REGISTER

COURSE INFORMATION LETTER

University: Constantine the Philosopher University in Nitra

Faculty: Faculty of Natural Sciences and Informatics

Code of course: KI/ DSAIMD/20	**Name of course:** Data Management

Type, extent and method of learning activities:
Form of study: Lecture
Recommended course-load (hours):
Per week: 2 **Per study period:** 26
Method of study: present

Number of credits: 5

Recommended semester/trimester of study:

Study level: III.

Prerequisites:

Conditions for completion the course:
Successful completion of the course is conditioned by an own solution of the research work and publication output in the field of the specialization Data Management.
Total student workload: 125 hours.
Out of which: lectures/consultations - 26 hours, solution of a research project - 75 hours, preparation of publication output - 24 hours.
Conditions for completion the course: Active participation in lectures/consultations, research solution, consisting in compiling research proposals and research methodology, conducting the research and presentation of research results in the form of research publication (min. 70% depending on the quality of publication output).

Learning outcomes:
The graduate student masters the theoretical basis of data management, data collecting, processing and analysing methods and techniques.
The graduate student is acquainted with selected data management methods and their applications to solve specific problems through case studies.
The graduate student understands data architecture, identifies suitable architectural patterns, knows and applies the data modelling methods depending on the nature of data.
The graduate student proposes appropriate ways of data integration, consolidation and data quality assurance.
The graduate student professionally discusses data security and quality, as well as the role of metadata, ethical and legal aspects of data processing and managing.
The graduate student applies knowledge and proposes new approaches in real projects focused on collecting, processing and analysing structured, semi-structured and unstructured data from heterogeneous resources and developing data-intensive software products.
The graduate student designs and manages the solutions of specific problems from IT practice and research to ensure the required data quality during the entire research process or software product development.

Brief outline of the course:

- Data management in the organization (definitions and characteristics, data life cycle, methods of modelling, acquiring, validating, storing, protecting and processing of structured, semi-structured unstructured data, integrating of data resources);
- Data quality (definitions, quality dimensions, standards, process frameworks);
- Relational database systems (data models, data integrity, database design methods, query languages, concurrency control, security, internal data organization, backup and recovery);
- Distributed database systems (theoretical background, architecture, design, transparency levels, distributed transaction management, concurrency control, data integrity, recovery control);
- NoSQL databases (definitions, theoretical background, types of NoSQL, CAP theorem, querying, indexing, concurrency control, computational models, scalability and sharding, applications);
- Data warehouses and business intelligence (definition, theoretical background, data models, architecture components, query languages, multidimensional data model, metadata, analytical operations, data warehouse design);
- Ecosystems for big data processing (characteristics of big data, data models of structured and unstructured data, streaming data models, big data repositories, programming models, applications);
- Data-intensive applications (reference architecture, assumptions and principles, design and architectural patterns, data repositories, computational models, data-centric architecture, batch processing vs streaming data);
- Data engineering - infrastructure, files and databases, data pre-processing, computational models, data pipelines, design, deployment, monitoring, batch and stream data, cloud services (AWS AI services, Azure Cognitive Services, Google Cloud - AI and machine learning services, ..);
- Ethical and legal aspects of data management in the organization;
- Emerging trends in data processing and management.

Recommended literature:

Connolly, T., Begg, C. 2015. Database Systems: A Practical Approach to Design, Implementation, and Management. Addison Wesley, 2015. 1425 p. ISBN 0-321-21025-5
Crickard, P. 2020. Data Engineering with Python. Packt Publishing, 2020.
Henderson, D. et al. 2017. Data Management Body of Knowledge DAMA-DMBOK. 2nd ed, DAMA International, Technics Publications, New Jersey, 2017. ISBN 978-1634622349
Inmon, B., Levins, M., Srivastava, R. 2020. Building the Data Lakehouse. Technics Publication, Databricks, 2020.
Drlík, M. 2020. Vybrané témy analýzy dát a vývoja softvéru v doméne Learning Analytics. Výstup národného projektu „IT Akadémia – vzdelávanie pre 21. storočie“, edícia Prírodovedec č. 726, 2020.
Kumar, A. 2018. Architecting Data-Intensive Applications. Packt Publishing, 2018. 330 p. ISBN 978-1-78646-509-2
Kukreja, M. 2021. Data Engineering with Apache Spark, Delta Lake, and Lakehouse. Packt Publishing, 2021. ISBN 978-1-80107-774-3
Laudon, K.C., Laudon, J.P. 2012. Management Information Systems: Managing The Digital Firm. Prentice-Hall, 2012. 677 p. ISBN 978-0-13-214285-4
Lee, J., Wei, T., Mukhiya, S.K. 2018. Hands-On Big Data Modeling. Packt Publishing, 2018. 330 p. ISBN 978-1-78862-090-1
Munk, M., Pilkova, A., Kapusta, J., Svec, P., Drlik, M. (2013). Pillar 3 and modelling of stakeholders behaviour at the commercial bank website during the recent financial crisis. PROCEDIA COMPUTER SCIENCE: ICCS 2013 International Conference on Computational Science (A-ranked conference series), Elsevier, 18, 1747-1756.
Phaltankar, A. 2020. MongoDB Fundamentals. Pack Publishing. 2020. 748 p. ISBN 978-1-83921-064-8

Rábová, I., Drlík, M. 2013. Podnikové informačné systémy, ich architektúra a vývoj. Edícia Prírodovedec č. 520, UKF, Nitra, 2013.

Language knowledge required for passing the course:
Slovak/English

Notes:

Assessment of courses
The total number of assessed students: 2

ABS	N
100.0	0.0

Teachers: doc. Mgr. Martin Drlík, PhD., prof. RNDr. Michal Munk, PhD.,

Date of last change: 20.12.2022

Guarantor program:

COURSE INFORMATION LETTER

University: Constantine the Philosopher University in Nitra	
Faculty: Faculty of Natural Sciences and Informatics	
Code of course: KI/ DS/16	**Name of course:** Dissertation examination
Type, extent and method of learning activities: **Form of study:** **Recommended course-load (hours):** **Per week: Per study period:** **Method of study:** present	
Number of credits: 20	
Recommended semester/trimester of study:	
Study level: III.	
Prerequisites:	
Conditions for completion the course: Elaboration of a written work for the dissertation exam according to the focus of the dissertation.	
Learning outcomes: The student demonstrates: • ability to study the issue of the dissertation, • ability to prepare research and process its results, • ability to literally process the results of their work, • in the defense of the job, the ability to respond and answer questions.	
Brief outline of the course: • elaboration of a written work for the dissertation exam, • presentation and defense of the work, • answer the questions asked.	
Recommended literature: Free choice of literature and other sources according to the supervisor's recommendations and the topic of the dissertation thesis. • UKF guideline in Nitra no. 13/2020 Directive on final, rigorous habilitation theses (www.uk.ukf.sk) • KATUŠČÁK, D. 2013. Ako písať záverečné a kvalifikačné práce. Nitra : Enigma, • Kolektív autorov 2013. Pravidlá slovenského pravopisu. VEDA, Bratislava •MEŠKO, D., KATUŠČÁK, D. a kol. 2004. Akademická príručka. Martin : Osveta, 2004. 317s. ISBN 80-8063-150-6 •REDHAMMER, R. 1995. Ako obhájiť diplomovku. Bratislava : STU, 1995. 48 s. ISBN 80-227-0765-1 • SKALKA, J. a kol. 2009. Prevencia a odhaľovanie plagiátorstva. Nitra : UKF, 2009. 126 s. ISBN 978-80-8094-612-80	
Language knowledge required for passing the course: Slovak/English	
Notes:	

Assessment of courses
The total number of assessed students: 15

A	B	C	D	E	FX
66.67	13.33	13.33	6.67	0.0	0.0

Teachers:

Date of last change: 30.03.2022

Guarantor program:

COURSE INFORMATION LETTER

University: Constantine the Philosopher University in Nitra

Faculty: Faculty of Natural Sciences and Informatics

Code of course: KAJK/dCJPr14/22	**Name of course:** ESP for Doctoral Studies

Type, extent and method of learning activities:
Form of study: Seminar
Recommended course-load (hours):
Per week: 2 **Per study period:** 26
Method of study: present

Number of credits: 5

Recommended semester/trimester of study:

Study level: III.

Prerequisites:

Conditions for completion the course:
Total student workload: 125 hours
Full-time teaching 8 hours + self-study 58 hours + portfolio preparation 59 hours
Active participation in seminars (20%)
Portfolio and project development according to the teacher's assignment (60%)
Project presentation. Factors will be evaluated: language level (pronunciation, correct use technical terminology), structure and graphic design (20%).
Evaluation - success rate A = 100% - 95%, B = 94% - 90%, C = 89% - 85%, D = 84 - 80, E = 79 - 75, FX = less

Learning outcomes:
1. The student activates previous knowledge and skills in a foreign language with a focus on professional vocabulary and receptive speech skills reading comprehension.
2. The student solves practical tasks and develops practical communication skills in the receptive part, communication focused on his field of research.
3. The student abstracts and generalizes ideas from sources that he can paraphrase in English language and formulate their ideas in a foreign language in writing
4. The student applies knowledge in the speech in a foreign language and uses suitable functions of prepared speech
5. The student knows the principles of working with professional text and professional terminology and applies theoretical knowledge in understanding, analysis and evaluation of professional text
6. The student applies knowledge of a foreign language in written and oral forms and creates in a foreign language professional presentations in the field he deals with in his dissertation
7. Study of professional texts in a foreign language
8. Analysis of professional texts in a foreign language
9. Discussion
10. Presentation

Brief outline of the course:
1. Reading with a focus on understanding the context
2. Reading aimed at finding specific information
3. Reading aimed at understanding the main topic

4. Writing paragraphs
5. Writing introduction and conclusion
6. Grammatical structures in writing a professional text
7. Work with professional terminology in a foreign language

Recommended literature:
LMS Moodle Course, TED talks, professional and research studies according to the research field of a PhD student

Language knowledge required for passing the course:
English

Notes:

Assessment of courses
The total number of assessed students: 10

A	B	C	D	E	FX
30.0	40.0	20.0	10.0	0.0	0.0

Teachers: PaedDr. Zuzana Hrdličková, Ph.D.,

Date of last change: 25.05.2022

Guarantor program:

COURSE INFORMATION LETTER

University: Constantine the Philosopher University in Nitra	
Faculty: Faculty of Natural Sciences and Informatics	
Code of course: KI/ DSPA1/16	**Name of course:** Educational activities – 1st year
Type, extent and method of learning activities: **Form of study:** **Recommended course-load (hours):** **Per week: Per study period:** **Method of study:** present	
Number of credits: 0	
Recommended semester/trimester of study: 2.	
Study level: III.	
Prerequisites:	

Conditions for completion the course:

Credits are granted for passing individual activities and after approval of the committee based on the proposal for the annual evaluation of the doctoral student.

Activities:

• Authorship, co-authorship of a book – 15 credits/book
• Authorship, co-authorship of book chapters – 10 credits/book chapter
• Indirect teaching, 4 hours/week – 5 credits
• Direct teaching, 4 hours/week – 5 credits
• Student's scientific work or student's scientific conference supervision – 7 credits/work
• Elaboration of review to final bachelor's thesis – 2 credits/review
• Public presentation at a local conference – 5 credits/presentation. Presenting the results of own work in a world language. Maximally 15 credits per study period.
• Public presentation at a conference abroad – 10 credits/presentation. Presenting the results of own work in a world language. Maximally 30 credits per study period.
• Scientific results dissemination and popularization – maximally 10 credits/year. The committee suggests the number of credits during the yearly evaluation of the doctoral student.

Learning outcomes:

• The student actively transfers the acquired knowledge and experience associated with his/her pedagogical and scientific activities into publication outputs. He/She knows how to use the obtained knowledge and interpret it didactically clearly, and comprehensibly, using appropriate terminology and precisely formulate it in written form (printed or electronic). He/She follows the didactical and pedagogical principles of creating professional teaching materials during the creation of the textbook.
• The student knows how to analyze the study materials of other authors critically and can assess the composition and suitability of the study materials for the university students of study programs oriented to the related field of study.
• The student knows how to work professionally with national and foreign information resources respecting professional academic ethics and standards. He/She demonstrates skills and abilities generally usable in a review of scientific or other professional outputs that can be published in a Slovak or foreign publishing house or periodical publications.

• The student can obtain relevant factual data and information, interpret them correctly, and defend and argue. He/She can conceive, construct, implement, edit, and publish a substantial part of his/her research in periodicals, conference proceedings, or other monographic publications registered in the WoS and Scopus databases.
• The student focuses on activities connected with his/her pedagogical and research activities. He/She actively participates in activities related to presenting the results of doctoral studies, as well as the popularization of science in the given scientific field. He/She can present his/her knowledge and current results of a scientific field in a way that is comprehensible to the lay public and the broader community of experts from other scientific fields.
All activities are relevant for doctoral studies and create a part of an individual study plan. The student critically analyzes, re-evaluates and, considering the conditions of the training workplace, also applies acquired knowledge, skills, habits, and scientific-pedagogical information to his/her scientific and/or didactic research.

Brief outline of the course:
1. Authorship, co-authorship of a book
2. Authorship, co-authorship of a book chapter
3. Indirect teaching, 4 hours/week
4. Direct teaching, 4 hours/week
5. Student's scientific work or student's scientific conference supervision
6. Final thesis review of bachelor's studies
7. Presenting at a local conference
8. Presenting at a conference abroad
9. Dissemination, popularization and application results of science and technology in practice

Recommended literature:
• Alley M. (2011). The Craft of Scientific Presentation. Springer. 4. ed.
• Katuščák, D. (2004). Ako písať záverečné a kvalifikačné práce. Enigma
• STN 01 6910 Pravidlá písania a úpravy písomností (výklad normy, 2021)
• Gastel, B., Day, R. A. (2016). How to Write and Publish a Scientific Paper. Greenwood, ISBN: 978-1440842801,
• Glasman, D. (2009). Science Research Writing for Non-Native Speakers of English. World Scientific Publishing,
• Burton, H. M. (2021). Your First Research Paper: Learn how to start, structure, write and publish a perfect research paper to get the top mark. Independently Publisher

Language knowledge required for passing the course:
Slovak/English

Notes:
Only a book, textbook, and monograph where the total share per author is at least 1 AH is considered to report the results of a doctoral student's study.
A publication published in another world language can also be recognized as a publication in English if a renowned scientific publishing house publishes it.
Publications are documented by an extract from the system of publication activity at the UKF
A condition for proper completion of studies at the Faculty of Natural Sciences and Informatics of the UKF in Nitra is acquiring at least 30 credits for teaching activities.
Study rules of doctoral studies at the FPVaI - appendix 2: Sample report on doctoral studies

Assessment of courses The total number of assessed students: 17	
ABS	N
100.0	0.0
Teachers:	
Date of last change: 24.08.2022	
Guarantor program:	

COURSE INFORMATION LETTER

University: Constantine the Philosopher University in Nitra
Faculty: Faculty of Natural Sciences and Informatics
Code of course: KI/ DSPA2/16 — **Name of course:** Educational activities – 2nd year
Type, extent and method of learning activities: **Form of study:** **Recommended course-load (hours):** **Per week: Per study period:** **Method of study:** present
Number of credits: 0
Recommended semester/trimester of study: 4.
Study level: III.
Prerequisites:

Conditions for completion the course:
Credits are granted for passing individual activities and after approval of the committee based on the proposal for the annual evaluation of the doctoral student.
Activities:
• Authorship, co-authorship of a book – 15 credits/book
• Authorship, co-authorship of book chapters – 10 credits/book chapter
• Indirect teaching, 4 hours/week – 5 credits
• Direct teaching, 4 hours/week – 5 credits
• Student's scientific work or student's scientific conference supervision – 7 credits/work
• Elaboration of review to final bachelor's thesis – 2 credits/review
• Public presentation at a local conference – 5 credits/presentation. Presenting the results of own work in a world language. Maximally 15 credits per study period.
• Public presentation at a conference abroad – 10 credits/presentation. Presenting the results of own work in a world language. Maximally 30 credits per study period.
• Scientific results dissemination and popularization – maximally 10 credits/year. The committee suggests the number of credits during the yearly evaluation of the doctoral student.

Learning outcomes:
• The student actively transfers the acquired knowledge and experience associated with his/her pedagogical and scientific activities into publication outputs. He/She knows how to use the obtained knowledge and interpret it didactically clearly, and comprehensibly, using appropriate terminology and precisely formulate it in written form (printed or electronic). He/She follows the didactical and pedagogical principles of creating professional teaching materials during the creation of the textbook.
• The student knows how to analyze the study materials of other authors critically and can assess the composition and suitability of the study materials for the university students of study programs oriented to the related field of study.
• The student knows how to work professionally with national and foreign information resources respecting professional academic ethics and standards. He/She demonstrates skills and abilities generally usable in a review of scientific or other professional outputs that can be published in a Slovak or foreign publishing house or periodical publications.

• The student can obtain relevant factual data and information, interpret them correctly, and defend and argue. He/She can conceive, construct, implement, edit, and publish a substantial part of his/her research in periodicals, conference proceedings, or other monographic publications registered in the WoS and Scopus databases.
• The student focuses on activities connected with his/her pedagogical and research activities. He/She actively participates in activities related to presenting the results of doctoral studies, as well as the popularization of science in the given scientific field. He/She can present his/her knowledge and current results of a scientific field in a way that is comprehensible to the lay public and the broader community of experts from other scientific fields.
All activities are relevant for doctoral studies and create a part of an individual study plan. The student critically analyzes, re-evaluates and, considering the conditions of the training workplace, also applies acquired knowledge, skills, habits, and scientific-pedagogical information to his/her scientific and/or didactic research.

Brief outline of the course:
1. Authorship, co-authorship of a book
2. Authorship, co-authorship of a book chapter
3. Indirect teaching, 4 hours/week
4. Direct teaching, 4 hours/week
5. Student's scientific work or student's scientific conference supervision
6. Final thesis review of bachelor's studies
7. Presenting at a local conference
8. Presenting at a conference abroad
9. Dissemination, popularization and application results of science and technology in practice

Recommended literature:
• Alley M. (2011). The Craft of Scientific Presentation. Springer. 4. ed.
• Katuščák, D. (2004). Ako písať záverečné a kvalifikačné práce. Enigma
• STN 01 6910 Pravidlá písania a úpravy písomností (výklad normy, 2021)
• Gastel, B., Day, R. A. (2016). How to Write and Publish a Scientific Paper. Greenwood, ISBN: 978-1440842801,
• Glasman, D. (2009). Science Research Writing for Non-Native Speakers of English. World Scientific Publishing,
• Burton, H. M. (2021). Your First Research Paper: Learn how to start, structure, write and publish a perfect research paper to get the top mark. Independently Publisher

Language knowledge required for passing the course:
Slovak/English

Notes:
Only a book, textbook, and monograph where the total share per author is at least 1 AH is considered to report the results of a doctoral student's study.
A publication published in another world language can also be recognized as a publication in English if a renowned scientific publishing house publishes it.
Publications are documented by an extract from the system of publication activity at the UKF
A condition for proper completion of studies at the Faculty of Natural Sciences and Informatics of the UKF in Nitra is acquiring at least 30 credits for teaching activities.
Study rules of doctoral studies at the FPVaI - appendix 2: Sample report on doctoral studies

Assessment of courses The total number of assessed students: 14	
ABS	N
100.0	0.0
Teachers:	
Date of last change: 24.08.2022	
Guarantor program:	

COURSE INFORMATION LETTER

University: Constantine the Philosopher University in Nitra	
Faculty: Faculty of Natural Sciences and Informatics	
Code of course: KI/ DSPA3/16	**Name of course:** Educational activities – 3rd year
Type, extent and method of learning activities: **Form of study:** **Recommended course-load (hours):** **Per week: Per study period:** **Method of study:** present	
Number of credits: 0	
Recommended semester/trimester of study: 6.	
Study level: III.	
Prerequisites:	
Conditions for completion the course: Credits are granted for passing individual activities and after approval of the committee based on the proposal for the annual evaluation of the doctoral student. Activities: • Authorship, co-authorship of a book – 15 credits/book • Authorship, co-authorship of book chapters – 10 credits/book chapter • Indirect teaching, 4 hours/week – 5 credits • Direct teaching, 4 hours/week – 5 credits • Student's scientific work or student's scientific conference supervision – 7 credits/work • Elaboration of review to final bachelor's thesis – 2 credits/review • Public presentation at a local conference – 5 credits/presentation. Presenting the results of own work in a world language. Maximally 15 credits per study period. • Public presentation at a conference abroad – 10 credits/presentation. Presenting the results of own work in a world language. Maximally 30 credits per study period. • Scientific results dissemination and popularization – maximally 10 credits/year. The committee suggests the number of credits during the yearly evaluation of the doctoral student.	
Learning outcomes: • The student actively transfers the acquired knowledge and experience associated with his/her pedagogical and scientific activities into publication outputs. He/She knows how to use the obtained knowledge and interpret it didactically clearly, and comprehensibly, using appropriate terminology and precisely formulate it in written form (printed or electronic). He/She follows the didactical and pedagogical principles of creating professional teaching materials during the creation of the textbook. • The student knows how to analyze the study materials of other authors critically and can assess the composition and suitability of the study materials for the university students of study programs oriented to the related field of study. • The student knows how to work professionally with national and foreign information resources respecting professional academic ethics and standards. He/She demonstrates skills and abilities generally usable in a review of scientific or other professional outputs that can be published in a Slovak or foreign publishing house or periodical publications.	

• The student can obtain relevant factual data and information, interpret them correctly, and defend and argue. He/She can conceive, construct, implement, edit, and publish a substantial part of his/her research in periodicals, conference proceedings, or other monographic publications registered in the WoS and Scopus databases.
• The student focuses on activities connected with his/her pedagogical and research activities. He/She actively participates in activities related to presenting the results of doctoral studies, as well as the popularization of science in the given scientific field. He/She can present his/her knowledge and current results of a scientific field in a way that is comprehensible to the lay public and the broader community of experts from other scientific fields.
All activities are relevant for doctoral studies and create a part of an individual study plan. The student critically analyzes, re-evaluates and, considering the conditions of the training workplace, also applies acquired knowledge, skills, habits, and scientific-pedagogical information to his/her scientific and/or didactic research.

Brief outline of the course:
1. Authorship, co-authorship of a book
2. Authorship, co-authorship of a book chapter
3. Indirect teaching, 4 hours/week
4. Direct teaching, 4 hours/week
5. Student's scientific work or student's scientific conference supervision
6. Final thesis review of bachelor's studies
7. Presenting at a local conference
8. Presenting at a conference abroad
9. Dissemination, popularization and application results of science and technology in practice

Recommended literature:
• Alley M. (2011). The Craft of Scientific Presentation. Springer. 4. vydanie
• Katuščák, D. (2004). Ako písať záverečné a kvalifikačné práce. Enigma
• STN 01 6910 Pravidlá písania a úpravy písomností (výklad normy, 2021)
• Gastel, B., Day, R. A. (2016). How to Write and Publish a Scientific Paper. Greenwood, ISBn: 978-1440842801,
• Glasman, D. (2009). Science Research Writing for Non-Native Speakers of English. World Scientific Publishing,
• Burton, H. M. (2021). Your First Research Paper: Learn how to start, structure, write and publish a perfect research paper to get the top mark. Independently Publisher

Language knowledge required for passing the course:
Slovak/English

Notes:
Only a book, textbook, and monograph where the total share per author is at least 1 AH is considered to report the results of a doctoral student's study.
A publication published in another world language can also be recognized as a publication in English if a renowned scientific publishing house publishes it.
Publications are documented by an extract from the system of publication activity at the UKF
A condition for proper completion of studies at the Faculty of Natural Sciences and Informatics of the UKF in Nitra is acquiring at least 30 credits for teaching activities.
Study rules of doctoral studies at the FPVaI - appendix 2: Sample report on doctoral studies

Assessment of courses The total number of assessed students: 9	
ABS	N
100.0	0.0

Teachers:

Date of last change: 24.08.2022

Guarantor program:

COURSE INFORMATION LETTER

University: Constantine the Philosopher University in Nitra	
Faculty: Faculty of Natural Sciences and Informatics	
Code of course: KI/ DSPA4/16	**Name of course:** Educational activities – 4th year
Type, extent and method of learning activities: **Form of study:** **Recommended course-load (hours):** **Per week: Per study period:** **Method of study:** present	
Number of credits: 0	
Recommended semester/trimester of study: 6.	
Study level: III.	
Prerequisites:	

Conditions for completion the course:

Credits are granted for passing individual activities and after approval of the committee based on the proposal for the annual evaluation of the doctoral student.

Activities:

• Authorship, co-authorship of a book – 15 credits/book
• Authorship, co-authorship of book chapters – 10 credits/book chapter
• Indirect teaching, 4 hours/week – 5 credits
• Direct teaching, 4 hours/week – 5 credits
• Student's scientific work or student's scientific conference supervision – 7 credits/work
• Elaboration of review to final bachelor's thesis – 2 credits/review
• Public presentation at a local conference – 5 credits/presentation. Presenting the results of own work in a world language. Maximally 15 credits per study period.
• Public presentation at a conference abroad – 10 credits/presentation. Presenting the results of own work in a world language. Maximally 30 credits per study period.
• Scientific results dissemination and popularization – maximally 10 credits/year. The committee suggests the number of credits during the yearly evaluation of the doctoral student.

Learning outcomes:

• The student actively transfers the acquired knowledge and experience associated with his/her pedagogical and scientific activities into publication outputs. He/She knows how to use the obtained knowledge and interpret it didactically clearly, and comprehensibly, using appropriate terminology and precisely formulate it in written form (printed or electronic). He/She follows the didactical and pedagogical principles of creating professional teaching materials during the creation of the textbook.
• The student knows how to analyze the study materials of other authors critically and can assess the composition and suitability of the study materials for the university students of study programs oriented to the related field of study.
• The student knows how to work professionally with national and foreign information resources respecting professional academic ethics and standards. He/She demonstrates skills and abilities generally usable in a review of scientific or other professional outputs that can be published in a Slovak or foreign publishing house or periodical publications.

• The student can obtain relevant factual data and information, interpret them correctly, and defend and argue. He/She can conceive, construct, implement, edit, and publish a substantial part of his/her research in periodicals, conference proceedings, or other monographic publications registered in the WoS and Scopus databases.
• The student focuses on activities connected with his/her pedagogical and research activities. He/She actively participates in activities related to presenting the results of doctoral studies, as well as the popularization of science in the given scientific field. He/She can present his/her knowledge and current results of a scientific field in a way that is comprehensible to the lay public and the broader community of experts from other scientific fields.
All activities are relevant for doctoral studies and create a part of an individual study plan. The student critically analyzes, re-evaluates and, considering the conditions of the training workplace, also applies acquired knowledge, skills, habits, and scientific-pedagogical information to his/her scientific and/or didactic research.

Brief outline of the course:
1. Authorship, co-authorship of a book
2. Authorship, co-authorship of a book chapter
3. Indirect teaching, 4 hours/week
4. Direct teaching, 4 hours/week
5. Student's scientific work or student's scientific conference supervision
6. Final thesis review of bachelor's studies
7. Presenting at a local conference
8. Presenting at a conference abroad
9. Dissemination, popularization and application results of science and technology in practice

Recommended literature:
• Alley M. (2011). The Craft of Scientific Presentation. Springer. 4. ed.
• Katuščák, D. (2004). Ako písať záverečné a kvalifikačné práce. Enigma
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• Gastel, B., Day, R. A. (2016). How to Write and Publish a Scientific Paper. Greenwood, ISBN: 978-1440842801,
• Glasman, D. (2009). Science Research Writing for Non-Native Speakers of English. World Scientific Publishing,
• Burton, H. M. (2021). Your First Research Paper: Learn how to start, structure, write and publish a perfect research paper to get the top mark. Independently Publisher

Language knowledge required for passing the course:
Slovak/English

Notes:
Only a book, textbook, and monograph where the total share per author is at least 1 AH is considered to report the results of a doctoral student's study.
A publication published in another world language can also be recognized as a publication in English if a renowned scientific publishing house publishes it.
Publications are documented by an extract from the system of publication activity at the UKF
A condition for proper completion of studies at the Faculty of Natural Sciences and Informatics of the UKF in Nitra is acquiring at least 30 credits for teaching activities.
Study rules of doctoral studies at the FPVaI - appendix 2: Sample report on doctoral studies

Assessment of courses The total number of assessed students: 9	
ABS	N
100.0	0.0
Teachers:	
Date of last change: 24.08.2022	
Guarantor program:	

COURSE INFORMATION LETTER

University: Constantine the Philosopher University in Nitra

Faculty: Faculty of Natural Sciences and Informatics

Code of course: KI/ DSPA5/16	**Name of course:** Educational activities – 5th year

Type, extent and method of learning activities:
Form of study:
Recommended course-load (hours):
Per week: Per study period:
Method of study: present

Number of credits: 0

Recommended semester/trimester of study: 6.

Study level: III.

Prerequisites:

Conditions for completion the course:
Credits are granted for passing individual activities and after approval of the committee based on the proposal for the annual evaluation of the doctoral student.
Activities:
• Authorship, co-authorship of a book – 15 credits/book
• Authorship, co-authorship of book chapters – 10 credits/book chapter
• Indirect teaching, 4 hours/week – 5 credits
• Direct teaching, 4 hours/week – 5 credits
• Student's scientific work or student's scientific conference supervision – 7 credits/work
• Elaboration of review to final bachelor's thesis – 2 credits/review
• Public presentation at a local conference – 5 credits/presentation. Presenting the results of own work in a world language. Maximally 15 credits per study period.
• Public presentation at a conference abroad – 10 credits/presentation. Presenting the results of own work in a world language. Maximally 30 credits per study period.
• Scientific results dissemination and popularization – maximally 10 credits/year. The committee suggests the number of credits during the yearly evaluation of the doctoral student.

Learning outcomes:
• The student actively transfers the acquired knowledge and experience associated with his/her pedagogical and scientific activities into publication outputs. He/She knows how to use the obtained knowledge and interpret it didactically clearly, and comprehensibly, using appropriate terminology and precisely formulate it in written form (printed or electronic). He/She follows the didactical and pedagogical principles of creating professional teaching materials during the creation of the textbook.
• The student knows how to analyze the study materials of other authors critically and can assess the composition and suitability of the study materials for the university students of study programs oriented to the related field of study.
• The student knows how to work professionally with national and foreign information resources respecting professional academic ethics and standards. He/She demonstrates skills and abilities generally usable in a review of scientific or other professional outputs that can be published in a Slovak or foreign publishing house or periodical publications.

• The student can obtain relevant factual data and information, interpret them correctly, and defend and argue. He/She can conceive, construct, implement, edit, and publish a substantial part of his/her research in periodicals, conference proceedings, or other monographic publications registered in the WoS and Scopus databases.
• The student focuses on activities connected with his/her pedagogical and research activities. He/She actively participates in activities related to presenting the results of doctoral studies, as well as the popularization of science in the given scientific field. He/She can present his/her knowledge and current results of a scientific field in a way that is comprehensible to the lay public and the broader community of experts from other scientific fields.
All activities are relevant for doctoral studies and create a part of an individual study plan. The student critically analyzes, re-evaluates and, considering the conditions of the training workplace, also applies acquired knowledge, skills, habits, and scientific-pedagogical information to his/her scientific and/or didactic research.

Brief outline of the course:
1. Authorship, co-authorship of a book
2. Authorship, co-authorship of a book chapter
3. Indirect teaching, 4 hours/week
4. Direct teaching, 4 hours/week
5. Student's scientific work or student's scientific conference supervision
6. Final thesis review of bachelor's studies
7. Presenting at a local conference
8. Presenting at a conference abroad
9. Dissemination, popularization and application results of science and technology in practice

Recommended literature:
• Alley M. (2011). The Craft of Scientific Presentation. Springer. 4. ed.
• Katuščák, D. (2004). Ako písať záverečné a kvalifikačné práce. Enigma
• STN 01 6910 Pravidlá písania a úpravy písomností (výklad normy, 2021)
• Gastel, B., Day, R. A. (2016). How to Write and Publish a Scientific Paper. Greenwood, ISBN: 978-1440842801,
• Glasman, D. (2009). Science Research Writing for Non-Native Speakers of English. World Scientific Publishing,
• Burton, H. M. (2021). Your First Research Paper: Learn how to start, structure, write and publish a perfect research paper to get the top mark. Independently Publisher

Language knowledge required for passing the course:
Slovak/English

Notes:
Only a book, textbook, and monograph where the total share per author is at least 1 AH is considered to report the results of a doctoral student's study.
A publication published in another world language can also be recognized as a publication in English if a renowned scientific publishing house publishes it.
Publications are documented by an extract from the system of publication activity at the UKF
A condition for proper completion of studies at the Faculty of Natural Sciences and Informatics of the UKF in Nitra is acquiring at least 30 credits for teaching activities.
Study rules of doctoral studies at the FPVaI - appendix 2: Sample report on doctoral studies

Assessment of courses The total number of assessed students: 1	
ABS	N
100.0	0.0

Teachers:

Date of last change: 24.08.2022

Guarantor program:

COURSE INFORMATION LETTER

University: Constantine the Philosopher University in Nitra

Faculty: Faculty of Natural Sciences and Informatics

Code of course: KI/ DSAIGIS/20	**Name of course:** Geographic Information Systems

Type, extent and method of learning activities:
Form of study: Lecture
Recommended course-load (hours):
Per week: 2 **Per study period:** 26
Method of study: present

Number of credits: 5

Recommended semester/trimester of study:

Study level: III.

Prerequisites:

Conditions for completion the course:
Successful completion of the course is conditioned by an own solution of the research work and publication output in the field of the following specialization Geographic Information Systems.
Total student workload: 125 hours.
Of which: lectures/consultations - 26 hours, solution of a research project - 75 hours, preparation of publication output - 24 hours.
Conditions for course completion: Active participation in lectures/consultations, research solution, consisting of compiling research proposals and research methodology, conducting the research and presentation of research results in the form of research publication (min. 70% depending on the quality of publication output).

Learning outcomes:
The graduate student understands the individual steps in the planning of research. The graduate student is able to compile research proposals, research methodology, conduct own scientific research, and present the results in the field of specialization Geographic Information Systems.
The graduate student is capable of analyzing the latest knowledge concerning the geographic information systems (GIS) and geoinformatics. Student is capable of applying GIS and create spatial data and then analyse them in a type of research for the specific purposes. Student is capable of evaluating GIS and selected software ArcGIS. Through the solved examples and case studies, the graduate student can apply the selected GIS methods useful in practice (map analyses, spatial sensing, multi-criteria assessment of spatial problems and assessment of expert systems, modelling). The graduate student applies the selected cartographic methods for geographic data imaging and is able to create a composition of purpose-built special maps in ArcGIS software and, subsequently, present and publish them.

Brief outline of the course:
- The structure of geographic information systems (GIS), geoinformatics as a scientific discipline and geoinformatics technologies;
- ArcGIS software, requirements for hardware and software, basic tools;
- Visual environment ArcGIS, coordinates systems;
- Geographic information data and sources;
- Collection and preparation of spatial data for GIS, geodatabases;

- Spatial representation of data;
- Spatial analyses and modelling in GIS;
- Digital models and relief analyses;
- Visualization and cartographic presentation by means of GIS;
- Mobil GIS and Web GIS;
- Infrastructure for spatial information in Europe (INSPIRE), National infrastructure for spatial information (NIPI);
- GIS in practice;
- Final research project in GIS;
- Presentation of research results in form of publication output.

Recommended literature:

Boltižiar, M. 2007. GIS pre geografov I. FPV UKF Nitra, 2007. 96 s. ISBN 978-80-8094-196-3
Boltižiar, M., Vojtek, M. 2009. Geografické informačné systémy pre geografov II. FPV UKF Nitra, 2009. 140 s. + CD-ROM príloha. ISBN 978-80-8094-553-4
Boltižiar, M., Biskupič, M. Barka, I. 2016. Spatial avalanche modelling by application of GIS on the selected slopes of Western Tatra Mts. and Belianske Tatra Mts. (Slovakia). Geographia Polonica. 2016, 89(1), 79-90.
Boltižiar, M., Chrastina, P. 2018. Application of Geographical Information System (GIS) in Geography (Digital Data Pre-processing for Land-use Changes Analysis). In DIVAI 2018: 11th International scientific conference on distance learning in applied informatics. Wolters Kluwer, 2016. 29-36.
Burrough, P.A., McDonnell, R.A., Lloyd, C.D. 2015. Principles of Geographical Information Systems. Oxford University Press, 2015. 432 p. ISBN 978-01-9874-284-5
Hofierka, J. 2003. Geografické informačné systémy a diaľkový prieskum Zeme. Vysokoškolské učebné texty, FHPV PU, 2013. 106 s. ISBN 80-8068-219-4
Hofierka, J., Kaňuk, J., Gallay, M. 2014: Geoinformatika. Univerzita Pavla Jozefa Šafárika v Košiciach, 192 s. ISBN 978-80-8152-178-2
Klaučo, M., Weis, K., Gregorová, B., Anstead, L. 2014. Geografické informačné systémy 1. Belianum UMB, 2014. 71 s. ISBN 978-80-557-0679-5
Klaučo, M., Weis, K., Gregorová, B., Anstead, L. 2014. Geografické informačné systémy 2. Belianum UMB, 2014. 99 s. ISBN 978-80-557-0684-9
Kang-Tsung, CH. 2010. Introduction to Geographic Information Systems. 5. vyd., McGraw-Hill, Boston, 2010. 384 p.
Miklín, J., Dušek, R., Krtička, L., Kaláb, O. 2018. Tvorba map. Ostravská univerzita, 2018. 302 s. ISBN 978-80-7599-017-4
Longley, P.A., Goodchild, M.F., Maguire, D.J., Rhind, D.M. 2001. Geographic Information Systems and Science. Wiley & Sons, 2001. 472 p.
Peterson, N.G. 2009. GIS Cartography: A Guide to Effective Map Design. CRC Press, 2009. 248 p.
Rapant, P. 2006. Geoinformatika a geoinformační technologie. 1. vyd., VŠB-TU Ostrava, 2006. 513 s. ISBN 80-248-1264-9
Tyner, J. 2010. Principles of Map Design. Guilford Press, New York, 2010. 259 p. ISBN 978-1-60623-44-7
Vojteková, J., Žoncová, M. 2021. Geografické informačné systémy - tvorba vybraných tematických máp. UKF v Nitre, 2021. 88 s. ISBN 978-80-558-1696-8
Voženílek, V. 2005. Cartography for GIS - geovisualization and map communication. Vydavatelství UP, Olomouc, 2005. 140 p. ISBN 80-244-1047-8

Language knowledge required for passing the course:

Slovak/English
Notes:
Assessment of courses The total number of assessed students: 0

ABS	N
0.0	0.0

Teachers: prof. PaedDr. PhDr. RNDr. Martin Boltižiar, PhD., doc. RNDr. Matej Vojtek, PhD.,
Date of last change: 09.01.2022
Guarantor program:

COURSE INFORMATION LETTER

University: Constantine the Philosopher University in Nitra	
Faculty: Faculty of Natural Sciences and Informatics	
Code of course: KI/ DSAIVI/20	**Name of course:** Information Visualization
Type, extent and method of learning activities: **Form of study:** Lecture **Recommended course-load (hours):** **Per week:** 2 **Per study period:** 26 **Method of study:** present	
Number of credits: 5	
Recommended semester/trimester of study:	
Study level: III.	
Prerequisites:	
Conditions for completion the course: Successful completion of the course is conditioned by an own solution of the research work and publication output in the field of the following specialization Information Visualization. Total student workload: 125 hours. Of which: lectures/consultations - 26 hours, solution of a research project - 75 hours, preparation of publication output - 24 hours. Conditions for course completion: Active participation in lectures/consultations, research solution, consisting of compiling research proposals and research methodology, conducting the research and presentation of research results in the form of research publication (min. 70% depending on the quality of publication output).	
Learning outcomes: The graduate student understands the individual steps in the planning of research. The graduate student is able to compile research proposals, research methodology, conduct own scientific research, and present the results in the field of specialization Information Visualization. The graduate student is able to define the basic concepts of scientific visualization and information visualization, can name the criteria for good visual representation and decide whether they are followed in specific (also historical) examples. The graduate student knows the principles of visual perception, the role of brightness, contrast, texture, colours, etc., and he/she can apply them appropriately. The graduate student is able to analyse and classify data, interpret the relationships between the various elements to create a visual representation, and can apply different techniques of information visualization. The graduate student is able to design a suitable visual representation for data of different type and structure. The student is able to critically analyze and synthesize relevant case studies.	
Brief outline of the course: - Scientific visualisation of data and information; A model of perceptual processing; - Criteria of good visual representation, Tufte's principles; - Environment, optics, resolution and the display; Lightness, brightness, contrast and colours; - Visual attention and information that pops out, preattentive processing; - The Gabor model and texture in visualisation;	

- Glyphs and multivariate discrete data; Visualization of multidimensional data using parallel coordinates;
- Static and moving patterns; Gestalt principles, perception of causality and animate motion;
- Visual objects and data objects; Image-based and structure-based object recognition, Biederman's geon theory;
- Space perception and the display of data in space; Perspective, shadows, depth of space, stereoscopic imaging;
- Interacting with visualisation, location and selection, reaction time, exploration and navigation loop.

Recommended literature:

Ware, C. 2012. Information Visualization: Perception for Design. Third Edition, Morgan Kaufmann, Elsevier, 2012. 512 p.
Cheong, S.H., Si, Y.W. 2020. Force-directed algorithms for schematic drawings and placement: A survey. Information visualization, 2020, 19(1), 65-91.
Chatzimparmpas, A., Martins, R.M. et al. 2020. A survey of surveys on the use of visualization for interpreting machine learning models. Information visualization. 2020, 19(3), 207-233.
Brodbeck D., Mazza R., Lalanne D. 2009. Interactive Visualization - A Survey. In Lalanne D., Kohlas J. (eds) Human Machine Interaction. Lecture Notes in Computer Science, 2009, 5440, Springer, Berlin, Heidelberg, 2009.
Chen, C. 2006. Information Visualization: Beyond the Horizon. Second Edition, Springer, 2006.
Mazza, R. 2009. Introduction to Information Visualization. Springer, 2009.
Tufte, E.R. 2001. The Visual Display of Quantitative Information. 2nd edition, Graphic Press, 2001.
Tufte. E.R. 1990. Envisioning Information. Graphic Press, 1990.
Tufte, E.R. 1997. Visual Explanations, Images and Quantities, Evidence and Narrative. Graphic Press, 1997.
Inselberg, A. 2009. Parallel Coordinates, Visual Multidimensional Geometry and Its Applications. Springer, 2009.
Kmeťová, M., Kmeť, T. 2013. Visualization of Some Geometric Relationships with Parallel Coordinates Using GeoGebra. In AIP Conference Proceedings, 2013, 1558, 2431-2434.
Kmeťová, M. 2012. Paralelné súradnice v geometrii. G – Slovenský časopis pre geometriu a grafiku, 2012, 9(18), 31-40.

Language knowledge required for passing the course:
Slovak/English

Notes:

Assessment of courses
The total number of assessed students: 0

ABS	N
0.0	0.0

Teachers: doc. RNDr. Mária Kmeťová, PhD., doc. Mgr. Martin Drlík, PhD.,

Date of last change: 09.01.2022

Guarantor program:

COURSE INFORMATION LETTER

University: Constantine the Philosopher University in Nitra

Faculty: Faculty of Natural Sciences and Informatics

Code of course: KI/ DSAIAU/22	**Name of course:** Learning Analytics

Type, extent and method of learning activities:
Form of study: Lecture
Recommended course-load (hours):
Per week: 2 **Per study period:** 26
Method of study: present

Number of credits: 5

Recommended semester/trimester of study:

Study level: III.

Prerequisites:

Conditions for completion the course:
Successful completion of the course is conditioned by an own solution of the research work and publication output in the field of the specialization Learning Analytics and Educational Data Mining.
Total student workload: 125 hours.
Out of which: lectures/consultations - 26 hours, solution of a research project - 75 hours, preparation of publication output - 24 hours.
Conditions for completion the course: Active participation in lectures/consultations, research solution, consisting in compiling research proposals and research methodology, conducting the research and presentation of research results in the form of research publication (min. 70% depending on the quality of publication output).

Learning outcomes:
The graduate student understands the individual steps in the planning of a research. The graduate student is able to compile research proposals, research methodology, conduct own scientific research, and present the results in the field of specialization Learning Analytics.
The graduate student characterizes the goals and follows the research trends of educational data mining and learning analytics.
The graduate student critically analyses and synthesizes relevant case studies.
The graduate student understands the specifics of data management in the domain of education.
The graduate student masters advanced techniques of creating consolidated data resources and applies appropriate data pre-processing techniques for the research project.
The graduate student proposes specific research scenarios to achieve the research goals.
The graduate student methodologically supports specific research in educational data mining and learning analytics.
The graduate student correctly implements specific activities in the particular stages of the knowledge discovery process.
The graduate student masters the techniques for storing, processing, analysing, and visualizing educational data from the software engineering point of view.
The graduate student critically evaluates new approaches and technologies, suggests their suitable application in research and deployment in the educational organization.

The graduate student professionally discusses and critically evaluates compliance with ethical and legal conditions for the processing and analysis of educational data.

Brief outline of the course:
- Basic definitions and characteristics of the research area of educational data mining (Learning Analytics), relation to related disciplines;
- Learning Analytics applications (learning progress tracking, predicting student's results and failures, recommending content, adaptive and personalized learning, curriculum design);
- Data management of the educational organization;
- Data resources and data types, data repositories, protocols and standards, ETL process, metadata, Learning Analytics architecture;
- Educational data pre-processing;
- Knowledge discovery tasks in the Learning Analytics domain - (description and summarization, segmentation, description of concepts, classification, prediction, relationship analysis);
- The role of time in research domain (time-on-task, trends, time-series, seasonality);
- Data visualization, trends and development of personalized Learning Analytics dashboards;
- Learning Analytics intervention mechanisms and their implementation;
- Specifics of software product development for Learning Analytics;
- Development, evaluation and deployment of a software product with an implemented machine learning model;
- Processing of large data in the field of education;
- Implementation and adaptation of Learning Analytics results in the conditions of the educational organization;
- Ethical and legal aspects of educational data analysis;
- Emerging trends in Learning Analytics (Discourse Analytics, Multimodal Learning Analytics).

Recommended literature:

Drlik, M., Munk, M., Skalka, J. 2021. Identification of Changes in VLE Stakeholders' Behavior Over Time Using Frequent Patterns Mining. IEEE Access. 2021, 9, 23795-23813.

Drlik, M., Munk, M. 2019. Understanding Time-Based Trends in Stakeholders' Choice of Learning Activity Type Using Predictive Models. IEEE Access. 2019, 7, 3106-3121.

Sclater, N. 2017. Learning analytics explained. Routledge, Taylor & Francis Group, London, 2017. ISBN 978-1-13893-173-2

Lang, C., Siemens, G., Wise, A.F., Gaševič, D. 2017. The Handbook of Learning Analytics. Society for Learning Analytics Research, 2017. ISBN 978-0-9952408-0-3

Pena-Ayala, A. 2017. Learning Analytics: Fundaments, Applications, and Trends. A View of the Current State of the Art to Enhance e-Learning. Springer International Publishing, 2017. ISBN 978-3-319-52976-9

Raschka, S., Mirjalili, V. 2017. Python Machine Learning Second Edition - Machine Learning and Deep Learning with Python, Scikit-learn, and TensorFlow. Packt Publishing, 2017. ISBN 978-1-78712-593-3

Drlík, M. 2020. Vybrané témy analýzy dát a vývoja softvéru v doméne Learning Analytics. Výstup národného projektu „IT Akadémia – vzdelávanie pre 21. storočie", edícia Prírodovedec č. 726, 2020.

Larusson, J.A., White A.B. 2014. Learning Analytics. From Research to Practice. Springer-Verlag New York, 2014. ISBN 978-1-4614-3304-0

Munk, M., Drlik, M. 2011. Impact of Different Pre-Processing Tasks on Effective Identification of Users' Behavioral Patterns in Web-based Educational System. PROCEDIA COMPUTER SCIENCE: ICCS 2011 International Conference on Computational Science (A-ranked conference series), Elsevier, 4, 1640-1649.

Language knowledge required for passing the course:
Slovak/English

Notes:

Assessment of courses
The total number of assessed students: 0

ABS	N
0.0	0.0

Teachers: doc. Mgr. Martin Drlík, PhD., doc. RNDr. Gabriela Lovászová, PhD.,

Date of last change: 20.12.2022

Guarantor program:

COURSE INFORMATION LETTER

University: Constantine the Philosopher University in Nitra	
Faculty: Faculty of Natural Sciences and Informatics	
Code of course: KI/ DSAISU/20	**Name of course:** Machine Learning
Type, extent and method of learning activities: **Form of study:** Lecture **Recommended course-load (hours):** **Per week:** 2 **Per study period:** 26 **Method of study:** present	
Number of credits: 5	
Recommended semester/trimester of study:	
Study level: III.	
Prerequisites:	
Conditions for completion the course: Successful completion of the course is conditioned by an own solution of the research work and publication output in the field of the following specialization Machine Learning. Total student workload: 125 hours. Of which: lectures/consultations - 26 hours, solution of a research project - 75 hours, preparation of publication output - 24 hours. Conditions for course completion: Active participation in lectures/consultations, research solution, consisting of compiling research proposals and research methodology, conducting the research and presentation of research results in the form of research publication (min. 70% depending on the quality of publication output).	
Learning outcomes: The graduate student understands the individual steps in the planning of research. The graduate student is able to compile research proposals, research methodology, conduct own scientific research, and present the results in the field of specialization Machine Learning. The graduate student can identify potential applications of machine learning in practice, can select the appropriate method based on the tasks and the nature of the source data. For the purposes of the research project, the student is able to prepare and select appropriate features from the data that serve as input to machine learning models. To achieve the research goal, the graduate student is able to use machine learning methods in areas such as regression, classification, clustering, search, and recommendation. The student is able to evaluate the quality of the created model in terms of relevant performance measures, can implement machine learning methods in the selected analytical tool, and/or using selected libraries in the selected programming language. The graduate student is able to critically evaluate contributions from scientific journals and conferences focused on machine learning.	
Brief outline of the course: - Machine learning applications, types of tasks for supervised and unsupervised learning, Python machine learning libraries (Keras, TensorFlow, PyTorch, Caffee, ..); - Regression - linear regression, non-linear regression, use of regression in selected tasks, model evaluation methods;	

- Classification - linear classifiers, Naive Bayes classifier, use of linear classifiers in selected tasks - sentiment analysis, spam identification, fake news identification;
- Classification - decision trees, selection of the most suitable property for division, creation of a decision tree using a tricky algorithm, conditions for stopping tree creation, learning of the model in regression and learning in the decision tree, simplification of the decision tree by pruning;
- Classification - K-Nearest Neighbor, use of the method for selected problems, the problem of missing data in a dataset, metrics accuracy and error rate in classification, confusion matrix;
- Clustering and similarity - document search, document representation model, TF/IDF, document similarity metrics, K-Means Clustering;
- Recommender Systems - a creation of the recommendation matrix, cold start problem, a recommendation as a classification task, collaborative filtering.

Recommended literature:

1. Müller, A.C., Guido, S. 2016. Introduction to Machine Learning with Python. O'Reilly Media, 2016. 400 p.
2. James, G., Witten, D., Hastie, T., Tibshirani, R. 2013. An Introduction to Statistical Learning. Springer, 2013. https://link.springer.com/book/10.1007/978-1-4614-7138-7#toc
3. Shai, S.S., Shai, B.D. 2014. Understanding Machine Learning: From Theory to Algorithms. Cambridge University Press, 2014. 424 p.
4. Murphy, K.P. 2012. Machine learning: a probabilistic perspective. MIT Press, 2012. 1104 p.
5. scikit-learn - Machine Learning in Python, https://scikit-learn.org/stable/#
6. Kapusta, J., Drlík, M., Munk, M. 2021. Using of n-grams from morphological tags for fake news classification, In. PeerJ Computer Science, 2021, 7, 1-27.
7. Kapusta, J., Benko. Ľ., Munková, D., Munk, M. 2021. Analysis of edit operations for post-editing systems. International Journal of Computational Intelligence Systems. 2021. 14, 197 (2021).
8. Nagy, K., Kapusta, J. 2021. Improving fake news classification using dependency grammar. PLOS ONE. 2021, 16, 1-22.
9. Pilkova, A., Munk, M., Benko, L., Blazekova, P., Kapusta, J. 2021. Pillar 3: Does banking regulation support stakeholders' interest in banks financial and risk profile? PLOS ONE, 16(10), 1-22.

Language knowledge required for passing the course:
Slovak/English

Notes:

Assessment of courses
The total number of assessed students: 3

ABS	N
100.0	0.0

Teachers: doc. PaedDr. Jozef Kapusta, PhD., prof. RNDr. Michal Munk, PhD.,

Date of last change: 30.03.2022

Guarantor program:

COURSE INFORMATION LETTER

University: Constantine the Philosopher University in Nitra	
Faculty: Faculty of Natural Sciences and Informatics	
Code of course: KI/ DSAIMPI/20	**Name of course:** Mathematical Principles of Informatics
Type, extent and method of learning activities: **Form of study:** Lecture **Recommended course-load (hours):** **Per week:** 2 **Per study period:** 26 **Method of study:** present	
Number of credits: 5	
Recommended semester/trimester of study:	
Study level: III.	
Prerequisites:	
Conditions for completion the course: Successful completion of the course is conditioned by proving the ability to apply the acquired knowledge to scientific work. Total student workload: 125 hours. Of which: lectures/consultations - 26 hours, own data analysis project solution - 99 hours. Conditions for course completion: The successful completion of the course is conditioned by an own project solution. Credits will not be awarded to a student who gains less than 70 percent of the total score.	
Learning outcomes: The graduate student gains familiarity with the fundamental factual, conceptual, and procedural knowledge of the mathematical principles of informatics in the application domain - knowledge discovery and data analysis, which is able to be creatively applied in scientific work in the field of applied informatics. The graduate student is able to apply statistical analysis procedures in order to verify research hypotheses and assumptions. For this purpose, the student will be able to obtain the necessary data through the measurement procedures. The graduate student is able to critically analyze and synthesize research concepts, report on analysis results, make statistical predictions, and provide visual data presentation. The graduate student is able to analyse and prove the correctness and computational complexity of non-trivial algorithmic problem-solving using a mathematical formalism. The graduate student is able to apply nondeterministic strategies based on random processes in solving the complex algorithmic problems. The graduate student is able to independently study the scientific literature and communicate own results of scientific work at a high formal level.	
Brief outline of the course: - Exploratory analysis (summarization, data description and visualization, analysis of residual values, data transformation); - Probability as a theoretical basis of inferential analysis (normal distribution of a random variable, overview of distributions derived from the normal distribution); - inferential analysis (parameter estimates and hypotheses testing, parametric/non-parametric tests, dependent/independent samples, univariate/multiple/multivariate analyzes);	

- Basic statistical methods (descriptive statistics, distribution tests, tests about variance and their non-parametric alternatives, tests about expected value and their non-parametric alternatives, relations between variables);
- Multivariate exploratory techniques (measures of relations, segmentation, classification, dimension reduction, reliability analysis);
- Linear models (regression analysis, analysis of variance), general linear models GLM, generalized linear models GLZM;
- Generating functions (simple sequences and their generating functions, operations with generating function, generating functions for recurrent sequences);
- Asymptotic analysis of algorithms complexity (upper O, lower Ω, exact bound function of complexity, asymptotic properties, asymptotic hierarchy, manipulations with O-notation);
- Discrete probability as a formal mathematical basics for analysing probabilistic algorithms (axiomatic definition of probability, discrete probability space, discrete random variables and their properties);
Probabilistic algorithms (classification, examples, probabilistic analysis of correctness and computational complexity of randomized algorithms, derandomization).

Recommended literature:

Munk, M. 2011. Počítačová analýza dát. Nitra : UKF, 2011. 361 s. ISBN 978-80-8094-895-5
Benko, Ľ., Munk, M. 2021. Data Mining. Nitra : UKF, 2021. 131 s. ISBN 978-80-558-1794-1
Antoni, Ľ. a kol. 2020. Dátová veda a jej aplikácie : národný výstup projektu IT Akadémia – vzdelávanie pre 21. storočie. Košice : ŠafárikPress, 2020. 188 s. ISBN 978-80-8152-917-7
Munk, M., Pilkova, A., Benko, L., Blazekova, P., Svec, P. 2021. Web usage analysis of Pillar 3 disclosed information by deposit customers in turbulent times. Expert Systems with Applications. 2021, 185, art. no. 115503.
Munk, M., Drlik, M., Benko, L., Reichel, J. 2017. Quantitative and Qualitative Evaluation of Sequence Patterns Found by Application of Different Educational Data Preprocessing Techniques. IEEE Access. 2017, 5, art. no. 7932437.
Anděl, J. 2007. Statistické metody. Praha : MATFYZPRESS, 2007. 299 s. ISBN 80-86732-08-8
Meloun, M., Militký, J., Hill, M. 2005. Počítačová analýza vícerozměrných dat v příkladech. Praha : ACADEMIA, 2005. 450 s. ISBN 80-200-1335-0
Meloun, M., Militký, J. 2004. Statistická analýza experimentálních dat. Praha : ACADEMIA, 2004. 954 s. ISBN 80-200-1254-0
Vaishnavi, V.K., Kuechler, W. Jr. 2008. Design Science Research Methods and Pattens: Innovating Information and Communication Technology. CRC Press, 2008. ISBN 978-1-4200-5932-8
Hill, T., Lewicki, P. 2006. Statistics: methods and applications : a comprehensive reference for science, insdustry and data mining. Tulsa : StatSoft, 2006. 832 p. ISBN 1-884233-59-7
Graham, L., Knuth, D.E., Patashnik, O. 1994. Concrete Mathematics: A Foundation for Computer Science. Addison-Wesley, 1994. 657 p. ISBN 0-201-55802-5
Mitzenmacher, M., Upfal, E. 2005. Probability and Computing - Randomized Algorithms and Probabilistic Analysis. Cambridge University Press, 2005. 352 p. ISBN 0-521-83540-2
Hromkovič, J. 2005. Design and Analysis of Randomized Algorithms. Springer, 2005. ISBN ISBN-103-540-23949-9
Lovász, L. 2007. Combinatorial Problems and Exercises. Second Edition. AMS Chelsea Publishing, 2007. 639 p. ISBN 978-0-8218-4262-1

Language knowledge required for passing the course:
Slovak/English

Notes:

Assessment of courses The total number of assessed students: 8	
ABS	N
100.0	0.0

Teachers: prof. RNDr. Michal Munk, PhD., doc. RNDr. Gabriela Lovászová, PhD.,

Date of last change: 30.03.2022

Guarantor program:

COURSE INFORMATION LETTER

University: Constantine the Philosopher University in Nitra
Faculty: Faculty of Natural Sciences and Informatics
Code of course: KI/DSAIMRS/20 — **Name of course:** Monitoring and Control Systems
Type, extent and method of learning activities: **Form of study:** Lecture **Recommended course-load (hours):** **Per week:** 2 **Per study period:** 26 **Method of study:** present
Number of credits: 5
Recommended semester/trimester of study:
Study level: III.
Prerequisites:
Conditions for completion the course: Successful completion of the course is conditioned by an own solution of the research work and publication output in the field of the following specialization Monitoring and Control Systems. Total student workload: 125 hours. Of which: lectures/consultations - 26 hours, solution of a research project - 75 hours, preparation of publication output - 24 hours. Conditions for course completion: Active participation in lectures/consultations, research solution, consisting of compiling research proposals and research methodology, conducting the research and presentation of research results in the form of research publication (min. 70% depending on the quality of publication output).
Learning outcomes: The graduate student understands the individual steps in the planning of research. The graduate student is able to compile research proposals, research methodology, conduct own scientific research, and present the results in the following field of specialization Monitoring and Control Systems. The graduate student is able to apply knowledge of the theoretical principles of intelligent systems and is familiar with the latest trends in research and development in a relevant scientific field, which is the subject of the student´s research work. The student gains knowledge of the methodology of intelligent systems and is able to develop and use these systems in process management using the Arduino microcontroller and Raspberry microcomputer by applying new technologies directly in industry. The graduate student is able to analyse and subsequently set up the procedures and tools for the specification and configuration of specific control systems in practice. The graduate student can critically evaluate contributions from journal articles and conferences focused on monitoring and control systems.
Brief outline of the course: - Trends in monitoring and control system technologies; - Programmable control systems; - Implementation of control circuits in monitoring and control systems; - Application of microcontrollers in monitoring and control systems; - Programming languages for microcontrollers and microcomputers;

- Analyzing and evaluating sensor signals;
- Intelligent devices in the field of control systems.

Recommended literature:

Language knowledge required for passing the course:
Slovak/English

Notes:

Assessment of courses
The total number of assessed students: 0

ABS	N
0.0	0.0

Teachers: doc. Ing. Štefan Koprda, PhD., doc. PaedDr. Martin Magdin, Ph.D.,

Date of last change: 12.01.2022

Guarantor program:

COURSE INFORMATION LETTER

University: Constantine the Philosopher University in Nitra	
Faculty: Faculty of Natural Sciences and Informatics	
Code of course: KI/ DSAISPJ/20	**Name of course:** Natural Language Processing
Type, extent and method of learning activities: **Form of study:** Lecture **Recommended course-load (hours):** **Per week:** 2 **Per study period:** 26 **Method of study:** present	
Number of credits: 5	
Recommended semester/trimester of study:	
Study level: III.	
Prerequisites:	
Conditions for completion the course: Successful completion of the course is conditioned by an own solution of the research work and publication output in the field of the following specialization - Natural Language Processing. Total student workload: 125 hours. Of which: lectures/consultations - 26 hours, solution of a research project - 75 hours, preparation of publication output - 24 hours. Conditions for course completion: Active participation in lectures/consultations, research solution, consisting of compiling research proposals and research methodology, conducting the research and presentation of research results in the form of research publication (min. 70% depending on the quality of publication output).	
Learning outcomes: The graduate student understands the individual steps in the planning of research. The graduate student is able to compile research proposals, research methodology, conduct own scientific research, and present the results in the field of specialization Natural Language Processing. The graduate student is familiar with the current challenges and solutions for NLP tasks in the field of text-to-text transformations such as machine translation. The graduate student has mastered the methods of scientific research to be able to solve current problems in NLP area. The graduate student is able to critically analyse and synthesize new and more complex NLP concepts. The graduate student is familiar with important linguistic concepts involved in language understanding and generation. The graduate student is able to devise, implement, and apply relevant pre-processing steps for NLP components. The graduate student can build, evaluate, critically analyse, and improve models using existing ML algorithms and frameworks for various NLP tasks, primarily for machine translation. The graduate student has skills to conduct own experiment and evaluate its results focused on machine translation.	
Brief outline of the course: - Uncertainty and Ambiguity in Natural Language Processing (NLP); - Word Representation Techniques (Count Vectorization, Word2Vec, etc.); - NLP Task and Techniques (Stemming, Lemmatization, Tokenization, Stopwords Removal, Word Sense Disambiguation, POS Tagging);	

- Machine Translation (Different types of machine translation in NLP); Evolution of Machine Translation; Applications of Machine Translation (Transformation Tasks, Text and Speech Translation);
- Machine Translation Models (Encoder-Decoder Models, Attention Model, Transformer Model: BERT, GPT);
- Machine Translation Evaluation; Evaluation of MT Models Performance (SacreBLEU, BERTScore);
- Manual MT Evaluation; Quality Criteria: adequacy (accuracy, fidelity), comprehensibility (intelligibility) and fluency (grammaticality); Ranking; Error Classification and Error Typology;
- Automatic MT Evaluation; Automatic MT Metrics (Precision, Recall, f-score, BLEU, METEOR, NIST, TER, etc.);
- Quality Estimation for MT (Applications, Labels, Features, Architectures, Evaluation, etc.).

Recommended literature:

Language knowledge required for passing the course:
Slovak/English

Notes:

Assessment of courses
The total number of assessed students: 2

ABS	N
100.0	0.0

Teachers: prof. RNDr. Daša Munková, PhD., prof. Mgr. Štefan Beňuš, PhD.,

Date of last change: 20.12.2022

Guarantor program:

COURSE INFORMATION LETTER

University: Constantine the Philosopher University in Nitra	
Faculty: Faculty of Natural Sciences and Informatics	
Code of course: KI/DSAIRV/20	**Name of course:** Pattern Recognition
Type, extent and method of learning activities: **Form of study:** Lecture **Recommended course-load (hours):** **Per week:** 2 **Per study period:** 26 **Method of study:** present	
Number of credits: 5	
Recommended semester/trimester of study:	
Study level: III.	
Prerequisites:	
Conditions for completion the course: Successful completion of the course is conditioned by an own solution of the research work and publication output in the field of the following specialization Pattern Recognition. Total student workload: 125 hours. Of which: lectures/consultations - 26 hours, solution of a research project - 75 hours, preparation of publication output - 24 hours. Conditions for course completion: Active participation in lectures/consultations, research solution, consisting of compiling research proposals and research methodology, conducting the research and presentation of research results in the form of research publication (min. 70% depending on the quality of publication output).	
Learning outcomes: The graduate student understands the individual steps in the planning of research. The graduate student is able to compile research proposals, research methodology, conduct own scientific research, and present the results in the field of specialization Pattern Recognition. The graduate student is able to identify potential applications of pattern recognition in practice, knows the basic methods of pattern recognition, can choose the appropriate method based on the assignment of the solved task. The graduate student can prepare and select appropriate features for pattern recognition, knows the basic advantages, disadvantages and limitations of methods used in recognition, can apply these methods to real problems in the field of text recognition from image, speech analysis, human recognition, their age, gender, detection, extraction and classification of the user's emotional state, etc. The graduate student can implement pattern recognition methods in the selected analytical tool, and/or using selected libraries in the selected programming language. The graduate student can critically evaluate contributions from articles and conferences focused on pattern recognition.	
Brief outline of the course: - Pattern recognition tasks, features selection; - Pattern recognition with supervised learning methods, classifiers based on Bayesian decision theory; - Linear and non-linear classifiers - neural networks, decision trees, template matching, SVM (Support Vector Machine);	

- Pattern recognition with unsupervised learning methods, basic principles of clustering;
- Perception and internal model of the world, pattern recognition (feature recognition, scene analysis);
- Text recognition (binarizer, segmenter, thresholder, typesetter, scaler, matcher, linguist);
- Selection of features in text recognition, templates, histograms, intersections, Fourier transform, hysteresis smoothing, Gabor Filters, Local Binary Patterns LBP;
- Pattern comparison methods, minimum error method, similarity metrics;
- Sound analysis, pulse code modulation, short-term function of the mean number of signal transitions to zero, DTW algorithm, application of sound analysis methods;
- Pattern recognition applications (machine vision, computer diagnostics, speech recognition, character recognition, text recognition, person recognition, age, gender, detection, extraction and classification of the user's emotional state, etc.).

Recommended literature:

Behera, N.K.S., Sa, P.K., Bakshi, S. 2020. Person re-identification for smart cities: State-of-the-art and the path ahead. PATTERN RECOGNITION LETTERS. 2020, 138, 282-289.
Ivanovs, M., Kadikis, R., Ozols, K. 2021. Perturbation-based methods for explaining deep neural networks: A survey. PATTERN RECOGNITION LETTERS. 2021. 150, 228-234.
Bishop, C.M. 2016. Pattern Recognition and Machine Learning, Springer, 2016. 738 s.
Theodoridis, S., Koutroumbas, K. 2008. Pattern Recognition. 4th Edition, Elsevier Academic Press, 2008. 984 p.
Chen, C.H. 2016. Handbook Of Pattern Recognition And Computer Vision. 5th Edition, World Scientific Publishing, 2016. 561 p.
Duda, R.O., Hart, P.E., Stork, D.G. 2000. Pattern Classification. Second Edition, A Wiley-Interscience Publication, 2000. 688 p.
Evangelia, M.T. 2000. Supervised and Unsupervisd Pattern Recognition, Feature Extraction and Computational Intellingence. CRC Press, 2000. 392 p.
Marsland, S. 2009. Machine Learning: An Algorithmic Perspective. CRC Press, 2009.
Magdin, M. 2016. Metódy detekcie, extrakcie a klasifikácie emocionálneho stavu používateľa. 1. vyd., Nitra : UKF, 2016. 140 s. ISBN 978-80-558-1020-1
Magdin, M., Balogh, Z., Reichel, J., Francisti, J., Koprda, Š., & György, M. (2021). Automatic detection and classification of emotional states in virtual reality and standard environments (LCD): comparing valence and arousal of induced emotions. Virtual Reality, 1-13.
Balogh, Z., Magdin, M., & Molnár, G. (2019). Motion Detection and Face Recognition using Raspberry Pi, as a Part of, the Internet of Things. Acta Polytechnica Hungarica, 16(3), 167-185.

Language knowledge required for passing the course:
Slovak/English

Notes:

Assessment of courses
The total number of assessed students: 0

ABS	N
0.0	0.0

Teachers: doc. PaedDr. Martin Magdin, Ph.D., doc. PaedDr. Jozef Kapusta, PhD.,

Date of last change: 13.01.2022

Guarantor program:

COURSE INFORMATION LETTER

University: Constantine the Philosopher University in Nitra	
Faculty: Faculty of Natural Sciences and Informatics	
Code of course: KI/ SSdd/15	**Name of course:** PhD Thesis and Its Defence
Type, extent and method of learning activities: **Form of study:** **Recommended course-load (hours):** **Per week:** **Per study period:** **Method of study:** present	
Number of credits: 30	
Recommended semester/trimester of study:	
Study level: III.	
Prerequisites:	
Conditions for completion the course: The total workload per student is to obtain 150 credits for the relevant degree. Prerequisites: The condition for the submission of the dissertation and its subsequent defense is the successful completion of all compulsory subjects and the number of compulsory elective and elective subjects prescribed by the relevant study program. During the defense of the thesis, the student presents the achieved results obtained by processing issues, while consistently respecting the topic of the work, adhering to the annotation of the work and time limited to presentation. During the defense, he clearly, concisely and consistently presents the methodology of work processing, results obtained by its solution, the contribution of the solved problem, recommendations for theory and professional practice. In the ensuing discussion, he responds and answers questions or comments from members of the State Commission exams.	
Learning outcomes: By processing and defending the dissertation, the student demonstrates: • ability and readiness for independent scientific and creative activity in the field of research or development, or for independent theoretical and creative artistic activity, • ability to present the results of scientific research and the application of research results in social practice, • the ability to work with information sources and to cite and search them correctly, both in library and electronic media and international databases, and to select from them essential information for their topic, and to cite it correctly, respecting the principles of ethics. The result of the dissertation should be the acquisition of new knowledge in the field.	
Brief outline of the course: • elaboration of the dissertation • presentation of the dissertation • defense of the dissertation in terms of reviews and discussion of the work	
Recommended literature: • UKF guideline in Nitra no. 13/2020 Directive on final, rigorous habilitation theses (www.uk.ukf.sk)	

• KATUŠČÁK, D. 2013. Ako písať záverečné a kvalifikačné práce. Nitra : Enigma,
• Kolektív autorov 2013. Pravidlá slovenského pravopisu. VEDA, Bratislava
•MEŠKO, D., KATUŠČÁK, D. a kol. 2004. Akademická príručka. Martin : Osveta, 2004. 317 s. ISBN 80-8063-150-6
•REDHAMMER, R. 1995. Ako obhájiť diplomovku. Bratislava : STU, 1995. 48 s. ISBN 80-227-0765-1
• SKALKA, J. a kol. 2009. Prevencia a odhaľovanie plagiátorstva. Nitra : UKF, 2009. 126 s. ISBN 978-80-8094-612-8

Language knowledge required for passing the course:
Slovak/English

Notes:

Assessment of courses
The total number of assessed students: 9

A	B	C	D	E	FX	RNPR	RPR
66.67	22.22	0.0	11.11	0.0	0.0	0.0	0.0

Teachers:

Date of last change: 30.03.2022

Guarantor program:

COURSE INFORMATION LETTER

University: Constantine the Philosopher University in Nitra	
Faculty: Faculty of Natural Sciences and Informatics	
Code of course: KI/DSAIPM/20	**Name of course:** Process Modelling
Type, extent and method of learning activities: **Form of study:** Lecture **Recommended course-load (hours):** **Per week:** 2 **Per study period:** 26 **Method of study:** present	
Number of credits: 5	
Recommended semester/trimester of study:	
Study level: III.	
Prerequisites:	
Conditions for completion the course: Successful completion of the course is conditioned by an own solution of the research work and publication output in the field of the following specialization Process Modelling. Total student workload: 125 hours. Of which: lectures/consultations - 26 hours, solution of a research project - 75 hours, preparation of publication output - 24 hours. Conditions for course completion: Active participation in lectures/consultations, research solution, consisting of compiling research proposals and research methodology, conducting the research and presentation of research results in the form of research publication (min. 70% depending on the quality of publication output).	
Learning outcomes: The graduate student understands the individual steps in the planning of research. The graduate student is able to compile research proposals, research methodology, conduct own scientific research, and present the results in the field of specialization Process Modelling. The graduate student gains familiarity with the crucial knowledge in the field of process modelling and simulation. The graduate student gains a deeper knowledge of simulation tools, especially Petri nets. The student understands the principles of simulation systems, allowing their problem ´s orientation. The graduate student gains general knowledge and skills in the area of process modelling using Petri nets and is able to implement gained knowledge in specific systems. To achieve the research goal, the student is able to model IF THEN rules by using Petri nets, implement fuzzy logic in Petri nets, model public service systems, and model logical and continuous systems. The graduate student can critically analyze and synthesize the relevant case studies and to creatively apply the latest scientific knowledge in solving the scientific and technical problems. The student is able to design original procedures and solutions with a clear contribution to theory and practice.	
Brief outline of the course: - Advanced systems modelling and simulation (classification of systems: deterministic and non-deterministic (stochastic) systems, continuous and discrete systems, centralised and distributed systems); - Principles of system modelling and simulation (classification of models, finite automata, DES (discrete event systems));	

- Petri Nets (Low-level Petri Nets: C/E (Condition/Event) Petri Nets, P/T (Place/Transitions) Petri Nets, Deterministic Timed Petri Nets, Stochastic Timed Petri Nets, Higher level Petri nets: Coloured Petri nets, Hierarchical Petri nets, Fuzzy Petri nets, Object-Oriented Petri nets);
- Process modelling (process design, process modelling, process implementation, process execution, process monitoring, process optimization);
- Modelling of public service system by Petri nets;
- Modelling of logical and continuous systems by Petri nets.

Recommended literature:

Balogh, Z., Kuchárik, M. 2019. Predicting Student Grades Based on Their Usage of LMS Moodle Using Petri Nets. Appl. Sci. 2019, 9, 4211, 1-16.
Kuchárik, M., Balogh, Z. 2019. Modeling of uncertainty with Petri nets. In Lecture Notes in Computer Science, 11th Asian Conference on Intelligent Information and Database Systems, ACIIDS 2019. Springer, 2019, 11431, 499-509.
Kuchárik, M., Balogh, Z. 2016. Evaluation of fuzzy Petri nets with the tool TransPlaceSim. In 2016 IEEE 10th International Conference on Application of Information and Communication Technologies (AICT). IEEE, 2016, 148-152.
Balogh, Z., Turčáni, M. 2016. Modeling of data security in cloud computing. In 10th Annual International Systems Conference IEEE, (SysCon). IEEE, 2016, 1-6.
Klimeš, C., Balogh, Z. 2012. Modelovanie procesov pomocou Petriho sietí. Nitra : UKF, 2012. 203 s. ISBN 978-80-558-0044-8
Klimeš, C., Balogh, Z. 2008. Modelovanie paralelných procesov v operačných systémoch pomocou Petriho sieti. Nitra : UKF, 2008. 101 s. ISBN 978-80-8094-420-9
Donatelli, S., Haar, S. 2019. Application and Theory of Petri Nets and Concurrency: 40th International Conference, PETRI NETS 2019. Springer, 2019. 475 p.
Hollý, J. 2009. Stochastické Petriho siete II. Bratislava : STU, 2009.
Hrúz, B., Zhou, M.C. 2007. Modeling and Control of Discrete-event Dynamic Systems: with Petri Nets and Other Tools. Springer, 2007. 333 p.
Reisig, W., Rozenberg, G. (Eds.). 1998. Lectures on Petri nets I: Basic Models: Advances in Petri nets. Springer Science & Business Media, 1998. 477 p.

Language knowledge required for passing the course:
Slovak/English

Notes:

Assessment of courses
The total number of assessed students: 1

ABS	N
100.0	0.0

Teachers: doc. Ing. Zoltán Balogh, PhD., doc. Ing. Štefan Koprda, PhD.,

Date of last change: 13.01.2022

Guarantor program:

COURSE INFORMATION LETTER

University: Constantine the Philosopher University in Nitra
Faculty: Faculty of Natural Sciences and Informatics

Code of course: KI/ DSVV1/16	**Name of course:** Research activities – 1st year

Type, extent and method of learning activities:
Form of study:
Recommended course-load (hours):
Per week: **Per study period:**
Method of study: present

Number of credits: 0

Recommended semester/trimester of study: 2.

Study level: III.

Prerequisites:

Conditions for completion the course:
Credits are granted for absolving individual activities and after approval of the committee based on the proposal for the annual evaluation of the doctoral student.
Activities:
• Scientific work in a journal with a non-zero IF categorized in Q1 or Q2 according to the JCR® in the particular or related field – 50 credits/work
• Scientific work in a journal with a non-zero IF categorized in Q3 or Q4 according to the JCR® in the particular or related field – 30 credits/work
• Scientific work in a conference proceeding or journal without IF indexed in international citation databases (WOS, Scopus) – 20 credits/work
• Scientific work in a reviewed, non-indexed scientific journal – 5 credits/work, maximally 15 credits per study period
• Scientific work in reviewed, non-indexed scientific proceedings – 3 credits/work, maximally 12 credits per study period
• International patent – 50 credits/patent
• National patent – 30 credits/patent
• Citation registered in international citation database (WOS, Scopus) – 10 credits/citation
• Membership in an international project – 20 credits/membership
• Membership in a national project – 10 credits/membership

Learning outcomes:
• The student actively transfers the acquired knowledge and experience associated with his/her scientific activities into publication outputs. He/She knows how to use obtained knowledge to explain it clearly and comprehensibly, using appropriate terminology and precisely formulate it in written form.
• The student knows how to work professionally with national and foreign information resources, respecting professional academic ethics and standards. He/She demonstrates skills and abilities generally usable in a review of scientific or other professional outputs that can be published in a Slovak or foreign publishing house or periodical publications.
• The student can obtain relevant factual data and information, interpret them correctly, and defend and argue. He/She can conceive, construct, implement, edit, and publish a substantial part of his/

her research in periodicals, conference proceedings, or other monographic publications registered in the WoS and Scopus databases.
All activities are relevant for doctoral studies and create a part of an individual study plan. The student critically analyzes, re-evaluates and, considering the conditions of the training workplace, also applies acquired knowledge, skills, habits, and scientific information to his/her scientific research.

Brief outline of the course:
1. Scientific work in a journal with a non-zero IF categorized in Q1 or Q2 according to the JCR® in the particular or related field
2. Scientific work in a journal with a non-zero IF categorized in Q3 or Q4 according to the JCR® in the particular or related field
3. Scientific work in a conference proceeding or journal without IF indexed in international citation databases (WOS, Scopus)
4. Scientific work in a reviewed, non-indexed scientific journal.
5. International or national patent
6. Citation registered in international citation database (WOS, Scopus)
7. Membership in an international or national project

Recommended literature:
• Alley M. (2011). The Craft of Scientific Presentation. Springer. 4. vydanie
• Katuščák, D. (2004). Ako písať záverečné a kvalifikačné práce. Enigma
• STN 01 6910 Pravidlá písania a úpravy písomností (výklad normy, 2021)
• Gastel, B., Day, R. A. (2016). How to Write and Publish a Scientific Paper. Greenwood, ISBn: 978-1440842801,
• Glasman, D. (2009). Science Research Writing for Non-Native Speakers of English. World Scientific Publishing,
• Burton, H. M. (2021). Your First Research Paper: Learn how to start, structure, write and publish a perfect research paper to get the top mark. Independently Publisher

Language knowledge required for passing the course:
Slovak/English

Notes:
The committee proposes the number of credits for publication activities as a proportional part of the credits based on the assessment of the significance of the author's share.
Publications are documented by an extract from the system of publication activity at the UKF.
The condition for the proper completion of studies at the Faculty of Natural Sciences and Informatics of the UKF in Nitra is the publication of at least two scientific papers of the quality determined by the committee and the acquisition of at least 60 credits for scientific activities.
Study rules of doctoral studies at the FPVaI - appendix 2: Sample report on doctoral studies

Assessment of courses
The total number of assessed students: 17

ABS	N
100.0	0.0

Teachers:

Date of last change: 24.08.2022

Guarantor program:

COURSE INFORMATION LETTER

University: Constantine the Philosopher University in Nitra

Faculty: Faculty of Natural Sciences and Informatics

Code of course: KI/ DSVV2/16	**Name of course:** Research activities – 2nd year

Type, extent and method of learning activities:
Form of study:
Recommended course-load (hours):
Per week: **Per study period:**
Method of study: present

Number of credits: 0

Recommended semester/trimester of study: 4.

Study level: III.

Prerequisites:

Conditions for completion the course:
Credits are granted for absolving individual activities and after approval of the committee based on the proposal for the annual evaluation of the doctoral student.
Activities:
• Scientific work in a journal with a non-zero IF categorized in Q1 or Q2 according to the JCR® in the particular or related field – 50 credits/work
• Scientific work in a journal with a non-zero IF categorized in Q3 or Q4 according to the JCR® in the particular or related field – 30 credits/work
• Scientific work in a conference proceeding or journal without IF indexed in international citation databases (WOS, Scopus) – 20 credits/work
• Scientific work in a reviewed, non-indexed scientific journal – 5 credits/work, maximally 15 credits per study period
• Scientific work in reviewed, non-indexed scientific proceedings – 3 credits/work, maximally 12 credits per study period
• International patent – 50 credits/patent
• National patent – 30 credits/patent
• Citation registered in international citation database (WOS, Scopus) – 10 credits/citation
• Membership in an international project – 20 credits/membership
• Membership in a national project – 10 credits/membership

Learning outcomes:
• The student actively transfers the acquired knowledge and experience associated with his/her scientific activities into publication outputs. He/She knows how to use obtained knowledge to explain it clearly and comprehensibly, using appropriate terminology and precisely formulate it in written form.
• The student knows how to work professionally with national and foreign information resources, respecting professional academic ethics and standards. He/She demonstrates skills and abilities generally usable in a review of scientific or other professional outputs that can be published in a Slovak or foreign publishing house or periodical publications.
• The student can obtain relevant factual data and information, interpret them correctly, and defend and argue. He/She can conceive, construct, implement, edit, and publish a substantial part of his/

her research in periodicals, conference proceedings, or other monographic publications registered in the WoS and Scopus databases.
All activities are relevant for doctoral studies and create a part of an individual study plan. The student critically analyzes, re-evaluates and, considering the conditions of the training workplace, also applies acquired knowledge, skills, habits, and scientific information to his/her scientific research.

Brief outline of the course:
1. Scientific work in a journal with a non-zero IF categorized in Q1 or Q2 according to the JCR® in the particular or related field
2. Scientific work in a journal with a non-zero IF categorized in Q3 or Q4 according to the JCR® in the particular or related field
3. Scientific work in a conference proceeding or journal without IF indexed in international citation databases (WOS, Scopus)
4. Scientific work in a reviewed, non-indexed scientific journal.
5. International or national patent
6. Citation registered in international citation database (WOS, Scopus)
7. Membership in an international or national project

Recommended literature:
• Alley M. (2011). The Craft of Scientific Presentation. Springer. 4. vydanie
• Katuščák, D. (2004). Ako písať záverečné a kvalifikačné práce. Enigma
• STN 01 6910 Pravidlá písania a úpravy písomností (výklad normy, 2021)
• Gastel, B., Day, R. A. (2016). How to Write and Publish a Scientific Paper. Greenwood, ISBn: 978-1440842801,
• Glasman, D. (2009). Science Research Writing for Non-Native Speakers of English. World Scientific Publishing,
• Burton, H. M. (2021). Your First Research Paper: Learn how to start, structure, write and publish a perfect research paper to get the top mark. Independently Publisher

Language knowledge required for passing the course:
Slovak/English

Notes:
The committee proposes the number of credits for publication activities as a proportional part of the credits based on the assessment of the significance of the author's share.
Publications are documented by an extract from the system of publication activity at the UKF.
The condition for the proper completion of studies at the Faculty of Natural Sciences and Informatics of the UKF in Nitra is the publication of at least two scientific papers of the quality determined by the committee and the acquisition of at least 60 credits for scientific activities.
Study rules of doctoral studies at the FPVaI - appendix 2: Sample report on doctoral studies

Assessment of courses
The total number of assessed students: 14

ABS	N
100.0	0.0

Teachers:

Date of last change: 24.08.2022

Guarantor program:

COURSE INFORMATION LETTER

University: Constantine the Philosopher University in Nitra	
Faculty: Faculty of Natural Sciences and Informatics	
Code of course: KI/ DSVV3/16	**Name of course:** Research activities – 3rd year
Type, extent and method of learning activities: **Form of study:** **Recommended course-load (hours):** **Per week: Per study period:** **Method of study:** present	
Number of credits: 0	
Recommended semester/trimester of study: 6.	
Study level: III.	
Prerequisites:	

Conditions for completion the course:

Credits are granted for absolving individual activities and after approval of the committee based on the proposal for the annual evaluation of the doctoral student.

Activities:

• Scientific work in a journal with a non-zero IF categorized in Q1 or Q2 according to the JCR® in the particular or related field – 50 credits/work
• Scientific work in a journal with a non-zero IF categorized in Q3 or Q4 according to the JCR® in the particular or related field – 30 credits/work
• Scientific work in a conference proceeding or journal without IF indexed in international citation databases (WOS, Scopus) – 20 credits/work
• Scientific work in a reviewed, non-indexed scientific journal – 5 credits/work, maximally 15 credits per study period
• Scientific work in reviewed, non-indexed scientific proceedings – 3 credits/work, maximally 12 credits per study period
• International patent – 50 credits/patent
• National patent – 30 credits/patent
• Citation registered in international citation database (WOS, Scopus) – 10 credits/citation
• Membership in an international project – 20 credits/membership
• Membership in a national project – 10 credits/membership

Learning outcomes:

• The student actively transfers the acquired knowledge and experience associated with his/her scientific activities into publication outputs. He/She knows how to use obtained knowledge to explain it clearly and comprehensibly, using appropriate terminology and precisely formulate it in written form.
• The student knows how to work professionally with national and foreign information resources, respecting professional academic ethics and standards. He/She demonstrates skills and abilities generally usable in a review of scientific or other professional outputs that can be published in a Slovak or foreign publishing house or periodical publications.
• The student can obtain relevant factual data and information, interpret them correctly, and defend and argue. He/She can conceive, construct, implement, edit, and publish a substantial part of his/

her research in periodicals, conference proceedings, or other monographic publications registered in the WoS and Scopus databases.
All activities are relevant for doctoral studies and create a part of an individual study plan. The student critically analyzes, re-evaluates and, considering the conditions of the training workplace, also applies acquired knowledge, skills, habits, and scientific information to his/her scientific research.

Brief outline of the course:
1. Scientific work in a journal with a non-zero IF categorized in Q1 or Q2 according to the JCR® in the particular or related field
2. Scientific work in a journal with a non-zero IF categorized in Q3 or Q4 according to the JCR® in the particular or related field
3. Scientific work in a conference proceeding or journal without IF indexed in international citation databases (WOS, Scopus)
4. Scientific work in a reviewed, non-indexed scientific journal.
5. International or national patent
6. Citation registered in international citation database (WOS, Scopus)
7. Membership in an international or national project

Recommended literature:
• Alley M. (2011). The Craft of Scientific Presentation. Springer. 4. vydanie
• Katuščák, D. (2004). Ako písať záverečné a kvalifikačné práce. Enigma
• STN 01 6910 Pravidlá písania a úpravy písomností (výklad normy, 2021)
• Gastel, B., Day, R. A. (2016). How to Write and Publish a Scientific Paper. Greenwood, ISBn: 978-1440842801,
• Glasman, D. (2009). Science Research Writing for Non-Native Speakers of English. World Scientific Publishing,
• Burton, H. M. (2021). Your First Research Paper: Learn how to start, structure, write and publish a perfect research paper to get the top mark. Independently Publisher

Language knowledge required for passing the course:
Slovak/English

Notes:
The committee proposes the number of credits for publication activities as a proportional part of the credits based on the assessment of the significance of the author's share.
Publications are documented by an extract from the system of publication activity at the UKF.
The condition for the proper completion of studies at the Faculty of Natural Sciences and Informatics of the UKF in Nitra is the publication of at least two scientific papers of the quality determined by the committee and the acquisition of at least 60 credits for scientific activities.
Study rules of doctoral studies at the FPVaI - appendix 2: Sample report on doctoral studies

Assessment of courses
The total number of assessed students: 9

ABS	N
100.0	0.0

Teachers:

Date of last change: 24.08.2022

Guarantor program:

COURSE INFORMATION LETTER

University: Constantine the Philosopher University in Nitra	
Faculty: Faculty of Natural Sciences and Informatics	
Code of course: KI/ DSVV4/16	**Name of course:** Research activities – 4th year
Type, extent and method of learning activities: **Form of study:** **Recommended course-load (hours):** **Per week: Per study period:** **Method of study:** present	
Number of credits: 0	
Recommended semester/trimester of study: 6.	
Study level: III.	
Prerequisites:	
Conditions for completion the course: Credits are granted for absolving individual activities and after approval of the committee based on the proposal for the annual evaluation of the doctoral student. Activities: • Scientific work in a journal with a non-zero IF categorized in Q1 or Q2 according to the JCR® in the particular or related field – 50 credits/work • Scientific work in a journal with a non-zero IF categorized in Q3 or Q4 according to the JCR® in the particular or related field – 30 credits/work • Scientific work in a conference proceeding or journal without IF indexed in international citation databases (WOS, Scopus) – 20 credits/work • Scientific work in a reviewed, non-indexed scientific journal – 5 credits/work, maximally 15 credits per study period • Scientific work in reviewed, non-indexed scientific proceedings – 3 credits/work, maximally 12 credits per study period • International patent – 50 credits/patent • National patent – 30 credits/patent • Citation registered in international citation database (WOS, Scopus) – 10 credits/citation • Membership in an international project – 20 credits/membership • Membership in a national project – 10 credits/membership	
Learning outcomes: • The student actively transfers the acquired knowledge and experience associated with his/her scientific activities into publication outputs. He/She knows how to use obtained knowledge to explain it clearly and comprehensibly, using appropriate terminology and precisely formulate it in written form. • The student knows how to work professionally with national and foreign information resources, respecting professional academic ethics and standards. He/She demonstrates skills and abilities generally usable in a review of scientific or other professional outputs that can be published in a Slovak or foreign publishing house or periodical publications. • The student can obtain relevant factual data and information, interpret them correctly, and defend and argue. He/She can conceive, construct, implement, edit, and publish a substantial part of his/	

her research in periodicals, conference proceedings, or other monographic publications registered in the WoS and Scopus databases.
All activities are relevant for doctoral studies and create a part of an individual study plan. The student critically analyzes, re-evaluates and, considering the conditions of the training workplace, also applies acquired knowledge, skills, habits, and scientific information to his/her scientific research.

Brief outline of the course:
1. Scientific work in a journal with a non-zero IF categorized in Q1 or Q2 according to the JCR® in the particular or related field
2. Scientific work in a journal with a non-zero IF categorized in Q3 or Q4 according to the JCR® in the particular or related field
3. Scientific work in a conference proceeding or journal without IF indexed in international citation databases (WOS, Scopus)
4. Scientific work in a reviewed, non-indexed scientific journal.
5. International or national patent
6. Citation registered in international citation database (WOS, Scopus)
7. Membership in an international or national project

Recommended literature:
• Alley M. (2011). The Craft of Scientific Presentation. Springer. 4. vydanie
• Katuščák, D. (2004). Ako písať záverečné a kvalifikačné práce. Enigma
• STN 01 6910 Pravidlá písania a úpravy písomností (výklad normy, 2021)
• Gastel, B., Day, R. A. (2016). How to Write and Publish a Scientific Paper. Greenwood, ISBn: 978-1440842801,
• Glasman, D. (2009). Science Research Writing for Non-Native Speakers of English. World Scientific Publishing,
• Burton, H. M. (2021). Your First Research Paper: Learn how to start, structure, write and publish a perfect research paper to get the top mark. Independently Publisher

Language knowledge required for passing the course:
Slovak/English

Notes:
The committee proposes the number of credits for publication activities as a proportional part of the credits based on the assessment of the significance of the author's share.
Publications are documented by an extract from the system of publication activity at the UKF.
The condition for the proper completion of studies at the Faculty of Natural Sciences and Informatics of the UKF in Nitra is the publication of at least two scientific papers of the quality determined by the committee and the acquisition of at least 60 credits for scientific activities.
Study rules of doctoral studies at the FPVaI - appendix 2: Sample report on doctoral studies

Assessment of courses
The total number of assessed students: 9

ABS	N
100.0	0.0

Teachers:

Date of last change: 24.08.2022

Guarantor program:

COURSE INFORMATION LETTER

University: Constantine the Philosopher University in Nitra	
Faculty: Faculty of Natural Sciences and Informatics	
Code of course: KI/ DSVV5/16	**Name of course:** Research activities – 5th year
Type, extent and method of learning activities: **Form of study:** **Recommended course-load (hours):** **Per week: Per study period:** **Method of study:** present	
Number of credits: 0	
Recommended semester/trimester of study: 6.	
Study level: III.	
Prerequisites:	
Conditions for completion the course: Credits are granted for absolving individual activities and after approval of the committee based on the proposal for the annual evaluation of the doctoral student. Activities: • Scientific work in a journal with a non-zero IF categorized in Q1 or Q2 according to the JCR® in the particular or related field – 50 credits/work • Scientific work in a journal with a non-zero IF categorized in Q3 or Q4 according to the JCR® in the particular or related field – 30 credits/work • Scientific work in a conference proceeding or journal without IF indexed in international citation databases (WOS, Scopus) – 20 credits/work • Scientific work in a reviewed, non-indexed scientific journal – 5 credits/work, maximally 15 credits per study period • Scientific work in reviewed, non-indexed scientific proceedings – 3 credits/work, maximally 12 credits per study period • International patent – 50 credits/patent • National patent – 30 credits/patent • Citation registered in international citation database (WOS, Scopus) – 10 credits/citation • Membership in an international project – 20 credits/membership • Membership in a national project – 10 credits/membership	
Learning outcomes: • The student actively transfers the acquired knowledge and experience associated with his/her scientific activities into publication outputs. He/She knows how to use obtained knowledge to explain it clearly and comprehensibly, using appropriate terminology and precisely formulate it in written form. • The student knows how to work professionally with national and foreign information resources, respecting professional academic ethics and standards. He/She demonstrates skills and abilities generally usable in a review of scientific or other professional outputs that can be published in a Slovak or foreign publishing house or periodical publications. • The student can obtain relevant factual data and information, interpret them correctly, and defend and argue. He/She can conceive, construct, implement, edit, and publish a substantial part of his/	

her research in periodicals, conference proceedings, or other monographic publications registered in the WoS and Scopus databases.
All activities are relevant for doctoral studies and create a part of an individual study plan. The student critically analyzes, re-evaluates and, considering the conditions of the training workplace, also applies acquired knowledge, skills, habits, and scientific information to his/her scientific research.

Brief outline of the course:
1. Scientific work in a journal with a non-zero IF categorized in Q1 or Q2 according to the JCR® in the particular or related field
2. Scientific work in a journal with a non-zero IF categorized in Q3 or Q4 according to the JCR® in the particular or related field
3. Scientific work in a conference proceeding or journal without IF indexed in international citation databases (WOS, Scopus)
4. Scientific work in a reviewed, non-indexed scientific journal.
5. International or national patent
6. Citation registered in international citation database (WOS, Scopus)
7. Membership in an international or national project

Recommended literature:
• Alley M. (2011). The Craft of Scientific Presentation. Springer. 4. vydanie
• Katuščák, D. (2004). Ako písať záverečné a kvalifikačné práce. Enigma
• STN 01 6910 Pravidlá písania a úpravy písomností (výklad normy, 2021)
• Gastel, B., Day, R. A. (2016). How to Write and Publish a Scientific Paper. Greenwood, ISBn: 978-1440842801,
• Glasman, D. (2009). Science Research Writing for Non-Native Speakers of English. World Scientific Publishing,
• Burton, H. M. (2021). Your First Research Paper: Learn how to start, structure, write and publish a perfect research paper to get the top mark. Independently Publisher

Language knowledge required for passing the course:
Slovak/English

Notes:
The committee proposes the number of credits for publication activities as a proportional part of the credits based on the assessment of the significance of the author's share.
Publications are documented by an extract from the system of publication activity at the UKF.
The condition for the proper completion of studies at the Faculty of Natural Sciences and Informatics of the UKF in Nitra is the publication of at least two scientific papers of the quality determined by the committee and the acquisition of at least 60 credits for scientific activities.
Study rules of doctoral studies at the FPVaI - appendix 2: Sample report on doctoral studies

Assessment of courses
The total number of assessed students: 1

ABS	N
100.0	0.0

Teachers:

Date of last change: 24.08.2022

Guarantor program:

COURSE INFORMATION LETTER

University: Constantine the Philosopher University in Nitra

Faculty: Faculty of Natural Sciences and Informatics

Code of course: KI/ DSAIBEP/22	**Name of course:** Security, Ethical, and Legal Aspects of ICT

Type, extent and method of learning activities:
Form of study: Lecture
Recommended course-load (hours):
Per week: 2 **Per study period:** 26
Method of study: present

Number of credits: 5

Recommended semester/trimester of study:

Study level: III.

Prerequisites:

Conditions for completion the course:
Successful completion of the course is conditioned by an own solution of the research work and publication output in the field of the following specialization Security, Ethical and Legal Aspects of ICT.
Total student workload: 125 hours.
Of which: lectures/consultations - 26 hours, solution of a research project - 75 hours, preparation of publication output - 24 hours.
Conditions for course completion: Active participation in lectures/consultations, research solution, consisting of compiling research proposals and research methodology, conducting the research and presentation of research results in the form of research publication (min. 70% depending on the quality of publication output).

Learning outcomes:
The graduate student understands the individual steps in the planning of research. The graduate student is able to compile research proposals, research methodology, conduct own scientific research, and present the results in the field of specialization Security, Ethical and Legal Aspects of ICT.
The graduate student will gain deeper theoretical and methodological knowledge and practical experience in key areas of applied informatics at the current state of the art. The graduate student will learn the principles of individual and team scientific work, research, problem formulation, solving complex scientific problems and presenting of scientific results. The student will gain basic knowledge in the field of information and communication technology (ICT) and will understand modern security threats. The graduate student will gain basic knowledge of selected areas of copyright. They will get acquainted with the basic legal concepts and regulations for ICT. They will learn to comply to the legal norms and gain an overview of current trends in Internet regulation, data protection and e-commerce. They will gain knowledge of methods and means of ensuring data security on the Internet. The graduate student will be able to describe the architecture, structure and procedures of implementing security mechanisms and functions at the level of network technology and the basic technologies of web applications. They will be acquainted with the issue of personal data protection. The graduate student will gain knowledge and understanding of ICT in the period of applying the information revolution Industry 4.0 in the context of EU and will gain knowledge of ethics concerning emerging information ecology. The graduate student will be able to follow the

latest scientific and research trends in the applications of computer science in the natural, technical, economic, mathematical and social sciences and to supplement and update their knowledge in the form of lifelong learning. The graduate student will be able to consider legal, social, moral, ethical, economic and environmental aspects of their work.

Brief outline of the course:
- The social context of informatics and information and communication technologies;
- Trends in data security, current security threats;
- Security administration, legal and ethical issues of computer security;
- Methods and techniques of data security management (authentication, authorization, monitoring);
- Computer (software) piracy, computer-related crime;
- Personal data protection and cross-border flow of personal data;
- Internet security, the Internet and its legal status in the conditions of the Slovak Republic;
- Domains, domain names, domain registration, domain disputes;
- E-commerce and its legal regulation in the conditions of the Slovak Republic;
- Information and communication technology law;
- Computer program as a subject of copyright protection;
- Information ethics in the context of information ecology.

Recommended literature:

Haftor, D., Mirijam A. 2011. Komunikačné technológie, spoločnosť a ľudské bytosti: teória a rámec. Švédsko, Linnaeus University.2011.
Olejár, D., Hudec, L., Janáček, J., Stanek, M. 2010. Štandardy základných znalostí v oblasti informačnej bezpečnosti. FMFI UK, 2010.
Čorejová, A. 2018. Transfer poznania a ochrana duševného vlastníctva v podmienkach IKT sektora. Žilinská univerzita v Žiline, 2018.
Maisner, M. a kol. 2013. Základy práva informačných technológií. IURA EDITION, 2013. ISBN 9788080785949
Maisner, M. 2011. Základy softwarového práva. Wolters Kluwer, 2011. ISBN 9788073576387
Polčák, R. 2012. Internet a proměny práva. Auditorium, 2012. ISBN 9788087284223
Kožíšek, M., Písecký, V. 2016. Bezpečně na internetu - průvodce chováním ve světě online. Grada, 2016. ISBN 978-80-247-5595-3
Husovec, M. – Mesarčík, M. – Andraško, J.: Právo informačných a komunikačných technológií 1. TINCT, 2020. s. 262
Andraško, J. a kol.: Právo informačných a komunikačných technológií 2. TINCT, 2021, s. 328
Hučková, R. a kol.: Právo informačných a komunikačných technológií, UPJŠ, ŠafárikPress, 2020, s. 140
Jókay, M. 2021. Počítačová kriminalita. FEI STU v Bratislave, 2021.
Balogh, Z., Turčáni, M. 2016. Modeling of data security in cloud computing. In SysCon 2016 : Proceedings from 10th Annual International Systems Conference IEEE. IEEE, 2016. 940-946.
Steinerová, J. 2014. Informačná etika v súvislostiach informačnej ekológie. Knihovna. 2014, 25(1), 23-35.

Language knowledge required for passing the course:
Slovak/English

Notes:

Assessment of courses The total number of assessed students: 0	
ABS	N
0.0	0.0

Teachers: prof. Ing. Milan Turčáni, CSc., doc. Ing. Zoltán Balogh, PhD.,

Date of last change: 24.01.2022

Guarantor program:

COURSE INFORMATION LETTER

University: Constantine the Philosopher University in Nitra	
Faculty: Faculty of Natural Sciences and Informatics	
Code of course: KI/ DSAISR/20	**Name of course:** Speech Processing
Type, extent and method of learning activities: **Form of study:** Lecture **Recommended course-load (hours):** **Per week:** 2 **Per study period:** 26 **Method of study:** present	
Number of credits: 5	
Recommended semester/trimester of study:	
Study level: III.	
Prerequisites:	
Conditions for completion the course: Successful completion of the course is conditioned by an own solution of the research work and publication output in the field of the following specialization Speech Processing. Total student workload: 125 hours. Of which: lectures/consultations - 26 hours, solution of a research project - 75 hours, preparation of publication output - 24 hours. Conditions for course completion: Active participation in lectures/consultations, research solution, consisting of compiling research proposals and research methodology, conducting the research and presentation of research results in the form of research publication (min. 70% depending on the quality of publication output).	
Learning outcomes: The graduate student understands the individual steps in the planning of research. The graduate student is able to compile research proposals, research methodology, conduct own scientific research, and present the results in the field of specialization Speech Processing. The graduate student demonstrates a systematic understanding of the basic articulatory and acoustic characteristics of speech and is able to design and goals and methods for specific research on the relationship between different meanings and different speech characteristics. For the purposes of the research project, the student understands the creation of speech corpora and masters the methodology of speech annotation and subsequent extraction of speech characteristics from these corpora. To achieve the research goal, the student is able to design specific scenarios of human and machine speech interaction and the possibilities of implementation. The student is able to critically analyze and synthesize relevant case studies.	
Brief outline of the course: - Basic characteristics of speech (articulatory and acoustic-prosodic, the relationship between the form of speech and its meaning in communication); - Speech corpus creation and analysis (Praat software tutorial, speech annotation, extraction of acoustic-prosodic characteristics); - Speech dialogue systems (pitfalls of human-machine communication, interpersonal communication processes (intrusions, discourse markers, conversational fillers), overview of the basics of speech synthesis and recognition, turn-taking, speech entrainment).	

Recommended literature:

Adolphs, S., Carter,R. 2013. Spoken corpus linguistics. From monomodal to multimodal. Routledge Advances in Corpus Linguistics. 15, Routledge (Taylor and Francis), London and New York, 2013. ix + 205 p. ISBN 978-04-158-8829-5

Beňuš, Š., Trnka, M, Kuric, E., Marták, L., Gravano, A., Hirschberg, J., Levitan, R. 2018. Prosodic entrainment and trust in human-computer interaction. In Proceedings of 9th International Conference on Speech Prosody. 2018. 220-224.

Brusco, P., Vidal, J., Beňuš, Š., Gravano, A. 2020. A cross-linguistic analysis of the temporal dynamics of turn-taking cues using machine learning as a descriptive tool. Speech Communication. 2020, 125, 24-40.

Gálvez, R., Gravano, A., Beňuš, Š., Levitan, R., Trnka, M., Hirschberg, J. 2020. An empirical study of the effect of acoustic-prosodic entrainment on the perceived trustworthiness of conversational avatars. Speech Communication. 2020, 124, 46-67.

Hirschberg, J., Beňuš, Š., Gravano, A., Levitan, R. 2020. Prosody in discourse and speaker state. In Gussenhoven, Carlos and Chen, Aoju (eds.) The Oxford Handbook of Language Prosody. Oxford University Press, 2020. 468-476.

Jurafsky, D., Martin, J.H. 2002. Speech and Language Processing - An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition. Pearson Education, 2002. 934 p. ISBN 81-7808-594-1

Language knowledge required for passing the course:
Slovak/English

Notes:

Assessment of courses
The total number of assessed students: 0

ABS	N
0.0	0.0

Teachers: prof. Mgr. Štefan Beňuš, PhD., prof. RNDr. Daša Munková, PhD.,

Date of last change: 09.01.2022

Guarantor program:

COURSE INFORMATION LETTER

University: Constantine the Philosopher University in Nitra

Faculty: Faculty of Natural Sciences and Informatics

Code of course: KI/DSSC1/16	**Name of course:** Study activities – 1st year

Type, extent and method of learning activities:
Form of study:
Recommended course-load (hours):
Per week: **Per study period:**
Method of study: present

Number of credits: 0

Recommended semester/trimester of study: 2.

Study level: III.

Prerequisites:

Conditions for completion the course:
Credits are granted for passing individual activities and after approval of the committee based on the proposal for the annual evaluation of the doctoral student.
Activities:
• Passing a mandatory or optional compulsory course – 5 credits/course
• Attending internship or study visit abroad – 15 credits/internship. Only stays longer than 14 days are accepted. The content should relate to the topic of the dissertation thesis.
• Passing Professional English for Doctoral Students course – 5 credits/course
• Local internship or study visit – 5 credits/internship. Only stays longer than 14 days are accepted, the content of which is related to the topic of the dissertation.
• Passing specialized training or accredited course of further education finished with a diploma or certificate, attending a summer school, passing a rigorous exam including defence – 5 credits/activity. Only activities whose content is related to the topic of the dissertation are accepted.
• Scientific seminar for doctoral students – 3 credits/course. The seminar must be oriented towards the methodology of the dissertation.

Learning outcomes:
• The student focuses on studying selected scientific disciplines and courses in the relevant research or study field. He/She can actively acquire new skills, competencies and information that expand and significantly enrich his/her research field.
• The student focuses on scientific, pedagogical, and other activities, writing publications with a scientific and pedagogical staff of a national or foreign institution. He/She actively acquires new knowledge and information about current scientific events and the development of the local scientific school in the given field.
• The student focuses on the lectures presented by domestic and foreign lecturers, which are relevant to his/her scientific and pedagogical specialization. He/She acquires the necessary skills for experimental scientific work using the available material and technical equipment of the receiving institution.
• The student participates in lectures and acquires new knowledge and information about the development and current direction of scientific research while critically analyzing, re-evaluating, and applying them to his/her scientific or didactic research.

All activities are relevant for doctoral studies and create a part of an individual study plan. The student critically analyzes, re-evaluates and, considering the training workplace conditions, applies acquired knowledge, skills, habits, and scientific-pedagogical information to his/her scientific and/or didactic research.

Brief outline of the course:
1. Passing a mandatory or optional compulsory course.
2. Attending an internship or study visit in a local institution or abroad.
3. Attending lectures for doctoral students.
4. Passing specialized training or accredited course of further education finished with a diploma or certificate, attending a summer school, passing rigorous exam including defence, defending Rigorous Thesis.
5. Passing Scientific seminar for doctoral students.

Recommended literature:
• Recommended literature – as suggested by a supervisor, lecturer, or chief researcher…
• https://www.saia.sk/sk/main/stipendia/ a https://www.saia.sk/sk/main/studium-a-vyskum/

Language knowledge required for passing the course:
Slovak/English

Notes:
The student acquires at least 20 credits and maximally 40 credits for a study part of the doctoral program during the study period.
Study rules of doctoral studies at the FPVaI - appendix 2: Sample report on doctoral studies

Assessment of courses
The total number of assessed students: 15

ABS	N
100.0	0.0

Teachers:

Date of last change: 24.08.2022

Guarantor program:

COURSE INFORMATION LETTER

University: Constantine the Philosopher University in Nitra	
Faculty: Faculty of Natural Sciences and Informatics	
Code of course: KI/ DSSC2/16	**Name of course:** Study activities – 2nd year
Type, extent and method of learning activities: **Form of study:** **Recommended course-load (hours):** **Per week: Per study period:** **Method of study:** present	
Number of credits: 0	
Recommended semester/trimester of study: 4.	
Study level: III.	
Prerequisites:	
Conditions for completion the course: Credits are granted for passing individual activities and after approval of the committee based on the proposal for the annual evaluation of the doctoral student. Activities: • Passing a mandatory or optional compulsory course – 5 credits/course • Attending internship or study visit abroad – 15 credits/internship. Only stays longer than 14 days are accepted. The content should relate to the topic of the dissertation thesis. • Passing Professional English for Doctoral Students course – 5 credits/course • Local internship or study visit – 5 credits/internship. Only stays longer than 14 days are accepted, the content of which is related to the topic of the dissertation. • Passing specialized training or accredited course of further education finished with a diploma or certificate, attending a summer school, passing a rigorous exam including defence – 5 credits/ activity. Only activities whose content is related to the topic of the dissertation are accepted. • Scientific seminar for doctoral students – 3 credits/course. The seminar must be oriented towards the methodology of the dissertation.	
Learning outcomes: • The student focuses on studying selected scientific disciplines and courses in the relevant research or study field. He/She can actively acquire new skills, competencies and information that expand and significantly enrich his/her research field. • The student focuses on scientific, pedagogical, and other activities, writing publications with a scientific and pedagogical staff of a national or foreign institution. He/She actively acquires new knowledge and information about current scientific events and the development of the local scientific school in the given field. • The student focuses on the lectures presented by domestic and foreign lecturers, which are relevant to his/her scientific and pedagogical specialization. He/She acquires the necessary skills for experimental scientific work using the available material and technical equipment of the receiving institution. • The student participates in lectures and acquires new knowledge and information about the development and current direction of scientific research while critically analyzing, re-evaluating, and applying them to his/her scientific or didactic research.	

All activities are relevant for doctoral studies and create a part of an individual study plan. The student critically analyzes, re-evaluates and, considering the training workplace conditions, applies acquired knowledge, skills, habits, and scientific-pedagogical information to his/her scientific and/or didactic research.

Brief outline of the course:
1. Passing a mandatory or optional compulsory course.
2. Attending an internship or study visit in a local institution or abroad.
3. Attending lectures for doctoral students.
4. Passing specialized training or accredited course of further education finished with a diploma or certificate, attending a summer school, passing rigorous exam including defence, defending Rigorous Thesis.
5. Passing Scientific seminar for doctoral students.

Recommended literature:
• Recommended literature – as suggested by a supervisor, lecturer, or chief researcher…
• https://www.saia.sk/sk/main/stipendia/ a https://www.saia.sk/sk/main/studium-a-vyskum/

Language knowledge required for passing the course:
Slovak/English

Notes:
The student acquires at least 20 credits and maximally 40 credits for a study part of the doctoral program during the study period.
Study rules of doctoral studies at the FPVaI - appendix 2: Sample report on doctoral studies

Assessment of courses
The total number of assessed students: 8

ABS	N
100.0	0.0

Teachers:

Date of last change: 24.08.2022

Guarantor program:

COURSE INFORMATION LETTER

University: Constantine the Philosopher University in Nitra	
Faculty: Faculty of Natural Sciences and Informatics	
Code of course: KI/ DSSC3/16	**Name of course:** Study activities – 3rd year
Type, extent and method of learning activities: **Form of study:** **Recommended course-load (hours):** **Per week:** **Per study period:** **Method of study:** present	
Number of credits: 0	
Recommended semester/trimester of study: 6.	
Study level: III.	
Prerequisites:	
Conditions for completion the course: Credits are granted for passing individual activities and after approval of the committee based on the proposal for the annual evaluation of the doctoral student. Activities: • Passing a mandatory or optional compulsory course – 5 credits/course • Attending internship or study visit abroad – 15 credits/internship. Only stays longer than 14 days are accepted. The content should relate to the topic of the dissertation thesis. • Passing Professional English for Doctoral Students course – 5 credits/course • Local internship or study visit – 5 credits/internship. Only stays longer than 14 days are accepted, the content of which is related to the topic of the dissertation. • Passing specialized training or accredited course of further education finished with a diploma or certificate, attending a summer school, passing a rigorous exam including defence – 5 credits/ activity. Only activities whose content is related to the topic of the dissertation are accepted. • Scientific seminar for doctoral students – 3 credits/course. The seminar must be oriented towards the methodology of the dissertation.	
Learning outcomes: • The student focuses on studying selected scientific disciplines and courses in the relevant research or study field. He/She can actively acquire new skills, competencies and information that expand and significantly enrich his/her research field. • The student focuses on scientific, pedagogical, and other activities, writing publications with a scientific and pedagogical staff of a national or foreign institution. He/She actively acquires new knowledge and information about current scientific events and the development of the local scientific school in the given field. • The student focuses on the lectures presented by domestic and foreign lecturers, which are relevant to his/her scientific and pedagogical specialization. He/She acquires the necessary skills for experimental scientific work using the available material and technical equipment of the receiving institution. • The student participates in lectures and acquires new knowledge and information about the development and current direction of scientific research while critically analyzing, re-evaluating, and applying them to his/her scientific or didactic research.	

All activities are relevant for doctoral studies and create a part of an individual study plan. The student critically analyzes, re-evaluates and, considering the training workplace conditions, applies acquired knowledge, skills, habits, and scientific-pedagogical information to his/her scientific and/ or didactic research.

Brief outline of the course:
1. Passing a mandatory or optional compulsory course.
2. Attending an internship or study visit in a local institution or abroad.
3. Attending lectures for doctoral students.
4. Passing specialized training or accredited course of further education finished with a diploma or certificate, attending a summer school, passing rigorous exam including defence, defending Rigorous Thesis.
5. Passing Scientific seminar for doctoral students.

Recommended literature:
• Recommended literature – as suggested by a supervisor, lecturer, or chief researcher…
• https://www.saia.sk/sk/main/stipendia/ a https://www.saia.sk/sk/main/studium-a-vyskum/

Language knowledge required for passing the course:
Slovak/English

Notes:
The student acquires at least 20 credits and maximally 40 credits for a study part of the doctoral program during the study period.
Study rules of doctoral studies at the FPVaI - appendix 2: Sample report on doctoral studies

Assessment of courses
The total number of assessed students: 2

ABS	N
100.0	0.0

Teachers:

Date of last change: 24.08.2022

Guarantor program:

COURSE INFORMATION LETTER

University: Constantine the Philosopher University in Nitra	
Faculty: Faculty of Natural Sciences and Informatics	
Code of course: KI/ DSSC4/16	**Name of course:** Study activities – 4th year
Type, extent and method of learning activities: **Form of study:** **Recommended course-load (hours):** **Per week: Per study period:** **Method of study:** present	
Number of credits: 0	
Recommended semester/trimester of study: 6.	
Study level: III.	
Prerequisites:	
Conditions for completion the course: Credits are granted for passing individual activities and after approval of the committee based on the proposal for the annual evaluation of the doctoral student. Activities: • Passing a mandatory or optional compulsory course – 5 credits/course • Attending internship or study visit abroad – 15 credits/internship. Only stays longer than 14 days are accepted. The content should relate to the topic of the dissertation thesis. • Passing Professional English for Doctoral Students course – 5 credits/course • Local internship or study visit – 5 credits/internship. Only stays longer than 14 days are accepted, the content of which is related to the topic of the dissertation. • Passing specialized training or accredited course of further education finished with a diploma or certificate, attending a summer school, passing a rigorous exam including defence – 5 credits/ activity. Only activities whose content is related to the topic of the dissertation are accepted. • Scientific seminar for doctoral students – 3 credits/course. The seminar must be oriented towards the methodology of the dissertation.	
Learning outcomes: • The student focuses on studying selected scientific disciplines and courses in the relevant research or study field. He/She can actively acquire new skills, competencies and information that expand and significantly enrich his/her research field. • The student focuses on scientific, pedagogical, and other activities, writing publications with a scientific and pedagogical staff of a national or foreign institution. He/She actively acquires new knowledge and information about current scientific events and the development of the local scientific school in the given field. • The student focuses on the lectures presented by domestic and foreign lecturers, which are relevant to his/her scientific and pedagogical specialization. He/She acquires the necessary skills for experimental scientific work using the available material and technical equipment of the receiving institution. • The student participates in lectures and acquires new knowledge and information about the development and current direction of scientific research while critically analyzing, re-evaluating, and applying them to his/her scientific or didactic research.	

All activities are relevant for doctoral studies and create a part of an individual study plan. The student critically analyzes, re-evaluates and, considering the training workplace conditions, applies acquired knowledge, skills, habits, and scientific-pedagogical information to his/her scientific and/or didactic research.

Brief outline of the course:

1. Passing a mandatory or optional compulsory course.
2. Attending an internship or study visit in a local institution or abroad.
3. Attending lectures for doctoral students.
4. Passing specialized training or accredited course of further education finished with a diploma or certificate, attending a summer school, passing rigorous exam including defence, defending Rigorous Thesis.
5. Passing Scientific seminar for doctoral students.

Recommended literature:

• Recommended literature – as suggested by a supervisor, lecturer, or chief researcher…
• https://www.saia.sk/sk/main/stipendia/ a https://www.saia.sk/sk/main/studium-a-vyskum/

Language knowledge required for passing the course:
Slovak/English

Notes:
The student acquires at least 20 credits and maximally 40 credits for a study part of the doctoral program during the study period.
Study rules of doctoral studies at the FPVaI - appendix 2: Sample report on doctoral studies

Assessment of courses
The total number of assessed students: 3

ABS	N
100.0	0.0

Teachers:

Date of last change: 24.08.2022

Guarantor program:

COURSE INFORMATION LETTER

University: Constantine the Philosopher University in Nitra	
Faculty: Faculty of Natural Sciences and Informatics	
Code of course: KI/ DSSC5/16	**Name of course:** Study activities – 5th year
Type, extent and method of learning activities: **Form of study:** **Recommended course-load (hours):** **Per week: Per study period:** **Method of study:** present	
Number of credits: 0	
Recommended semester/trimester of study: 6.	
Study level: III.	
Prerequisites:	
Conditions for completion the course: Credits are granted for passing individual activities and after approval of the committee based on the proposal for the annual evaluation of the doctoral student. Activities: • Passing a mandatory or optional compulsory course – 5 credits/course • Attending internship or study visit abroad – 15 credits/internship. Only stays longer than 14 days are accepted. The content should relate to the topic of the dissertation thesis. • Passing Professional English for Doctoral Students course – 5 credits/course • Local internship or study visit – 5 credits/internship. Only stays longer than 14 days are accepted, the content of which is related to the topic of the dissertation. • Passing specialized training or accredited course of further education finished with a diploma or certificate, attending a summer school, passing a rigorous exam including defence – 5 credits/ activity. Only activities whose content is related to the topic of the dissertation are accepted. • Scientific seminar for doctoral students – 3 credits/course. The seminar must be oriented towards the methodology of the dissertation.	
Learning outcomes: • The student focuses on studying selected scientific disciplines and courses in the relevant research or study field. He/She can actively acquire new skills, competencies and information that expand and significantly enrich his/her research field. • The student focuses on scientific, pedagogical, and other activities, writing publications with a scientific and pedagogical staff of a national or foreign institution. He/She actively acquires new knowledge and information about current scientific events and the development of the local scientific school in the given field. • The student focuses on the lectures presented by domestic and foreign lecturers, which are relevant to his/her scientific and pedagogical specialization. He/She acquires the necessary skills for experimental scientific work using the available material and technical equipment of the receiving institution. • The student participates in lectures and acquires new knowledge and information about the development and current direction of scientific research while critically analyzing, re-evaluating, and applying them to his/her scientific or didactic research.	

All activities are relevant for doctoral studies and create a part of an individual study plan. The student critically analyzes, re-evaluates and, considering the training workplace conditions, applies acquired knowledge, skills, habits, and scientific-pedagogical information to his/her scientific and/or didactic research.

Brief outline of the course:
1. Passing a mandatory or optional compulsory course.
2. Attending an internship or study visit in a local institution or abroad.
3. Attending lectures for doctoral students.
4. Passing specialized training or accredited course of further education finished with a diploma or certificate, attending a summer school, passing rigorous exam including defence, defending Rigorous Thesis.
5. Passing Scientific seminar for doctoral students.

Recommended literature:
• Recommended literature – as suggested by a supervisor, lecturer, or chief researcher…
• https://www.saia.sk/sk/main/stipendia/ a https://www.saia.sk/sk/main/studium-a-vyskum/

Language knowledge required for passing the course:
Slovak/English

Notes:
The student acquires at least 20 credits and maximally 40 credits for a study part of the doctoral program during the study period.
Study rules of doctoral studies at the FPVaI - appendix 2: Sample report on doctoral studies

Assessment of courses
The total number of assessed students: 1

ABS	N
100.0	0.0

Teachers:

Date of last change: 24.08.2022

Guarantor program:

COURSE INFORMATION LETTER

University: Constantine the Philosopher University in Nitra	
Faculty: Faculty of Natural Sciences and Informatics	
Code of course: KI/ DSAITMAI/20	**Name of course:** Theory and Methodology of Applied Informatics
Type, extent and method of learning activities: **Form of study:** Lecture **Recommended course-load (hours):** **Per week:** 2 **Per study period:** 26 **Method of study:** present	
Number of credits: 5	
Recommended semester/trimester of study:	
Study level: III.	
Prerequisites:	
Conditions for completion the course: Successful completion of the course is conditioned by proving the ability to apply the acquired knowledge to scientific work. Total student workload: 125 hours. Of which: lecture/consultations - 26 hours, own solution of knowledge discovery task - 99 hours. Conditions for course completion: The successful completion of the course is conditioned by an exam and an own solution of knowledge discovery task. The oral exam consists of theoretical questions (40%) and project/task defense (60%). The subject examination is given by the result of the exam. Credits will not be awarded to a student who gains less than 70 percent of the total score. Rating: A = 100% - 95%, B = 94% - 90%, C = 89% - 85%, D = 84% -80%, E = 79% - 70%, FX = 69% - 0%.	
Learning outcomes: The graduate student gains familiarity with the fundamental factual, conceptual, and procedural knowledge of the theory and methodology of applied informatics in the application domain - knowledge discovery and data analysis, which can be creatively applied in scientific work in the field of applied informatics. The graduate student can perform data mining. For this purpose, the student can evaluate data sources, combine data sources, extend data sources with data obtained from its own survey, and define the criteria of data quality. The graduate student can pre-process heterogeneous data sources, analyze pre-processed data, empirically describe the acquired knowledge, and evaluate the quality of acquired knowledge. The student discusses the possibilities of data analysis - the application of analytical methods to solve specific tasks of knowledge discovery. The graduate student understands the limitations of neural network applications. The student knows how to design and train own neural network with various topologies and activation functions in dependence on the knowledge discovery task. The student is able to use a neural network to verify the data suitability for classification and prediction tasks of own research. The graduate student is able to manage the process of knowledge discovery and critically evaluate contributions from scientific journals and conferences focused on the knowledge discovery.	
Brief outline of the course:	

- Main areas of knowledge discovery (KDD, text mining, web mining) and data sources (databases/ data warehouses, documents´ collections, log files);
- Web mining domains (web content mining, web structure mining, web usage mining) and data sources (documents´/websites´ collection, site map, web crawling, common log file, extended log file, cookies);
- Process management of knowledge discovery (definition of the target task and determination of the problem type, relevant data acquisition and data exploration, data pre-processing, data mining/application of analytical methods, evaluation of found knowledge, application of acquired knowledge);
- Pre-processing of web usage data (data cleaning, users´/sessions´ identification, reconstruction of web user activities/paths´ completion);
- Text pre-processing and representation (web content, documents´ collections), natural language processing (NLP), document representation, suitable metrics for text comparison;
- Knowledge discovery tasks (data description and summarization, segmentation, concepts´ description, classification, prediction, dependency analysis) in the context of the relevant area/ domain;
- Data mining, analytical method selection, statistical methods (multivariate exploratory techniques, linear/non-linear models), machine learning methods (symbolic, subsymbolic methods), application of selected analytical methods (cluster analysis, discriminant analysis, generalized linear models, association and sequential rules analysis, decision trees/rules, analogy-based methods, neural networks, Bayesian networks), evaluation of results (verifying the assumptions, comparison of results, visualization, cross-validation, k-fold cross-validation);
- Basic NLP applications, textual documents classification (Naive Bayes, Nearest Neighbor, Decision Trees), the use of documents classification and categorization - sentiment analysis, spam analysis, fake news identification;
- Advanced NLP applications, topic modeling, text summarization, knowledge extraction from textual documents;
- Neural networks, neural networks learning, gradient descent algorithm, backpropagation method, topologies of neural networks, interconnected neural networks, competitive networks, neural network applications;
- Recurrent networks, time structure in data, time delay neural network (TDNN), example of training recurrent neural network;
- Neural networks applications in NPL, classification tasks, application of recurrent networks in NLP;
- Application of NS for prediction and classification tasks, and application of NS for generative tasks;
- Current trends in NS, NS application in research tasks.

Recommended literature:

Benko, Ľ., Munk, M. 2020. Data Mining: Modelovanie správania sa používateľov webu. Nitra : UKF, 2020. 202 s. ISBN 978-80-558-1575-6
Benko, Ľ., Munk, M. 2021. Data Mining. Nitra : UKF, 2021. 131 s. ISBN 978-80-558-1794-1
Munk, M., Pilkova, A., Benko, L., Blazekova, P., Svec, P. 2021. Web usage analysis of Pillar 3 disclosed information by deposit customers in turbulent times. Expert Systems with Applications. 2021, 185, 115503.
Munk, M., Kapusta, J. 2014. Web Usage Mining : príprava a modelovanie dát. Nitra : UKF, 2014. 136 s. ISBN 978-80-558-0692-1
Kapusta, J., Munk, M. 2014. Web Structure Mining : analýza pozorovanej a očakávanej návštevnosti webu. Nitra : UKF, 2014. 140 s. ISBN 978-80-558-0661-7

Munková, M., Munk, M. 2016. Evalvácia strojového prekladu. Nitra : UKF, 2016. 173 s. ISBN 978-80-558-1116-1
Berka, P. 2003. Dobývání znalostí z databází. Praha : Academia, 2003. ISBN 80-200-1062-9
Liu, B. 2007. Web data mining: Exploring hyperlinks, contents and usage data. Berlin : Springer, 2007. 532 p. ISBN 978-3-540-37881-5
Weiss, S.M., Indurkhya, N., Zhang, T., Damerau, F. 2005. Text Mining : Predictive Methods for Analyzing Unstructured Information. New York : Springer. 2005. 237 p. ISBN 978-0-387-95433-2
Bird, S., Klein, E., Loper, E. 2009. Natural Language Processing with Python - Analyzing Text with the Natural Language Toolkit. O'Reilly Media, 2009.
Jurafsky, D., Martin, J. H. 2018. Speech and Language Processing - An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition. Stanford. 2018. 551 p.
Cooper, S. 2018. Neural Networks: A Practical Guide for Understanding and Programming Neural Networks and Useful Insights for Inspiring Reinvention. CreateSpace Independent Publishing Platform. 2018. 170 p.
Aggarwal, C.C. 2018. Neural Networks and Deep Learning: A Textbook. Springer, 2018. ISBN 978-3-030-06856-1
Hajek, P., Barushka, A., Munk, M. 2021. Neural Networks with Emotion Associations, Topic Modeling and Supervised Term Weighting for Sentiment Analysis. International Journal of Neural Systems. 2021, 31(10), 2150013.
Hajek, P., Barushka, A., Munk, M. 2020. Fake consumer review detection using deep neural networks integrating word embeddings and emotion mining. Neural Computing and Applications. 2020, 32(23), 17259-17274.
Kapusta, J., Munk, M., Drlik, M. 2018. Website structure improvement based on the combination of selected web structure and web usage mining methods. International Journal of Information Technology & Decision Making. 2018, 17(6), 1743-1776.
Kapusta, J., Munk, M., Svec, P., Pilkova, A. 2014. Determining the time window threshold to identify user sessions of stakeholders of a commercial bank portal. Procedia Computer Science: ICCS 2014, 29, 1779-1790.
Kapusta, J., Drlík, M., Munk, M. 2021. Using of n-grams from morphological tags for fake news classification. PEERJ Computer Science, 2021, 7, 1-27.

Language knowledge required for passing the course:
Slovak/English

Notes:

Assessment of courses
The total number of assessed students: 8

A	B	C	D	E	FX
100.0	0.0	0.0	0.0	0.0	0.0

Teachers: prof. RNDr. Michal Munk, PhD., doc. PaedDr. Jozef Kapusta, PhD.,

Date of last change: 30.03.2022

Guarantor program: