CONTENT

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚINF/ ADA/19 | **Course name:** Applications of data analysis

Course type, scope and the method:
Course type: Lecture / Practice
Recommended course-load (hours):
Per week: 2 / 2 **Per study period:** 28 / 28
Course method: present

Number of ECTS credits: 5

Recommended semester/trimester of the course: 2.

Course level: II.

Prerequisities:

Conditions for course completion:

Learning outcomes:

Brief outline of the course:

Recommended literature:

Course language:

Notes:

Course assessment
Total number of assessed students: 6

A	B	C	D	E	FX
66.67	16.67	16.67	0.0	0.0	0.0

Provides: doc. Mgr. Michal Gallay, PhD., doc. Ing. Norbert Kopčo, PhD., doc. RNDr. Peter Pristaš, CSc., univerzitný profesor, RNDr. Jana Kisková, PhD., doc. RNDr. Ján Kaňuk, PhD.

Date of last modification: 08.07.2021

Approved: prof. RNDr. Gabriel Semanišin, PhD., prof. RNDr. Ivan Žežula, CSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: ÚMV/ ATG/13	**Course name:** Applied graph theory
Course type, scope and the method: **Course type:** Lecture / Practice **Recommended course-load (hours):** **Per week:** 2 / 1 **Per study period:** 28 / 14 **Course method:** present	
Number of ECTS credits: 5	
Recommended semester/trimester of the course: 1.	
Course level: II.	
Prerequisities:	
Conditions for course completion: To complete the course, it is necessary to demonstrate the ability to formulate definitions and theorems from the lectured material, to demonstrate the proofs of theorems and solve selected problems based on the presented areas of graph theory. The exam takes written form by elaborating a test containing several questions of a theoretical and practical nature; the maximum number of points that can be obtained is 100. To pass the exam, it is necessary to obtain more than half of the maximum number of 100 points (otherwise the exam is evaluated by FX), while the rating E is given in the case of points 51-59, D in the case of 60- 69, C for 70-79, B for 80-89 and A for over 90 points.	
Learning outcomes: After completing the course, the student is acquainted with selected applications of graph theory in the natural and technical sciences and mathematical properties of related graph concepts.	
Brief outline of the course: Week 1: Working with graphs in computer algebra systems Maple and Wolfram Mathematica. Weeks 2 - 4: Practical problems leading to the use of graph coloring (scheduling and resource allocation); common types of graph colorings for practice and their properties; algorithms and heuristics for graph coloring. Weeks 5 - 7: Polynomial cases of NP-complete graph problems (the most important graph classes, their properties and efficient algorithms for calculating selected invariants) Weeks 8 - 10: Basics of complex network analysis (centrality, community structure) Weeks 11 - 13: Chemical graph theory (Wiener index and its properties, related topological indices)	
Recommended literature: U. Brandes, T. Erlebach: Network analysis. Methodological Foundations, Springer, 2005.	
Course language: Slovak or English	
Notes: Intermediate knowledge of graph theory and general programming is assumed, as well as the basics of working with computer algebra systems.	

Course assessment
Total number of assessed students: 22

A	B	C	D	E	FX
13.64	36.36	27.27	9.09	13.64	0.0

Provides: prof. RNDr. Tomáš Madaras, PhD.

Date of last modification: 14.04.2022

Approved: prof. RNDr. Gabriel Semanišin, PhD., prof. RNDr. Ivan Žežula, CSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: ÚINF/ APA1/21	**Course name:** Approximation algorithms
Course type, scope and the method: **Course type:** Lecture **Recommended course-load (hours):** **Per week:** 3 **Per study period:** 42 **Course method:** present	
Number of ECTS credits: 5	
Recommended semester/trimester of the course: 3.	
Course level: II.	
Prerequisities:	
Conditions for course completion: Continuous assessment is awarded on the basis of the quality of homework given in lectures and continuous written test. Oral final exam.	
Learning outcomes: To learn basic conceptions of randomized algorithms and to classify the algorithms due to their error probability.	
Brief outline of the course: 1. Basic notions of Probability Theory. 2. Basic randomized computing models and its characterisations. 3. Las Vegas algorithms. 4. One sided error Monte Carlo algorithms. 5. Two sided bounded error Monte Carlo algorithms. 6. Two sided unbounded error Monte Carlo algorithms. 7. Classes of randomized algorithms with polynomial time complexity and relationships between them. 8. Optimisation problem, approximation algorithm, relative error, approximation ratio. 9. Special optimisation problems and approximation solutions. 10. Classification of optimisation problems based upon their approximations. 11. FPTAS. 12. PTAS. 13. TSP problem and its relaxations. 14. Unapproximability.	
Recommended literature: Hromkovič, J.: Algorithmics for Hard Problems, Introduction to Combinatorial Optimization, Randomization, Approximation, and Heuristics, Springer=Verlag 2004. Hromkovič, J.: Communication Protocols - An Exemplary Study of the Power of Randomness. In: Handbook on Randomized Computing, P.Pardalos, S.Rajasekaran, J.Reif, J.Rolim, Eds., Kluwer Publ., 2001. Hromkovič, J.: Design and analysis of ranodmized algorithms. Springer-Verlag, 2005.	

Hromkovič, J.: Einführung in die algorithmischen Konzepte der Informatik, Teubner, 2001.
Motwani R. and Raghavan P.: Randomized Algorithms. Cambridge University Press 1995.
Mitzenmacher M. and Upfal P.: Probability and Computing: Randomized Algorithms and Probabilistic Analysis. Cambridge University Press 2005.

Course language:
Slovak or English

Notes:
content prerequisites: basics of probability, basics of algorithms and data structures

Course assessment
Total number of assessed students: 105

A	B	C	D	E	FX
22.86	13.33	25.71	14.29	21.9	1.9

Provides: doc. RNDr. Ondrej Krídlo, PhD.

Date of last modification: 23.11.2021

Approved: prof. RNDr. Gabriel Semanišin, PhD., prof. RNDr. Ivan Žežula, CSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: ÚMV/ VMO/22	**Course name:** Calculus of variations in optimization
Course type, scope and the method: **Course type:** Lecture / Practice **Recommended course-load (hours):** **Per week:** 2 / 2 **Per study period:** 28 / 28 **Course method:** present	
Number of ECTS credits: 6	
Recommended semester/trimester of the course: 2.	
Course level: II.	
Prerequisities:	
Conditions for course completion: EN Ongoing evaluation takes the form of a written test during the semester and attendance in lectures or exercises. The overal evaluation is based on a result of mid-term evaluation (60%) and the result of final written and oral examination (40%).	
Learning outcomes: Students will learn to find local extremes of functionals, especially to derive variational integrals. They will be able to verify the necessary and sufficient conditions for the existence of global and local extrema for specific functionals, find extremals in the case of one-dimensional integrals, and determine whether they are weak or strong extremes. Use theoretical results for examples from geometry, physics, chemistry or financial mathematics.	
Brief outline of the course: Abstract variational calculus in Banach space - critical points, extremals, sufficient conditions for the existence of a (global) minimizer and its uniqueness. Differentiability in Banach spaces (Gateaux and Fréchet derivative, variation of functionals). Euler's necessary condition (Beltrami's identity) and Lagrange's sufficient condition of local extremes. Lagrange’s multipliers method. Courant-Weinstein principle and Rayleigh's quotient. Ekeland's principle of variation. Rayleigh-Ritz method. The mountain pass theorem. Least squares method in spaces with infinite dimension. Bayesian variational methods. Discrete variational calculus. Du Bois-Reymond, Legendre and Weierstrass necessary conditions. Lavrentiev phenomenon. Conjugate points method. Sufficient conditions for weak and strong extremes. Hamilton-Jacobi equation. Geometric and physical aspects of calculus of variations (minimum areas, harmonic representations, central tendency measures, curvature equations, isoperimetric problem, geodetic calculation, Lagrange and Hamiltonian formulation of mechanics, Legendre transform, Fermat's principle).	
Recommended literature: 1. K. Rektorys: Variační metody, Academia - nakladatelství, ISBN: 80-200-0714-8, 602 s.,1999. 2. J. Bouchala: Variační metody, https://mi21.vsb.cz/sites/mi21.vsb.cz/files/unit/ variacni_metody.pdf, 2012. 3. Cassel, Kevin W.: Variational Methods with Applications in Science and Engineering, Cambridge University Press, 2013.	

4. Elsgolc, L.E.: Calculus of Variations, Courier Corporation, ISBN 9780486457994, 2007.

Course language:
Slovak

Notes:

Course assessment
Total number of assessed students: 4

A	B	C	D	E	FX
25.0	75.0	0.0	0.0	0.0	0.0

Provides: doc. Mgr. Jozef Kiseľák, PhD.

Date of last modification: 19.04.2022

Approved: prof. RNDr. Gabriel Semanišin, PhD., prof. RNDr. Ivan Žežula, CSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: ÚINF/ PSDU/16	**Course name:** Case studies in data mining
Course type, scope and the method: **Course type:** Lecture / Practice **Recommended course-load (hours):** **Per week:** 2 / 2 **Per study period:** 28 / 28 **Course method:** present	
Number of ECTS credits: 4	
Recommended semester/trimester of the course: 1.	
Course level: II.	
Prerequisities:	
Conditions for course completion: The realization of a project focused on case studies in data mining. Successful completion of the written and oral part of the exam focused on case studies in data mining.	
Learning outcomes: Solving practical tasks in the field of data mining. Basic concepts of data mining. Knowledge of data mining methods.	
Brief outline of the course: 1. Basic notions in data mining 2. Data preparation in data mining 3. Methods and algorithms of data mining 4. Methods and algorithms of data mining II 5. Extraction of knowledge from large data volumes 6. Case study analysis using data mining methods in different application areas 7. Case study analysis using data mining methods in different application areas II 8. Application of methods for automated analysis of large data volumes 9. Solving practical tasks using appropriate software tools 10. Solving practical tasks using appropriate software tools II 11. Solving practical tasks using appropriate software tools III 12. Testing data mining algorithms 13. Testing data mining algorithms II	
Recommended literature: [1] Watt, J., Borhani, R., Katsaggelos, A.K.: Machine learning refined: foundations, algorithms, and applications. Cambridge: Cambridge University Press, 2016. [2] Zhao, Y., Cen, Y.: Data Mining Applications with R. Elsevier Inc. 2014. [3] Han, J. and Kamber, M.: Data Mining Concepts and Techniques. 3rd Edition, Morgan Kaufmann, Burlington, 2011. [4] Witten, I.E., Frank, E.: Data Mining: Practical Machine Learning Tools and Techniques, Elsevier, 2005.	

Course language:
Slovak or English

Notes:

Course assessment
Total number of assessed students: 41

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

Provides: doc. RNDr. Ľubomír Antoni, PhD.

Date of last modification: 14.11.2021

Approved: prof. RNDr. Gabriel Semanišin, PhD., prof. RNDr. Ivan Žežula, CSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: ÚINF/ KKV1/21	**Course name:** Classical and quantum computations
Course type, scope and the method: **Course type:** Lecture / Practice **Recommended course-load (hours):** **Per week:** 3 / 2 **Per study period:** 42 / 28 **Course method:** present	
Number of ECTS credits: 6	
Recommended semester/trimester of the course: 3.	
Course level: II., N	
Prerequisities:	
Conditions for course completion: Successful completion of the subject is conditioned by proper acquisition of basic concepts, algorithms and models and demonstrating the ability to apply them creatively. The acquisition of knowledge takes place: - continuously during the semester in the form of partial assignments, - a written test during the semester, - a written test at the exam, - oral exam. In order to receive an evaluation, it is necessary to obtain at least 50% of points from each of the three parts (assignments during the semester, written part of the exam, oral part of the exam). The detailed evaluation method is published in the AIS.	
Learning outcomes: By completing the subject, the student will get: - knowledge of the classification and design of probabilistic algorithms, - basic knowledge of the principles of quantum computers and their differences compared to classical computing models, - knowledge and skills about the design and functioning of quantum computing and become familiar with the most well-known algorithms, = basic quantum computer programming skills.	
Brief outline of the course: 1. Introduction to quantum quantum computers. Basics of classical complexity theory. 2. Boolean circuits and their basic properties. 3. Probability algorithms. 4. BPP class and probability testing. 5. Basic properties of circuits and Fermat's test. 6. Miller - Rabin's test and the position of the BPP class in the hierarchy of complexity models. 7. Introduction to quantum computing and mathematical foundations of quantum theory. 8. Spectral representation of self-adjoint operators. 9. Quantum states and Hilbert vector spaces. 10. Basic quantum operators and basic quantum algorithms.	

11. Quantum teleportation, superdense coding and Grover's algorithm.
12. Fourier transformation.
13. Shor's algorithm.

Recommended literature:

1. BERMAN,G.P., DOOLEN,G.D., MAINIERI, R., TSIFRINOVIC, V.I. Introduction to Quantum Computers. World Scientific, 2003.
2. GRUSKA, J. Quantum Computing. McGraw-Hill, 1999.
3. JOHNSON, G. A Shortcut Through Time: The Path to the Quantum Computer, Knopf 2003.
4. KITAEV, A.Y., SHEN, A.H., VYALYI, M.N. Classical and Quantum Computation. American Mathematical Society, 2002.
5. NIELSEN, M.A., CHUANG, I.L. Quantum Computation and Quantum Information. Cambridge University Press, 2000.
6. HIRVENSALO, M., Quantum Computing, Springer 2004

Course language:
Slovak or english

Notes:
Content prerequisites:
Linear algebra, Group theory, Probability theory, Theory of algorithms, Introduction to quantum computers.

Course assessment
Total number of assessed students: 93

A	B	C	D	E	FX
27.96	38.71	16.13	5.38	4.3	7.53

Provides: prof. RNDr. Gabriel Semanišin, PhD., Mgr. Viktor Olejár

Date of last modification: 25.07.2022

Approved: prof. RNDr. Gabriel Semanišin, PhD., prof. RNDr. Ivan Žežula, CSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: ÚINF/ KMU1/15	**Course name:** Coding and multimedial data transition
Course type, scope and the method: **Course type:** Lecture / Practice **Recommended course-load (hours):** **Per week:** 2 / 1 **Per study period:** 28 / 14 **Course method:** present	
Number of ECTS credits: 4	
Recommended semester/trimester of the course: 1., 3.	
Course level: I., II.	
Prerequisities:	
Conditions for course completion: Homeworks, active participation in laboratory exercises, midterm test. Final written exam, oral examination.	
Learning outcomes: Understand the principles of lossy compression algorithms. Be able to apply different methods of quantization, prediction and difference procedures in lossy image and sound compression algorithms. Understand the JPEG and MPEG compression standards.	
Brief outline of the course: 1. Formal model of coding and information transfer, compression ratio, criteria of uniquely decodable codes, block and prefix lossless codes. 2. Coding with known distribution of probabilities of occurrences of input characters, relation to entropy, Huffman construction, adaptive variants. 3. Arithmetic coding, integer, binary, adaptive versions, advantages and disadvantages of statistical codes. 4. Context coding, prediction methods, JBIG, JPEG-LS standards, PPM. 5. Dictionary compression methods, LZ77, LZW, use of transformations, BWT, ACB, dynamic Markov chains. 6. Principles of lossy compression, RD function, probabilistic and physiological models for efficient compression. Uniform and non-uniform scalar quantization, adaptive versions. 7. Vector quantization, optimization according to distribution function, compressors and expanders. 8. Differential techniques, prediction methods, adaptive quantization with prediction, DPCM method, use in audio and video coding. 9. Transformations in lossy coding, orthonormal representations, component analysis, two-dimensional transformations. 10. Discrete Fourier transform, use in image compression, JPEG encoder. 11. Subband filters, signal decomposition, signal synthesis from subbands, use in sound compression, psychoacoustic models, MP3, AAC coding. 12. Wavelet transforms, EZW encoder, use in audio and video coding. 13. Video compression, MPEG standards, adaptive algorithms for streaming and video conferencing.	

Recommended literature:
1. D. Salomon: Data Compression, The Complete Reference, Springer, 2004.
2. K. Sayood: Introduction to Data Compression, Morgan Kaufmann, 2012.

Course language:
Slovak or English

Notes:

Course assessment
Total number of assessed students: 21

A	B	C	D	E	FX
28.57	4.76	28.57	19.05	19.05	0.0

Provides: doc. RNDr. Jozef Jirásek, PhD.

Date of last modification: 08.01.2022

Approved: prof. RNDr. Gabriel Semanišin, PhD., prof. RNDr. Ivan Žežula, CSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: ÚMV/ KOA/10	**Course name:** Combinatorial algorithms
Course type, scope and the method: **Course type:** Lecture / Practice **Recommended course-load (hours):** **Per week:** 3 / 1 **Per study period:** 42 / 14 **Course method:** present	
Number of ECTS credits: 6	
Recommended semester/trimester of the course: 2.	
Course level: II.	
Prerequisities:	
Conditions for course completion: The evaluation consists of a project (30 points) and an oral exam (70 points). The semester project consists of the elaboration of a computer program that returns the optimal solution or a acceptable approximation of the optimal solution, respectively, of a selected graph problem given by a suitable representation.	
Learning outcomes: Understanding of basic graph algorithm, the close connection between the theoretical and algorithmic aspects of discrete mathematics, ability to understand how selected algorithms can be derived from mathematical statements, ability to prove the correctness of algorithms.	
Brief outline of the course: Basic notions from graph theory. Introduction to algorithms and complexity. Basic types of algorithms - sorting algorithms, search algorithms, greedy algorithms. NP-completeness. Trees, spanning trees and rooted trees. Depth first search, breadth first search. Generating of all spanning trees of a graph, number of spanning trees. Minimum spanning tree problem (Kruskal, Prim, and Boruvka´s algorithms). Distance in graphs. Shortest path problem in (non)oriented (weighted) graphs (various types of algorithms) and other variations of this problem. Introduction to network analysis, critical path method. Flows in networks, the max-flow min-cut theorem and related concepts. Matchings, maximum matchings in bipartite and general graphs, finding a matching with maximum weight in bipartite graphs. Location of centers in graphs, finding a center, absolute center, and a median of a graph. Eulerian graphs and Chinese postman's problem. Hamiltonian graphs, Travelling salesman problem and approximation algorithms for TSP.	
Recommended literature: 1. G. Chartrand, O.R. Oellermann: Applied and Algorithmic Graph Theory, McGraw-Hill, Inc. New York 1993. 2. J.L. Gross, J. Yellen: Graph Theory and Its Applications, Chapman & Hall/CRC 2006. 3. D. Jungnickel: Graphs, Networks, and Algorithms, Springer-Verlag Berlin 2005.	

4. J. Plesník: Grafové algoritmy, Veda Bratislava 1983.

Course language:
Slovak

Notes:

Course assessment
Total number of assessed students: 109

A	B	C	D	E	FX
35.78	24.77	22.02	8.26	6.42	2.75

Provides: RNDr. Alfréd Onderko, PhD.

Date of last modification: 19.04.2022

Approved: prof. RNDr. Gabriel Semanišin, PhD., prof. RNDr. Ivan Žežula, CSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚINF/ VKN2/22	**Course name:** Computational and cognitive neuroscience II

Course type, scope and the method:
Course type: Lecture / Practice
Recommended course-load (hours):
Per week: 2 / 2 **Per study period:** 28 / 28
Course method: present

Number of ECTS credits: 5

Recommended semester/trimester of the course: 3.

Course level: II., N

Prerequisities:

Conditions for course completion:
Midterm exam
Final exam consisting of written and/or oral part

Learning outcomes:
Advanced topics in computational and cognitive neuroscience, and in the tools used in neuroscience.

Brief outline of the course:
1. Intro: Cognitive psychology, neural modeling.
Theme 1: Topics in cognitive and neural science
2. Neural basis of vision
3. Visual object recognition and visual scene analysis
4. Auditory cognition. Echo suppression. Auditory scene analysis
5. Cortical sound processing.
6. Other topics in the study of brain and main: thinking, consciousness, emotions, motivation
Topic 2: Modeling in cognitive and neural science
7. Intro
8. Connectionism, STM and LTM modeling
9. Additive and shunting neural networks.
10. Learning rule Outstar.
11. Adaptive resonance theory.
12. Statistical and decision-theory modeling
Topic 3: Current research at UPJS
13. Invited lecture

Recommended literature:
1. KANDEL, E. R., SCHWARTZ, J. H. and JESSELL, T.M.: Principles of Neural Science. McGraw-Hill, 2021 ISBN-13: 978-1259642234
2. Dayan P and LF Abbott: Theoretical Neuroscience - Computational and Mathematical Modeling of Neural Systems. MIT Press, 2005 ISBN-13: 978-0262541855
3. Thagard P: Mind: Introduction to Cognitive Science, 2nd Edition. Bradford Books. ISBN-13 : 978-0262701099

4. HERTZ, J., KROGH, A. and PALMER R. G.: Introduction to the theory of neural computation. Addison-Wesley 1991 ISBN-13: 978-0201515602

Course language:
Slovak or English

Notes:
Content prerequisites:
basics of neurobiology, cognitive psychology, linear algebra and differential equations, programing, or instructor's consent

Course assessment
Total number of assessed students: 9

A	B	C	D	E	FX
33.33	11.11	11.11	11.11	33.33	0.0

Provides: doc. Ing. Norbert Kopčo, PhD., RNDr. Keerthi Kumar Doreswamy, Ing. Udbhav Singhal, Myroslav Fedorenko

Date of last modification: 14.02.2022

Approved: prof. RNDr. Gabriel Semanišin, PhD., prof. RNDr. Ivan Žežula, CSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: ÚINF/ VYZ1/15	**Course name:** Computational complexity
Course type, scope and the method: **Course type:** Lecture **Recommended course-load (hours):** **Per week:** 2 **Per study period:** 28 **Course method:** present	
Number of ECTS credits: 4	
Recommended semester/trimester of the course: 1.	
Course level: II., N	
Prerequisities:	
Conditions for course completion: Oral examination.	
Learning outcomes: To give students theoretical background in computational complexity and theory of NP-completeness.	
Brief outline of the course: 1: Introduction: the notion of computational complexity, computational time, computational model, example - the problem of sorting, computational complexity as an asymptotic function 2: Basic computational models: RAM and RASP computers, the cost of an elementary step on these computers, single-tape Turing machine, multi-tape Turing machine, nondeterministic variants of these computational models, transformations among these models with respect to the time complexity 3: The classes P and NP: basic definitions, presenting (un)undirected graphs on the input, 3COL – the set of all 3-colorable graphs is in NP, 2COL - the set of all 2-colorable graphs is in P, SAT – the set of satisfiable Boolean formulas is in NP, CNF-SAT - Boolean formulas in conjunctive normal form 4: Variants of P and NP: decision problem, the problem of finding a solution, optimization problem, polynomial conversions among different variants 5: NP-completeness: reducibility in polynomial time and its transitivity, definition of the NP-completeness and its basic properties 6: NP-completeness of SAT 7: Variants of SAT: 3CNF-SAT - satisfiability of Boolean formulas in 3-conjunctive normal form, kCNF-SAT, CNF-SAT - satisfiability in k-conjunctive (conjunctive) normal form, 2CNF-SAT is in P 8: 3COL and its variants: 3COL (the problem of coloring vertices of a graph with 3 colors) in NP-complete, consequently: for each k>3, kCOL (the problem of coloring with k colors) is NP-complete as well 9: Colorability of a planar graph with three colors: presenting a planar graph on the input, the proof of NP-completeness, coloring with a larger number of colors 10: Another NP-complete problems: Exact set cover, Clique, Vertex cover	

11: Hamiltonian path: Hamiltonian path in a directed and in undirected graph
12: Subset-sum-like problems: Subset Sum - the problem of whether any subset of the integers sum to precisely a target sum, Partition - the problem of whether a given multiset of positive integers can be partitioned into two subsets with equal sums, a “more relaxed” version of Partition - achieving an approximate equality of the sums, distribution of tasks among K parallel processors
13: Beyond P a NP: a review of the basic complexity classes - L, NL, P, NP, PSpace , NPSpace, ExpTime, NExpTime, …, simulation of (non)deterministic space in (non)deterministic time, conversions in opposite directions
14: PSpace: QBF - true quantified Boolean formulas, prenex normal form, Pspace completeness of QBF, PSpace = NPSpace

Recommended literature:

1. J.E. Hopcroft, R.Motwani, J.D. Ullman: Introduction to automata theory, languages, and computation, Addison-Wesley, 2007.
2. M. Sipser: Introduction to the Theory of Computation, Thomson, 2nd edition, 2006.
3. L.A.Hemaspaandra, M.Ogihara: Complexity theory companion, EATCS series, texts in computer science, Springer-Verlag, 2002.
4. S. Arora, B. Barak: Computational Complexity: A Modern Approach, Cambridge Univ. Pess, 2009. 5. G.Brassard, P.Bradley: Fundamentals of algorithmics, Prentice Hall, 1996.
6. D.P.Bovet, P.Crescenzi: Introduction to the theory of complexity, Prentice Hall, 1994.
7. C. Calude and J. Hromkovič: Complexity: A Language-Theoretic Point of View, in G. Rozenberg and A. Salomaa, Handbook of Formal Languages II, Springer, 1997.

Course language:
Slovak or english

Notes:
Content prerequisities:
Basic notions from the theory of automata and formal languages.
Basic skills in programming and design of algorithms (in any programming language).
Basics knowledge in mathematical logic, set theory, and graph theory.

Course assessment
Total number of assessed students: 380

A	B	C	D	E	FX
57.11	15.79	13.16	6.84	6.84	0.26

Provides: prof. RNDr. Viliam Geffert, DrSc.

Date of last modification: 23.11.2021

Approved: prof. RNDr. Gabriel Semanišin, PhD., prof. RNDr. Ivan Žežula, CSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: ÚMV/ VSM/10	**Course name:** Computational statistics and simulation methods
Course type, scope and the method: **Course type:** Lecture / Practice **Recommended course-load (hours):** **Per week:** 2 / 2 **Per study period:** 28 / 28 **Course method:** present	
Number of ECTS credits: 5	
Recommended semester/trimester of the course: 3.	
Course level: II.	
Prerequisities:	
Conditions for course completion: Written tests. Final evaluation is given at the basis of partial examination, written and oral part of exam.	
Learning outcomes: Getting to know modern software and computational and simulation methods in statistics.	
Brief outline of the course: o Types of statistical computations, popular mathematical software o Computing distribution and quantile functions o Matrix computations o Random numbers generation: a) Uniform distribution (linear reccurent generators, bit reccurent generators, nonlinear generators) b) General methods for other distributions c) Special methods for other distributions o Simulations o Approximate evaluation of an integral o Bootstrap method o Random processes and MCMC method o Introduction to Exploratory data analysis o Principles of cluster analysis o Principal component analysis o Factor analysis o GUHA method	
Recommended literature: • Olehla, Věchet, Olehla: Řešení úloh matematické statistiky ve Fortranu, Nadas, 1982 • Olver et al.: NIST Handbook of mathematical functions, NIST and Cambridge University Press, 2010 • Deák: Random number generators and simulation, Akadémiai kiadó, 1990 • Fishman: Monte Carlo. Concepts, Algorithms, and Applications., Springer, 1996 • Backhaus, Erichson, Plinke, Weiber: Multivariate Analysemethoden, 7th ed., Springer, 1994 • Tan, Steinbach, Kumar: Introduction to Data Mining, Pearson Education Ltd., 2014	

Course language:
Slovak

Notes:

Course assessment
Total number of assessed students: 58

A	B	C	D	E	FX
15.52	20.69	25.86	10.34	24.14	3.45

Provides: prof. RNDr. Ivan Žežula, CSc., doc. RNDr. Daniel Klein, PhD.

Date of last modification: 14.04.2022

Approved: prof. RNDr. Gabriel Semanišin, PhD., prof. RNDr. Ivan Žežula, CSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: ÚINF/ SDMa/21	**Course name:** Data Management Seminar II
Course type, scope and the method: **Course type:** Practice **Recommended course-load (hours):** **Per week:** 2 **Per study period:** 28 **Course method:** present	
Number of ECTS credits: 2	
Recommended semester/trimester of the course: 2.	
Course level: II.	
Prerequisities:	
Conditions for course completion: Active presentation of own and already known and published results related to diploma thesis in the middle and end of semester.	
Learning outcomes: To become familiar with selected current knowledge from the area of data analysis, machine learning and artificial intelligence. Developing skills such as understanding and interpreting scientific text.	
Brief outline of the course: 1. - 2. Data mining case studies 3. - 4. Graph algorithms 5. - 6. Group work with students on topics in the field of data management 7. - 8. Individual work with students on topics in the field of data management 9. - 10. Applications of machine learning methods in solving problems in different application domains. 11. - 12. Applications of in-depth learning methods in solving problems in different application domains.	
Recommended literature: 1. CHOLLET, François. Deep learning v jazyku Python: knihovny Keras, Tensorflow. Přeložil Rudolf PECINOVSKÝ. Praha: Grada Publishing, 2019. Knihovna programátora (Grada). ISBN 978-80-247-3100-1. 2. GOODFELLOW Ian, BENGIO Yoshua a Aaron COURVILLE. Deep Learning. MIT Press, 2016. ISBN: 9780262035613. 3. Current articles from scientific journals, contributions at the scientific and professional conferences related to the topic of diploma thesis.	
Course language: English	
Notes:	

Course assessment
Total number of assessed students: 15

abs	n
100.0	0.0

Provides:

Date of last modification: 20.09.2021

Approved: prof. RNDr. Gabriel Semanišin, PhD., prof. RNDr. Ivan Žežula, CSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: ÚINF/ SDMb/19	**Course name:** Data Management Seminar II
Course type, scope and the method: **Course type:** Practice **Recommended course-load (hours):** **Per week:** 2 **Per study period:** 28 **Course method:** present	
Number of ECTS credits: 2	
Recommended semester/trimester of the course: 3.	
Course level: II.	
Prerequisities:	
Conditions for course completion: Active presentation of known and own results related to final thesis in the middle and end of semester.	
Learning outcomes: To become familiar with selected current knowledge from the area of data analysis, machine learning and artificial intelligence. Developing skills such as understanding and interpreting scientific text.	
Brief outline of the course: 1. - 2. Data mining case studies 3. - 4. Graph algorithms 5. - 6. Group work with students on topics in the field of data management 7. - 8. Individual work with students on topics in the field of data management 9. - 10. Applications of machine learning methods in solving problems in different application domains. 11. - 12. Applications of deep learning methods in solving problems in different application domains.	
Recommended literature: 1. CHOLLET, François. Deep learning v jazyku Python: knihovny Keras, Tensorflow. Přeložil Rudolf PECINOVSKÝ. Praha: Grada Publishing, 2019. Knihovna programátora (Grada). ISBN 978-80-247-3100-1. 2. GOODFELLOW Ian, BENGIO Yoshua a Aaron COURVILLE. Deep Learning. MIT Press, 2016. ISBN: 9780262035613. 3. Current articles from scientific journals, contributions at the scientific and professional conferences related to the topic of diploma thesis.	
Course language: English	
Notes:	

Course assessment Total number of assessed students: 7	
abs	n
100.0	0.0

Provides:

Date of last modification: 25.07.2022

Approved: prof. RNDr. Gabriel Semanišin, PhD., prof. RNDr. Ivan Žežula, CSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: ÚMV/ DPP1a/22	**Course name:** Diploma project I
Course type, scope and the method: **Course type:** **Recommended course-load (hours):** **Per week: Per study period:** **Course method:** present	
Number of ECTS credits: 1	
Recommended semester/trimester of the course: 1.	
Course level: II.	
Prerequisities:	
Conditions for course completion:	
Learning outcomes:	
Brief outline of the course:	
Recommended literature:	
Course language:	
Notes:	
Course assessment Total number of assessed students: 10	
abs	n
100.0	0.0
Provides:	
Date of last modification: 24.08.2022	
Approved: prof. RNDr. Gabriel Semanišin, PhD., prof. RNDr. Ivan Žežula, CSc.	

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚMV/ DPP1b/22	**Course name:** Diploma project II

Course type, scope and the method:
Course type:
Recommended course-load (hours):
Per week: Per study period:
Course method: present

Number of ECTS credits: 2

Recommended semester/trimester of the course: 2.

Course level: II.

Prerequisities:

Conditions for course completion:

Learning outcomes:

Brief outline of the course:

Recommended literature:

Course language:

Notes:

Course assessment
Total number of assessed students: 10

abs	n
100.0	0.0

Provides:

Date of last modification: 24.08.2022

Approved: prof. RNDr. Gabriel Semanišin, PhD., prof. RNDr. Ivan Žežula, CSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: ÚMV/ DPP1c/22	**Course name:** Diploma project III
Course type, scope and the method: **Course type:** **Recommended course-load (hours):** **Per week: Per study period:** **Course method:** present	
Number of ECTS credits: 2	
Recommended semester/trimester of the course: 3.	
Course level: II.	
Prerequisities:	
Conditions for course completion:	
Learning outcomes:	
Brief outline of the course:	
Recommended literature:	
Course language:	
Notes:	
Course assessment Total number of assessed students: 15	
abs	n
100.0	0.0
Provides:	
Date of last modification: 24.08.2022	
Approved: prof. RNDr. Gabriel Semanišin, PhD., prof. RNDr. Ivan Žežula, CSc.	

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice
Faculty: Faculty of Science
Course ID: ÚMV/DPP1d/22 — **Course name:** Diploma project IV
Course type, scope and the method: **Course type:** **Recommended course-load (hours):** **Per week:** **Per study period:** **Course method:** present
Number of ECTS credits: 2
Recommended semester/trimester of the course: 4.
Course level: II.
Prerequisities:
Conditions for course completion:
Learning outcomes:
Brief outline of the course:
Recommended literature:
Course language:
Notes:
Course assessment Total number of assessed students: 15

abs	n
100.0	0.0

Provides:
Date of last modification: 24.08.2022
Approved: prof. RNDr. Gabriel Semanišin, PhD., prof. RNDr. Ivan Žežula, CSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚMV/ DPO/22	**Course name:** Diploma thesis and its defence

Course type, scope and the method:
Course type:
Recommended course-load (hours):
Per week: Per study period:
Course method: present

Number of ECTS credits: 16

Recommended semester/trimester of the course:

Course level: II.

Prerequisities:

Conditions for course completion:
The diploma thesis is the result of the student's own work. It must not show elements of academic fraud and must meet the criteria of good research practice defined in the Rector's Decision no. 21/2021, which lays down the rules for assessing plagiarism at Pavol Jozef Šafárik University in Košice and its components. Fulfillment of the criteria is verified mainly in the process of supervision and in the process of thesis defense. Failure to do so is reason for disciplinary action.

Learning outcomes:
The diploma thesis demonstrates mastery of extended theory and professional terminology of the field of study, acquisition of knowledge, skills and competencies in accordance with the declared profile of the graduate of the study program, as well as the ability to apply them creatively in solving selected field problems. Student demonstrates the ability of independent professional work in terms of content, formal and ethical. Further details on the diploma thesis are determined by Directive no. 1/2011 on the basic requirements of final theses and the Study Regulations of UPJŠ in Košice.

Brief outline of the course:
1. Elaboration of the diploma thesis in accordance with the instructions of the supervisor.
2. Presentation of the results of the diploma thesis before the examination commission.
3. Answering questions related to the topic of the diploma thesis within the discussion.

Recommended literature:
The recommended literature is determined individually in accordance with the topic of the diploma thesis.

Course language:
Slovak

Notes:

Course assessment
Total number of assessed students: 14

A	B	C	D	E	FX
71.43	7.14	14.29	0.0	7.14	0.0

Provides:
Date of last modification: 19.04.2022
Approved: prof. RNDr. Gabriel Semanišin, PhD., prof. RNDr. Ivan Žežula, CSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: ÚINF/ DPO/22	**Course name:** Doctoral Thesis and its Defence
Course type, scope and the method: **Course type:** **Recommended course-load (hours):** **Per week: Per study period:** **Course method:** present	
Number of ECTS credits: 16	
Recommended semester/trimester of the course:	
Course level: II.	
Prerequisities: ÚINF/SDI1c/15	
Conditions for course completion: The diploma thesis is the result of the student's own work. It must not show elements of academic fraud and must meet the criteria of good research practice defined in the Rector's Decision no. 21/2021, which lays down the rules for assessing plagiarism at Pavol Jozef Šafárik University in Košice and its components. Fulfillment of the criteria is verified mainly in the process of supervision and in the process of thesis defense. Failure to do so is reason for disciplinary action.	
Learning outcomes: The diploma thesis demonstrates mastery of extended theory and professional terminology of the field of study, acquisition of knowledge, skills and competencies in accordance with the declared profile of the graduate of the study program, as well as the ability to apply them creatively in solving selected field problems. Student demonstrates the ability of independent professional work in terms of content, formal and ethical. Further details on the diploma thesis are determined by Directive no. 1/2011 on the basic requirements of final theses and the Study Regulations of UPJŠ in Košice for the 1st, 2nd and combined 1st and 2nd degree.	
Brief outline of the course: 1. Elaboration of the diploma thesis in accordance with the instructions of the supervisor. 2, Presentation of the results of the diploma thesis before the examination commission. 3. Answering questions related to the topic of the diploma thesis within the discussion.	
Recommended literature: The recommended literature is determined individually in accordance with the topic of the diploma thesis.	
Course language: Slovak and optionally English.	
Notes:	

Course assessment
Total number of assessed students: 11

A	B	C	D	E	FX
45.45	9.09	36.36	9.09	0.0	0.0

Provides:

Date of last modification: 19.11.2021

Approved: prof. RNDr. Gabriel Semanišin, PhD., prof. RNDr. Ivan Žežula, CSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: ÚINF/ ZNA1/21	**Course name:** Foundations of knowledge systems
Course type, scope and the method: **Course type:** Lecture **Recommended course-load (hours):** **Per week:** 3 **Per study period:** 42 **Course method:** present	
Number of ECTS credits: 4	
Recommended semester/trimester of the course: 2.	
Course level: II.	
Prerequisities:	
Conditions for course completion: Test of theoretical knowledge in the middle of the semester. Written and oral exam.	
Learning outcomes: The goal is to teach students some advanced applications of logic, fuzzy logic and basic clustering methods, especially in database and knowledge systems.	
Brief outline of the course: 1. basic notions of Ordered sets and Formal concept analysis, motivation example 2. closure operator, closure system, Galois conection and concept lattice, example 3. basic notions of fuzzy logic, one-sided and fuzzy formal concept analysis 4. basic algorithms of Formal concept analysis 5. optimal decomposition of formal context, optimal factors, algorithms, example 6. intercontextual structures, bonds, direct products and selection of best bonds, relationship with factorisation 7. aplications on real data	
Recommended literature: 1. Bělohlávek, R. (2002). Fuzzy Relational Systems: Foundations and Principles. New York: Kluwer Academic/Plenum Publishers. 2. Carpineto, C., & Romano, G. (2004). Concept Data Analysis: Theory and Applications. Hoboken, NJ: John Wiley & Sons, Inc. 3. Ganter, B., & Wille, R. (1999). Formal Concept Analysis: Mathematical Foundations. Berlin: Springer. 4. Guniš, J., Šnajder, L., Antoni, L., Eliaš, P., Krídlo, O., & Krajči, S. (2024). Formal Concept Analysis of Students’ Solutions on Computational Thinking Game. IEEE Transactions on Education. doi:10.1109/TE.2024.3442612. 5. Krídlo, O., Antoni, Ľ., & Krajči, S. (2022). Selection of appropriate bonds between L-fuzzy formal contexts for recommendation tasks. Information Sciences, 606, 21-37. ISSN 0020-0255. https://doi.org/10.1016/j.ins.2022.05.047.	

6. Krídlo, O., López-Rodríguez, D., Antoni, Ľ., Eliaš, P., Krajči, S., & Ojeda-Aciego, M. (2023). Connecting concept lattices with bonds induced by external information. Information Sciences, 648, 119498. ISSN 0020-0255. https://doi.org/10.1016/j.ins.2023.119498.
7. Pitka, T., Bucko, Ľ., Šnajder, L., et al. (2024). Time analysis of online consumer behavior by decision trees, GUHA association rules, and formal concept analysis. Journal of Marketing Analytics. https://doi.org/10.1057/s41270-023-00274-y.

Course language:
Slovak or English

Notes:
content prerequisites: basics of logic, introduction to computer science

Course assessment
Total number of assessed students: 99

A	B	C	D	E	FX
53.54	4.04	19.19	8.08	12.12	3.03

Provides: doc. RNDr. Ondrej Krídlo, PhD.

Date of last modification: 03.11.2024

Approved: prof. RNDr. Gabriel Semanišin, PhD., prof. RNDr. Ivan Žežula, CSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚMV/ FAN/22	**Course name:** Functional analysis

Course type, scope and the method:
Course type: Lecture / Practice
Recommended course-load (hours):
Per week: 2 / 2 **Per study period:** 28 / 28
Course method: present

Number of ECTS credits: 6

Recommended semester/trimester of the course: 1.

Course level: II.

Prerequisities:

Conditions for course completion:
exam

Learning outcomes:
Understanding of the basic rigorous ideas of Applied Functional Analysis.

Brief outline of the course:
Linear spaces. Algebraic base and dimension. Linear operators and functionals. Algebraic dual spaces. Linear topological space. Locally convex space. Normed space. L(p) spaces. Dual spaces of L(p) spaces. Hilbert space. Applications of Baire category theorem. Open mapping theorem. Closed graph theorem. Hahn-Banach theorem. Spectrum of linear compact operator.

Recommended literature:
A. M. Bruckner, J. B. Bruckner, B. S. Thomson: Real Analysis, Prentice Hall, 1997.
B. P. Rynne, M. A. Youngson: Linear Functional Analysis, Springer-Verlag, 2008.

Course language:
Slovak

Notes:

Course assessment
Total number of assessed students: 47

A	B	C	D	E	FX
19.15	10.64	10.64	17.02	34.04	8.51

Provides: RNDr. Jaroslav Šupina, PhD.

Date of last modification: 19.04.2022

Approved: prof. RNDr. Gabriel Semanišin, PhD., prof. RNDr. Ivan Žežula, CSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚMV/THR/22 | **Course name:** Game theory

Course type, scope and the method:
Course type: Lecture / Practice
Recommended course-load (hours):
Per week: 2 / 2 **Per study period:** 28 / 28
Course method: present

Number of ECTS credits: 6

Recommended semester/trimester of the course: 1., 3.

Course level: II.

Prerequisities:

Conditions for course completion:
Two written exams dring the semester (solving problems), presentation of an interesting model. The final assessment is based on the written tests and oral examination.

Learning outcomes:
Knowledge of basic models of noncooperative and cooperative game theory, solution methods and applications of game-theoretic models in economics and everyday life.

Brief outline of the course:
Examples of games. Extensive form of a game, value of the game. Von Neumann Morgenstern utility theory. Matrix games and their solution methods: geometric, linear programming . Bimatrix games. Nash equilibrium and its computation. Negotiations theory. Cooperative n-person games: core, Shapley value. Economic applications of game theory.

Recommended literature:

1. K. Binmore, Fun and games, D.C. Heath, 1992
2. G. Owen, Game Theory, Academic Press (existuje ruský preklad).
3. A.R. Karlin, Y.Peres, Game theory alive, American Mathematical Society, 2017
4. L.C. Thomas, Games, Theory and Applications, Wiley, New York.
5. H.S. Bierman, L. Fernandez, Game Theory with Economic Applications, Addison-Wesley, 1998.

Course language:
Slovak

Notes:
The students should have basic knowledge in probability theory and linear programming (including duality theory and simplex method).

Course assessment
Total number of assessed students: 97

A	B	C	D	E	FX
22.68	21.65	23.71	16.49	13.4	2.06

Provides: prof. RNDr. Katarína Cechlárová, DrSc.
Date of last modification: 24.11.2024
Approved: prof. RNDr. Gabriel Semanišin, PhD., prof. RNDr. Ivan Žežula, CSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚINF/IMUI/19	**Course name:** Information management and artificial intelligence methods

Course type, scope and the method:
Course type:
Recommended course-load (hours):
Per week: **Per study period:**
Course method: present

Number of ECTS credits: 4

Recommended semester/trimester of the course:

Course level: II.

Prerequisities: ÚINF/ZNA1/21 and ÚINF/NEU/24 and ÚINF/STU1/16 and ÚMV/VSM/10 and ÚMV/NPR/19

Conditions for course completion:
Appropriate knowledge and competencies from the profile subjects of the study program, demonstrating the ability to synthesize the acquired knowledge and procedures and apply them to the problems of data analysis and artificial intelligence.

Learning outcomes:
Verification of acquired student competencies in accordance with the graduate profile.

Brief outline of the course:
1. Basics of knowledge systems and their principles
2. Principles and methods of neural networks
3. Principles and methods of machine learning
4. Computational and simulation methods
5. Principles and methods of random processes

Recommended literature:
Information sources recommended within individual profile subjects.

Course language:
Slovak language or English language

Notes:

Course assessment
Total number of assessed students: 4

A	B	C	D	E	FX
50.0	25.0	0.0	0.0	25.0	0.0

Provides:

Date of last modification: 31.03.2022

Approved: prof. RNDr. Gabriel Semanišin, PhD., prof. RNDr. Ivan Žežula, CSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚINF/ TIK1/22	**Course name:** Information theory, encoding

Course type, scope and the method:
Course type: Lecture / Practice
Recommended course-load (hours):
Per week: 2 / 1 **Per study period:** 28 / 14
Course method: present

Number of ECTS credits: 3

Recommended semester/trimester of the course: 1.

Course level: II.

Prerequisities:

Conditions for course completion:
Satisfiable knowledge of basic notions

Learning outcomes:
To understand principles of lossless coding and entropy and their mutual relationship.

Brief outline of the course:
1. Word and language
2. Decodable codes
3. Prefix-free codes
4. Krafto-McMillan inequality
5.-7. Entropy
8.-9. Price of code sequence
10. Shannon's theorem
11. Fano's code sequence
12. Huffman's optimal code sequence

Recommended literature:
1. D. Hankersson, G. Harris, P. Johnson: Introduction to Information Theory and Data Compression, CRC Pr., 1998.
2. J. Adámek: Kódovaní a teorie informace, Vydavatelství ČVUT, Praha 1994
3. J. Černý: Entrópia a informácia v kybernetike, Alfa 1981

Course language:
Slovak

Notes:

Course assessment
Total number of assessed students: 124

A	B	C	D	E	FX
58.87	19.35	12.1	4.03	0.0	5.65

Provides: prof. RNDr. Stanislav Krajči, PhD.

Date of last modification: 08.02.2022	
Approved: prof. RNDr. Gabriel Semanišin, PhD., prof. RNDr. Ivan Žežula, CSc.	

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice
Faculty: Faculty of Science

Course ID: ÚINF/ IDS18/18	**Course name:** Introduction to data science

Course type, scope and the method:
Course type: Lecture
Recommended course-load (hours):
Per week: 2 **Per study period:** 28
Course method: present

Number of ECTS credits: 3

Recommended semester/trimester of the course: 2., 4.

Course level: II.

Prerequisities:

Conditions for course completion:
Evaluation is based on the practical and the theoretical part of the exam. Practical exam consists of the defense of the semestral project, based on the report the student submit until the end of the semester. Student can get at most 50 points from the practical part. The theoretical part consists of answers to questions related to the theory of underlying methods presented during the course of the lecture. From the theoretical part the student can get at most 50 points. The final grade is based on the sum of the points the student has got for the practical and the theoretical part. To pass the course, the student need to get at least 60 points.

Learning outcomes:
Knowledge of basic principles and concepts of data mining, practical experience with working on a data mining project, such that, ability to analyze the problem and available data, pre=processing of data and modeling, ability to evaluate the success of a data mining project and application of its results into production.

Brief outline of the course:
1) Introduction: History of data mining, CRISP-DM method.
2) Clustering: similarities of various data types, agglomerative clustering, k-means clustering, DBSCAN, evaluation of clusters.
3) Frequent patterns: frequent itemsets, algorithms of Apriori, Eclat and FP-Growth, association rules, frequent sequences, evaluation of the quality of patterns.
4) Prediction: the task of regression and classification, linear model, parameters and hyper-parameters of models, regularization, bias and variance, cross-validation, Bayes model, discriminant function, hyper-parameter tuning, quality of models.
5) Recommendation techniques: explicit and implicit feedback, collaborative filtering, recommendation via matrix factorization, quality of recommendation.
6) Data pre-processing: data quality, noise, missing values, transformation of data, normalization, attribute selection, dimension reduction, sampling.

Recommended literature:
- Peter Flach (2012). Machine Learning: The Art and Science of Algorithms that Make Sense of Data. Cambridge University Press.

- Jiawei Han, Micheline Kamber, Jian Pei (2011). Data Mining: Concepts and Techniques. Morgan Kaufmann.
- Pang-Ning Tan, Michael Steinbach, Vipin Kumar (2005). Introduction to Data Mining. Addison Wesley.
- João Moreira, Andre de Carvalho, Tomáš Horváth (2018). A General Introduction to Data Analytics. Wiley.

Course language:
Slovak or English

Notes:
Content prerequisities: derivation, working with vectors and matrices, programming, data structures

Course assessment
Total number of assessed students: 17

A	B	C	D	E	FX
76.47	5.88	0.0	11.76	5.88	0.0

Provides: RNDr. Šimon Horvát, PhD., RNDr. Tomáš Horváth, PhD.

Date of last modification: 12.11.2021

Approved: prof. RNDr. Gabriel Semanišin, PhD., prof. RNDr. Ivan Žežula, CSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚMV/ LTM/10	**Course name:** Logic and set theory

Course type, scope and the method:
Course type: Lecture / Practice
Recommended course-load (hours):
Per week: 3 / 2 **Per study period:** 42 / 28
Course method: present

Number of ECTS credits: 6

Recommended semester/trimester of the course: 1.

Course level: I., II.

Prerequisities: ÚMV/MANb/19 or ÚMV/FRPb/19 or ÚMV/MAN2b/22

Conditions for course completion:
Exam

Learning outcomes:
To obtain a basic knowledge on the mathematical notion of an infinity. Analysis of the notion of a proof.

Brief outline of the course:
Set as a mathematical formularization of an infinity. Properties of the set of reals. Relations and mappings.
Finite and countable sets. Cardinality of continuum. Elementary cardinal arithmetics.
Sentential calculus, an axiomatization. Completness Theorem. Methods of proofs. Language of predicate calculus, examples. Axiomatizations of predicate calculus and the notion of a proof. Methods of proofs in predicate calculus.

Recommended literature:
L. Bukovský: Teória množín, ES UPJŠ, Košice, 1984.
L. Bukovský: Množiny a všeličo okolo nich, ES UPJŠ, Košice, 2005.
L. Bukovský, Úvod do matematickej logiky, elektronický učebný text.
A. Sochor: Klasická matematická logika, Karolinum, Praha, 2001.
E. Mendelson, Introduction to Mathematical Logic, van Nostrand 1964.

Course language:
Slovak

Notes:

Course assessment
Total number of assessed students: 280

A	B	C	D	E	FX
12.86	18.93	18.93	16.43	31.07	1.79

Provides: RNDr. Jaroslav Šupina, PhD., RNDr. Adam Marton, PhD.

Date of last modification: 19.04.2022

Approved: prof. RNDr. Gabriel Semanišin, PhD., prof. RNDr. Ivan Žežula, CSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚINF/ STU1/16	**Course name:** Machine learning

Course type, scope and the method:
Course type: Lecture / Practice
Recommended course-load (hours):
Per week: 2 / 2 **Per study period:** 28 / 28
Course method: present

Number of ECTS credits: 5

Recommended semester/trimester of the course: 2.

Course level: II.

Prerequisities:

Conditions for course completion:
The realization of a project focused on the application of machine solution methods in solving practical tasks. Successful completion of two written tests based on machine learning, probabilistic learning, classification tasks. Successful completion of the written and oral part of the exam based on machine learning, probabilistic learning, classification tasks.

Learning outcomes:
The result of education is an understanding of the basic principles of machine learning. The student will gain the ability to analyze data using selected methods of machine learning and artificial intelligence. Can work with a selected tool for modeling neural networks.

Brief outline of the course:
1. Learning algorithms, concepts, hypotheses. Training and learning, learning by construction and numbering.
2. Boolean formulas and their representation. Learning algorithms for monocells. Hypothesis space representation.
3. Probabilistic learning. An estimate of the number of examples needed to achieve some accuracy and credibility.
4. Probabilistic learning and consistent algorithms.
5. Relationships between attribute sets and predicted variables. Regression. Linear modeling using the least squares method of deviations.
6. Linear modeling, generalization, nonlinear responses from a linear model, data validation. Classification.
7. Linear modeling using probability theory and maximum confidence.
8. VC (Vapnik - Cervonenkis) dimension of its relation to perceptrons.
9. Bayesian approach to learning. SVM.
10. Clustering.
11. Hidden Markov models.

Recommended literature:
1. ANTHONY, Martin a Norman BIGGS. Computational Learning Theory, Cambridge University Press, 1997. ISBN 978-0521599221.
2. BROWNLEE, Jason. Machine Learning Mastery With Python. 2019.

3. WATT, Jeremy, Reza BORHANI a Aggelos K. KATSAGGELOS. Machine learning refined: foundations, algorithms, and applications. Cambridge: Cambridge University Press, 2016. ISBN 978-1-107-12352-6.

Course language:
Slovak language or English language

Notes:

Course assessment
Total number of assessed students: 75

A	B	C	D	E	FX
37.33	17.33	26.67	12.0	6.67	0.0

Provides: doc. RNDr. Ľubomír Antoni, PhD., doc. RNDr. Gabriela Andrejková, CSc., RNDr. Zoltán Szoplák, RNDr. Šimon Horvát, PhD.

Date of last modification: 31.03.2022

Approved: prof. RNDr. Gabriel Semanišin, PhD., prof. RNDr. Ivan Žežula, CSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: ÚMV/ MPA/19	**Course name:** Markov's processes and their applications
Course type, scope and the method: **Course type:** Lecture / Practice **Recommended course-load (hours):** **Per week:** 3 / 2 **Per study period:** 42 / 28 **Course method:** present	
Number of ECTS credits: 6	
Recommended semester/trimester of the course: 1.	
Course level: II.	
Prerequisities:	

Conditions for course completion:
Total evaluation based on 2 written tests (2x40p) + assignment (5p) and oral exam (40p).
At least 50% must be obtained from each part.
Final evaluation: ≥90% A; ≥80% B; ≥70% C; ≥60% D; ≥50% E; <50% FX.

Learning outcomes:
Student should:
1. Obtain the knowledge about modelling of real stochastic processes.
2. Apply theoretical knowledge in practical problems solving in queuing and renewal theory.
3. Obtain basic skills with CAS software SageMath based on Python.

Brief outline of the course:
1. Stochastic (random) processes (definition, characteristics, classification of processes).
2. Markov chains (Markov property, transition matrix, discrete-time Markov chains).
3. Classification of states of the process.
4. Evaluation of transitions, optimal strategies, Howard´s algorithm.
5. Special chains with continuous time (continuous-time Markov chains, intensity of transition, Kolmogorov´s differential equations, Poisson process).
6. Birth-and-death processes.
7. Applications in queuing theory (Kendall´s classification of queuing systems, efficiency indicators, opened systems without waiting).
8.-9. Opened systems with waiting, closed systems.
10. Applications in renewal theory and reliability. Markov chains in discrete renewal models.
11. Renewal process with continuous time.
12. Reliability of the system of elements.
13. Limit theorems of renewal theory.

Recommended literature:
1. Skřivánková V., Hančová M.: Náhodné procesy a ich aplikácie, UPJŠ, Košice, 2018 (in Slovak)
2. Beichelt F.: Applied Probability and Stochastic Processes, 2nd Ed., Chapman and Hall, 2016
3. Ross S. M.: Introduction to Probability Models, 13th ed., Elsevier, 2023
4. Janková, K. a kol. Markovove reťazce a ich aplikácie, epos, 2014 (in Slovak)

5. Prášková Z., Lachout P.: Základy náhodných procesu, MFF UK, Praha, 2020 (in Czech)

Course language:
Slovak

Notes:
The students are required to have basic knowledge about axiomatical theory of probability, distributions and characteristics of random variables.

Course assessment
Total number of assessed students: 89

A	B	C	D	E	FX
24.72	16.85	20.22	19.1	15.73	3.37

Provides: doc. RNDr. Martina Hančová, PhD., RNDr. Andrej Gajdoš, PhD.

Date of last modification: 21.11.2024

Approved: prof. RNDr. Gabriel Semanišin, PhD., prof. RNDr. Ivan Žežula, CSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚMV/VRS/14	**Course name:** Multidimensional statistical methods

Course type, scope and the method:
Course type: Practice
Recommended course-load (hours):
Per week: 3 **Per study period:** 42
Course method: present

Number of ECTS credits: 4

Recommended semester/trimester of the course: 2.

Course level: II.

Prerequisities:

Conditions for course completion:
Given at the basis of partial examination and working out an individual project.

Learning outcomes:
To learn to use the most widely used multivariate methods of data processing practically.

Brief outline of the course:
Multivariate data, graphical visualization. Multivariate normal distribution. Inference for multivariate normal distribution. Dimension reduction - principal component analysis, factor analysis. Multidimensional scaling. Cluster analysis. Odds and risk ratios. Logistic regression.

Recommended literature:
1. W. Härdle, L. Simar. Applied multivariate statistical analysis. Heidelberg: Springer, 2019
2. W. Härdle, Z. Hlávka: Multivariate statistics: Exercises and solutions. New York: Springer, 2007
3. R.A. Johnson, D.W. Wichern. Applied multivariate statistical analysis. Upper Saddle River, N.J: Pearson Prentice Hall, 2014 (6. vydanie)
4. B. Everitt and T. Hothorn. An introduction to applied multivariate analysis with R. New York: Springer, 2011
5. D.J. Bartholomew et al. Analysis of multivariate social science data. Chapman & Hall, 2008 (2. vydanie)

Course language:
Slovak

Notes:

Course assessment
Total number of assessed students: 16

A	B	C	D	E	FX
50.0	31.25	12.5	0.0	6.25	0.0

Provides: doc. RNDr. Daniel Klein, PhD.

Date of last modification: 27.01.2022

Approved: prof. RNDr. Gabriel Semanišin, PhD., prof. RNDr. Ivan Žežula, CSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚINF/ NEU1/15	**Course name:** Neural networks

Course type, scope and the method:
Course type: Lecture / Practice
Recommended course-load (hours):
Per week: 2 / 1 **Per study period:** 28 / 14
Course method: present

Number of ECTS credits: 5

Recommended semester/trimester of the course: 3.

Course level: II.

Prerequisities:

Conditions for course completion:
Successful realization of a project focused on the applications of neural networks. Successful completion of two written tests at 60% which are focused on various architectures of neural networks and the connections with other areas of computer science - automata, fuzzy logic. Demonstration of knowledge focused on neural network methods and their application in the exam.

Learning outcomes:
Knowledge of basic paradigms of neural networks. Knowledge about applications of neural networks in various fields. Ability to assess the applicability of neural networks in solving algorithmic problems.

Brief outline of the course:
1. Motivational examples. Mathematical model of neuron and neural network. Perceptrons. Linear separable objects, adaptation process (learning), perceptron convergence, multiple perceptrons.
2. Computational power of single input neural networks, neuromata. Simulation of automata using neural networks.
3. Classical layer neural networks, hidden neurons, adaptation process (learning), feedback method backpropagation and its variants.
4. Recurrent neural networks, algorithm for training recurrent networks. Examples of use.
5. Self-organization of neural networks and Kohonen neural networks, learning algorithm, use.
6. Networks with local neurons, RBF networks, networks with semi - local units. RBF approximations
networks.
7. Written test I. Neuromat for regular language. neural network to deterministic finite state automaton, recurrent backpropagation algorithm and its applications, Kohonen ane RBF neural networks.
8. Convolutional neural networks. Basic knowledge of convolution. Convolutional neural networks for image processing.
9. Deep neural networks and their use.
10. Graph neural networks, structure, learning and applications.
11. Deductive systems of fuzzy logic. Fuzzy neural networks and their use. Fuzzy controller.

12. Universal approximation using neural networks, Kolmogorov theorem. Approximation properties layered neural networks.
13. Solving practical problems using neural networks.
14. Written test II. Convolution and convolutional neural networks, deep neural networks, graph neural networks, constructtion of fuzzy regulator, Kolmogorov theorem and idea of its proof.

Recommended literature:

1. Y. Bengio: Learning Deep Architectures for AI, Foundations and Trends in ML, Vol. 2, No. 1 , 2009, pp. 1-127 ##
2. I. Goodfellow, Y. Bengio and A. Courville: Deep Learning, MIT Press book, 2016, ISBN-13: 978-0262035613
https://www.deeplearningbook.org/ ##
3. M. H. Hassoun: Fundamentals of artificial neural networks. MIT Press, Cambridge, 1995. ##
4. J. Hertz, A. Krogh, R.G. Palmer: Introduction to the theory of neural computation, Addison-Wesley, 1991. ##
5. V. Kvasnička a kol.: Úvod do teórie neurónových sietí, IRIS, Bratislava, 1997. ##
6. P. Sinčák, G. Andrejková: Neurónové siete. I. diel: Dopredné siete, II. diel: Rekurentné a modulárne siete, Košice, 1997. ##
7. J. Šíma, R. Neruda: Teoretické otázky neuronových sití, Matfyzpress, MFF UK, Praha, 1996. ##
8. F. Scarselli, M. Gori, Ah Ch. Tsoi, M. Hagenbuchner, and G. Monfardini: The Graph Neural Network Model. IEEE TRANSACTIONS ON NEURAL NETWORKS, VOL. 20, NO. 1, JANUARY 2009 ##

Course language:
Slovak or English

Notes:
For ERASMUS students:
It is necessary to know a model of artificial neurons, its computation and its setting, layered neural networks and backpropagation training algorithm.

Course assessment
Total number of assessed students: 258

A	B	C	D	E	FX
20.16	16.28	23.26	18.6	17.44	4.26

Provides: doc. RNDr. Ľubomír Antoni, PhD., doc. RNDr. Gabriela Andrejková, CSc.

Date of last modification: 20.09.2021

Approved: prof. RNDr. Gabriel Semanišin, PhD., prof. RNDr. Ivan Žežula, CSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: ÚMV/ TOR/22	**Course name:** Optimal control theory
Course type, scope and the method: **Course type:** Lecture / Practice **Recommended course-load (hours):** **Per week:** 2 / 2 **Per study period:** 28 / 28 **Course method:** present	
Number of ECTS credits: 6	
Recommended semester/trimester of the course: 1., 3.	
Course level: II.	
Prerequisities:	
Conditions for course completion: Based on two written tests during the semester and on the oral examination.	
Learning outcomes: To learn the basic notions and applications of the theory of controllable systems.	
Brief outline of the course: The notion of a controllable system. Examples of mechanical, electrical, biological and economic systems. Controllable set and its properties. Theorem on complete controllability of a linear system. Pontrjagins maximum principle and its variants. Transversality conditions. Optimal control of linear systems, bang-bang principle, switching points, singular regulations. Applications of theoretical results in practical problems. Modelling of economic and financial systems.	
Recommended literature: 1. D.G. Zill, M. R. Cullen Differential Equations with Boundary-Value Problems, Brooks/Cole, Cengage Learning, 2005 2. S.S. Sethi, Optimal control theory, Applications to management science and economics, Springer, 2021 3. J. Macki, A. Strauss, Introduction to Optimal Control Theory, Springer, Berlin, 1980. 4 L.M. Hocking, Optimal control, an introduction to the theory with applications, Clarendon Press; 1991 5. M. Vlach, Optimální řízení regulovatelných systému, SNTL, Praha, 1975. 6. G. Feichtinger, R.F. Hartl: Optimale Kontrolle okonomischer Prozesse, Berlin, 1986.	
Course language: Slovak	
Notes: The students are required to have basic knowledge about differential equations. Properties of convex sets are recommended.	

Course assessment
Total number of assessed students: 90

A	B	C	D	E	FX
24.44	26.67	22.22	13.33	13.33	0.0

Provides: prof. RNDr. Katarína Cechlárová, DrSc.

Date of last modification: 24.11.2024

Approved: prof. RNDr. Gabriel Semanišin, PhD., prof. RNDr. Ivan Žežula, CSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: ÚINF/ PDB1/15	**Course name:** Organization and data processing
Course type, scope and the method: **Course type:** Lecture / Practice **Recommended course-load (hours):** **Per week:** 2 / 1 **Per study period:** 28 / 14 **Course method:** present	
Number of ECTS credits: 4	
Recommended semester/trimester of the course: 1.	
Course level: II.	
Prerequisities:	
Conditions for course completion: Conditions for the final evaluation: final test	
Learning outcomes: To understand the principles of database management systems. To be able to use the knowledge when solving optimization problems over big data and managing parallel and distributed databases.	
Brief outline of the course: 1. Data representation, disk and file organization, 2. Tree-based indexing methods B+tree, R-tree, 3. Working with low-level classes to working with files 4. Creation of clustered and unclustered indexes 5. Hash-based indexing methods, external sorting, 6. Enumeration of relational operators, query optimization, 7. Case study: practical DB optimalization 8. Transaction management, 9. Crash recovery 10. Parallel databases, evaluation of relational operators in parallel databases 11. Distributed databases, evaluation of relational operators in distributed databases, database security and data consistency, recovery management in distributed database, distributed trasactions, distribution of table replicas	
Recommended literature: 1. R. RAMAKRISHNAN, J. GEHRKE: Database Management Systems, McGraw Hill Higher Education, 2003 2. A. SILBERSCHATZ, H. F. KORTH, S. SUDARSHAN: Database system concepts, McGraw Hill Higher Education, 2006	
Course language: Slovak or English	
Notes: Content prerequisities: SQL language (DBS1a), basics of programming (PAZ1a)	

Course assessment
Total number of assessed students: 138

A	B	C	D	E	FX
28.99	19.57	14.49	10.87	23.91	2.17

Provides: RNDr. Peter Gurský, PhD.

Date of last modification: 04.01.2022

Approved: prof. RNDr. Gabriel Semanišin, PhD., prof. RNDr. Ivan Žežula, CSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: ÚINF/ PDS1/21	**Course name:** Parallel and distributed systems
Course type, scope and the method: **Course type:** Lecture / Practice **Recommended course-load (hours):** **Per week:** 2 / 2 **Per study period:** 28 / 28 **Course method:** present	
Number of ECTS credits: 5	
Recommended semester/trimester of the course: 2.	
Course level: II., N	
Prerequisities:	
Conditions for course completion: Home assignments, class project from tutorials, midterm written exam. Final written and oral exam.	
Learning outcomes: Understand the principles, basic problems and algorithms of parallel programming. Be able to implement synchronization procedures and manage and use interprocess communication. Master the basics of GPU programming. Understand the differences between parallel and distributed computational models. Master basic distributed algorithms and know how to implement them. Understand the problems of creating a distributed system environment and know how to solve them. Be able to use distributed environments in practical applications.	
Brief outline of the course: Parallel architectures, parallel computational model, access to shared memory. Basic algorithms, scaling, optimality. Effective methods of parallel search and sorting. Working in a GPU environment. Distributed computational model, communication protocols, characteristics of distributed systems. Intercomputer communication, distributed synchronization algorithms, transactions, termination and deadlock detection. Consistency issues with distributed memory sharing. Distributed application environment. Reliable calculations in an environment with errors.	
Recommended literature: 1. J. JáJá: An Introduction to Parallel Algorithms, Addison-Wesley, 1992, ISBN 0-201-54856-9 2. P. Sanders, K. Mehlhorn, M. Dietzfelbinger, R. Dementiev: Sequential and Parallel Algorithms and Data Structures, Springer, 2019 3. Sukumar Ghosh: Distributed Systems and Algorithms (Second Edition), CRC Press 2014 4. M. Raynal: Distributed Algorithms for Message-Passing Systems, Springer, 2013 5. Gerard Tel: Introduction to Distributed Algorithms, Cambridge University Press, 2001	
Course language: Slovak or English	
Notes: Content prerequisities: basic of concurrent programming, basic of operating system principles	

Course assessment
Total number of assessed students: 63

A	B	C	D	E	FX
19.05	6.35	19.05	20.63	23.81	11.11

Provides: doc. RNDr. Jozef Jirásek, PhD., RNDr. Rastislav Krivoš-Belluš, PhD., Bc. Marián Dvorský, RNDr. Ladislav Mikeš, PhD.

Date of last modification: 23.11.2021

Approved: prof. RNDr. Gabriel Semanišin, PhD., prof. RNDr. Ivan Žežula, CSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚINF/ PDSI1/15	**Course name:** Pro-seminar to diploma thesis in informatics

Course type, scope and the method:
Course type: Practice
Recommended course-load (hours):
Per week: 2 **Per study period:** 28
Course method: present

Number of ECTS credits: 2

Recommended semester/trimester of the course: 1.

Course level: II.

Prerequisities:

Conditions for course completion:
Evaluation of the student's paper with a focus on the issue of the diploma thesis.
Evaluation of the achieved results of the student during the semester on the diploma thesis on the basis of his / her report and the created diploma website.

Learning outcomes:
To inform students about areas of informatics they are suitable to work in diploma theses. In the end of semester students have to prepared themes of diploma theses, goals and recommended study literature.

Brief outline of the course:
The seminar is oriented to problems prospective to preparations of Diploma theses.

Recommended literature:
1. MEŠKO, D., KATUŠČÁK, D. Akademická príručka. 1. vyd. Vydavateľstvo Osveta : Martin, 2004. 316 s. ISBN 80-8063-150-6
2. ISO 690: 1987 Documentation - Bibliographic references. Content, form and structure.
3. ISO 2145: 1978 Documentation - Numbering of divisions and subdivisions in written documents.
4. Eco, U.: Jak napsat diplomovou práci, z taliančiny Come si fa una tesi di laures, Milano, 1977, Olomouc, Votobiax.
5. Professional and scientific literature related to the diploma thesis according to the recommendation of the thesis supervisor.

Course language:
Slovak or English

Notes:

Course assessment
Total number of assessed students: 109

abs	n
98.17	1.83

Provides:
Date of last modification: 08.01.2022
Approved: prof. RNDr. Gabriel Semanišin, PhD., prof. RNDr. Ivan Žežula, CSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: ÚINF/ BPD1/15	**Course name:** Security of computer systems and data
Course type, scope and the method: **Course type:** Lecture / Practice **Recommended course-load (hours):** **Per week:** 2 / 2 **Per study period:** 28 / 28 **Course method:** present	
Number of ECTS credits: 5	
Recommended semester/trimester of the course: 3.	
Course level: I., II.	
Prerequisities:	
Conditions for course completion: Homeworks, active participation in laboratory exercises. Final practical test, oral examination.	
Learning outcomes: Familiarize with the concepts, methods, and means to ensure the confidentiality, integrity, and availability of computer systems assets. To control in more detail the issues of access control to computer system resources, operating system security, program security, database systems security. Gain the ability to create security models, use cryptographic methods to ensure security, know how to evaluate system and communication security. By completing the course the student will gain the knowledge necessary in the design of secure computer and information systems, risk analysis and security audit of information systems.	
Brief outline of the course: 1. Computer security concepts, information security, security policies for its individual components. 2. User authentication principles, password generation and management, multifactor authentication, vulnerabilities. 3. Access control models, access matrices, attribute models, multilevel models, reference monitors, access monitoring and audit. 4. System security. System installation, update management, service configuration, resource management and monitoring, user administration, remote access, virtualization, hardening. 5. Equipment for digital data storage, coding, durability, confidentiality, integrity, availability, replication, archiving, disposal. 6. System startup (BIOS, UEFI), disk data organization, file systems and their vulnerabilities. 7. Management and monitoring of processes, operating system services, executable files and their structure, metadata. 8. Intel and ARM processor architecture, assembler, memory access organization, segmentation and paging support, process execution support. 9. Malicious software, advanced persistence threat. Methods of system attacks, static analysis of potentially malicious software, countermeasures. 10. Dynamic analysis of malicious software, basics of disassembly techniques.	

11. Mechanisms of attacks at the level of application programs, exceeding the allocated resources, code insertion, social engineering.
12. Vulnerabilities of database systems, security of requirements, inference channels, problems of cloud implementations, archiving and secure data deletion.
13. Secure software development, defensive programming, input validation, formal verification, OWASP principles for web application development.

Recommended literature:

1. STALLINGS, W.: Computer Security: Principles and Practice, 4.ed., Pearson, 2017, ISBN 978-0134794105
2. PFLEEGER, CH.,P.: Security in Computing. 4th ed. Prentice-Hall International, Inc., 2006, ISBN: 0-13-2390779
3. GOLLMANN, D.: Computer Security. John Wiley & Sons, 2011, ISBN: 0-470-741155.

Course language:
Slovak or English

Notes:

Course assessment
Total number of assessed students: 68

A	B	C	D	E	FX
20.59	17.65	17.65	20.59	23.53	0.0

Provides: doc. RNDr. Jozef Jirásek, PhD., RNDr. Rastislav Krivoš-Belluš, PhD.

Date of last modification: 23.11.2021

Approved: prof. RNDr. Gabriel Semanišin, PhD., prof. RNDr. Ivan Žežula, CSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚINF/SDI1a/15	**Course name:** Seminar to diploma theses in informatics

Course type, scope and the method:
Course type: Practice
Recommended course-load (hours):
Per week: 2 **Per study period:** 28
Course method: present

Number of ECTS credits: 2

Recommended semester/trimester of the course: 2.

Course level: II.

Prerequisities: ÚINF/PDSI1/15

Conditions for course completion:
Presentation of the analysis of the assignment and the proposal of the solution of the diploma thesis tasks, editing of the web page, written elaboration of the analysis and design of the solution.

Learning outcomes:
Monitoring and public presentation of work done so fare on thesis preparation

Brief outline of the course:
The seminar serves for control, public presentation and defense of partial results at DP. In order to be awarded the credits, it is necessary to successfully complete the presentation of the analysis of the assignment and the achieved results, including the proposal of specific steps of the further solution procedure, update the presentation of the diploma thesis on the network and prepare a written analysis and proposal for solving the assigned problem in the range of 15-20 pages.

Recommended literature:
According to the topic of diploma thesis.

Course language:
Slovak or English

Notes:

Course assessment
Total number of assessed students: 212

abs	n
95.75	4.25

Provides:

Date of last modification: 08.01.2022

Approved: prof. RNDr. Gabriel Semanišin, PhD., prof. RNDr. Ivan Žežula, CSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: ÚINF/ SDI1b/15	**Course name:** Seminar to diploma theses in informatics
Course type, scope and the method: **Course type:** Practice **Recommended course-load (hours):** **Per week:** 2 **Per study period:** 28 **Course method:** present	
Number of ECTS credits: 2	
Recommended semester/trimester of the course: 3.	
Course level: II.	
Prerequisities: ÚINF/SDI1a/15	
Conditions for course completion: Presentation of achieved results on the diploma thesis, web page modification, written processing of results.	
Learning outcomes: Monitoring and public presentation of work done so fare on thesis preparation	
Brief outline of the course: Every thesis has a compulsory theoretical part and may also contain a software part. To gain recognition, the following is necessary: a detailed compilation of studied literature (a minimum of thirty pages) and at least twenty pages of text containing the candidate's own views of the problem area, possible research goals, own results are welcome (if the thesis is purely theoretical, this will be judged more strictly). For the SW part: a tested implementation (must conform to user requirements, help and user friendly user interface not necessary at this stage) and access to source texts. For both parts there will be an oral presentation and discussion.	
Recommended literature: According to the topic of diploma thesis	
Course language: Slovak or English	
Notes:	
Course assessment Total number of assessed students: 181	

abs	n
99.45	0.55

Provides:	
Date of last modification: 08.01.2022	
Approved: prof. RNDr. Gabriel Semanišin, PhD., prof. RNDr. Ivan Žežula, CSc.	

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice

Faculty: Faculty of Science

Course ID: ÚINF/ SDI1c/15	**Course name:** Seminar to diploma theses in informatics

Course type, scope and the method:
Course type: Practice
Recommended course-load (hours):
Per week: 2 **Per study period:** 28
Course method: present

Number of ECTS credits: 2

Recommended semester/trimester of the course: 4.

Course level: II.

Prerequisities: ÚINF/SDI1b/15

Conditions for course completion:
Presentation of the achieved results of the diploma thesis with a discussion. Final editing of the web page.

Learning outcomes:
Monitoring and public presentation of work done so fare on thesis preparation

Brief outline of the course:
The seminar serves for control, public presentation and defense of DP results. In order to be awarded the credits, it is necessary to complete a public presentation of the work associated with the discussion, together with the final presentation of the presentation on the Internet.

Recommended literature:
According to the topic of diploma thesis.

Course language:
Slovak or English

Notes:

Course assessment
Total number of assessed students: 164

abs	n
100.0	0.0

Provides:

Date of last modification: 08.01.2022

Approved: prof. RNDr. Gabriel Semanišin, PhD., prof. RNDr. Ivan Žežula, CSc.

COURSE INFORMATION LETTER

University: P. J. Šafárik University in Košice	
Faculty: Faculty of Science	
Course ID: ÚMV/ NPR/19	**Course name:** Stochastic processes
Course type, scope and the method: **Course type:** Lecture / Practice **Recommended course-load (hours):** **Per week:** 3 / 2 **Per study period:** 42 / 28 **Course method:** present	
Number of ECTS credits: 6	
Recommended semester/trimester of the course: 2.	
Course level: II.	
Prerequisities:	
Conditions for course completion: Total evaluation based on a written test (30p) + individual project work (30p) and oral exam (40p). At least 50% must be obtained from each part. Final evaluation: ≥90% A; ≥80% B; ≥70% C; ≥60% D; ≥50% E; <50% FX.	
Learning outcomes: To obtain knowledge of the stationary stochastic processes analysis in time domain and spectral domain. To study properties of random processes with discrete time (time series) and continuous time and their application in finance. To obtain skills in time series analysis with software R.	
Brief outline of the course: 1.-2. Stationary precess, linear process. 3. Causal and invertible process. 4. Time domain analysis (autocovariance, autocorrelation and partial autocorrelation function). 5. Sample characteristic of time series and their properties. 6.-7. Frequency domain analysis (spectral density and distribution function, periodogram). 8. Prediction of time series. 9. Random processes with continuous time (fundamental concepts). 10. Brownian motion, Itô’s process, Itô’s lemma and its application. 11.-12. The Black-Scholes formula.	
Recommended literature: 1. Brockwell P., Davis R.: Introduction to Time Series and Forecasting, 3rd ed., Springer, New York, 2016 2. Prášková Z.: Základy náhodných procesů II, Karolinum, Praha, 2016 (in Czech) 3. Tsay R.: Analysis of Financial Time Series, 3rd ed., Wiley Interscience, New Jersey, 2010 4. Shumway R., Stoffer D.: Time Series Analysis and Its Applications with R Examples, 5th ed., Springer, New York, 2024 5. Melicherčík I., Olšarová L., Úradníček V.: Kapitoly z finančnej matematiky, Epos, Bratislava, 2005 (in Slovak) 6. Oksendal B.K.: Stochastic Differential Equations, 6th ed., Springer, 2014	

Course language:
Slovak

Notes:
The students are required to have basic knowledge about random vectors and their characteristics, conditional distribution, estimation theory and hypothesis testing.

Course assessment
Total number of assessed students: 91

A	B	C	D	E	FX
41.76	20.88	19.78	8.79	5.49	3.3

Provides: doc. RNDr. Martina Hančová, PhD.

Date of last modification: 21.11.2024

Approved: prof. RNDr. Gabriel Semanišin, PhD., prof. RNDr. Ivan Žežula, CSc.