixation, methanogenesis
• biochemical transformation of complex organic compounds
• mechanisms of transporting nutrients from the environment
• influence of ecological factors on growth parameters</td></tr>
<tr><td colspan="4">Course outcome
The student should be able to
• analyze anabolic and catabolic processes in microorganisms
• predict the effects of ecological factors on the parameters of microbial cell growth
• estimate enzymatic activity of microorganisms
• describe primary and secondary microbial metabolites
• discuss and critically test scientific hypotheses, design an experiment, analyze the results andpresent the acquired knowledge in written and oral form</td></tr>
<tr><td colspan="4">Course content
Theoretical lectures
Anabolism and catabolism of proteins, fats and carbohydrates at microorganisms
Enzymes as biocatalysators
Metabolic processes which are only characteristic for microorganisms
Biological nitrogen fixation mechanism, methanogenesis, biochemical transformation processes ofcomplex organic compounds
Practical lectures
The influence of ecological factors on the metabolic pathways, primary and secondary microbial metabolites, enzymatic activity of the soil, microbial biomass of the soil as a parameter of thebiochemical activity of the soil</td></tr>
<tr><td colspan="4">Recommended literature
1. Kushkevych, I. (2023). Bacterial physiology and biochemistry. Academic Press.
2. Cohen, G.N. (2014). Microbial biochemistry. Springer Netherlands.
3. Madigan, M., Bender, K., Buckley, D., Sattley, W., Stahl, D. (2019). Brock biology of microorganisms. Pearson.</td></tr>
<tr><td colspan="2">Number of classes of active teaching</td><td>Lectures: 3</td><td>SRW: 3</td></tr>
<tr><td colspan="4">Methods of teaching
Theoretical and practical teaching in combination with interactive teaching, mentoring, eLearning andcase-study. Preparation and presentation of seminar work is mandatory. A printed scientific paper or announced at a gathering, printed in its entirety is evaluated as well as seminar work.</td></tr>
<tr><td colspan="4">Assessment of knowledge (maximum of 100 points)</td></tr>
<tr><td>Pre-exam</td><td>Points 60</td><td>Final exam</td><td>Points 40</td></tr>
<tr><td>Seminar</td><td>60</td><td>Final exam</td><td>40</td></tr>
</table>

Table 5.1. Specification of subjects in the doctoral studies study program

Course: Biodiversity and Evolution of Microorganisms			
Teacher or teachers (surname, middle letter, name)**:** Jelena P. Jovičić-Petrović, Igor S. Kljujev			
Course status: Elective			
Number of ECTS credits: 8			
Admission requirement:none			
Course aim • is to provide students knowledge about the • origin of Life on Earth • microbial evolution and diversity • genetic and non-genetic diversity of microbes • horizontal gene transfer in soil • information about contemporary scientific results and scientific research process for environmental biodiversity investigations			
Course outcome At the end of the course students should be adept to • use nomenclature of microorganisms • define the main microbial groups • understand and present the importance and potential of microbial diversity in industry, environmentprotection and biotechnology • individually select methods and techniques to identify environmental pathogenic bacteria • analyze and interpret experimental data of microbial diversity			
Course outcome *Theoretical lectures* Microbial phylogeny and diversity Molecular phylogeny, genetic diversity, mechanisms for generating genetic diversity Horizontal gene transfer and microevolution Microbial identification and taxonomy *Practical lectures* Microorganisms in specific natural habitats Diversity of soil microbial community and effects of agrotechnical measures to structure of microbial communities			
Recommended literature .1. Ventosa, A., Romalde, J.L., Balboa, S. (2019). Microbial taxonomy, phylogeny and biodiversity. Frontiers Media SA. .2. Pontarotti. P. (2018). Origin and evolution of biodiversity. Springer International Publishing. .3. Madigan, M., Bender, K., Buckley, D., Sattley, W., Stahl, D. (2019). Brock biology of microorganisms. Pearson.			
Number of classes of active teaching	Lectures: 3	Study research work: 3	
Methods of teaching Theoretical and practical lessons, interactive classes, mentoring program, case study, e-learning. Oralpresentations of seminar work is obligate. An original scientific full paper presented on Conference and/or included in Conference Proceeding may be prepared instead of seminar work.			
Assessment of knowledge (maximum of 100 points)			
Pre-exam	**Points 60**	**Final exam**	**Points 40**
Seminar	60	Final exam	40

Table 5.1. Specification of subjects in the doctoral studies study program

Course: Environmental microbiology

Teachers (surname, middle letter, name)**:**: Jelena P. Jovičić-Petrović, Blažo T. Lalević

Course status: Elective

Number of ECTS credits: 8

Admission requirements:none

Course aim

Course should enable students to understand

- the microbial diversity in ecosystems, as well as their interactions with plants, significance of plant growth promoting bacteria
- application of microorganisms in bioremediation processes, bioconversion of agroindustrial waste, and microbiological contamination of fresh friuts and vegetables by human pathogens
- multidisciplinary approach to the study and characterization of ecosystems and gives insight into modern and reliable methods for detection of saprotrophic and pathogenic microorganisms in the environment

Course outcome

At the end of the course student should integrate knowledge about

- mutual interactions between microbial populations as well as plant-microbial interactions
- association of ecological problems in agriculture and environment with possibility of practical application of microorganisms in solving environmental problems (bioremediation), environmental protection (biofertilization and biological control), and safe food production (implementation of Good Agricultural Practice principles)
- transfer professional knowledge and contribute to the raising of ecological awareness about environmental protection and importance of microbiological control in the food chain
- application of information and communications technologies in the area of applied ecology in agriculture

Course content

Theoretical lectures

Concept of individua, species and population in microbiology
Metabolic, ecological and genetic diversity of microorganisms
Microbial populations in diferent ecosystems
Interactions between microbial popuplations
Plant growth promoting bacteria
Agriculture impact on biogeochemical cycles.

Practical lectures

Role of microorganisms in sustainable agriculture, bioremediation, and bioconversion of agroindustrialwaste
Microorganisms as contaminants of fresh vegetables and fruits

Recommended Literature

1. Karnwal, A., Al-Tawaha, A.R.M.S. (2022). Environmental microbiology: advanced researchand multidisciplinary applications. Bentham books.
2. Barton, L.L., McLean, R.J.C. (2019). Environmental microbiology and microbial ecology.Wiley.
3. Madigan, M., Bender, K., Buckley, D., Sattley, W., Stahl, D. (2019). Brock biology ofmicroorganisms. Pearson.

Number of classes of activeeaching	Lectures: 3	Study research work: 3

Methods of teaching

Lectures in combination with interactive classes, seminars, consultations and mentoring, case study, e-learning.

Knowledge assessment (maximum of 100 points)			
Pre-exam	**Points 60**	**Final exam**	**Points 40**
Seminars	60	Final exam	40

Table 5.1. Specification of subjects in the doctoral studies study program

Course: Rhizosphere and microorganisms

Teacher or teachers (surname, middle letter, name)**:** Blažo T. Lalević, Jelena P. Jovičić-Petrović

Course status: Elective

Number of ECTS credits: 8

Admission requirement:none

Course aim

Course should enable students to establish the knowledge about the

- rhizosphere as a habitat
- plant-microbial interactions
- rhizosphere bacteria
- role of microorganisms in plants nutrition
- types and importance of mycorrhiza in soil
- mechanisms of influence of plant-growth-promoting-bacteria on plant growth
- microbial antagonism and biological control of pathogens

Course outcome

At the end of cours, student should be able to

- compare and describe the complex interactions between plants and microorganisms
- connect the rhizospheric microflora with supplying of plants with necessairy nutrients
- describe and analyse the mechanisms of its influence on plants
- determinate the importance and to analyse the practical application of plant-growth-promoting-bacteria and mycorrhiza in sustainable agriculture and environmental protection

Course content *Theoretical*
lectures Rhizosphere as
habitat
Population dynamics, rhizosphere interaction and genetic aspects of rhizosphere interactionMicrobial antagonism and biological control of pathogens
Plant-growth-promoting bacteria and mechanism of its influence on plants
Practical lectures
Basic characteristics and types of mycorrhiza and practical application
Soil and rhizosphere aspects of nitrogen fixation in plant-microbial interactions
Usage of plant-growth-promoting bacteria as biofertilizers, phytostimulators, biopesticides andphytoremediators

Recommended literature

1. Sharma, A.K., Gupta, V.V.S.R. (2020). Rhizosphere biology: interactions between microbesand plants. Springer Nature Singapore.
2. Singh, H.V., Sharma, P.K., Sahu, P.K., Sharma, S.K., Singh, U.B. (2021). Rhizospheremicrobes. Soil and plant functions. Springer Nature Singapore.
3. Madigan, M., Bender, K., Buckley, D., Sattley, W., Stahl, D. (2019). Brock biology of microorganisms. Pearson.

Number of classes of active teaching	Lectures: 3	Study research work: 3

Methods of teaching

Theoretical teaching in combination with eLearning and case-study. Presentation of seminar, which may be replaced with publishing of scientific paper or presentation of paper in conference.

Knowledge assessment (maximum number of points = 100)

Pre-exam	**Points 60**	**Final exam**	**Points 40**
Seminar	60	Final exam	40

Table 5.1. Specification of subjects in the doctoral studies study program

Course: Microbial genetics

Teachers: Jelena P. Jovičić-Petrović, Blažo T. Lalević

Course status: Elective

Number of ECTS credits: 8

Admission requirements:none

Course aim

- Course should provide students with
- knowledge about structure and function of microbial genes
- basic principles of microbial genetics
- mechanisms of regulation, replication and gene expression, genetic variability, mutations and understanding of basic principles of recombinant DNA technology and possibilities of its application in agriculture and environmental protection
- knowledge about molecular methods for analyses of micronial populations and microbial diversity insoil

Course outcome

At the end of the course, student should be able to

- describe DNA structure
- sumarize main characteristics of gene organization in procaryotic and eycaryotic organisms
- explain priciples of recombinant DNA technology and bacterial transformations
- consider application of recombinant DNA technology in agriculture and environmental protection
- present experimental data and to give scientific background of the given topic

Course content

Theoretical lectures

Introduction to microbial genetics
Genetic code, gene structure, replication, transcription and translation in bacteria and archaea
Mutation and mutant isolation
Gene transfer between microorganisms
Regulation and the gene expression
Historical perspectives of DNA technology and possibilities of its application in agriculture andenvironmental protection

Practical lectures

Bacterial gene expression
Analyzis of microbial populations by fluorescent in sity hybridizationIsolation of soil DNA

Recommended literature

1. Okon, S., Zimowska, B., Rai, M. (2024). Microbial genetics. CRC Press. Taylor & Francis.
2. Pontarotti. P. (2018). Origin and evolution of biodiversity. Springer International Publishing.
3. Madigan, M., Bender, K., Buckley, D., Sattley, W., Stahl, D. (2019). Brock biology of microorganisms. Pearson.

Number of classes of active teaching	Lectures: 3	Study research work: 3

Methods of teaching

Lectures and practices in combination with interactive classes, mentoring, case study, and e-learning. Seminar paper and its presentation are mandatory. Published scientific paper or the paper presented on scientific conference are valued as seminar paper.

Knowledge assessment (maximum of 100 points)

Pre-exam	**Points 60**	**Final exam**	**Points 40**
Seminar	60	Final exam	40

Table 5.1. Specification of subjects in the doctoral studies study program

Name of the subject: Chemistry of bioactive substances from natural resources			
Teacher(s): Jelena Popović-Đorđević, Professor; Aleksandar Ž. Kostić, Associate professor			
Status of the subject: Elective			
Number of ECПБ points: 8			
Condition: Passed mandatory exams within the study program of doctoral studies			
Goal of the subject Enable to achieve: 1) knowledge, skills and attitudes on the chemical structure and bioactive propreties of phenolic compounds, carotenoides, fatty acids, terpenes, polyamines, phenyl amides and alkaloids from the natural sources, 2) skills in the isolation of compounds from natural sources, 3) ability to apply methods for characterizing structurally different compounds from natural sources.			
Outcome of the subject After completing a course students should be able to: 1) Define the origin of natural compounds, 2) Classify and analyze the chemical composition and structure of phenolic compounds, carotenoides, fatty acids, terpenes, polyamines, phenyl amides and alkaloids 3) Apply analytical methods for the monitoring of chemical structure of bioactive compounds, 4) Identify and analyze biological properties (antioxidant, immunomodulatory, antiflamatory, antiproliferative, antidiabetic) of natural compounds, 5) Demonstrate readiness for a team work, critical thinking, integration of knowledge from different fields, expressed ability of spoken and written communication and presentation of acquired knowledge.			
Content of the subject *Theoretical lectures* 1) Natural sources of bioactive compounds, 2) Chemical composition and structure of natural bioactive compounds (phenolics, carotenoides, fatty acids, terpenes, polyamines, phenyl amides and alkaloids) 3) 'Free radicals' and sources of 'free radicals'; 4) Oxidative stress and antioxidant properties of natural products, 5) Antidiabetic, immunomodulatory, antiflamatory and antiproliferative properties of natural bioactive compounds, 6) Application of structural-instrumental methods and spectrometry in the chemical characterization of natural bioactive compounds. *Practical lectures:* Analysis of the chemical composition and structure of selected natural products; Determination and analysis of antioxidant and enzyme inhibitory properties of bioactive compounds from selected natural sources *Seminar work* is foreseen for the proposed topics in the theoretical teaching. The exam covers the chapters foreseen in the content of the course.			
Recommended literature • Saffron, Galanakis, C. (Ed), 2021, Academic Press, Elsevier; https://doi.org/10.1016/B978-0-12-821219-6.00002-6 • Fruit and vegetable phytochemicals; Chemistry and human health, Yahia E.M., 2018, Blackwell Publishing, USA • Bioactive compounds of plant origin. Suleria H.A.L., Barrow, C. (Eds.), 2021, CRC Press, https://doi.org/10.1201/9780429029288 • Phytochemicals as lead compounds for new drug discovery, C. Egbuna, S. Kumar, J.C. Ifemeje, S.M. Ezzat, S. Kaliyaperumal (Eds.), 2020, Academic Press, Elsevier. https://doi.org/10.1016/C2018-0-02367-1			
Number of active classes	Theory: 3	Practice: 3	
Methods of delivering lectures Lectures, study research work and methods of interactive teaching and learning are used in teaching methods. The interactive teaching use collaborative and cooperative methods of active learning, developing of critical and creative thinking and presentation of the acquired knowledge.			
Evaluation of knowledge (maximum number of points 100)			
Pre-exam	**Points 60**	**Final exam**	**Points 40**
Activity during the lecture		Written test	
Practical classes		Oral exam	40
Colloquiums	20		
Seminars	40		
Project presentation			

Table 5.1. Specification of subjects in the doctoral studies study program

Name of the subject: Chemical contaminants in food			
Teacher(s): Vesna Antić, Mališa Antić, Nebojša Pantelić			
Status of the subject: Elective			
Number of ЕСПБ points: 8			
Condition: none			
Goal of the subject The course should enable students to acquire theoretical knowledge about basic food contaminants, the origin of pollution, characteristics of pollutants and their distribution in food, basics of preparation and processing of food samples and techniques for identifying and quantifying specific contaminants.			
Outcome of the subject At the end of the course, the student should be able to: • Define the most common sources of food contamination • Describe the chemical properties of food contaminants and defines the interactions of these substances with food. • Describe methods for the detection of contaminants in food. • Present acquired knowledge through written and oral presentation.			
Content of the subject *Theoretical lectures* Additives, veterinary drugs, heavy metals and pesticides in food. Persistent organic contaminants in food. Migration of substances from polymeric food packaging materials into food. Plasticizers, monomers, UV stabilizers. Endocrine-disrupting chemicals, EDCs (bisphenol A and phthalates). Microplastics in food. Determination of total and specific migration. Toxic substances formed during food processing (e.g. acrylamide). Effects of toxic substances on human health. Food fraud (economic and criminal). Methods of sample preparation for analysis (SPE, SPME, SBSE, etc.). Combination of analytical techniques in the analysis of food contaminants. *Practical lectures* Theoretical exercises related to the literature search on a specific type of pollutant, according to the topic of the doctoral dissertation.			
Recommended literature 1. V. Antić i M. Antic, Food Contaminants – lectures, IFC-WBG. 2. J. P. F. D'Mello (ed) (2003*):* Food Safety: Contaminants and Toxins, Scottish Agricultural College,Edinburgh, UK. 3. John M. deMan (1999): Principles of Food Chemistry—3rd, Aspen Publishers, Inc.			
Number of active classes	Theory: 3	Practice: 3	
Methods of delivering lectures Theoretical teaching, theoretical exercises and interactive teaching. Preparation of a seminar work.			
Evaluation of knowledge (maximum number of points 100)			
Pre-exam	**Points 30**	**Final exam**	**Points 70**
Activity during the lecture	/	Written test	/
Practical classes	/	Oral exam	70
Colloquiums	/		
Seminars	30		
Project presentation	/		

Table 5.1. Specification of subjects in the doctoral studies study program

Course: Food Microbiology			
Teacher or teachers (surname, middle letter, name): Pantić D. Milena, Mirković M. Milica			
Course status:elective			
Number of ECTS credits: 8			
Admission requirement: none			
Goal of the subject The subject should enable the student to acquire: knowledge/understanding of characteristics and detection of groups of microorganisms such as bacteria, fungi, yeasts relevant for food production, characteristics and detection of microorganisms that cause food spoilage and pathogenic microorganisms that impair food safety. The student should define groups of microorganisms important for the production, safety and sustainability of food, to manipulate them, to determine the conditions for the production of primary and secondary metabolites, to anticipate their activity under the influence of various ecological factors.			
Outcome of the subject At the end of the subject, the student should: define and compare the characteristics of different groups of microorganisms present in food products; determines the role of microorganisms in fermentation and transformation processes, and the role of their primary and secondary metabolites; defines and predicts physical, chemical and ecological factors that affect the activity of microorganisms; directs the activity of starters and complementary cultures in the production of food products; analyzes and detects pathogenic microorganisms, as well as those that cause food spoilage.			
Content of the subject *Theoretical lectures* Characteristics and metabolism of microorganisms important for industrial food production; Characteristics of starter cultures and application potentials: Propagation of microorganisms, process management and metabolite determination, Aerobic and anaerobic microbiological processes; Growth and metabolism of microorganisms causing intoxication and toxinfection in food; Significance of ecological factors for the development of microorganisms in food; Growth and metabolism of microorganisms that cause food products to spoil.			
Recommended literature 1. Ray, B., Bhunia, A. Fundamental Food Microbiology, 5th Edition, CRC Press 2013 2. Membre, J-M., Valdramidis, V. Modeling in food microbiology : from predictive microbiology to exposure assessment. ISTE Press ; Elsevier Ltd., 2016 3. Jay, J.M. Modern Food Microbiology. Springer US, 2012 4. Subramaniam, P. The stability and shelf-life of Food, 2nd Edition, CRC Press, 2016 5. Adams, R.M., Moss, O.M., McClure, P.J. Food Microbiology, 4th Edition, RSC Publishing, 2016			
Number of active classes	Theory: 3	Practice: 3	
Methods of delivering lectures Theoretical work: lectures, interactive teaching, literature search, writing seminar work, consultations			
Evaluation of knowledge (maximum number of points 100)			
Pre-exam	**Points 60**	**Final exam**	**Points 40**
Seminars	60	Oral exam	40

Table 5.1. Specification of subjects in the doctoral studies study program

Name of the subject: Microbiological spoilage of food			
Teacher(s): Anita Klaus			
Status of the subject: elective			
Number of ECTS credits: 8			
Admission requirement: none			
Goal of the subject The subject should enable the student to acquire: a) knowledge/understanding of the importance of microbiological food spoilage, study changes in perishable foods, compare changes in food of a microbiological and non-microbiological nature; b) the skill of recognizing the basic groups of microorganisms that represent the initial microflora on food of plant and animal origin, to recognize the causes of food spoilage as well as how to control the production process in order to reduce food spoilage, and all with the aim of effective learning, critical thinking and evaluation of teaching and learning outcomes			
Outcome of the subject At the end of the module, the student should: describe and explain the characteristics of the basic groups of molds, bacteria and yeasts that are found as initial microflora on food; defines the role of molds, bacteria and yeasts in the spoilage of food of plant and animal origin; explain how environmental and other factors affect the growth and development of microorganisms in food; looks at the role and importance of proper management of the production process in order to reduce product spoilage; evaluate the obtained results independently and in a group discussion, present the acquired knowledge and apply it in practice.			
Content of the subject *Theoretical teaching*: Introduction-concept, historical development, importance; Biochemical changes in perishable foods of plant and animal origin; Microbiological and non-microbiological changes in food; Microbiological changes in foods of plant origin and animal origin; Characteristic groups of microorganisms on foodstuffs and their relationship to water, temperature, oxygen and acidity; Initial microorganisms and spoilage microorganisms: meat and poultry products, fish, eggs and products, milk and products, fruits and vegetables and their products, spices, cereals and processed products, cocoa and chocolate, oil and oil-based products, refreshing soft drinks and nectars, beer, wine, fermented products; Control parameters of the production process in order to eliminate food spoilage. *Practical teaching*: The theoretical teaching is followed by the performance of practical laboratory exercises that include the recognition of basic and specific causes of spoilage in the specified types of food. The study research work includes detailed processing of one selected type of food and the microorganisms that spoil it.			
Recommended literature 1. Lorenzo, J.M., Munekata, P.E., Dominguez, R., Pateiro, M., Saraiva, J.A., Franco, D. Main groups of microorganisms of relevance for food safety and stability: general aspects and overall description, in: F.J. Barba, A.S. San`t Ana. V. Orlien, M. Koubaa (Eds.), Innovative Technologies for Food Preservation, Academic Press, 2018, pp.53-107. ISBN 9780128110317 2. Sperber, W.H., and Doyle, M.P., 2009. Compendium of the microbiological spoilage of foods and beverages, Springer-Verlag New York. ISBN 978-1-4419-0825-4 3. Microorganisms in foods 6. II edition. Microbial ecology of food commodities, Kluwer Academic/Plenum Publishers, New York, 2005. ISBN: 0-306-48675-X			
Number of active classes	Lectures:3	Study research work:3	
Methods of teaching Theoretical work: lectures, interactive teaching, literature search, writing seminar work, consultations Practical classes: Description, isolation and cultivation of food spoilage microorganisms			
Evaluation of knowledge (maximum number of points 100)			
Pre-exam	**Points 60**	**Final exam**	**Points 40**
Seminars	60	Oral exam	40

Table 5.1. Specification of subjects in the doctoral studies study program

Name of the subject: Trends in Food Biochemistry			
Teacher(s): Miroljub B. Barać, Mirjana B. Pešić			
Status of the subject: elective			
Number of ECTS points: 8			
Condition: none			
Goal of the subject The course aims to provide students with the knowledge and skills needed to understand the biochemicalprocesses involved in the production and processing of food and their effects on the functional properties of food.			
At the end of the course, students will be able to: explain biochemical changes during food production andprocessing, apply enzymes in food biotechnology, analyze the content and composition of biomolecules, and analyze and explain the functional properties of food.			
Content of the subject *Theoretical lectures* Application of enzymes in food production, biochemistry of meat and milk, biochemistry of meat and milk processing, biochemistry of fruit, vegetables and cereals, biochemistry of fruit, vegetable and cereal processing,functional foods and functional properties of foods, undesirable bioactive components of foods that are naturally present and are formed during food processing. *Practical lectures* Laboratory exercises: Extraction of important compounds, analysis of the content and composition of proteins, carbohydrates, lipids and bioactive food compounds, investigation of the functional properties of foods.			
Recommended literature Simpson, B.K. ed. (2012): Food Biochemistry and Food Processing, second edition, John Wiley & Sons,Ltd.ISBN:9781118308035 Whiterhurst, R.J., van Oort, M. eds., (2010). Enyzmes in food technology, second edition, Wiley-Blackwell,John Wiley & Sons, Ltd.ISBN 978-1-4051-8366-6 Barać, M., Pešić, M., A. Kostić (2015). Biologically active food components, University of Belgrade, Facultyof Agriculture, Belgrade-Zemun. ISBN 978-86-7834-220-2 Pešić, M., Kostić A., Barać M. (2017). Bioactive components of food –Laboratory textbook, University ofBelgrade, Faculty of Agriculture, Belgrade-Zemun. ISBN 978-86-7834-275-2			
Number of active classes	Theory: 3	Practice: 3	
Methods of delivering lectures Lectures, Laboratory exercises			
Evaluation of knowledge (maximum number of points 100)			
Pre-exam	**Points 30**	**Final exam**	**Points 70**
Seminars	30	Oral exam	70

Table 5.1. Specification of subjects in the doctoral studies study program

Name of the subject: Farm animals behaviour and welfare			
Teacher(s): Slavča V. Hristov, Branislav M. Stanković			
Status of the subject: elective			
Number of ECTS points: 8			
Condition: Passed exams in compulsory subjects for doctoral studies			
Goal of the subject: The course enables students to acquire in-depth knowledge, skills and attitudes in the field of mechanisms of regulation of behavior, category, system, forms and strategies of behavior of certain animal species, behavioral disorders in domestic animals, animal suffering, concepts and welfare indicators, as well as acquiring skills for solving of animal welfare problems**.**			
Outcome of the subject: After completing this course, the student should be able to: 1. systematically define and explain in detail the mechanisms of animal behavior regulation; 2. apply methods and determine animal behavior indicators, describe and analyze in detail the categories, forms, systems and strategies of behavior of certain animal species; 3. describe in detail and analyze the influence of man on the welfare of animals on farms, transport and slaughter; 4. define procedures and concepts and implement standard operational procedures in preventing the occurrence of behavioral disorders and solving the problem of animal welfare; 5. participate individually and in the team in solving concrete problems in the field of the subject in a creative manner, applying the methods of analysis, assessment and synthesis of new and complex ideas and concepts, and 6. demonstrate readiness and ability for team work, critical thinking, integration of knowledge from different fields, expressed ability of spoken and written communication and presentation of acquired knowledge.			
Content of the subject Theoretical lectures: 1. Mechanisms for regulation of animal behavior; 2. Categories, forms, systems and strategies of animal behavior; 3. Animal behavior indicators; 4. Behavior of certain animal species: behavior of cattle, sheep, goats, pigs, horses and poultry; 5. Animal welfare: concepts and welfare indicators, man's impact on the welfare of animals on farms, transport and slaughter; 6. Behavioral disorders, animal suffering and welfare problems. Practical lectures: Analysis of mechanisms of regulation of animal behavior; 2. Assessment and analysis of categories, forms, systems and strategies of animal behavior; 3. Assessment and analysis of animal behavior indicators; 4. Evaluation and analysis of the behavior of certain types of animals: behavior of cattle, sheep, goats, pigs, horses, poultry; 5. Analysis of animal welfare: concepts and welfare indicators, human influence on animal welfare on farms, during transport and slaughter; 6. Analysis of behavioral disorders, animal suffering and welfare problems on farms, during transport and slaughter.			
Recommended literature: 1. Broom D. Fraser A.: Farm animal behaviour and welfare. Fourth edition, Bailliere Tindall, London - Philadelphia - Toronto - Sydney – Tokyo, 2015; 2. Група аутора: Добробит животиња и биосигурност на фармама. Монографија, Пољопривредни факултет, Београд, 2007 (2. Group of authors: Animal welfare and biosecurity on farms. Monograph, Faculty of Agriculture, Belgrade, 2007); 3. Grandin T. (2010). Improving animal welfare: a practical approach. CAB International, Oxfordshire, UK; 4. Webster J. (2005). Animal Welfare: Limping Towards Eden. Blackwell Publishing.			
Number of active classes	Theory: 3	Practice: 3	
Methods of delivering lectures: Class teaching methods, exercises and methods of interactive teaching and learning are used as teaching methods. The methods of interactive teaching and learning use individual, group or team collaborative and cooperative methods of active learning.			
Evaluation of knowledge (maximum number of points 100)			
Pre-exam	**Points: 70**	**Final exam**	**Points: 30**
Activity during the lecture	10	Written test	
Practical classes	10	Oral exam	30
Colloquiums	10		
Seminars	20		
Project presentation	20		

Table 5.1. Specification of subjects in the doctoral studies study program

Name of the subject: Biosecurity on livestock farms			
Teacher(s): Slavča V. Hristov, Branislav M. Stanković			
Status of the subject: elective			
Number of ECTS points: 8			
Condition: Passed exams in compulsory subjects for doctoral studies			
Goal of the subject: The subject enables the student to gain deepened knowledge, skills and attitudes on biosecurity on farms, animal transport and slaughter.			
Outcome of the subject: After completing this course, the student should be able to: 1. assess the biorisks' factors and their impact on the occurrence of disease and productivity of animals on farms, in the transport of animals and on slaughter; 2. establish critical control points in animal production; 3. assess the efficiency of the application of biosecurity measures; 4. defines procedures, concepts and standard operational procedures for the application of biosecurity measures; 5. participates individually and in the team in solving concrete problems in the field of the subject in a creative way using methods of analysis, assessment and synthesis of new and complex ideas and concepts; and 6. demonstrates readiness and ability for team work, critical thinking, integration of knowledge from the multidisciplinary areas.			
Content of the subject: *Theoretical lectures:* 1. Biosecurity risk factors and their impact on disease and productivity of animals; 2. Evaluation of biosecurity risk and determination of critical points in animal production; 3. Methods of controlling biosecurity risk: the importance of selecting a method in early diagnosis of the presence of the disease cause, determining sample size, experimental design and interpretation of biosecurity risk results; 4. The most important measures of biosecurity risk control: control and prevention of transmission and spread of diseases between herd, pyramid of biosecurity, organization of production of animal species and advantages and disadvantages in term of biosecurity risk, prevention of infectious diseases, organization and implementation of biosecurity measures in raising and preserving the level of biosecurity; 5. Biosecurity on farms of cattle, sheep and goats, pigs and poultry; 6. Biosecurity measures for transport and slaughter. *Practical lectures:* Analysis of biorisk factors and their impact on disease occurrence and animal productivity; 2. Biorisk analysis and determination of critical points in animal production; 3. Application of biorisk control methods; 4. Analysis of the most significant biorisk control measures; 5. Analysis of the application of biosecurity measures on cattle, sheep and goat, pig and poultry farms; 6. Analysis of the application of biosecurity measures during transport and at the slaughterhouse.			
Recommended literature1.Hristov S. (2002): [1. Hristov S. (2002): Zoohigiene. University of Belgrade, Faculty of Agriculture, Belgrade; Group of authors: Animal welfare and biosecurity on farms. Monograph, Faculty of Agriculture, Belgrade, 2007; 3. Hristov S., Stankovic B. (2011). Biosecurity standards on farms of cattle, pigs and poultry. Guides for the Ministry of Agriculture, Forestry and Water Management, Belgrade]; 5. Viera Pinto M. (ed.): Safepork2015 Proceedings Book. Epidemiology and control of hazards in pork production chain – SAFEPORK. One health approach under a concept of farm to fork. September 2015 Porto – Portugal, 2015.; 6. Bojkovski J. Biosecurity on Pig Farms. LAP Lambert Academic Publishing, 2015.			
Number of active classes	Theory: 3	Practice: 3	
Methods of delivering lectures: lectures in combination with interactive teaching and learning methods are applied in all teaching chapters of the subject in the appropriate scope.			
Evaluation of knowledge (maximum number of points 100)			
Pre-exam	**Points: 70**	**Final exam**	**Points: 30**
Activity during the lecture	10	Written test	
Practical classes	10	Oral exam	30
Colloquiums	10		
Seminars	20		
Project presentation	20		

Table 5.1. Specification of subjects in the doctoral studies study program

Name of the subject: New trends in fruit production
Teacher(s): Dragan Radivojević, Jasminka Milivojević, Milica Fotirić Akšić
Status of the subject: elective
Number of ESPB points: 8
Condition: none
Goal of the subject The course will enable students to acquire knowledge in the field of innovations in cultivation systems, types of nursery trees, new varieties and rootstocks, and clones adapted to the concept of integral and organic fruit production; varietal composition, pollination, fertilization and yield increase; types and constructions of the protected environments (greenhouses, plastic tunnels and anti-hail systems) and characteristics of covering materials; the possibility of regulating the microclimate under protected conditions to prevent unfavorable effects of climatic factors and to achieve off-season production; as well as the acquisition of practical skills in the optimization cultural measures to ensure profitable production of high quality fruit.
Outcome of the subject The student should be able to decide how to design an orchard in both production concepts, choose the construction of the greenhouse/anti-hail system, as well as the type and characteristics of the covering material; demonstrates knowledge in the area of choosing an adequate growing system for each species/cultivars (in soil or in containers); select suitable varieties, type of nursery plants and planting time with the aim of achieving off- season production; combines suitable varieties at planting and monitoring the pollination and fertilization process; implements different methods of pruning and nutrition, and the use of plant growth regulators to control the growth and yield, and improve the quality of the fruit. At the end of the course, the student should be able to integrate different technological procedures in the cultivation of fruit species in the open field and in protected environments and to practically apply the acquired knowledge and skills.
Content of the subject *Theoretical lectures:* The subject comprises the following chapters: 1) Basics of growing different fruit species in conventional and organic production; 2) General characteristics of protected environments and covering materials (greenhouses, greenhouses and low/high PE tunnels, anti-hail systems); 3) Regulation of microclimate conditions with the aim of mitigating the effects of climate change; 4) Selection of nursery trees, varieties, substrates and cultivation systems of different fruit species; 5) Variety combination in planting, pollination and fertilization; 6) Specific effects of plant growth regulators in fruit growing; 7) Orchard management in organic production; 8) Optimizing of cultural measures adapted to the chosen cultivation system in both production concepts. *Practical lectures:* Planning of the cultivation technology of different fruit species; application of protected environments; monitoring of microclimatic factors in protected areas; practical determination of the best cultivar-pollinizer; practical application of plant growth regulators and performing specific cultural measures and other technological operations within the orchard management in the conventional and organic production.
Recommended literature 1. Milivojević, J., Miletić, N. (2022). Монографија „The Blueberry–. Универзитет у Београду, Пољопривредни факултет и АгроНЕТ – Центар за образовање и истраживања, Београд. 2. Vuković, M., Jurić, S., Maslov Bandić, L., Levaj, B., Fu, D.-Q., Jemrić, T. (2022). Sustainable Food Production: Innovative Netting Concepts and Their Mode of Action on Fruit Crops. ***Sustainability 14,*** 9264. https://doi.org/10.3390/su14159264 3. Heidenreich, C., Pritts, M., Demchak, K., Hanson, E., Weber, C., Kelly, M. (2012). High tunnel raspberries and blackberries. Department of Horticulture, Cornell University. 4. Funt, R.C., Hal, H.K. (2013). Raspberries. III. Series: Crop production science in horticulture, 23. 5. ***Lind***K, Lafer G, Schloffer K, Innerhofer G, Meister H. ***Organic fruit growing.*** CABI Publishing, Wallingford, Oxon, UK, 2004. 6. Al-Khayri, J.M., Mohan Jain, S., Johnson D.V. (Eds.). Advances in Plant Breeding Strategies: Fruits, Volume 3. Springer Cham, 2018 7. Badenes, M.L., Byrne D.H. (Eds). Fruit Breeding. Springer New York, NY, 2012. 8. Sansavini, S., Costa, G., Gucci, R., Inglese, P., Ramina, A., Xiloyannis, C., and Desjardins, Y., eds.(2019). Principles of Modern Fruit Science (Leuven, Belgium: ISHS), pp.421.
Number of active classes: Theory: 3 — Practice: 3
Methods of delivering lectures: Consultations, practical work, field exercises

Evaluation of knowledge (maximum number of points 100)			
Pre-exam	**Points 60**	**Final exam**	**Points 40**
Preparation and defense of seminar paper	**60**	Oral exam	**40**

Table 5.1. Specification of subjects in the doctoral studies study program

Name of the subject: Biotechnology and chemistry of bee products			
Teacher(s): Nebojša M. Nedić, Aleksandar Ž. Kostić			
Status of the subject: Elective			
Number of ЕСПБ points: 8			
Condition: none			
Goal of the subject The course should enable the student to acquire knowledge about different technologies, conditions and systems of honey bee and bee colony breeding for obtaining honey bee products**,** the definition and proximate chemical composition of bee products, phytochemicals presented in different products, their nutritional value, the qualitative characteristics of bee products and their classification, the legal regulations related to the beekeeping and production of bee products.			
Outcome of the subject The student should demonstrate knowledge and understanding of the methods and systems of honey bee breeding for obtaining different bee products and the physico-chemical characteristics of bee products. A detailed phytochemical composition will be also examined and discussed including differences among products with possible chemical markers as well as presence of different chemical contaminants in bee products.			
Content of the subject *Theoretical lectures* The subject is divided into several chapters: obtaining different bee product using different production technologies, quality and preservation of bee products, properties of honey and its application, critical points of production of honey and honey bee products, structure and persistence of pollen grain, chemical composition of pollen, bee bread and propolis, nutritional value of different products, biological activity, the most important chemical contaminants in honey and pollen, bioaccessibility and bioavailability of different phytochemicals after digestion process in human body. *Practical lectures* Study research work will include the creation and writing of a seminar or scientific paper.			
Recommended literature Dadant & Sons (2008): The Hive and the Honey Bee.USA Plavša, N., Nedić, N. (2015): Практикум из пчеларства. Пољопривредни факултет Универзитета у Новом Саду. Bayram N.E., Kostić A.Ž., Gercek Y.C. (eds.) (2024): Pollen Chemistry and Biotechnology, Springer Nature Switzerland AG, doi: 10.1007/978-3-031-47563-4 Туников, Г.М., Кривцов Н.И., Лебедев В.И., Кирљнов О.Н. (2001): Технологиа производства и переработки продукции пчеловодства. Колос, Руска Федерација. Apidiologie, Journal of Apiculture Research and other beekeeping journals			
Number of active classes	Theory: 3	Practice: 3	
Methods of delivering lectures Theoretical and practical teaching in combination with interactive teaching. Preparation and defense of a seminar paper is mandatory.			
Evaluation of knowledge (maximum number of points 100)			
Pre-exam	**Points: 30**	**Final exam**	**Points: 70**
Knowledge is tested through the defense of a seminar paper	30	Oral exam	70

Table 5.1. Specification of subjects in the doctoral studies study program

Name of the subject: Advance course in dairy science and technology			
Teacher(s): Jelena Miočinović			
Status of the subject: elected			
Number of ECIIБ points: 8			
Condition: no condition			
Goal of the subject Extending existing and acquiring new knowledge in the field of the chemistry and physics of milk as well as the technology and quality of different groups of dairy products.			
Outcome of the subject The student should demonstrate knowledge of the composition and properties of milk, the processes used in the production of various dairy products and the influence of various factors on product quality. At the end of the programme, the student should demonstrate - Knowledge and understanding of milk as a colloidal system, its composition and structure and the influence of selected factors; - Understanding of the formation mechanism, knowledge of the phenomenon of syneresis and changes in the rheological properties and structure of sour and acid casein gel and the processes used in the production of certain groups of dairy products - Ability to analyse the process control and production of dairy products and apply modern analytical test methods - Understanding of the factors that influence the quality, safety and functionality of dairy products; - independent solving of practical and theoretical problems in the field of milk processing and the process of manufacturing various products;			
Content of the subject *Theoretical lectures:* colloidal system and properties of milk; influence of various factors on the components of milk composition; mechanism of milk coagulation: rheological properties and microstructure of various gels; syneresis phenomena; cheese production: Characteristics of different types of cheese; Different aspects of cheese salting; Enzymology of cheese ripening; Sensory and nutritional aspects of cheese; Trends in production technology of different value-added dairy products (nutritional, dietary aspects and innovations); The possibility of using by-products of the dairy industry. *Practical lectures:* Practical classes include laboratory work based on the application of modern methods in analysing the composition and properties of milk and dairy products, as well as studio research work based on the study and analysis of professional and scientific literature in the field.			
Recommended literature Tsakalidou, E., Konstantinos Papadimitriou, K., (2016): Non-Bovine Milk and Milk Products, Elsevier.; El-Bakry, M., Mehta, B.M. (2022): Processed Cheese Science and Technology, Elsevier.; Adriano Gomes Da Cruz, A., Ranadheera,C.S., Nazzaro, F., Mortazavia, A. (2021): Dairy Foods Processing, Quality, and Analytical Techniques, Elsevier. 4. Saarela, M. (2007): Functional Dairy Products, Elsevier; Journals: Journal of Dairy Science, J. of Dairy Research, Int. Dairy Journal, Dairy Science, Journal of Food Processing and Preservation.			
Number of active classes	Theory: 3	Practice:3	
Methods of delivering lectures Theoretical and practical teaching is carried out as active teaching through consultations or theoretical lectures, laboratory work, processing and analysing current scientific literature. It is obligatory to write a seminar paper related to the research work of the study, a review of literature references in the chosen field as well as work on the dissertation.			
Evaluation of knowledge (maximum number of points 100)			
Pre-exam	**Points 60**	**Final exam**	**Points 40**
Practical classes	20	Oral exam	40
Seminar	40		

Table 5.1. Specification of subjects in the doctoral studies study program

Name of the subject: Advances in meat science and technology

Teacher(s): Igor Tomašević

Status of the subject: elective

Number of ECIIБ points: 8

Condition: none

Goal of the subject: Improving of existing and acquisition of new knowledge in the field of meat chemistry and physics and meattechnology and quality of different groups of meat products.

Outcome of the subject: The student should demonstrate knowledge of the composition and properties of meat, the processes used inthe production of different meat products, as well as the influence of various factors on product quality. At the end of the study, the student should demonstrate

- knowledge and understanding of meat as a complex biological system, its composition and structure and the influence of selected factors;
- understanding postmortem muscle metabolism and its relation to meat quality;
- essential and fundamental knowledge and understanding of the processes applied in the production ofcertain groups of meat products;
- analytical approach skills in managing processes and creating meat products using and connecting acquiredknowledge in the field of meat technology;
- understanding the factors that influence the quality, safety and functionality of meat products;
- the ability of an analytical approach in the application of modern scientific methods of investigation;
- ability to thoroughly analyze and interpret test results with modern statistical methods
- the ability to follow novelties in the field of meat science and technology;
- independent solving of practical and theoretical problems in the field of meat processing and the production of different products;
- thinks critically and develops creative thinking; presents acquired knowledge through written and oral forms of presentation.

Content of the subject

Theoretical lectures: Biological system of meat; Composition and technological properties of meat; The influence of various factors on meat composition, quality and safety; Meat emulsion: concept and structure; physico-chemical properties and stability of meat emulsion; factors influencing the stability of meat emulsion; Dynamics and kinetics of fermentation and drying processes in the production of meat products; Thermal and non-thermal preservation of meat and meat products. Trends in the production technology of different meat products with added value (nutritional, dietary aspects and innovations); The possibility of using by-products of the meat industry. New trends in the technology of production of dried meat products: alternative brine (brines with reduced sodium and nitrite content), fermented sausages with reduced sodium, nitrite content and oils replaced by adipose tissue; influence on physico-chemical properties and sensory quality. New trends in the production of cured sausages: meat emulsions with reduced fat content; meat emulsions with reduced salt and phosphate content; meat emulsions with edible oils; influence on the physico-chemical properties and sensory quality of the obtained products.

Practical lectures: Practical teaching includes laboratory work based on the application of modern methodsin the analysis of the chemical composition and properties of meat and meat products (analysis of composition, rheological and textural properties, protein profile, etc.) as well as study research work based on study and analysis of professional and scientific literature in this area.

Recommended literature

1. Feiner, G. (2006). Meat Products Handbook – Practical Science and Technology, Woodhead Publishing Ltd. England
2. Min, Du, McCormick, R. J. (2009). Applied Muscle Biology and Meat Science, CRC Press.
3. Toldra, Fidel (editor). Lawrie's Meat Science 9th edition (2023). Elsevier.
4. Dikeman, M., & Devine, C. (editors) (2014). Encyclopedia of Meat Sciences, 2nd edition, AcademicPress, UK.
5. Journals: Journal of Meat Science, Meat Technology, Theory and practice of meat processing,Journal of Food Processing and Preservation, Foods itd.

Number of active classes	Theory:3	Practice:3

Methods of delivering lectures: Theoretical and practical lectures will be conducted as active teaching methods through consultations or theoretical lectures, laboratory work, processing and analysis of scientific literature. It is mandatory to write a seminar paper that is connected to the research work, a review of literature in the chosen field, as well as the work on the doctoral dissertation. During the performance, students will present part of the acquired knowledge in the oral presentation of the seminar work.

Evaluation of knowledge (maximum number of points 100)

Pre-exam	**Points 60**	**Final exam**	**Points 40**
Practical work	20	Oral exam	40
Seminar	40		

Table 5.1. Specification of subjects in the doctoral studies study program

Name of the subject: Bioactives of fungi			
Teacher(s): Anita S. Klaus, Maja S. Kozarski			
Status of the subject: elective			
Number of ECIIБ points: 8			
Condition: none			
Goal of the subject The subject should enable the student to acquire: knowledge/understanding of fungal bioactive compounds: carbohydrates (glycans and glucans), proteins and peptides, triterpenoids, meroterpenoids, alkaloids and nucleosides, sterols, polyphenols, fatty acids, minerals which are responsible for different biological and therapeutic activities, including antimicrobial, antioxidant, anti-inflammatory, antidiabetic, anticancerous properties, antiviral, and immunomodulatory activities; purification and chemical characterization of bioactive substances; the possibility of using these components in the food and pharmaceutical industry.			
Outcome of the subject At the end of the module, the student should: defines possibilities for the application of bioactive substances; understands the mechanisms of action; adopts methods of isolation and purification of bioactive components; characterizes the role of bioactive components in the food and pharmaceutical industry; presents acquired knowledge and application in practice; show creativity in teamwork.			
Content of the subject *Theoretical lectures* Includes a more detailed introduction to the possibilities of applying bioactive substances of fungi; clarifying and explaining mechanisms of action of fungal bioactive compounds; defining procedures for extracting and purifying bioactive substances; examination of the possibility of using biologically active components in the food, nutraceutical and pharmaceutical industry. *Practical lectures* Includes practical laboratory exercises in the mentioned areas: techniques of isolation of bioactive substances from fungi, tests of biological activities *in vitro*, application of bioactive substances in the food, nutraceutical and cosmeceutical products.			
Recommended literature **1.** Philip G. Miles, Shu-Ting Chang, Mushrooms Cultivation, Nutritional Value, Medicinal Effect, and Environmental Impact, Taylor & Francis Ltd, London, 2004, ISBN 9780849310430 **2.** Klaus, A., and Wan-Mohtar, W.A.A.Q.I. Cultivation strategies of edible and medicinal mushrooms, in: S.B. Dhull, A. Bains, P. Chawla, P.K. Sadh (Eds.), Wild Mushrooms Characteristics, Nutrition, and Processing (1st Edition), Taylor & Francis Ltd, London, 2022, pp. 23-66. ISBN: 9780367692513 **3.** Kozarski, M., van Griensven, L.J.L.D. Oxidative stress prevention by edible mushrooms and their role in cellular longevity, in: S.B. Dhull, A. Bains, P. Chawla, P.K. Sadh (Eds.), Wild Mushrooms Characteristics, Nutrition, and Processing (1st Edition), Taylor & Francis Ltd, London, 2022, pp. 319-348. ISBN: 9780367692513 **4.** Stojkovic, D., Barros, L. Edible Fungi: Chemical Composition, Nutrition and Health Effects (Issn) 1st Edition, Royal Society of Chemistry, London, 2022, ISBN-10: 1839164018			
Number of active classes	Theory: 3	Practice: 3	
Methods of delivering lectures Theoretical work: lectures, interactive teaching, literature search, writing seminar work, consultations Practical classes: isolation, characterization and application of bioactives of fungi.			
Evaluation of knowledge (maximum number of points 100)			
Pre-exam	**Points 60**	**Final exam**	**Points 40**
Seminars	60	Oral exam	40

Table 5.1. Specification of subjects in the doctoral studies study program

Name of the subject: New trends in oil and fat technology			
Teacher(s): Biljana Rabrenović			
Status of the subject: elective			
Number of ESPB points: 8			
Condition: none			
Goal of the subject The course aims to provide students with a high level of knowledge of new, "green" methods of extraction of vegetable oils and the application of alternative organic solvents, innovations in refining processes, improvements in the design of extractors, innovations in the modification processes of vegetable fats - application of enzymes and specific catalysts, use of by-products fruit processing of for oil extraction, valorization of by-products of the oil industry, and market trends related to the trade of vegetable oils and fats.			
Outcome of the subject The student should be able: to participate actively in the schematic design of an industrial plant for the production of vegetable oil and find innovative solutions for the equipment; Reduce the consumption of solvents and therefore the emission of harmful vapors by choosing suitable process conditions; Know the characteristics of vegetable fats and choose suitable modification processes to obtain special fats with specific characteristics; Examine the possibility of using by-products of the fruit processing industry, especially seeds, to obtain specific vegetable oils, and the use of cakes and other by-products of oilseed processing to obtain value-added products. Knowledge of trends in the oils and fats market will enable students to plan production and develop innovative solutions in the oils and fats industry by applying the knowledge and skills acquired.			
Content of the subject *Theoretical lectures* The subject comprises the following chapters: 1) "Green" methods of oil extraction: cold pressing, oil extraction with non-hexane solvents, supercritical gases, membrane and biotechnological processes; 2) Innovations in bleaching, deodorization and physical refining processes; 3) Application of the Reflex® Quick Drip™ system to improve extractor performance; 4) Enzymatic interesterification; 5) Hydrogenation and application of new catalysts - obtaining fats without *trans* fatty acids; 6) Valorization of fruit seeds as a by-product for the extraction of specific vegetable oils; 7) Use of by-products from the vegetable oil industry (oil cake, oil residues and phospholipids) in other branches of the food industry; 8) Actuality on the market for oils and fats. *Practical lectures* Design of the technological process for the production of cold-pressed oils and the refining plant - process line and required equipment; calculation of the energy balance depending on the characteristics of the equipment; practical work on the screw press and adjustment of the process parameters depending on the raw material; implementation of the interesterification process under laboratory conditions.			
Recommended literature 1. Baileys Industrial Oil and Fat Products, Sixth Edition, Six Volume Set, Edited by Fereidoon Shahidi, Wiley and Sons, 2005. 2. Brian, R.O´., Farr, W.E., Wan, P.J. Introduction to Fats and Oils Technology, 2nd Ed., AOCS Press, Urbana, Illinois, 2004. 3. Green Vegetable Oil Processing, Edited by Farr, W. E. and Proctor, A., AOCS Press, Urbana, Illinois, 2013. 4. Bioactive Phytochemicals from Vegetable Oil and Oilseed Processing By-products, Edited by MF Ramadan, Springer, 2020. 5. Modifying Lipids for use in food, Edited by Gunstone F.D., CRC Press, Boca Raton, 2006.			
Number of active classes	Theory:3	Practice: 3	
Methods of delivering lectures Consultations, practical work, field exercises			
Evaluation of knowledge (maximum number of points 100)			
Pre-exam	Points	Final exam	Points
Activity during the lecture		Written test	
Practical classes		Oral exam	60
Colloquiums			
Seminars	40		
Project presentation			

Table 5.1. Specification of subjects in the doctoral studies study program

Name of the subject: Trends in Food packaging
Teacher(s): Tanja Petrović
Status of the subject: Optional
Number of ECIIБ points: 8
Condition: none
Goal of the subject This subject aims to provide students with in-depth knowledge, skills and abilities in the field of new food packaging technologies, in particular, active and intelligent packaging as well as biodegradable and edible packaging. Students will be able to broaden their knowledge in the field of nanotechnologies and the possibilities of their application in food packaging. Additionally, they will gain insights into packaging legislation and consumer attitudes towards current trends in food packaging.
Outcome of the subject Upon completion of this course, students are expected to: - Describe in detail the techniques and possibilities of using active and intelligent systems for food packaging; - Explain the application, basic properties, labeling and mode of degradation of biopolymers and ediblepackaging materials; - Knows the possibilities of using nanotechnology to obtain new materials for food packaging. - Knows regulatory requirements and consumer perceptions related to current trends in food packaging. - Demonstrates a willingness and ability to work in a team, think critically, and integrate knowledge from different fields.
Content of the subject ***Theoretical lectures****:* 1. Active food packaging; Internal and external factors influencing the shelf life of food; Active packaging techniques (absorbers, emitters, other systems); 3. Intelligent food packaging; Techniques ofintelligent packaging (indicators, sensors, data carriers); 4. Application of biopolymers for food packaging; Basic raw materials (renewable and non-renewable) for the production of biopolymers; Classification and properties of biomaterials; Edible packaging materials; Labeling of biodegradable materials; Decomposition of biomaterials; Trends in the development of biopolymers; 5. Application of nanotechnologies in food packaging; Nanocomposite packaging materials; Bionanocomposites; Possibilities of using nanosensors integrated into packaging materials to detect pathogens, allergens, and toxins in food; 6. Legal regulations and consumer attitudes towards new food packaging technologies. ***Practical lectures:*** Search, processing, and analysis of modern achievements in the field of new food packaging technologies and characterization of the basic and specific properties of new packaging materials. Investigate the impact of the use of new packaging materials.
Recommended literature • Trends in food packaging, PPT presentations. Petrović, T. University of Belgrade-Faculty ofAgriculture, Belgrade-Zemun, Serbia, 2023. • Innovation in Food Packaging, Ed. Jung H. Han. Elsevier, 2014. • Novel Food Packaging Techniques, Ed. Raija Ahvenainen. Woodhead Publishing in Food Science and Technology, Finland, 2003. • Active Packaging for Food Application, Ed. Aaron L. Brody, Eugene R. Strupinsky, Lauri R. Kline.CRS Press, 2001. • Journals: Journal of Food Science, Food Packaging and Shelf Life, Food Packaging and Preservation¸ Journal of Food Packaging and Research.

Number of active classes	Theory: 3	Practice: 3

Methods of delivering lectures: Lectures; interactive teaching; consultations - directly, by e-mail or via internet platforms.

Evaluation of knowledge (maximum number of points 100)

Pre-exam	**Points 60**	**Exam**	**Points 40**
Activity during class	10	Final exam	40
Oral defense of the seminar paper	50		

Table 5.1. Specification of subjects in the doctoral studies study program

Name of the subject: Innovative approaches in food safety assurance			
Teacher(s): Nada V. Šmigić, Nikola S. Tomić, Ilija V. Đekić			
Status of the subject: Elective course			
Number of ECПБ points: 8 ESPB			
Condition: none			
Goal of the subject The aim of the course is to create a dynamic and adaptable framework in which students delve into a customized topic under the guidance of their doctoral thesis and acquire specialized knowledge on their dissertation topic in the field of food safety management. This approach fosters an interdisciplinary understanding and enables students to develop into experts who can tackle complex food safety challenges and drive innovation in their field, making a significant contribution to the discipline through their unique scientific contributions.			
Outcome of the subject The outcomes that students achieve on completion of this course will depend on the doctoral thesis and may include the following: 1) apply methods to assess, identify and manage different types of food safety hazards, as well as methods to identify risk mitigation measures, 2) use advanced methods to validate and evaluate the effectiveness of control measures applied to ensure food safety and integrity ; 3) use models and technologies to predict, prevent and manage food safety.			
Content of the subject *Theoretical lectures:* This course covers the following topics: (1) Principles and elements of food safety management systems, including legal frameworks, standards and their application in the food industry; (2) Different types of hazards, sources and strategies to control and prevent contamination throughout the food supply chain. (3) Methods for risk assessment of the presence of chemical and microbiological hazards in food; (4) Concept of food fraud, types and methods of detection and vulnerability assessments to identify vulnerabilities. (5) Principles of food defence, potential threats to the food supply and protective measures against deliberate contamination or malicious acts. (6) Advanced methods to validate control measures to ensure food safety; (7) Predictive modelling, data analysis and technologies to anticipate food safety issues. (8) Importance of traceability, technology and implementation of traceability systems. (9) Sustainable practises, environmental aspects and their integration into food supply chains. (10) The role of artificial intelligence in food safety management, including predictive analytics, real-time monitoring and decision support systems. *Practical lectures:* The practical lectures offered in this course are closely linked to the topics of each PhD dissertation to ensure thatstudents receive practical training and application of concepts directly relevant to their specific areas of study in food safety management systems.			
Recommended literature Motarjemi, Y., Gerald, M., Todd, E. (2014) Encyclopedia of food safety, Academic Press; Andersen, V., Lelieveld, H., Motarjemi, Y. (2023) Food safety Management: A practical guide for the food industry, Academic Press; Newslow, D. (2014) Food Safety Management Programs Applications, Best Practices, and Compliance,CRC Press			
Number of active classes	Theory: 3	Practice: 3	
Methods of delivering lectures Oral and visual presentation and interaction during class. Consultation - direct and via e-mails.			
Evaluation of knowledge (maximum number of points 100)			
Pre-exam	**Points 40**	**Final exam**	**Points 60**
Activity during the lecture	/	Written test	/
Practical classes	20	Oral exam	60
Colloquiums	/		
Seminars	20		
Project presentation	/		

Table 5.1. Specification of subjects in the doctoral studies study program

Name of the subject:	**Environmental performance management in the food value chain**		
Teacher(s):	**Ilija V. Đekić, Nada V. Šmigić, Milica M. Fotirić Akšić, Mališa Antić**		
Status of the subject:	**Elective course**		
Number of ECПБ points:	**8 ESPB**		
Condition:	**None**		
Goal of the subject Depending on the PhD thesis, this course should enable students to gain theoretical and practical knowledge on environmental science deployed to three dimensions (food supply chain, food technology, food products), as follows: (a) modeling environmental improvements and analysis of environmental performance throughout the food supply chain; (b) calculating environmental footprints associated with traditional and/or novel food processing technologies; (c) performing a life-cycle assessment study on selected type of food.			
Outcome of the subject After completing the course, students will be able to: (1) Understand the theoretical principles and specific environmental impacts of food production depending on the role in the food chain; (2) Recognize and calculate different environmental indicators and evaluate environmental performance of food production; (3) Develop skills for performing a life-cycle assessment study; (4) Understand how to use scientific literature related to environmental performance management in the food value chain.			
Content of the subject *Theoretical lectures* Within this course the following environmental concepts may be selected: (1) environmental performance indicators in the "farm to fork" chain (such as carbon footprint, water footprint, energy footprint, etc.); (2) legal monitoring requirements and legal indicators; (3) natural resource-based footprints; (4) pollution-based footprints; (5) life-cycle assessment modelling; (6) food loss and food waste optimization in the food value chain; (7) management / mitigation strategies in improving environmental practices; (8) stakeholders and their role in environmental management; (9) sensitivity analysis and environmental modelling; (10) eco-design of food; (11) food sustainability, (12) food waste usage as route to circular economy. *Practical lectures* Application of environmental performance tools related to PhD thesis.			
Recommended literature Lozano, R., & Barreiro-Gen, M. (Eds.). (2021). Developing sustainability competences through pedagogical approaches: Experiences from international case studies. Springer Nature. Leal Filho, W., Djekic, I., Smetana, S., & Kovaleva, M. (Eds.). (2022). Handbook of Climate Change Across the Food Supply Chain. Springer. Muthu, S. S. (Ed.). (2019). Quantification of sustainability indicators in the food sector. Springer Singapore. Holder, J., & Lee, M. (2007). Environmental protection, law and policy: Text and materials. Cambridge University Press.			
Number of active classes	Theory: 3	Practice: 3	
Methods of delivering lectures Oral and visual presentation and interaction during class. Consultation - direct and via e-mails			
Evaluation of knowledge (maximum number of points 100)			
Pre-exam	**Points 60**	**Final exam**	**Points 40**
Seminars	60	Oral exam	40

Table 5.1. Specification of subjects in the doctoral studies study program

Name of the subject: Climate Change and Food

Teacher(s): Mirjam Vujadinović Mandić, Ana Vuković Vimić

Status of the subject: elective

Number of ECIIБ points: 8

Condition: none

Goal of the subject

Gain knowledge and deep understanding of complex climate system processes and its interactions to food systems; evaluate the impacts of climate change on different agricultural sectors; explore different adaptation measures; foster interdisciplinary thinking and research approaches; develop skills necessary to analyze climate data and climate impacts; promote the concept of sustainable food production; enhance critical thinking and problem-solving skills; improve communication skills.

Outcome of the subject

Students will acquire advanced knowledge on climate change and its impacts in agriculture and food systems; they will be able to integrate important knowledge from multiple disciplines; they will be able to critically analyze research literature, methods and case-studies; they will be capable to design and conduct original research on climate change and food; they will be able to assess the climate change impacts and propose adequate adaptation measures; they will be proficient in communicating their research.

Content of the subject

Theoretical lectures

Introduction to Climate System and Climate Change (climate and climate system, energy balance, biogeochemical cycles, climate modeling, climate change projections, adaptation, mitigation, international agreements, and policies)

Climate Change Impacts on Agriculture and Food Production (effects of temperature changes, precipitation patterns changes and extreme weather events on different agricultural sectors).

Adaptation Measures in Agriculture and Food Production (sustainable agricultural practice for creating climate resilient food systems).

Research Methods in Climate Change and Food Studies (data sources, data analysis, interdisciplinary research)

Practical lectures

Literature review on a specific aspect of climate change impacts to food production. Collecting and analyzing needed data. Writing and presenting a research project.

Recommended literature

Climate change and Land, Special Report, IPCC, 2019

Assessment Report 6, WG I and WG II, IPCC, 2022, 2023

Climate change and food security: risks and responses, FAO,2015

FAO Strategy on Climate Change 2022-2031, FAO 2022

Number of active classes	Theory: 3	Practice: 3

Methods of delivering lectures

Lectures combined with interactive discussions, project presentations, problem-based learning.

Evaluation of knowledge (maximum number of points 100)

Pre-exam	**Points 60**	**Final exam**	**Points 40**
Activity during the lecture		Written test	40
Practical classes	30	Oral exam	
Colloquiums			
Seminars	30		
Project presentation			

Table 5.1. Specification of subjects in the doctoral studies study program

Name of the subject:	**Food quality improvement**
Teacher(s):	**Ilija V. Djekić, Nikola S. Tomić**
Status of the subject:	**Elective course**
Number of ECПБ points:	**8 ESPB**
Condition:	**None**

Goal of the subject

Depending on the PhD thesis, this course should enable students to gain theoretical and practical knowledge on quality tools deployed to three dimensions (food supply chain, food technology, food products), as follows: (a) quality transformation modelling throughout the food supply chain; (b) quality engineering associated with improving food processes; (c) application of selected quality tools associated with food products.

Outcome of the subject

After completing the course, students will be able to:

(1) Understanding theoretical principles and specific quality concepts and their influence on the food value chain and close the gap between expected, designed and achieved quality;
(2) Recognize and apply different quality tools in the food value chain;
(3) Develop skills for effective and efficient use of quality tools associated with food products;
(4) Understand how to use scientific literature related to quality improvement in the food value chain.

Content of the subject

Theoretical lectures

Within this course the following quality concepts may be selected: (1) Quality function deployment through transforming and developing customer requirements into quality characteristics throughout the food value chain; (2) Taguchi concept of quality loss and quality loss function and route to quality engineering; (3) Kano model and quality characteristics - must-be quality characteristics, expected quality characteristics, innovative quality characteristics; (4) Voice of quality-related stakeholders in the food value chain and their satisfaction; (5) Quality management improvement tools and aspects of Total Quality Management; (6) Quality performance management - development of process indicators and quality indexing; (8) Lean manufacturing tools in the food supply chain; (8) Quality evolution and route to Food Quality 4.0; (9) Role of artificial intelligence in modeling food quality.

Practical lectures

Application of quality improvement tools related to PhD thesis.

Recommended literature

Allen, Theodore T. Introduction to engineering statistics and Lean Sigma: Statistical quality control and design of experiments and systems. Springer Science & Business Media, 2010.

Franceschini, F., Galetto, M., & Maisano, D. (2007). Management by measurement: Designing key indicators and performance measurement systems. Springer Science & Business Media.

Van Aartsengel, A., & Kurtoglu, S. (2013). Handbook on Continuous Improvement Transformation. Springer Books.

Oakland J. Statistical Process Control (2008), 6th Edition, Elsevier, Butterworth-Heinemann is an imprint of Elsevier, USA.

Taguchi G., Chowdhury S., Wu Y. (2005) Taguchi's Quality Engineering Handbook. John Wiley & Sons, Inc., Hoboken, New Jersey, USA.

Number of active classes	Theory: 3	Practice: 3

Methods of delivering lectures

Oral and visual presentation and interaction during class. Consultation - direct and via e-mails.

Evaluation of knowledge (maximum number of points 100)

Pre-exam	**Points 60**	**Final exam**	**Points 40**
Seminars	60	Oral exam	40

Table 5.1. Specification of subjects in the doctoral studies study program

<table>
<tr><td colspan="4">Name of the subject: Agricultural and rural policy</td></tr>
<tr><td colspan="4">Teacher(s): Ružica Papić Milojević</td></tr>
<tr><td colspan="4">Status of the subject: Elective</td></tr>
<tr><td colspan="4">Number of ECIIБ points: 8</td></tr>
<tr><td colspan="4">Condition: No conditions</td></tr>
<tr><td colspan="4">Goal of the subject
The aim of the course is to train the student: a) to critically consider and evaluate the effects of agricultural and rural policy in the appropriate context and theoretical-methodological framework; b) to propose, independently implement and communicate research results in this field; c) for independent scientific work or for assuming a leadership role in development projects in this area</td></tr>
<tr><td colspan="4">Outcome of the subject
1) Students independently set and solve practical and theoretical problems in the field of agricultural and rural policy; 2) know the theoretical and methodological framework for research in this area; 3) communicate scientific research results competently and professionally; 4) can be effectively involved in theimplementation of international scientific and development projects; 5) think critically, act creatively and independently; 6) respect the principles of the ethical code of good scientific practice.</td></tr>
<tr><td colspan="4">Content of the subject
Theoretical lectures: Theoretical and conceptual frameworks: Macroeconomic environment and agriculture – policies affecting economic growth and development, poverty and food security; Factors of importance for agricultural policy: diversity of resources, production, development dynamics and global opportunities. International trade policy for agricultural products - analysis and possible influence on the concepts of national agricultural policies.
Practical lectures: Preparation and presentation of seminar papers from the mentioned teaching chapters; Comparative analyzes performed on the data of relevant statistical national and international databases; Discussions; Literature review; Survey research, Case studies</td></tr>
<tr><td colspan="4">Recommended literature
George W. Norton, Jeffrey Alwang, and William A. Masters: Economics of Agricultural Development: 2nd Edition:Routledge: 2010.
Haroon Akram-Lodhi, Christobal Kay (Eds.); Peasants and Globalization: Political economy, rural transformation and the agrarian question: Routledge: 2011
Prabhu L. Pingali, Robert E. Evenson (Eds.): Handbook of Agricultural Economics, Volume 4: North Holland: 2010
Ricardo Melendez-Ortiz, Christophe Beilmann, Jonahtan Hepburn (Eds.): Agricultural Subsidies inthe WTO Green Box: Ensuring Coherence with Sustainable Development Goals Hardcover: Cambridge University Press; 1 edition: 2010
OECD (2017): Evaluation of Agricultural Policy in the European Union: CAP 2014-20, Paris
Johan F.M. Swinnen (Editor) (2015): The Political Economy of the 2014-2020 Common Agricultural Policy, An imperfect storm, CEPS, Brussels, Rowman and Littlefield International, London.
Chambers, R. Rural Development: Putting the last first: Routledge; Edition 2013
Pender, J.L., Weber, B.A., Johnson, T.G., & Fannin, J.M. (Eds.). (2014). Rural Wealth Creation.Routledge.
Oskam, A.J., Meester, G., & Silvis, H. (2011). EU policy for agriculture, food and rural areas.
Paloviita, A., & Järvelä, M. (Eds.). (2015). Climate Change Adaptation and Food Supply Chain Management (1st ed.). Routledge Other relevant literature - subject teachers submit a list before the start of classes.</td></tr>
<tr><td>Number of active classes</td><td colspan="2">Theory: 3</td><td>Practice: 3</td></tr>
<tr><td colspan="4">Methods of delivering lectures
Theoretical and interactive teaching, consultations, seminar work. Checking knowledge during classes through the presentation of a seminar paper/research project.</td></tr>
<tr><td colspan="4">Evaluation of knowledge (maximum number of points 100)</td></tr>
<tr><td>Pre-exam</td><td>Points 70</td><td>Final exam</td><td>Points 30</td></tr>
<tr><td>Seminars</td><td>70</td><td>Oral exam</td><td>30</td></tr>
</table>

Table 5.1. Specification of subjects in the doctoral studies study program

Name of the subject: Modern business models in the AgTech industry			
Teacher(s): Zarić Vlade, Vasilić Marina, Paunović Tamara			
Status of the subject: elective			
Number of ECIIБ points: 8			
Condition: None			
Goal of the subject Acquisition of relevant theoretical and practical knowledge necessary for the creation, transformation, development and evaluation of agricultural business models under the conditions of the digital economy. Consolidation and deepening of knowledge acquired at previous levels of study in the field of business administration. Enabling students to understand apply and manage the impact of digitalization on various activities in the agricultural value chain.			
Outcome of the subject Upon successful completion of this course, students will be able to consider the various determinants for the success of traditional and innovative business models in the agricultural sector and to recognize existing problems along the value chain. The acquired knowledge and skills enable students to identify opportunities for digital transformation and measure their value creation effects. Ultimately, the outcome of this course can be recognized in the improvement of the entrepreneurial decision-making process in the agribusiness sector.			
Content of the subject *Theoretical lectures* Concept, types and objectives of business models; agtech business models as a source of competitive advantages. Modeling as a method of scientific research. Financial models and cost of capital; short and long-term financial planning in a digital environment. Management and decision making models in agricultural production and the food industry. Analysis of performance at different levels/segments of business; reporting for internal and external needs; digital agriculture as an information resource for business decision making. Digitization of purchasing and sales functions and impact on business. Use of selected financial indicators for business decisions. Measuring the efficiency and effectiveness of agri-food business systems. *Practical lectures* Application of the model in a real environment. Analysis of successful cases from practice. Consideration of measures to improve the business through the implementation of innovative digital solutions.			
Recommended literature Paunović, B., Zipovski, D. (2016): Business plan - a guide to its preparation, Faculty of Economics, Belgrade N. Gregory Mankiw, Mark P. Taylor (2016): Economics, Faculty of Economics, Belgrade Atkinson, A, et al. (2012): Management Accounting: Information for decision making and strategy execution, Pearson Education Limited Wirtz et al (2016): Business Model Innovation: Development, Concept and Future Research Directions, Journal of Business Models, Vol. 4, No. 2, pp. 1-28 Wirtz, B.W., et al. (2015): Business Models: Origin, Development and Future Research Perspectives, Long Range Planning Internal material: Appendices with exercises, instructions for research papers and case studies**.**			
Number of active classes	Theory:3	Practice:3	
Methods of delivering lectures Interactive teaching and learning methods; application of theory in the analysis of practical cases; group and individual work in solving problems; discussions; individual consultations in all phases of the implementation of the curriculum.			
Evaluation of knowledge (maximum number of points 100)			
Pre-exam	**Points 50**	**Final exam**	**Points 50**
Activity during the lecture		Written test	
Practical classes		Oral exam	50
Colloquiums			
Seminars	50		
Project presentation			

Table 5.1. Specification of subjects in the doctoral studies study program

Name of the subject: Project management			
Teacher(s): Tamara Paunović, Bojan Dimitrijević			
Status of the subject: elective			
Number of ECIIБ points: 8			
Condition: none			
Goal of the subject The course enables the student to acquire: 1. Knowledge required for scientific research work in the field of planning and management in an organisation; 2. The ability to learn effectively and think critically about the fundamentals of project management, management functions, and linkages with other systems. 3. The ability to solve specific problems in the project management process.			
Outcome of the subject Upon completion of the course in this subject, the student should be able to: 1. conduct scientific research in the field of design and management in business; 2. critically comment on problems of management and project management problems in agricultural enterprises and other business systems; 3. practically apply the acquired knowledge of project management in various areas of agricultural production and the food industry.			
Content of the subject *Theoretical lectures* Introduction to project management. Growth and development of project management (basic management systems, project management development, project life cycle, project management methodology). Management functions (project execution, project control, project constraints, management (policies and procedures). Management and information system - implementation of information system, decision support systems, goal management, information system management). Quality Management (Quality Definition, Quality Improvement, ISO 9000, Total Quality Management (TQM). Management and Enterprise (Work, Ethics and Society, International Management, Strategic Management, Organizational Change). *Practical lectures* Study research work is planned in certain areas in consultation with the subject teacher.			
Recommended literature Biljana Stošić, Radul Milutinović (2022): Management of innovations and innovation projects, FON, ISBN978-86-7680-419-1 Snyder, Cynthia (2018): A project manager's book of tools and techniques, Wiley, ISBN 9781119424840(epdf) S. C. Certo, S. T. Certo (2008): Modern Management, Mate d.o.o., ISBN: 978-953-246-062-9. Ronald, D., Kay, Wieliam M. Edward, Patricia A. Duffy (2004): Farm Management, Mc Graw-Hill, NewYork. Ceranić, S. (2007): Planning in Agribusiness, Faculty of Agriculture, Belgrade. Baker A. Gregory, Grcheewald Orlen, Gorman D. Wiliam (2002): Introduction to Food and Agribusiness Management, Prentice Hall, New Jersey. James C. Sydney, Eberle R., Phielip (2000): Economic & Business Principles in Farm Planirang &Production. Iowa State University Press. Ames. Selected works, dissertations and monographs - will be published 15 days before the start of lectures in the school year.			
Number of active classes	Theory: 3	Practice: 3	
Methods of delivering lectures Lectures combined with interactive teaching and learning methods are applied in all educational sections of the course to a certain extent; Preparation and defense of an project presentation			
Evaluation of knowledge (maximum number of points 100)			
Pre-exam	**Points 50**	**Final exam**	**Points 50**
Activity during the lecture		Written test	
Practical classes		Oral exam	50
Colloquiums			
Seminars and Project presentation	50		

Table 5.1. Specification of subjects in the doctoral studies study program

Name of the subject: Water quality and pollution			
Teacher(s): Jelena Popović-Đorđević, Full Professor; Aleksandar Ž. Kostić, Associate Professor			
Status of the subject: Elective			
Number of ECIIБ points: 8			
Condition: Passed mandatory exams within the study program of doctoral studies			
Goal of the subject Enable to achieve: 1) knowledge and attitudes on the chemical structure, physical and chemical propreties of water, 2) skills in sampling water from natural sources, 3) ability to apply relevant methods for analyzing water samples, 4) ability to manage data obtained from analyses.			
Outcome of the subject After completing a course students should be able to: 1) Describe standard parameters of water quality, and procedures for testing and determining water quality that are in accordance with the latest standards and regulations; 2) Define the factors influencing the quality of water; 3) Develop surface and groundwater monitoring programme for different purposes; 4) Management and analyse data, 5) Create a report; 6) Use literature and other means in searching for the necessary information to improve the level of knowledge in this area; 7) Present acquired knowledge and assessment of learning outcomes.			
Content of the subject *Theoretical lectures* Classification of water; Parameters of water quality (physical, chemical, and biological); Origin/sources of water and pollutants; Toxic substances in water; Microplastics in water; Study project *Practical lectures* Water sampling; Determination of chemical parameters in water; Health risk assessment; Data presentation			
Recommended literature • Kabata-Pendias A., Szteke, B. Trace elements in abiotic and biotic environments, CRC Press, Taylor and Francis Group, LLC, Boca Raton, 2015 • Boyd, C.E. Water Quality. An introduction, (2nd Edition), Springer International Publishing AG Switzerland, 2015 • Nuro, A. (Ed.). Emerging Contaminants. IntechOpen, 2021			
Number of active classes	Theory: **3**	Practice: **3**	
Methods of delivering lectures Lectures, study research work, methods of interactive teaching and learning, and experimental work. The interactive teaching use collaborative and cooperative methods of active learning, developing of critical and creative thinking and presentation of the acquired knowledge.			
Evaluation of knowledge (maximum number of points 100)			
Pre-exam	**Points 50**	**Final exam**	**Points 50**
Activity during the lecture		Written test	
Practical classes	20	Oral exam	50
Colloquiums			
Seminars	30		
Project presentation			

Table 5.1. Specification of subjects in the doctoral studies study program

Name of the subject: Animal histology			
Teacher(s): Božidar Rašković			
Status of the subject:elective			
Number of ECIIБ points: 8			
Condition: none			
Goal of the subject The course is designed to enable students to acquire knowledge and understanding of vertebrate histology: cell and organelle morphology, cell cycle, classification and morphology of tissues, microscopic anatomy of vertebrate organ systems. Other aspects of the course include learning the basic principles of histotechniques, histopathology and stereology. The course is tailored to each student in terms of prior knowledge, choice of tissues and techniques used for the practical part of the doctoral programme.			
Outcome of the subject On successful completion of this course students should be able to: 1. Interpret morphology and life cycle of cells and cell organelles; 2. Interpret morphology of animal tissues; 3. Summarize animal tissue classification; 4. Interpret microscopic anatomical structure of vertebrates organ systems in the light of cell and tissues structure; 5. Explain main principles of histopathological alterations that occur in animal tissues; 6. Use the light microscope and a camera to make digital micrographs; 7. Make histological slides; 8. Explain protocols for analysis of 3D structures in cellsandtissues on histological sections.			
Content of the subject *Theoretical lectures* Citology: cell membranes, organelles, cell cycle, cell division. Histology: epithelial tissue, connective tissue, supporting tissue, fatty tissue, blood tissue and haemopoiesis, muscle tissue, nerve tissue and neuroglial tissue. Microscopic anatomy: structure of the organ systems (cardiovascular system, endocrine, skin, respiration, digestion, excretion, reproduction, nervous system, sensory organs). Histopathology: adaptation, ageing and cell death. Stereology: cells as 3D structures in sections. *Practical lectures* Microscopy: cellstructure, tissue (epithelialtissue, connectivetissue, supportingtissue, fattytissue, bloodtissue, muscles, nervoustissue). Organ structure of the cardiovascular, endocrine, skin, respiratory, digestive, excretory, reproductive, nervous and sensory systems. Adaptations: Hyperthrophy, hyperplasia, metaplasia, necrosis, apoptosis. Production of histological preparations: Fixation, embedding, sectioning and staining methods.			
Recommended literature Junqueira, L.C., Carneiro, J. (2005): *Basic histology: A text and atlas*. New York: McGraw-Hill Medical. Pawlina, W., Ross, M.H. (2020): *Histology: A text and atlas*. Philadelphia: Wolters Kluwer. Mouton, P.R. (2002): *Principles and practices of unbiased stereology*. Baltimore: Johns Hopkins UniversityPress.			
Number of active classes	Theory:3	Practice:3	
Methods of delivering lectures Lectures and practicals, assignment and defense of seminar work. A paper published or presented at a conference that is printed as a complete paper will be graded as a seminar work.			
Evaluation of knowledge			
Pre-exam	**Points 60**	**Final exam**	**Points 40**
Practical classes	30	Oral exam	40
Seminar paper	30		

Table 5.1. Specification of subjects in the doctoral studies study program

Name of the subject: Ecology and biomonitoring of freshwater habitats
Teacher(s): Zorka Dulić
Status of the subject: Elective
Number of ECIIБ points:8
Condition: none
Goal of the subject The course is designed to enable students to acquire knowledge and understanding of ecology and biomonitoring of aquatic habitats, introduction to the basic types of aquatic habitats, abiotic and biotic factors, characteristics of aquatic organisms, their relationships with the environment, as well as mutual relationships, with the importance of biodiversity and diversification of freshwater organisms, monitoring systems, bioindication and biological monitoring.
Outcome of the subject After completion of course, the student will be able to: 1. Understand key freshwater ecology concepts and relationships 2. Recognize different bioindicator groups of aquatic organisms 3. Show readiness to design a monitoring program for a given aquatic habitat 4. Apply biological monitoring methods to adequate aquatic habitats 5. Use methods to determine water quality using bioindicators
Content of the subject *Theoretical lectures* Types of aquatic habitats, lotic and lentic. The relationship between freshwater organisms and their environment, including terrestrial components of the watershed, which help shape the aquatic habitat and biological community structure. Biodiversity of aquatic organisms and their mutual relationships (inter- and intraspecific). Bioindicator groups of aquatic organisms. The concept of biological monitoring using various aquatic organisms for detecting, measuring and assessing the significance of ecological change caused by anthropogenic stressors, modern approaches to the monitoring of specific, endangered aquatic habitats. *Practical lectures* Application of methods for identification of groups of bioindicator organisms. Methods of sampling organisms and their ex-situ processing and analysis. Determining the degree of ecological change of the habitat in relation to the natural state. Designing a biomonitoring mini-program for a selected habitat. Analysis of anthropogenic impact and possibilities for its reduction or complete elimination.
Recommended literature Sumudumali R.G.I., Jayawardana J.M.C.K. A. 2022. Review of Biological Monitoring of Aquatic Ecosystems Approaches: with Special Reference to Macroinvertebrates and Pesticide Pollution. Environmental Management, 67, 263–276. Vadas Jr,Hughes M., Bae Y., Baek M., Gonzales O, Callisto M., Reis de Carvalho D., Chen K., Ferreira M., Fierro P., Harding S., Infante D., Kleynhans C., Macedo D., Martins I., Silva N., Moya N., Nichols S., Pompeu P., Ruaro R., Silva D., Stevenson J. , de Freitas Terra B., Thirion C., Ticiani D., Wang L., Yoder C.2022. Assemblage based biomonitoring of freshwater ecosystem health via multimetric indices: A critical review and suggestions for improving their applicability. Water Biology and Security, vol.1 (3), 100054. Woodward G., Gray C., Baird D. 2013.Biomonitoring for the 21st Century: new perspectives in an age of globalisation and emerging environmental threats. Limnetica, 32 (2), 159-174.

Number of active classes	Theory:3	Practice:3

Methods of delivering lectures Theoretical and interactive teaching/learning, practical work combined with mentoring, e-learning. Design and presentation of an independently created mini biomonitoring program.

Evaluation of knowledge (maximum number of points 100)			
Pre-exam	**Points:60**	**Final exam**	**Points:40**
Interactive classes	30	Written test	40
Project	30		

Table 5.1. Specification of subjects in the doctoral studies study program

Name of the subject:Advanced topics in animal science			
Teacher (s): Vladan T. Bogdanović			
Status of the subject: Elective			
Number of ECTS points: 8			
Condition: none			
Goals of the subject To enable students achieving: (1) advanced knowledge on new and innovative research related to the improvement in or modification of animal performance and product yield, composition and quality, (2) advanced knowledge of new and emerging areas of animal science related to growth and development, production and reproduction, (3) advanced knowledge on livestock production systems, their interaction with environment and social concerns regarding animal production.			
Outcome of the subject At the end of the subject student should be able to: a) understand the science behind animal breeding, farm animal production and the environmental impact of agricultural activity; b) evaluate genetic, genomic, and biotechnological methods applied to the production, reproduction, health and behaviour of domestic animals; c) analyse and compare the strengths and weaknesses of different livestock breeding and management techniques. At the end of the subject student should be qualified for critical analysis, evaluation, and synthesis of the new ideas in the field of animal science, presentation of accomplishment, to be able to give professional knowledge and ideas to the colleagues and broader academic community.			
Content of the subject Livestock production systems, environment and society; Environment and animal well-being; Challenges and opportunities in genetic improvement, management, reproduction and welfare of livestock; Genetic resources and genomics for adaptation of livestock to climate change; Biotechnology in animal science; Livestock safety and biosecurity. Student's research work will include individual work on seminar and research papers.			
Literature Collier, R.J., Collier, J.L. (Eds.) (2012). Environmental physiology of livestock. Wiley & Sons, Inc. Hall, S. J. G. (2004). Livestock Biodiversity – Genetic Resources for the Farming of the Future. Blackwell Publishing, Oxford, UK. Jarvis, D. I., Padoch, C., Cooper, H. D. (Eds.) (2007). Managing Biodiversity in Agricultural Ecosystems. Columbia University Press, New York, USA. Joost, S., Bruford, M. W., Curik, I., Kantanen, J., Lenstra, J. A., Sölkner, J., Andersson, G., Baret, P. V., Buys, N., Roosen, J., Tixier-Boichard, M., Marsan, P. A., eds. (2016). Advances in Farm Animal Genomic Resources. Lausanne: Frontiers Media. doi: 10.3389/978-2-88919-735-4. Robinson, T.P., Thornton P.K., Franceschini, G., Kruska, R.L., Chiozza, F., Notenbaert, A., Cecchi, G., Herrero, M., Epprecht, M., Fritz, S., You, L., Conchedda, G., See, L. (2011). Global livestock production systems. Rome, Food and Agriculture Organization of the United Nations (FAO) and International Livestock Research Institute (ILRI). Steinfeld, H., P. Gerber, T. Wassenaar, V. Castel, M. Rosales, C. de Haan (2006). Livestock's long shadow - Environmental issues and options, LEAD FAO, Rome. Secondary Guidelines for Development of National Farm Animal Genetic Resources Management Plans - Management of small populations at risk. FAO UNEP, Rome. Selected papers on animal science.			
Number of active classes:	Theory: 3	Practice: 3	
Methods of delivering lectures Lecture, class discussions, small group work, seminar work.			
Evaluation of knowledge (maximum number of points 100)			
Pre-exam	**Points:60**	**Final exam**	**Points:40**
Seminar and oral discussion on seminar topic	60	Written exam	40