SAGRIS Module 1 description

Code	Title of the module
Module 1	SMART Agriculture and Digitalization

1. Learning Objectives of the Module

Qualification objectives

The module aims at providing theoretical and practical skills in the development and application of resource-efficient approaches on the basis of modern, innovative technologies for the development of sustainable agriculture through building the competencies in the field of professional activity.

Competencies:

demonstrate their understanding of the potential of digital technologies and Smart Farming methods for the increase of resource-efficiency of agricultural production;
explain and demonstrate the technical background and functionality of Smart Farming systems for crop and animal production,
understand the functions of Farm Management Information Systems in practical agriculture and are capable of using Farm Management data for research purposes/

Skills:

describe and discuss the potential of Smart Farming technologies for increasing the resource-efficiency of agricultural production;
use and operate smart farming equipment and digital farming technologies, to evaluate them and to use the results obtained for research purposes;
apply Farm Management Information Systems in agricultural enterprises and to operate selected software systems;

Knowledge:

Smart Farming Systems, ICT-based technologies used in the agricultural sector and the development of automated systems and robotics in agricultural production;
concepts and indicators of sustainability and innovative digital-based technological approaches to increase resource-efficiency of agricultural production;
Farm Management Information Systems and Agricultural Decision Support Systems based on artificial intelligence.

Summary of the Content

Which professional, methodological, practical and interdisciplinary contents will be delivered?

Methodological: Concepts of sustainable agriculture and approaches for resource-efficient agricultural production.
Theoretical: ICT-based Farm Management Information Systems. Digital technologies and techniques applied for Precision Agriculture and Smart Farming systems.
Practical: Precision agriculture (crop farming and livestock breeding). Agricultural Automation and Robotics.
Professional: ICT application for solving problems of professional activity.

Teaching/learning forms (summary)

Lectures, binary lectures, seminars, case-studies, excursions

2. Preconditions for participation

Knowledge, skills, competences	MSc or comparable degree in Agricultural Sciences or a related subject
Preparation for the module	Preliminary study of the literature, obtaining basic knowledge about electronic databases and resources.

3. Module references to sustainable development

Which aspects of sustainable development (economic, ecological, social) will be treated?

The use of digital technologies and the application of Smart Farming approaches in agriculture results in resource efficiency and therefore contributes to the development of sustainable farming systems with regard to economic (e.g. cost reduction, increased profitability), environmental (e.g. higher efficiency when using farm inputs) and social (e.g. job qualification, salary, income in rural areas) aspects.

4. Exam performances (preconditions for allocation of credit points)

Type and duration (min)	Share %

- To be completed -	

5. Organisation

Responsible for the module Prof. Zholamanov K.K. Subtopic 1.1, 1.2. Prof. Petrov A.F. Subtopic 1.3 Prof. Tikhonovsky V.V. Subtopic 1.4, 1.5		
Type of the module Compulsory	**Regular cycle** Annually	**Duration** 1 Semester (RU), 1 trimester (KZ)
Admission requirements Admission requirements are based on the prerequisites for studying the module	**ECTS-points** 4 ECTS where 1 ECTS = 36 ac. hr (RU), 30 ac.hr (KZ)	**Presence (including academic) hours per week**
Workload 4 ECTS-Points x 36 hours = 144 hours – total workload, with the following allocation (RU) 4 ECTS-Points x 30 hours = 120 hours – total workload, with the following allocation (KZ)		
Presence/Contact hrs. 61 ac hr / 51 %	**Preparation/ follow up/ self-study** 31 ac hr / 26 %	**Tasks/Group work** 28 ac hr / 23 %

6. Module design

Sub-topics	
Subtopic 1	Resource-efficient approaches for sustainable agriculture
Subtopic 2	Digital technologies in agriculture and Smart Farming techniques
Subtopic 3	Farm Management Information Systems
Subtopic 4	Precision agriculture (crop farming and livestock breeding)
Subtopic 5	Agricultural Automation and Robotics

6.1. Subtopic description

Code	**Subtopic title:**
Subtopic 1	Resource-efficient approaches for sustainable agriculture

6.2. Subtopic design

Learning outcomes

What knowledge and skills should be acquired to achieve the learning objectives of the module?
To which competences will these contribute?

Competence 1 (C1): PhD-students are able to discuss and assess resource-efficient approaches to farming systems
Knowledge 1 (C1K1): PhD-students know resource-saving approaches for smart agriculture when applying digitalization, as well as indicators of resource-saving.
Skill 1 (C1S1): PhD-students are able to find, analyze, classify and summarize information on resource-saving approaches for agricultural production.

Competence 2 (C2): PhD-students understand the potential of digital technologies / Smart Farming methods for the increase of resource-efficiency of agricultural production.
Knowledge 1 (C2K1): PhD-students know innovative digital-based technological approaches to resource-saving technologies
Knowledge 2 (C2K2): PhD-students know the methods for planning, monitoring and assessing the work quality
Skill 1 (C2S1): PhD-students are able to utilize high-tech issues and instruments to assess the timing, quality and efficiency of conservation approaches in the frame of research projects.

Content

What professional, methodological, practical and interdisciplinary content is covered by the sub-topic?

Professional content. Obtaining and consolidating theoretical knowledge on the concept of resource-efficient approaches for the development of sustainable agriculture through the formation and development of competencies in the field of professional activity.
Methodological content. Methodology of scientific analysis and thinking, scientific and methodological approaches and methods of decision-making and their implementation in practice.
Practical content. Qualified identification and solution of practical and professional problems of resource- efficient technologies.
Interdisciplinary content. Connection with subjects: Information Technology, Technology of Agricultural Production, Modelling, Physics, Mathematics, Ecology.

Content:
1. Concepts, state and outlooks of resource efficiency in agriculture
2. Basic scientific theories and strategy formation in the field of resource saving
3. Efficiency of resource saving systems in agriculture
4. Resources used in agricultural production (natural, human and financial resources).
5. Objectives and aims of resource saving.
6. Resource-saving technologies in agriculture, potential of digital technologies with regard to resource-saving
7. Resource-saving management mechanisms (Organizational factors, Legislation and regulations. Measures to support resource-saving technologies).
8. Effectiveness of resource-saving technologies (Economic and ecological efficiency of resource-saving technologies. Methodology for assessing resource-saving technologies).

Seminars
1. Basic scientific theories in the field of resource-saving technologies.
2. Resource-saving technologies in agriculture, Sequence of building the resource-efficient effect, Technological structure of the agriculture. Structuring and development of resource-efficiency in agriculture.
3. Resource efficient systems in different sectors.
4. Modeling of resource-efficient systems, Resource-saving innovative projects.

Teachng/learning forms

lecture, binary lecture

Methods of teaching/learning

Presentations, group work, computer exercises

Literature/learning materials

Literature sources:

1. Galanakis, Charis M. (Hg.) (2018): Sustainable food systems from agriculture to industry. Improving production and processing. London: Academic Press an imprint of Elsevier. Available at: http://search.ebscohost.com/login.aspx?direct=true&scope=site&db=nlebk&AN=1566711.
2. Farooq, Muhammad; Pisante, Michele (2019): Innovations in Sustainable Agriculture. 1st ed. 2019. Cham: Springer International Publishing; Imprint: Springer.
3. Marta-Costa, Ana Alexandra; Soares da Silva, Emiliana L. D. G. (2013): Methods and Procedures for Building Sustainable Farming Systems. Application in the European Context. Dordrecht: Springer. Available at: http://dx.doi.org/10.1007/978-94-007-5003-6
4. Korsunova T.M. Sustainable Agriculture. St.Petersburg: Lan, 2019. 132 p. Available at: https://e.lanbook.com/book/113920.
5. Kiryushin V.I. Agrotechnologies. St.Petersburg: Lan, 2015. 464 p. Available at: https://e.lanbook.com/book/64331.
6. Truflyak E.V. Monitoring and forecasting in the field of digital agriculture following the results of 2018. Krasnodar, 2019. 100 p.
7. Promoting sustainable agriculture and rural development — Rome: FAO, 1996.
8. Ramdinthara, Immanuel Zion; P, Shanthi Bala (2020): Issues and Challenges in Smart Farming for Sustainable Agriculture. In: Yuchi Wang, N. Pradeep, Sandeep Kautish, C.R Nirmala, Vishal Goyal und Sonia Abdellatif (Hg.): Modern Techniques for Agricultural Disease Management and Crop Yield Prediction, Bd. 47: IGI Global (Advances in Environmental Engineering and Green Technologies), pp. 1–22.
9. Altieri, Miguel; Nicholls, Clara; Montalba, Rene (2017): Technological Approaches to Sustainable Agriculture at a Crossroads: An Agroecological Perspective. In: Sustainability 9 (3), S. 349. DOI: 10.3390/su9030349.
10.Sarker, Md Nazirul Islam; Wu, Min; Alam, G. MonirulM.; Islam, Md Saiful (2019): Role of climate smart agriculture in promoting sustainable agriculture: a systematic literature review. In: IJARGE 15 (4), S. 323. DOI: 10.1504/IJARGE.2019.104199.

Additional literature:

1. The program for agro-industrial complex development in the Republic of Kazakhstan in 2013–2020 "Agribusiness - 2020". Decree of the Government of the Republic of Kazakhstan on December 18, 2013.
2. Development programs of the agro-industrial complex of the Russian Federation, Ministry of Agriculture, 2018.

Internet-resources:

(www.minfin.gov.kz, www.stat.gov.kz, www.kase.kz,
www.investfunds.kz, www.nationalbank.kz, etc.)

Other

6.3. Subtopic organization

ECTS-Points	**Semester week hours**	**Grouping**	**Recommended study semester**	**Language**
0.7 credits = 21 h	3 h	No	1	Russian, Kazakh, English

Workload

0.7 ECTS-Point x 30 hours = 21 hours, **general workload with the following allocation**

Presence	**Preparation/ follow up/ self-study**	**Tasks/Group work**
11 ac.hr. / 52%	5 ac.hr. / 24%	5 ac.hr. / 24%

6.1. Subtopic description

Code	Subtopic title
Subtopic 2	Digital technologies in agriculture and Smart Farming techniques

6.2. Subtopic design

Learning outcomes

What knowledge and skills must be acquired to achieve the learning goals of the module?
What competencies will they help to acquire?

Competence 1 (C1): Understand the technical components of Smart Farming systems in crop and animal production and their functionality, they demonstrate the ability to analyze critically the contemporary problems of digital technologies in agriculture

Knowledge 1 (C1K1): Know advanced digital technologies and techniques of smart agriculture applied in the agro-industrial complex; they know and understand current trends in digital technologies.

Skill 1 (C1S1): Use and operate basic smart farming equipment and digital technologies in the production of agricultural products, they are able to evaluate them and to use the results obtained for research purposes.

Content

What professional, methodological, practical and interdisciplinary content is covered by the subtopic?

Methodological content. Methodology of scientific analysis and thinking, scientific and methodological approaches and methods of decision-making and its implementation in practice
Professional content. - awareness and availability of basic conditions: computer literacy, connectivity, financial inclusion, ICT education, e-government;
- use of the Internet, mobile phones and social networks. Skills in working with digital technologies, supporting a culture of entrepreneurship and innovation in the agro-food sector
Practical content. Use innovative software that consolidates in one window the data sets obtained from equipment, sensors, drones, satellites and other external applications to take practical skills with the best solution.
Interdisciplinary content
Connection with subjects: Information Technology, Technology of Agricultural Production, Modeling, Physics, Mathematics, Ecology.

Content by topic of lectures:

1. Technical basics of digital farming
2. Local meteorological stations
3. Aerial- & Satellite pictures
4. Real-time systems
5. Unmanned aerial systems (UAS)
6. Internet of Things & Machine-to-Machine communication

Teaching/learning forms

Seminar with practical elements

Methods of teaching/learning

Case study

Literature/learning materials

Literature sources:

1. Zhang, Qin (Hg.) (2016): Precision agriculture technology for crop farming. Boca Raton, London, New York: CRC Press Taylor & Francis Group.
2. Ahmad, Latief; Mahdi, Syed Sheraz (2018): Satellite Farming. An Information and Technology Based Agriculture. Cham: Springer International Publishing. Online verfügbar unter http://dx.doi.org/10.1007/978-3-030-03448-1.
3. Oliver, M. A. (2010): Geostatistical Applications for Precision Agriculture. Dordrecht: Springer Sci-ence+Business Media B.V. Available at http://dx.doi.org/10.1007/978-90-481-9133-8.
4. Digitalisation Agricultural Complex and the Russian, Ministry of Agriculture of the Russian Federation 2018.
5. Truflyak E.V. Precision farming. St.Petersburg: Lan, 2019. 376 p. Available at: https://e.lanbook.com/book/122186.
6. Fedorenko V.F. Smart systems in agriculture. Moscow: Rosinformagroteh Publ., 2017. 159 p. Available at: https://lib.rucont.ru/efd/653956 .
7. Ahmad, Latief; Mahdi, Syed Sheraz (2018): Satellite Farming. An Information and Technology Based Agriculture. Cham: Springer International Publishing. Available at: http://dx.doi.org/10.1007/978-3-030-03448-1

8.Noack, Patrick Ole (2019): Precision Farming – Smart Farming – Digital Farming. Grundlagen und Anwendungsfelder. Berlin, Offenbach: Wichmann.

Addititonal literature:

1. The concept of applying precision farming systems in the Republic of Kazakhstan. 2017.
2. Recommendations on applying space technology for maintaining a precision farming system in the Republic of Kazakhstan. 2018r.

Professional databases:

Site of remote university	http://www.kaznau.kz
Open systems: Internet publications on information technologies.	http://www.osp.ru
Open systems: Internet publications on information technologies.	http://www.osp.ru
Information technologies in education: Internet publications	http://www.rusedu.info

Other

colloquium, online training, internships in relevant organizations/ enterprises, invited experts

6.3. Subtopic organization

ECTS-Points	**Semester week hours**	**Grouping/**	**Recommended study semester**	**Language**
1.0	4	No	2	Russian, Kazakh, English

Workload

1 ECTS-Point x 30 hours = 30 hours, **with the following allocation**

Presence	**Preparation/ follow up/ self-study**	**Tasks/Group work**
15 ac.hr. / 50 %	8 ac. hr / 29 %	7 ac. hr. / 21 %

6.1. Subtopic description

Code	**Subtopic title:**
Subtopic 3	Farm Management Information Systems

6.2. Subtopic design

Learning outcomes

What knowledge and skills must be acquired to achieve the learning goals of the module?
What competencies will they help to acquire?

Competence 1 (C1): Have a holistic view of information technology in the field of management information in modern agriculture, they understand the functions of management information systems in practical agriculture.
Knowledge 1 (C1K1): Know how to classify management information systems, they know which management information systems exist in crop and animal production and know the main areas of research in the field of artificial intelligence
Knowledge 2 (C1K2): Know the Farm Management Information System software used in agricultural enterprises in crop and livestock production and how to apply the software effectively
Skill 1 (C1S1): Apply in practice the software that is used in crop production and livestock breeding on examples of programs like Panorama AGRO, ArcGIS, SELEX.
Skill 2 (C1S2): Distinguish between different approaches (agent-based approach, machine learning, neural networks) in the field of artificial intelligence.
Skill 3 (C1S3): Apply Farm Management Information Systems in crop production, to compile a field history book, plan crop rotations, calculate the amount of fertilizer and pesticide application, develop agrotechnical measures. Estimate costs and income, logistics, sales of goods, formation tasks for machine operators, generating reports.
Skill 4 (C1S4): Apply Farm Management Information Systems in Animal Production. They are able to maintain electronic livestock records, understand the automation and selection processes, compilation of genealogical branches, logistics, calculation of inbreeding coefficients.

Competence 2 (C2): Understand the classification of databases and their practical application in modern agriculture.
Knowledge 1 (C2K1): Know the basic types and functionality of databases and know where database systems are implemented in agriculture. They know approaches to enter and extract information into databases
Skill 1 (C2S1): Classify databases and to practically work with existing databases that are used as part of management information systems in agriculture.

Content

What professional, methodological, practical and interdisciplinary content is covered by the sub-theme?

Methodological: Principles and functions of Farm Management Information Systems in crop and livestock production
Professional: Use of artificial intelligence for decision support systems and their application in practice and research Types of databases and methods of working with databases.
Practical: Practical operation of Farm Management Information Systems in crop and animal production
Interdisciplinary: Connection with disciplines: information technology, agricultural production technology, modeling, physics, mathematic.

Content by topic of lectures:
1. Software systems for agricultural enterprises
2. Functions and Farm Management Information Systems
3. Decision Support Systems
4. Data infrastructure and databases
5. Data security
6. Future trends in the development of Farm Management Information Systems

Teaching/Learning forms

lecture, lecture-dialogue, seminar with practical elements, laboratory work, excursion

Teaching/Learning methods

presentations, seminar and project work

Literature/ learning materials **Literature sources:** 1. Machine Learning. Tom M. Mitchell, 1997 2. Doing Data Science: Straight Talk from the Frontline, Rachel Schutt and Cathy O'Neil, 2013 3. Bernard Marr и Matt Ward. Artificial Intelligence in Practice, 2019 4. Mastering Machine Learning with R, 2nd Edition, Lesmeister C., 2017 Equipment and software: Panorama AGRO, ArcGIS, SELEX
Other Colloquium

6.3. Subtopic organization

ECTS-Points 0.8	**Semester week hours** 4	**Grouping/** No	**Recommended study semester** 2	**Language** Russian, Kazakh, English
Workload 0.8 ECTS-Points x 30 hours = 24 hours, **with the following allocation**				
Presence 12 ac. hr. / 50%		**Preparation/ follow up/ self-study** 6 ac. hr. / 25 %		**Tasks/Group work** 6 ac. hr. / 25 %

6.1. Subtopic description

Code	Subtopic title
Subtopic 4	Precision agriculture (crop farming and livestock breeding)

6.2. Subtopic design

Learning outcomes

What knowledge and skills must be acquired to achieve the learning goals of the module?
What competencies will they help to acquire?

Competence 1 (C1): Understand precision farming systems and can use precision farming techniques to solve problems.
Knowledge 1 (C1K1): Know the tendencies in precision farming technologies in crop and livestock production; know the scope and methods of production management of the parameters of technological processes during the operation of machinery and equipment.
Skill 1 (C1S1): Operate the information technologies, computer technologies and software related to precision farming in the field of crop and livestock production.
Skill 2 (C1S2): Search for necessary information to solve professional problems on the basis of information technologies.
Skill 3 (C1S3): Operate Precision Farming equipment

Competence 2 (C2): Demonstrate their ability to conduct research, analyze results and prepare reporting documents by means of precision farming technology
Knowledge 1 (C2K1): Know current tendencies in scientific research, the methodology for performing technical measurements during experiments and processing data obtained while researching.
Skill 1 (C2S1): Use information resources and specific software for performing theoretical calculations and processing experimental data in precision farming.

Content

What professional, methodological, practical and interdisciplinary content is covered by the sub-theme?

Professional: Use of Precision Farming technologies in research projects.
Methodological: Use of methods for solving problems in the development of new technologies for precision farming.
Practical: Precision farming systems based on the practical application of smart agricultural machinery and digital equipment, navigation and information technologies for crop and livestock production.
Operation of UAVs for crop production and livestock breeding (drones, UAVs), taking into account their purpose and environmental friendliness.
Interdisciplinary: Connection with disciplines: information technology, modern problems of science and production in agroengineering, agricultural production technology, modeling, physics, mathematics.

Content by topic of lectures:
1. Precision crop farming
1.1 Parallel tracking / guidance systems
1.2 Soil and yield mapping
1.3 Variable Rate Application & Site-Specific Crop Management
1.4 Use of unmanned aerial vehicles (UAVs) in agriculture
2. Precision livestock breeding
2.1 Elements and examples of precision dairy farming
2.2 Elements and examples of precision pig production
2.3 Elements and examples of precision poultry farming

Teaching/Learning forms

Lecture combined with field trips, seminar

Teaching/Learning methods

Presentations, case-study, group work,

Literature/ learning materials

Literary sources:

1. Kalichkin V.K. Agronomic geoinformation systems. Novosibirsk, 2018. 347 p.
2. Yenina E. Scientific support of agro-industrial complex management. Moscow: Academic project, 2016. 368 p.
Workshop on precision farming. St. Petersburg: Lan, 2015. 224 p. Available at: https://e.lanbook.com/book/65047

3. Kiriushin, V.I. Agrotechnology. St. Petersburg: Lan, 2015. 464 p. Available at: https://e.lanbook.com/book/64331.
4. Korsunova T.M. Sustainable agriculture. St. Petersburg: Lan, 2019. 132 p. Available at: https://e.lanbook.com/book/113920.
5. Murtazaeva R.N. Innovative development of the agro-industrial complex. Volgograd: Volgograd SAU, 2018. 164 p. Available at: https://e.lanbook.com/book/112341.
6. Trufliak E. V. Monitoring and forecasting in the field of digital agriculture based on the results of 2018. Krasnodar: KubSAU, 2019. 100 p.
7. Trufliak E. V. Mapping yield. Krasnodar: KubSAU, 2016. 13 p.
8. Trufliak E.V. Precision farming. St. Petersburg: Lan, 2019. 376 p. Available at: https://e.lanbook.com/book/122186.
9. Trufliak E.V. Precision farming technical support. Laboratory workshop. St.Petersburg, Lan, 2017. 172 p. Available at: https://e.lanbook.com/book/92956.
10. Zhang, Qin (Hg.) (2016): Precision agriculture technology for crop farming. Boca Raton, London, New York: CRC Press Taylor & Francis Group.
11. Ahmad, Latief; Mahdi, Syed Sheraz (2018): Satellite Farming. An Information and Technology Based Agriculture. Cham: Springer International Publishing. Available at: http://dx.doi.org/10.1007/978-3-030-03448-1.

Additional literature:

1. Brovko E.A., Efimov S.A., Kozlova L.M. Analysis of the current state of work in the field of topographic monitoring based on remote sensing data. Native and foreign experience. Moscow, 2007. 128 p.
2. Kronberg P. Remote sensing of the Earth: Fundamentals and methods of remote sensing in geology. Available at: http://geoknigi.com/book_view.php?id=833
3. Fedorenko V.F. Smart systems in agriculture. Moscow, Rosinformagrotech Publ., 2017. 159 p. Available at: https://lib.rucont.ru/efd/653956.

E-resources

1. GIS "Panorama AGRO". Available at: https://gisinfo.ru/products/panagro.htm? Yclid = 1583119978754739191.
2. Engineering Center GEOMIR. Available at: http://www.geomir.ru
3. window.edu.ru.

Other

6.3. Subtopic organization

ECTS-Points	**Semester week hours**	**Grouping/**	**Reccommended study semester**	**Language**
1		No	2	Russian, English
Workload 1 ECTS-Point x 30 hours = 30 hours, **with the following allocation**				
Presence		**Preparation/ follow up/ self-study**		**Tasks/Group work**
15 acad.hr. / 50 %		8 acad. hr / 27 %		7 acad. hr. / 23 %

6.1. Subtopic description

Code	**Subtopic title**
Subtopic 5	Agricultural Automation and Robotics

6.2. Subtopic design

Learning outcomes

What knowledge and skills must be acquired to achieve the learning goals of the module?
What competencies will they help to acquire?

Competence 1 (C1): Proficient in modern technologies applied in agricultural production and have an understanding of the perspective areas of application of automation and robotics in agriculture.
Knowledge 1 (C1K1): Know the main directions for the development of automation and robotics and their impact on crop and livestock production.
Knowledge 2 (C1K2): Know current IT in agricultural production, the purpose and scope of logic (controllers), sensors and actuators for automation and robotization, the basics of operation, installation and adjustment of technical means for automation and robotics systems.
Skill 1 (C1S1): Apply modern information technologies to solve problems of scientific activities, as well as to use information resources in science and practice in the development of new technologies.

Competence 2 (C2): PhD-students are able to analyze the economic efficiency and assess the impact on the sustainability of agriculture and resource saving, accounting the use of automated machines and robots in agricultural production.
Knowledge 1 (C2K1): PhD-students know the methodology for calculating economic efficiency in the case of the use of automated machines and robots in agricultural production.
Skill 1 (C2S1): PhD-students are able to use methods of economic assessment of sustainability in the case of the use of automated machines and robotic devices in agricultural production

Content

What professional, methodological, practical and interdisciplinary content is covered by the sub-theme?

Professional: Capacities of automated systems application for research objectives. The concept and scope of artificial intelligence and the Internet of things. Possibilities and limiting factors for the use of automation and robotics in agriculture. Evaluation of economic efficiency and sustainability when using automation and robotics.
Methodological: Principles and methods of arrangement of theoretical and practical activities, taking into account the use of automated systems in crop and livestock production.
Practical: Functioning of automated systems in crop and livestock production (telemetric system, field robots, milking robots, a feed pusher robot to the feed table, a manure collector robot, an egg collector robot for outdoor poultry keeping).
Interdisciplinary: Connection with subjects: Mathematics, Physics, Computer Science, Electrical Engineering, Automation, Technology of Agricultural Production, Economics.

Content by topic of lectures:

1. Telemetry systems
2. Internet of Things
3. Robotics
4. Artificial intelligence
5. Autonomous controlled agricultural machinery

Teaching/Learning forms

lecture with practical elements

Teaching/Learning methods

Presentations, discussion, project work.

Literature/ learning materials

Literary sources:

1. Bernard Marr and Matt Ward. Artificial Intelligence in Practice. 2019.

2. Kuryshkin N.P. Fundamentals of robotics, Kemerovo, 2012. 168 p. Available at: https://e.lanbook.com/book/6605
3. Keldyshev D.A. Robotics in engineering and physical projects. 2018. 84 p. Available at: https://e.lanbook.com/book/115081
4. Tolmachev S.G. Fundamentals of artificial intelligence. St. Petersburg, 2017. 132 p. Available at: https://e.lanbook.com/book/121872
5. Dubkov I.S. Practical tasks on the basis of internet of things. Novosibirsk, 2017. 80p. Available at: https://e.lanbook.com/book/118206

Additional literature:

1. Anis Koubaa. Robot Operating System - The Complete Reference (Volume 4). 2019.
2. Rashka S., Mirdzhalili v. Python and machine learning, 2019.

Equipment:

educational constructors of programmable agricultural robots Agrobot, video camera with transmission signal

Software:

Arduino IDE, Python, ROS, RVIZ, Gazebo, TensorFlow

Other

practical visits: a field trip to a livestock farm

6.3. Subtopic organization

ECTS-Points	**Semester week hours**	**Grouping**	**Reccommended study semester**	**Language**
0.5		No	2	Russian, Kazakh, English

Workload 0,6 ECTS x 30 ac. h. = 17 ac.hr, with the following allocation

Presence	**Preparation/ follow up/ self-study**	**Tasks/Group work**
8 acad. hr. / 53 %	4 acad. hr./ 27 %	3 acad. hr. / 20 %