I. DESCRIPTION OF STUDY PROGRAMME FORM

<table>
<thead>
<tr>
<th>BASIC INFORMATION</th>
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<tbody>
<tr>
<td>Title of study programme</td>
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<tr>
<td>study programme coordinator</td>
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<tr>
<td>Study programme implementor</td>
</tr>
<tr>
<td>Type of study programme</td>
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<tr>
<td>Level of study programme</td>
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<tr>
<td>Academic/professional degree awarded upon completion of study</td>
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</table>

1. INTRODUCTION

1.1. Reasons for initiating the study

Reasons for initiating the study are: economy needs, improvement of scientific research at the University of Rijeka (by introducing contemporary methods of planning and analysis of experiments), shown interest of potential students and personnel potential of the Department of mathematics. Discrete mathematics is a branch of mathematics that has many applications in other fields of science and economy. In this study program students will, among other things, acquire knowledge from graph theory, optimization, cryptography, coding theory and design of experiments. Based on surveys of students on undergraduate course of mathematics at the University of Rijeka, we realized that there is great interest in this graduate program. We also believe that mentioned study program will attract students who live outside our district, since it will be the only study of this direction in the Republic of Croatia. Department of mathematics, University of Rijeka, has personnel capabilities for performing this study, since the scientific work of thirteen employees of the Department is closely associated with the fundamental topics that will be processed in the framework of this study.

1.2. Estimation of purpose with respect to labor market needs in public and private sector

Acquired knowledge in this study is very applicable in the economy; graph theory has broad applications, from telecommunications to the design of road networks, coding theory and cryptography is used in everyday communication. Since there will be more jobs related to ICT technologies and data protection, needs for this profile will be larger. Optimization is very purposeful in various business processes, while the design and analysis of experiments is necessary in conducting of any experiment, from the manufacturing new drugs and testing machines and their parts. Also, knowledge of design of experiments is also very applicable in analyzing characteristics of the finished products, so we expect that the labor market will identify and show need for this profile.

1.2.1. Relationship with the Local Community (economy, business, civil society)

Acquired knowledge in this study is applicable in various sectors of the economy. Because of acquired knowledge in coding theory, cryptography, graph theory, and subjects in computer science, graduates can be employed in the economic subjects dealing with telecommunications and information technology. Acquired knowledge from the optimization and design of experiments provides employment in several branches of economy, for example, in companies that need to test finished products or prototypes.

1.2.2. Compatibility with the requirements of professional associations (recommendation)

While creating a study program, the following resource was especially considered:

Tuning Educational Structures in Europe (http://tuning.unideusto.org/tuningeu/), especially the part that refers to the study of mathematics. (http://tuning.unideusto.org/tuningeu/index.php?option=content&task=view&id=27&Itemid=50).

1.2.3. List of the possible partners outside the higher education system who expressed interest for study program
For now, the greatest interest in this study showed companies dealing with information technology, since these companies are often employing former students of the Department of mathematics, who graduated on our educational courses: Mathematics and Mathematics and Computer Science.

1.3. Comparability of study program with similar programs of accredited institutions of higher education in Croatia and the EU (specify and explain the comparability of the two programs, of which at least one of the EU, with a program that is proposed, and state network sites)

<table>
<thead>
<tr>
<th>Study program of Discrete mathematics and implementation is comparable with the study program Mathematics (MSci) at the Queen Mary University of London [<a href="http://www.qmul.ac.uk/courses/courses.php?course_id=127&amp;dept_id=16&amp;ugcourses=1&amp;course_level=2">http://www.qmul.ac.uk/courses/courses.php?course_id=127&amp;dept_id=16&amp;ugcourses=1&amp;course_level=2</a>] and the study program at the University of Essex, modules MSc Discrete mathematics and its applications and MSc Statistics and Computer Science [<a href="http://www.essex.ac.uk/coursefinder/pdfs/pg/MATH.pdf">http://www.essex.ac.uk/coursefinder/pdfs/pg/MATH.pdf</a>].</th>
</tr>
</thead>
</table>

Comparability with the study of Mathematics (MSci) at the Queen Mary University of London is reflected in the subjects: combinatorics and graph theory (Combinatorics, Enumerative and Asymptotic Combinatorics, Extremal Combinatorics, Algorithmic Graph Theory), probability theory (Probability I, Probability II, Probability III), statistics (Introduction to Statistics, Statistical Modelling I, Statistical Modelling II, Advanced Statistical Modelling, Statistical Theory, Computational Statistics, Bayesian Statistics), coding theory and cryptography (Coding Theory, Cryptography), algebra and group theory (Algebraic Structures I, Algebraic Structures II, Fields and Galois Theory, Group Theory) and design of experiments (Design of Experiments). Courses of London’s studies are numerous because it is four-year study.

Comparability with studies at the University of Essex is evident over the subjects of Graph Theory, Cryptography and Codes, Stochastic Processes and Experimental Design, which are part of the module MSc Discrete Mathematics and its Applications and MSc Statistics and Computer Science.

Performers of mentiones programs emphasize that finishing this study represents a good basis for the possible development of scientific career in the field of natural sciences and engineering, but also allows employment in various areas where is required algorithmic way of thinking and the ability to analyse data.

1.4. Openness to the horizontal and vertical student mobility in national and international higher education

This graduate program can enroll bachelors who have completed undergraduate course in mathematics in any Croatian or foreign university. After finishing this study, masters of mathematics will be able to enroll the Common doctoral program in mathematics at the University J.J. Strossmayer in Osijek, University of Rijeka, University of Split and the University of Zagreb, as well as appropriate doctoral studies abroad.

1.5. Compatibility with mission and strategy of the University of Rijeka

According to the Strategy of University of Rijeka for 2007-2013, university will devote special attention to the development of natural science. Since this is the first noneducational graduate course in mathematics at our university, implementation of this study certainly contributes in achieving the strategic aim of development of the natural sciences. We also expect that this study will contribute to the development of other natural sciences at the University by creating personnel who can apply appropriate mathematical methods for improving the process of planning and implementing experiments. One of the strategic aims of the University is development of research in the field of information and communication technologies. Since coding theory and cryptography are one of the main content of this program, study also contributes in achieving goal of development of ICT research.

The programme is also adjusted with the Strategy of University of Rijeka 2014-2020.

- Increase the number of students in engineering, biomedicine, biotechnology and natural sciences, in information and communication technology and in interdisciplinary studies related to these fields

There is not many candidates with this profile in the labor market. According to the Strategy of University of Rijeka (2014-2020.), strategic goal of University is to increase entry quotas and the number of graduates on study programmes related to natural sciences.

- Achieve favorable ratio of students per lecturer

Entry quota of 15 enables a favorable ratio of students per lecturer on the Department studies.

- Increase eligibility in the regime of internal mobility

The programme ensures eligibility in the regime of internal mobility with the large number of elective courses in this study programme being compulsory on other study programmes (studies on Department of Mathematics, Department of Informatics or Department of Physics).
• Increase the portion of e-learning in study programmes
Almost all courses use advanced tools for e-learning, which causes quality changes in education. For the majority of courses, there is a version of a course on MudRi, e-learning system of University of Rijeka, at the same time keeping high standards of education quality, especially communication between professors and students. The needed ICT infrastructure is secured, ie. computer and software support for educational activities and e-learning.
• Ensure regular monitoring of students' satisfaction
Study programme predicts efficient administration of measures for monitoring and improvement of students' success which is conducted by the department's Board for quality assurance.
• Determine the list of practical competencies which are guaranteed after finishing the studies and adjust the study programmes in the (re)accreditational procedure.

1.6. Institutional development strategy of study programs (compatibility with the mission and strategic aims of the institution)
This study, as first noneducational course in mathematics at the University of Rijeka, is extremely important for implementing the strategy of development programs at the Department of mathematics. We also expect connecting with other programs of components of the University (mainly university departments) that should recognize the programs' potential in the development of competencies for future researchers.
On the 65. meeting, on October 20th, 2014., The Council of the Department of Mathematics has accepted the Strategy of University of Rijeka 2014.-2020. as a strategic document of the Department of Mathematics, University of Rijeka, and defined prioritized strategic goals of the Department. Some of the strategic goals related to education are:
• Increase the number of students who enrolled in graduate studies
• Increase the number of students who graduated
• Determine the list of practical competencies which are guaranteed after finishing the studies and adjust the study programmes in the (re)accreditational procedure
• Increase the portion of e-learning in study programmes
The implementation of Graduate university studies Discrete Mathematics and Applications is in accordance with the afore-mentioned mission and it contributes to realisation of strategic goals of Department of Mathematics, University of Rijeka.

1.7. Other important information - in the opinion of the proposer
Although the proposed study is first noneducational graduate course study implemented by the Department of mathematics, University of Rijeka, and different by its content and learning outcomes from existing courses of mathematics in Republic of Croatia, we want to emphasize that he will not represent a significant additional burden in terms of teacher load. In fact, some compulsory and all of elective courses are already implemented (as compulsory or elective) within the framework of existing studies performed by the Department of mathematics, Department of physics and Department of informatics, University of Rijeka (see section 3.4). Also, 6 new courses (36 ECTS) will be offered as an elective courses to students of existing programs in the Department of mathematics, as well as other components of the University of Rijeka.

2. GENERAL PART

2.1. Title of study programme
Discrete mathematics and its applications

2.1.1. Type of study programme
University

2.1.2. Level of study programme
Graduate

2.1.3. Area of study programme (scientific/artistic) – indicate the title
### Mathematics

2.2. **Study programme coordinator**

University of Rijeka

2.3. **Implementor/s of study programme**

Department of mathematics – University of Rijeka

2.4. **Duration of study programme (indicate possibilities of part-time study, long distance study)**

Study lasts 4 semesters, there is no possibility of attending classes in working time, neither through distance learning.

2.4.1. **ECTS credits – minimal number of credits required for completion of study programme**

120 ECTS

2.5. **Enrolment requirements and selection procedure**

Candidates who achieved mathematical competencies described by the following learning outcomes can enroll the study programme:

1. axiomatically and inductively construct the fields of real and complex numbers
2. describe an algebraic, metrical and topological structure of Euclidean space $\mathbb{R}^n$
3. determine limits of a function, continuity and uniform continuity, and other properties of a function from $\mathbb{R}^n$ to $\mathbb{R}^m$
4. analyse algebraic structures and differentiate basic properties of groups, rings, fields and vector spaces
5. differentiate properties of a linear operator
6. axiomatically construct Euclidean geometry with the overview of its historical development
7. formulate properties and existence conditions of regular polygons and polyhedra
8. formulate and analyse graph properties
9. formulate basic notions of descriptive statistics
10. use basic notions related to binary quadratic forms
11. describe set operations on finite and infinite sets
12. apply and understand properties of real elementary functions and fundamental complex functions of a complex variable
13. apply and understand use of differential calculus in geometry and in the analysis of properties of functions that are given in an explicit, implicit and parametric form
14. apply and understand use of integral calculus in geometry
15. apply and understand vector operations in problem solving
16. apply and understand properties of cyclic and permutation groups in problem solving
17. apply and understand the algorithm for finding the shortest path and the optimal tree in a graph
18. apply and understand properties of probability
19. apply and understand division algorithms
20. apply and understand numerical methods for solving nonlinear equations, definite integrals and ordinary differential equations, while analysing the obtained results
21. apply and understand simple and compound interest formulas in financial mathematics
22. solve indefinite and definite integral, Riemann integral of a function of several variables, and line and surface integral
23. expand functions into Taylor and Laurent series
24. determine the Jordan form of a matrix
25. choose an appropriate geometric construction for solving constructive problems using geometry equipment
26. choose an appropriate counting principle and/or a form of Dirichlet's principle for solving problems
27. solve combinatorial problems using recurrence relations
28. solve problems using properties of random variables
29. conduct statistical data analysis and testing hypothesis using computers
30. count using modular arithmetic, solve congruence equations and different types of congruence systems
31. apply methods for solving interpolation problems and function approximations
32. determine present value of money flow, financial rent, installments loan and compound interests in applications
33. solve problems using Lagrange’s theorem, Sylow’s theorems and Chinese remainder theorem
34. analyse convergence of sequences and series in Rn
35. construct orthonormal basis for an inner product space
36. differentiate vector and matrix norms, differentiate inner product spaces, normed spaces and metric spaces
37. differentiate and apply methods for solving systems of linear equations and geometrically interpret solvability of the systems in the plane and in the space
38. analyse mappings of algebraic structures with the emphasis on the isomorphism theorems
39. relate types of walks in a graph and their properties with applications in problem solving
40. compare plane geometries (Euclidean and non-Euclidean) and their models according to their characteristics
41. analyse mappings of n-dimensional Euclidean space and corresponding methods in solving problems using a constructive and an analytical approach
42. analyse basic probability models and distributions
43. explain a role of mathematical logic in mathematics as a science, the historical and intuitive importance of the logic of statements, and reasons for occurrence of the stronger logical theories, especially first-order logic

This graduate courses at the Department of Mathematics can be enrolled by the bachelors who finished the graduate course if one or the following conditions is satisfied:

1. The applicants who have finished the university graduate course and have acquired minimally 135 ECTS from mathematical courses, which is determined on the submitted documentation,
2. the applicants have who finished the university graduate course and have acquired minimally 120 ECTS from mathematical courses and have passed the examination organized by the Department of Mathematics.

Applications for the examination are accepted every year until 15th May, while the time period for the examination lasts from 1st June until 15th July.

2.6. Study programme learning outcomes

2.6.1. Competences which student gains upon completion of study (according to CROQF (HKO): knowledge, skills and competences in a restricted sense – independence and responsibility)

Through the study programme, students will acquire theoretical and practical knowledge which helps them find a job in economy, and moreover, acquisition of learning new skills. Furthermore, students will be able to:

- apply and understand the aspects of real, complex, harmonic analysis and measure theory in solving problems
- apply and understand the aspects of linear algebra, algebra and group theory in solving problems
- apply and understand the aspects of models of geometry with the emphasis on Euclidean geometry in problem solving, while using a constructive and an analytical approach
- apply and understand the aspects of discrete and combinatorial mathematics, probability and statistics in solving problems
- apply and understand the aspects of number theory, set theory and mathematical logic in solving problems
- apply and understand the aspects of applied mathematics in solving problems
- differentiate and analyse cryptographic systems
- differentiate and analyse different types of codes
- differentiate methods for detecting errors in data transmission and analyse conditions in under which it is possible to correct the error
- apply and understand use of the simplex algorithm and other linear programming methods
- have knowledge of matrix games
- successfully solve integer programming problems
- conduct a procedure for testing statistical hypothesis and apply methods for of statistical data analysis with or without using appropriate computer programs
- design and analyse experiments and solve a problem while using appropriate computer programs
- solve problems using graph theory, design theory and coding theory, writing advanced algorithms and implementing them in appropriate computer programs if needed
- mathematically prove validity of procedures and formulas that are used within the courses of the study programme
- use acquired knowledge of theorems, procedures and formulas in solving problems

Described learning outcomes for the proposed program, or competences that students acquire, in accordance with the Croatian Qualifications Framework qualify this program as a program of "Level 7", where labels A-G and associated levels are introduced as follows:

A – factual knowledge  
B – theoretical knowledge  
C – cognitive skills  
D – practical skills  
E – social skills  
F – autonomy  
G – responsibility

Through this course students will develop independence and responsibility, in particular through the seminars, projects, and solving individual assignments.

<table>
<thead>
<tr>
<th>LEVELS</th>
<th>KNOWLEDGE</th>
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<tbody>
<tr>
<td></td>
<td>A</td>
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<tr>
<td></td>
<td>Factual knowledge</td>
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<tr>
<td>1</td>
<td>Memorizing general facts</td>
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<tr>
<td>2</td>
<td>Understanding basic facts in performing simple tasks</td>
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<tr>
<td>3</td>
<td>Applying basic facts in solving problems within a field of work or study</td>
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<tr>
<td>4</td>
<td>Analyzing facts within a field of work or study</td>
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<tr>
<td>5</td>
<td>Analyzing and synthesizing facts that create awareness of the known boundaries of the knowledge within a field of work or study, and their evaluation</td>
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<tr>
<td>6</td>
<td>Evaluation of the facts within the field of work or study, a part of which is at the forefront of knowledge in a field of work or study</td>
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<tr>
<td>7</td>
<td>Evaluation of the facts at the most advanced frontier of a field (of work or research) and at the interface between different fields that could be the basis of scientific research in a part of this field</td>
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<tr>
<td>8</td>
<td>Creating and evaluating facts in part of the field of scientific research, which leads to shifting boundaries of knowledge</td>
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<table>
<thead>
<tr>
<th>LEVELS</th>
<th>SKILLS</th>
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<tr>
<td>C</td>
<td>D</td>
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<td></td>
<td>Cognitive skills</td>
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<tr>
<td>1</td>
<td><strong>C1</strong> Basic concrete <strong>logical</strong> thinking (required for execution of simple</td>
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<td></td>
<td>concrete tasks in familiar conditions)</td>
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<tr>
<td>2</td>
<td><strong>C2</strong> Concrete <strong>logical</strong> thinking (required for application of relevant</td>
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<td>information in the execution of a set of simple tasks in familiar conditions)</td>
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<td>3</td>
<td><strong>C3</strong> Basic concrete <strong>creative</strong> thinking (required for selection and</td>
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<td></td>
<td>application of relevant information in the execution of a set of complex routine</td>
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<td></td>
<td>tasks in familiar conditions)</td>
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<td>4</td>
<td><strong>C4</strong> Basic abstract <strong>logical</strong> thinking (required for selection and</td>
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<td></td>
<td>application of relevant information in the execution of a set of complex specific</td>
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<td></td>
<td>tasks in changing conditions)</td>
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<td>5</td>
<td><strong>C5</strong> Basic abstract <strong>creative</strong> thinking (required for developing solutions</td>
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<td></td>
<td>of abstract problems in partially unpredictable conditions)</td>
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<tr>
<td>6</td>
<td><strong>C6</strong> Abstract <strong>logical</strong> thinking (required for developing solutions of</td>
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<td>abstract problems in unpredictable conditions)</td>
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<tr>
<td>7</td>
<td><strong>C7</strong> Abstract <strong>creative</strong> thinking (required in research for development of</td>
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<td></td>
<td>new skills and procedures and for integration of different areas)</td>
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<tr>
<td>LEVELS</td>
<td>COMPETENCES</td>
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<tr>
<td></td>
<td>F Autonomy</td>
</tr>
<tr>
<td>1</td>
<td>Execution of simple tasks under constant direct and professional guidance in familiar conditions</td>
</tr>
<tr>
<td>2</td>
<td>Execution of simple tasks under occasional direct and professional guidance in familiar conditions</td>
</tr>
<tr>
<td>3</td>
<td>Execution of complex tasks and adjustment of your own behavior within the given guidelines in familiar conditions</td>
</tr>
<tr>
<td>4</td>
<td>Execution of complex tasks and adjustment of your own behavior within the given guidelines in changing conditions</td>
</tr>
<tr>
<td>5</td>
<td>Participation in managing activities in partially unpredictable conditions</td>
</tr>
<tr>
<td>6</td>
<td>Managing professional projects in unpredictable conditions</td>
</tr>
<tr>
<td>7</td>
<td>Managing complex and changing surrounding conditions and deciding about changing them</td>
</tr>
<tr>
<td>8</td>
<td>Expressing personal professional and ethical authority and permanent commitment to researching and developing new processes</td>
</tr>
</tbody>
</table>

2.6.2. Employment possibility (list of possible employers and compliance with professional association’s requirements)
Acquired knowledge in this study is very applicable in the economy; graph theory has broad applications, from telecommunications to the design of road networks, coding theory and cryptography is used in everyday communication. Acquired knowledge from the optimization and design of experiments provides employment in several branches of economy, for example, in companies that need to test finished products or prototypes.

<table>
<thead>
<tr>
<th>2.6.3. Possibility of continuation of study on higher level</th>
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<tbody>
<tr>
<td>After finishing this study, masters of mathematics will be able to enroll the Common doctoral program in mathematics at the University J.J. Strossmayer in Osijek, University of Rijeka, University of Split and the University of Zagreb, as well as appropriate doctoral studies abroad.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>2.7. Upon applying for graduate studies list proposer's or other Croatian institution’s undergraduate study programmes which enable enrolment to the proposed study programme</th>
</tr>
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<tbody>
<tr>
<td>Enroll to this graduate program is possible with finished undergraduate course Mathematics completed at the Department of mathematics, University of Rijeka, and finished undergraduate studies of mathematics in any of the Croatian and foreign universities.</td>
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</table>

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<tr>
<th>2.8. Upon application of integrated studies - name reasons for integration of undergraduate and graduate level of study programme</th>
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</table>


3. PROGRAMME DESCRIPTION

3.1. List of compulsory and elective subjects and/or modules (if existing) with the number of active teaching hours required for their implementation and number of ECTS-credits (appendix: Table 1)

3.2. Description of each subject (appendix: Table 2)

3.3. Structure of study programme, dynamic of study and students' obligations

The study consists of a major number of compulsory subjects (92 ECTS) and a minor number of elective courses (28 ECTS, or 23.33% of the total number of ECTS for the study). Basic subjects differ among the compulsory subjects, and they should be common to all (future) noneducational mathematics graduate programs at the Department of mathematics, University of Rijeka (56 ECTS), with whose adoption students acquire the necessary knowledge, skills and competences for further development in the field of mathematics, and set the basis for adoption subjects in area of discrete mathematics and applications. The rest of the compulsory courses (36 ECTS) is closely associated with the name of study, respectively with learning outcomes from section 2.6.1..

By choosing elective courses student is developing himself, so he can acquire knowledge, on his own choice, that will introduce him with related fields of physics, computer science or education of mathematics. In cooperation with the Department of physics, Department of mathematics and the Faculty of Philosophy interdisciplinary nature of this study is increasing.

Rhythm of study is defined by Study regulations at the University of Rijeka, as well as general obligation, whereas the specific responsibilities of students are determined by description of each course and associated executive program, which is published every year before the related semester.

3.3.1. Enrolment requirements for the next semester or trimester (course title)

Admission requirements are determined by the Study regulations at the University of Rijeka.

3.4. List of courses and/or modules student can choose from other study programmes

<table>
<thead>
<tr>
<th>Course title (course status within the proposed program)</th>
<th>The existing program in which the course is taught (course status within the other program)</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vector Spaces 1 (compulsory)</td>
<td>Graduate course in Mathematics – Math. Education Specialization (compulsory)</td>
<td>DM</td>
</tr>
<tr>
<td>Measure and Integral (compulsory)</td>
<td>Graduate course in Mathematics – Math. Education Specialization (elective)</td>
<td>DM</td>
</tr>
<tr>
<td>Algebra 1 (compulsory)</td>
<td>Graduate course in Mathematics – Math. Education Specialization (elective)</td>
<td>DM</td>
</tr>
<tr>
<td>Linear Programming (compulsory)</td>
<td>Graduate course in Mathematics – Math. Education Specialization (compulsory)</td>
<td>DM</td>
</tr>
<tr>
<td>Partial Differential Equations (elective)</td>
<td>Undergraduate course in Mathematics (elective)</td>
<td>DM, because of the complexity of the course it is transferred to graduate level</td>
</tr>
<tr>
<td>Mathematics Education 1 (elective)</td>
<td>Graduate course in Mathematics – Math. Education Specialization (compulsory)</td>
<td>DM</td>
</tr>
<tr>
<td>Vector Spaces 2 (compulsory)</td>
<td>Graduate course in Mathematics – Math. Education Specialization (compulsory)</td>
<td>DM</td>
</tr>
<tr>
<td><strong>Education Specialization (elective)</strong></td>
<td><strong>Graduate course in Mathematics – Math. Education Specialization (elective)</strong></td>
<td><strong>DM</strong></td>
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<td>----------------------------------------</td>
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<tr>
<td>Algebra 2 (compulsory)</td>
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<tr>
<td>Probability Theory (compulsory)</td>
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<td>Coding Theory and Cryptography (compulsory)</td>
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<tr>
<td>Introduction to Databases (elective)</td>
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<tr>
<td>Computer Networks 1 (elective)</td>
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<tr>
<td>Seminar 3 (elective)</td>
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<tr>
<td>Physics 1: Mechanics (elective)</td>
<td>Undergraduate course in Physics (compulsory)</td>
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<tr>
<td>Operations Research (elective)</td>
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<tr>
<td>Formal Languages and Compilers (elective)</td>
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<td>Topics in Contemporary Mathematics (elective)</td>
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<td>Information Systems 1 (elective)</td>
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<td>History of Mathematics (elective)</td>
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<td>Multimedia Systems (elective)</td>
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<td>Basics of Philosophy of Mathematics (elective)</td>
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<td>Descriptive Geometry (elective)</td>
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<tr>
<td>Introduction to Optimization (elective)</td>
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<tr>
<td>Physics 2: Electricity and Magnetism (elective)</td>
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<tr>
<td>Popularization of Science (elective)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Information systems 2 (elective)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mathematics Education 2 (elective)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*DM* – Department of mathematics  
*DP* – Department of physics  
*DCS* – Department of computer science
3.5. List of courses and/or modules that can be implemented in a foreign language (specify the language)

All compulsory courses of this study can be performed in English.

3.6. Allocated ECTS credits that enable national and international mobility

The proposed study enables mobility among the related studies in all Croatian universities and abroad. We expect especially good cooperation with the Department of mathematics, University of Ghent, Belgium, with which the Department of mathematics, University of Rijeka has signed bilateral Erasmus agreement and where exists many courses in the area of discrete mathematics.

3.7. Multidisciplinarity/interdisciplinarity of study programme

Through this study program, students will gain knowledge which will enable cooperation with scientists from other fields of science. Graph theory is widely used in chemistry and computer science, and students will be able to participate in scientific and professional work in these areas. Knowledge of coding theory and cryptography will enable collaboration with experts in the field of Information and communication technology, while knowledge in designing experiments will qualify them for connecting with teams of experts who conduct experiments in various fields of science, for example, in studies in medicine and biotechnology. Knowledge gained from the optimization is also applicable in various fields of science, for example in scientific and professional work in the technical sciences. Through elective courses, which are realized in cooperation with the Department of informatics and Department of physics of our University, interdisciplinary of study program is additionaly induced.

3.8. Mode of study programme completion

The final part of the study is exam in front of committee consisting of three members. An integral part of the graduate exam is presentation and defense of thesis which student made during the last semester. Student has right to access final exam after he passed all exams and fulfilled all obligations assigned by study program.

3.8.1. Conditions of approval of final work/thesis and/or final/thesis exam application

Conditions for approval of application for the graduate exam are assigned by Regulation of thesis and final exam at the university graduate courses of Department of mathematics, University of Rijeka (http://www.math.uniri.hr/dokumenti.php).

3.8.2. Composing and furnishing of final work/thesis

Forming thesis is defined by Regulations of thesis and final exam at university graduate courses of Department of mathematics, University of Rijeka (http://www.math.uniri.hr/dokumenti.php).

3.8.3. Final work/thesis assessment procedure and evaluation and defense of final work/thesis

Evaluation process of thesis and graduate exam is defined by Regulations of thesis and final exam at the university graduate courses of Department of mathematics, University of Rijeka (http://www.math.uniri.hr/dokumenti.php).
## 3.1. List of compulsory and elective courses and/or modules with teaching hours required and ECTS credits allocated

### LIST OF MODULES/COURSES

**Year of study: 1.**  
**Semester: winter**

<table>
<thead>
<tr>
<th>MODULE</th>
<th>COURSE</th>
<th>COURSE COORDINATOR</th>
<th>L</th>
<th>E</th>
<th>S</th>
<th>ECTS</th>
<th>STATUS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Vector spaces 1</td>
<td></td>
<td>30</td>
<td>30</td>
<td>0</td>
<td>6</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>Measure and Integral</td>
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<td>30</td>
<td>30</td>
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<td>6</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>Algebra 1</td>
<td></td>
<td>30</td>
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<td>0</td>
<td>6</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>Linear programming</td>
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<td>30</td>
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<td>6</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>Graph theory</td>
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<td>30</td>
<td>15</td>
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</tbody>
</table>

### LIST OF MODULES/COURSES

**Year of study: 1.**  
**Semester: summer**

<table>
<thead>
<tr>
<th>MODULE</th>
<th>COURSE</th>
<th>COURSE COORDINATOR</th>
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<th>E</th>
<th>S</th>
<th>ECTS</th>
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<td></td>
<td>Statistics</td>
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<td>30</td>
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<td>0</td>
<td>6</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>Algebra 2</td>
<td></td>
<td>30</td>
<td>30</td>
<td>0</td>
<td>6</td>
<td>C</td>
</tr>
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<tr>
<td></td>
<td>Harmonic analysis</td>
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<td>C</td>
</tr>
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<td></td>
<td>Coding theory and cryptography</td>
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<td>30</td>
<td>0</td>
<td>15</td>
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<td>C</td>
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### LIST OF MODULES/COURSES

**Year of study: 2.**  
**Semester: winter (5 ECTS on elective courses)**

<table>
<thead>
<tr>
<th>MODULE</th>
<th>COURSE</th>
<th>COURSE COORDINATOR</th>
<th>L</th>
<th>E</th>
<th>S</th>
<th>ECTS</th>
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<tr>
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<td>Number theory</td>
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<tr>
<td></td>
<td>Introduction to design theory</td>
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<td></td>
<td>Design and analysis of experiments</td>
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<td>C</td>
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<tr>
<td></td>
<td>Introduction to databases</td>
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<td>Introduction to combinatorial topology</td>
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<td>E</td>
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<tr>
<td></td>
<td>Mathematics education 1</td>
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<td>30</td>
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<td>E</td>
</tr>
</tbody>
</table>

1. IMPORTANT: Insert C for compulsory course or e for elective course.
2. IMPORTANT: Insert C for compulsory course or e for elective course.
### LIST OF MODULES/COURSES

**Year of study:** 2  
**Semester:** summer (22 ECTS on elective courses)

<table>
<thead>
<tr>
<th>MODULE</th>
<th>COURSE</th>
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<th>E</th>
<th>S</th>
<th>ECTS</th>
<th>STATUS</th>
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<td>Vector spaces 2</td>
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<td>30</td>
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<td>0</td>
<td>6</td>
<td></td>
<td>E</td>
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<tr>
<td>History of mathematics</td>
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<td>E</td>
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<tr>
<td>Science popularization</td>
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<td>0</td>
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<td></td>
<td>E</td>
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<tr>
<td>Mathematics education 2</td>
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<td>0</td>
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<td>Computer networks 2</td>
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<td>E</td>
</tr>
<tr>
<td>Databases</td>
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<td>30</td>
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<td>0</td>
<td>5</td>
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<td>E</td>
</tr>
<tr>
<td>Statistical practicum</td>
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<td>6</td>
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<td>E</td>
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<td>0</td>
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<td>E</td>
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<td>Topics in contemporary mathematics</td>
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<td>15</td>
<td>3</td>
<td></td>
<td>E</td>
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<tr>
<td>Partial differential equations</td>
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<td>0</td>
<td>6</td>
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<td>E</td>
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<td>Graduation</td>
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<td>4</td>
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</table>
## General information

<table>
<thead>
<tr>
<th>Lecturer</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Course title</td>
<td>Vector spaces 1</td>
<td></td>
</tr>
<tr>
<td>Program</td>
<td>Graduate course in Discrete mathematics and its applications</td>
<td></td>
</tr>
<tr>
<td>Course status</td>
<td>Compulsory</td>
<td></td>
</tr>
<tr>
<td>Year</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Credit values and modes of instruction</td>
<td>ECTS credits / student workload</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Hours (L+E+S)</td>
<td>30 + 30 + 0</td>
</tr>
</tbody>
</table>

### 1. COURSE DESCRIPTION

#### 1.1. Course objectives

The main course objective is to get students familiar with basic concepts of vector space theory. For this purpose, it is necessary within the course to:

- define vector space and describe characteristic examples of vector spaces
- define linear operators and analyse their properties
- analyse matrix representation of a linear operator
- define adjoint space
- define and analyse invariant subspaces and operator eigenvalues
- describe reduction of operator on finite dimensional vector spaces
- define bilinear form
- define and describe properties of a normal operator

#### 1.2. Course prerequisite

None.

#### 1.3. Expected outcomes for the course

After completing this course, the students are expected to:

- know basic examples of vector spaces and linear operators (A6, B6, C6, D4, E4, F3)
- solve problems related to the calculation of the rank (A6, B6, C6, D4, E5, F3)
- solve problems related to adjoint spaces (A6, B6, D4, E5, F3)
- construct Jordan basis (A6, B6, C6, D4, E5, F3)
- apply and understand the procedure of reduction of an operator on finite dimensional vector spaces in particular problems (A6, B6, D4, E5, F3)
- know basic examples of unitary spaces (A6, B7, D4, E5, F3)
- classify main properties of bilinear forms (A6, B6, D4, E5, F3)
- classify main properties and examples of normal operators (A6, B6, D4, E5, F3)
- mathematically prove validity of all procedures and formulas that are used within the course (A6, B6, D4, E5, F3)

#### 1.4. Course content

- Vector space, basic notions and example. Quotient space. Linear operators, basic notions and examples. The space (X,Y).
1.5. Modes of instruction

| ☒ lectures | ☐ seminars and workshops | ☐ independent work |
| ☒ exercises | ☐ e-learning | ☐ multimedia and the internet |
| ☐ field work | ☐ laboratory | ☐ tutorials |
| ☐ other | ☐ | |

1.6. Comments

1.7. Student requirements

Students are required to attend classes and actively participate in them. They are required to achieve a certain number of points during the semester and to pass the final exam (details will be described in the course curriculum).

1.8. Evaluation of assessment:

| Class attendance & class participation | 1.5 | Seminar paper | Experiment |
| Written exam | 2 | Oral exam | 2 | Essay | Research work |
| Project | Continuous assessment | 0.5 | Presentation | Practical work |
| Portfolio | |

1.9. Assessment and evaluation of students' work during the semester and on the final exam

Students' work will be evaluated and assessed during the semester (e.g. preliminary exams, tests, seminars, online tests, homework etc.) and on the final exam.

Total number of points student can earn during the semester is 70, while on the final exam student can achieve 30 points.

The detailed elaboration of monitoring and evaluation of students' work will be described in the course curriculum.

1.10. Required literature (when proposing the program)

2. H. Kraljević, Vektorski prostori, Odjel za matematiku, Sveučilište u Osijeku

1.11. Recommended literature (when proposing the program)


1.12. Number of copies of required literature in relation to the number of students currently attending classes of the course

<table>
<thead>
<tr>
<th>Title</th>
<th>Number of copies</th>
<th>Number of students</th>
</tr>
</thead>
</table>

1.13. Quality assurance which ensure acquisition of knowledge, skills and competencies

In the last week of this course, the students will evaluate the quality of the lectures. Additionally, the analysis of the exam results will be conducted.

---

3 IMPORTANT: Fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.
General information

<table>
<thead>
<tr>
<th>Lecturer</th>
<th>Measure and Integral</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course title</td>
<td>Measure and Integral</td>
</tr>
<tr>
<td>Program</td>
<td>Graduate course in Discrete mathematics and its applications</td>
</tr>
<tr>
<td>Course status</td>
<td>Compulsory</td>
</tr>
<tr>
<td>Year</td>
<td>1</td>
</tr>
<tr>
<td>Credit values and modes of instruction</td>
<td>ECTS credits / student workload: 6, Hours (L+E+S): 30 + 30 + 0</td>
</tr>
</tbody>
</table>

1. COURSE DESCRIPTION

1.1. Course objectives

The main course objective is to get students acquainted with the basic notions of the measure and integral theory. For this purpose it is necessary within the course to:

- define the measure and analyse its properties,
- describe basic examples of a measure space,
- define the Lebesgue measure and analyse its properties,
- define the notion of a measurable function,
- define the integral of a function on a measure space and analyse its properties,
- prove Lebesgue's monotone and dominated convergence theorem and Fatou's lemma,
- describe the construction of a product measure and prove Fubini's theorem,
- describe the notions of absolute continuity and singularity of a measure,
- prove Radon – Nikodym theorem,
- analyse the connection between Riemann and Lebesgue integral.

1.2. Course prerequisite

None.

1.3. Expected outcomes for the course

After completing this course, the students are expected to:

- use and understand the properties of a measure and integral (A7, B7, C7),
- analyse examples of a measure with a special emphasis on the Lebesgue measure (A7, B7, C7),
- use and understand the convergence theorems in problem solving (A7, B7, C7, F7),
- use and understand the Fubini's theorem in problem solving (A7, B7, C7, F7),
- analyse the notions of absolute continuity and singularity of a measure and the relations among them (A7, B7, C7, F7),
- analyse the connections and differences between Riemann and Lebesgue integral (A7, B7, C7),
- mathematically prove validity of all procedures and formulas that are used within the course (A7, B7, C7).

1.4. Course content

1.5. Modes of instruction

<table>
<thead>
<tr>
<th>Lecture</th>
<th>Seminars and workshops</th>
<th>Exercises</th>
<th>E-learning</th>
<th>Independent work</th>
<th>Multimedia and the internet</th>
<th>Laboratory</th>
<th>Tutorials</th>
<th>Other consultations</th>
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</thead>
</table>

1.6. Comments

1.7. Student requirements

Students are required to attend classes and actively participate in them. They are required to achieve a certain number of points during the semester and to pass the final exam (details will be described in the course curriculum).

1.8. Evaluation of assessment

<table>
<thead>
<tr>
<th>Class attendance &amp; class participation</th>
<th>1.5</th>
<th>Seminar paper</th>
<th>Experiment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Written exam</td>
<td>2</td>
<td>Oral exam</td>
<td>2</td>
</tr>
<tr>
<td>Project</td>
<td></td>
<td>Continuous assessment</td>
<td>0.5</td>
</tr>
<tr>
<td>Portfolio</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1.9. Assessment and evaluation of students’ work during the semester and on the final exam

Students’ work will be evaluated and assessed during the semester (e.g. preliminary exams, tests, seminars, online tests, homework etc.) and on the final exam. Total number of points student can earn during the semester is 70, while on the final exam student can achieve 30 points. The detailed elaboration of monitoring and evaluation of students’ work will be described in the course curriculum.

1.10. Required literature (when proposing the program)


1.11. Recommended literature (when proposing the program)


1.12. Number of copies of required literature in relation to the number of students currently attending classes of the course

<table>
<thead>
<tr>
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<th>Number of students</th>
</tr>
</thead>
</table>

1.13. Quality assurance which ensure acquisition of knowledge, skills and competencies

In the last week of this course, the students will evaluate the quality of the lectures. Additionally, the analysis of the exam results will be conducted.

---

4 IMPORTANT: Fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.
General information

<table>
<thead>
<tr>
<th>Lecturer</th>
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<tbody>
<tr>
<td>Course title</td>
<td>Algebra 1</td>
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<tr>
<td>Program</td>
<td>Graduate course in Discrete mathematics and its applications</td>
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<td>Course status</td>
<td>Compulsory</td>
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<td>Credit values and modes of instruction</td>
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<td></td>
<td>Hours (L+E+S) 30 + 30 + 0</td>
</tr>
</tbody>
</table>

1. COURSE DESCRIPTION

1.1. Course objectives
The main course objective is to get students acquainted with the advanced theory of permutation groups. For this purpose it is necessary within the course to:
- define categories and analyse different examples of categories,
- define free groups and analyse their properties,
- define modules and analyse their properties,
- define lattices of groups,
- define subgroup series and characterise different types of subgroup series,
- define solvable groups, analyse their properties and characterise them using different methods,
- define nilpotent groups, analyse their properties and characterise them using different methods.

1.2. Course prerequisite
None.

1.3. Expected outcomes for the course
After completing this course, the students are expected to:
- define and analyse properties of free groups, apply and understand the adequate method while solving problems (A7, B7, C7, D7, E5, F7, G7),
- differentiate and analyse different categories, apply and understand the adequate method while solving problems (A7, B7, C7, D7, E5, F7, G7),
- define and analyse properties of modules, apply and understand the adequate method while solving problems (A7, B7, C7, D7, E5, F7, G7),
- define solvable groups and characterize them using different methods, apply and understand the adequate method while solving problems (A7, B7, C7, D7, E5, F7, G7),
- define nilpotent groups and characterize them using different methods, apply and understand the adequate method while solving problems (A7, B7, C7, D7, E5, F7, G7),
- mathematically prove validity of all procedures and formulas that are used within the course (B7, F4).

1.4. Course content

1.5. Modes of instruction
- lectures
- seminars and workshops
- exercises
- e-learning
- independent work
- multimedia and the internet
- laboratory
- tutorials
- other
### 1.6. Comments

### 1.7. Student requirements

Students are required to attend classes and actively participate in them. They are required to achieve a certain number of points during the semester and to pass the final exam (details will be described in the course curriculum).

### 1.8. Evaluation of assessments

<table>
<thead>
<tr>
<th>Class attendance &amp; class participation</th>
<th>2</th>
<th>Seminar paper</th>
<th>Experiment</th>
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<tbody>
<tr>
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<td>Oral exam</td>
<td>1.5</td>
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<td>Project</td>
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<td>Continuous assessment</td>
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</tr>
<tr>
<td>Portfolio</td>
<td></td>
<td>Presentation</td>
<td>Practical work</td>
</tr>
</tbody>
</table>

### 1.9. Assessment and evaluation of students' work during the semester and on the final exam

Students' work will be evaluated and assessed during the semester (e.g. preliminary exams, tests, seminars, online tests, homework etc.) and on the final exam.

Total number of points student can earn during the semester is 70, while on the final exam student can achieve 30 points. The detailed elaboration of monitoring and evaluation of students' work will be described in the course curriculum.

### 1.10. Required literature (when proposing the program)


### 1.11. Recommended literature (when proposing the program)


### 1.12. Number of copies of required literature in relation to the number of students currently attending classes of the course

<table>
<thead>
<tr>
<th>Title</th>
<th>Number of copies</th>
<th>Number of students</th>
</tr>
</thead>
<tbody>
<tr>
<td>T.W. Hungerford: Algebra, Reinhart and Winston, NY, 1989.</td>
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<td>15</td>
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</tbody>
</table>

### 1.13. Quality assurance which ensure acquisition of knowledge, skills and competencies

In the last week of this course, the students will evaluate the quality of the lectures. Additionally, the analysis of the exam results will be conducted.

---

**IMPORTANT**: Fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.
### General information

<table>
<thead>
<tr>
<th>Lecturer</th>
<th>Linear programming</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course title</td>
<td>Linear programming</td>
</tr>
<tr>
<td>Program</td>
<td>Graduate course in Discrete mathematics and its applications</td>
</tr>
<tr>
<td>Course status</td>
<td>Compulsory</td>
</tr>
<tr>
<td>Year</td>
<td>1</td>
</tr>
<tr>
<td>Credit values and modes of instruction</td>
<td>ECTS credits / student workload: 6</td>
</tr>
<tr>
<td>Hours (L+E+S)</td>
<td>30 + 30 + 0</td>
</tr>
</tbody>
</table>

### 1. COURSE DESCRIPTION

#### 1.1. Course objectives

The main course objective is to get students familiar with:
- basic types of the linear programming problems
- basic principles and algorithms for solving problems of finding minimum and maximum values
- notions of dual problems of linear programming
- basic notions of the matrix game theory
- basics of convex programming
- basics of integer programming

#### 1.2. Course prerequisite

None.

#### 1.3. Expected outcomes for the course

After completing this course, the students are expected to:
- classify basic convex sets of points in n-dimensional Euclidean space and proper analytical methods of solving linear programming problems (A6, B6, C6, D6, E6, F6)
- apply properties of a linear (affine) function to a linear programming problem with understanding (A6, B6, C6, D6, E6, F6)
- define the goal function in simple linear programming problems (A6, B6, C6, D6, E6, F6)
- apply and understand various algorithms for finding extreme values of a linear function on a convex set (A6, B6, C6, D6, E6, F6)
- solve the dual problem of linear programming (A6, B6, C6, D6, E6, F6)
- apply and understand the Simplex algorithm (A6, B6, C6, D6, E6, F6)
- analyse the concept of matrix games (A6, B6, C6, D6, E6, F6)
- solve problems of integer programming (A6, B6, C6, D6, E6, F6)
- analyse the basics of convex programming (A6, B6, C6, D6, E6, F6)

#### 1.4. Course content

1.5. Modes of instruction

☒ lectures
☐ seminars and workshops
☒ exercises
☒ e-learning
☐ field work

☒ independent work
☐ multimedia and the internet
☐ laboratory
☐ tutorials
☐ consultations
☐ other

1.6. Comments

1.7. Student requirements

Students are required to attend classes and actively participate in them. They are required to achieve a certain number of points during the semester and to pass the final exam (details will be described in the course curriculum).

1.8. Evaluation of assessment

| Class attendance & class participation | 1.5 | Seminar paper | Experiment |
| Written exam | 1.5 | Oral exam | 2 | Essay | Research work |
| Project | Continuous assessment | 1 | Presentation | Practical work |
| Portfolio | |

1.9. Assessment and evaluation of students' work during the semester and on the final exam

Students’ work will be evaluated and assessed during the semester (e.g. preliminary exams, tests, seminars, online tests, homework etc.) and on the final exam. Total number of points student can earn during the semester is 70, while on the final exam student can achieve 30 points. The detailed elaboration of monitoring and evaluation of students’ work will be described in the course curriculum.

1.10. Required literature (when proposing the program)


1.11. Recommended literature (when proposing the program)


1.12. Number of copies of required literature in relation to the number of students currently attending classes of the course

<table>
<thead>
<tr>
<th>Title</th>
<th>Number of copies</th>
<th>Number of students</th>
</tr>
</thead>
<tbody>
<tr>
<td>N.Linić, H.Pašagić, Č.Rnjak: Linearno i nelinearno programiranje, Informator, Zgb, 1978</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>K.Murty: Linear and Combinatorial Programming, John Wiley and Sons, NY, 1976</td>
<td>1</td>
<td>10</td>
</tr>
</tbody>
</table>

1.13. Quality assurance which ensure acquisition of knowledge, skills and competencies

In the last week of this course, the students will evaluate the quality of the lectures. Additionally, the analysis of the exam results will be conducted.

IMPORTANT: Fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.
General information

<table>
<thead>
<tr>
<th>Lecturer</th>
<th>Graph theory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course title</td>
<td>Graph theory</td>
</tr>
<tr>
<td>Program</td>
<td>Graduate course in Discrete mathematics and its applications</td>
</tr>
<tr>
<td>Course status</td>
<td>Compulsory</td>
</tr>
<tr>
<td>Year</td>
<td>1</td>
</tr>
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<td>Credit values and modes of instruction</td>
<td>ECTS credits / student workload: 6</td>
</tr>
<tr>
<td>Hours (L+E+S)</td>
<td>30 + 15 + 15</td>
</tr>
</tbody>
</table>

1. COURSE DESCRIPTION

1.1. Course objectives

The main course objective is to get students acquainted with basic concepts in graph theory and applications of graph theory. For this purpose it is necessary within the course to:
- define basic concepts in graph theory and describe their basic properties
- define Eulerian and Hamiltonian graph, prove some of their properties and describe its applications
- define concepts of graph connectivity, analyse properties of connected graphs and the application in constructing reliable communication networks
- define matching and perfect matching in graphs and elaborate corresponding statements and applications
- define basic concepts in Ramsey theory for graphs
- define basic concepts in directed graph theory, elaborate basic properties and some applications
- analyse and compare certain algorithms

1.2. Course prerequisite

None.

1.3. Expected outcomes for the course

After completing the course, the students are expected to:
- differentiate the concepts and graphs properties and apply and understand appropriate properties and statements in solving exercises (A7, B7, C7, D7, E5, F7, G7),
- analyse problems of graph connectivity and related properties (A7, B7, C7, D7, E5, F7, G7),
- analyse Eulerian and Hamiltonian graphs and apply and understand the definitions and properties in solving exercises (A7, B7, C7, D7, E5, F7, G7),
- solve problems related to a matching of graphs (A7, B7, C7, D7, E5, F7, G7),
- apply statements and algorithms elaborated within the course (A7, B7, C7, D7, E5, F7, G7),
- mathematically prove validity of all procedures and formulas that are used within the course (B7, F4).

1.4. Course content

1.5. Modes of instruction

☒ lectures
☒ seminars and workshops
☒ exercises
☒ e-learning
☐ field work

☒ independent work
☒ multimedia and the internet
☐ laboratory
☒ tutorials
☒ other
Consultations, project strategies

1.6. Comments

1.7. Student requirements

Students are required to attend classes and actively participate in them. They are required to achieve a certain number of points during the semester and to pass the final exam (details will be described in the course curriculum).

1.8. Evaluation of assessment:

<table>
<thead>
<tr>
<th>Category</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class attendance &amp; class participation</td>
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</tr>
<tr>
<td>Seminar paper</td>
<td>0.7</td>
</tr>
<tr>
<td>Experiment</td>
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<tr>
<td>Written exam</td>
<td>2</td>
</tr>
<tr>
<td>Oral exam</td>
<td>1.8</td>
</tr>
<tr>
<td>Essay</td>
<td></td>
</tr>
<tr>
<td>Project</td>
<td>1</td>
</tr>
<tr>
<td>Continuous assessment</td>
<td></td>
</tr>
<tr>
<td>Presentation</td>
<td></td>
</tr>
<tr>
<td>Practical work</td>
<td></td>
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<td>Portfolio</td>
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1.9. Assessment and evaluation of students’ work during the semester and on the final exam

Students’ work will be evaluated and assessed during the semester (e.g. preliminary exams, tests, seminars, online tests, homework etc.) and on the final exam.

Total number of points student can earn during the semester is 70, while on the final exam student can achieve 30 points.

The detailed elaboration of monitoring and evaluation of students’ work will be described in the course curriculum.

1.10. Required literature (when proposing the program)


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1.12. Number of copies of required literature in relation to the number of students currently attending classes of the course

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<th>Title</th>
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<th>Number of students</th>
</tr>
</thead>
<tbody>
<tr>
<td>D.Veljan: Kombinatorika i diskretna matematika, Algoritam, Zagreb,</td>
<td>5</td>
<td>30</td>
</tr>
<tr>
<td>D.Veljan: Kombinatorika s teorijom grafova, Školska knjiga, Zagreb,</td>
<td>5</td>
<td>30</td>
</tr>
<tr>
<td>1989.</td>
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</tbody>
</table>

1.13. Quality assurance which ensure acquisition of knowledge, skills and competencies

In the last week of this course, the students will evaluate the quality of the lectures. Additionally, the analysis of the exam results will be conducted.

7 IMPORTANT: Fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.
### General information

<table>
<thead>
<tr>
<th>Lecturer</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Course title</td>
<td>Statistics</td>
</tr>
<tr>
<td>Program</td>
<td>Graduate course in Discrete mathematics and its applications</td>
</tr>
<tr>
<td>Course status</td>
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<tr>
<td>Year</td>
<td>1</td>
</tr>
<tr>
<td>Credit values and modes of instruction</td>
<td>ECTS credits / student workload: 6</td>
</tr>
</tbody>
</table>

### 1. COURSE DESCRIPTION

#### 1.1. Course objectives

The main course objective is to get students familiar with basic ideas and concepts of mathematical statistics. For that purpose, it is necessary within the course to:

- demonstrate basic ways of presentation of statistical data
- describe the classification of statistical variates
- define parameters of a sequence of statistical data
- analyse continuous random variables and vectors that are important in statistics
- define estimators and describe their properties
- define confidence intervals
- define and analyse statistical hypothesis testing
- describe methods of hypothesis testing
- enable students to independently use computer software for statistical data analysis

#### 1.2. Course prerequisite

None.

#### 1.3. Expected outcomes for the course

After completing this course, the students are expected to:

- present statistical data in tabular and graphical form (A7, B7, E4, F5)
- explain the classification of statistical variables (A7, B7, E4, F5)
- analyse continuous random variables and vectors that are used in statistics (A7, B7, E4, F5)
- use and understand estimators and their properties within the specific statistical models (A7, B7, E4, F5)
- using a computer, construct confidence intervals and conduct a procedure of testing statistical hypotheses (A7, B7, E4, F5)
- using a computer, apply methods of statistical data analysis (A7, B7, E4, F5)
- mathematically prove validity of all procedures and formulas that are used within the course (A7, B7, E4, F5)

#### 1.4. Course content


#### 1.5. Modes of instruction

- lectures
- seminars and workshops
- exercises
- e-learning
- field work
- practice
- independent work
- multimedia and the internet
- laboratory
- tutorials
- consultations
- other
1.7. Student requirements

Students are required to attend classes and actively participate in them. They are required to achieve a certain number of points during the semester and to pass the final exam (details will be described in the course curriculum).

1.8. Evaluation of assessment

<table>
<thead>
<tr>
<th>Class attendance &amp; class participation</th>
<th>2</th>
<th>Seminar paper</th>
<th>Experiment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Written exam</td>
<td>2</td>
<td>Oral exam</td>
<td>1.5</td>
</tr>
<tr>
<td>Project</td>
<td>0.5</td>
<td>Essay</td>
<td>Research work</td>
</tr>
<tr>
<td>Continuous assessment</td>
<td>0.5</td>
<td>Presentation</td>
<td>Practical work</td>
</tr>
<tr>
<td>Portfolio</td>
<td></td>
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1.9. Assessment and evaluation of students’ work during the semester and on the final exam

Students’ work will be evaluated and assessed during the semester (e.g. preliminary exams, tests, seminars, online tests, homework etc.) and on the final exam. Total number of points student can earn during the semester is 70, while on the final exam student can achieve 30 points. The detailed elaboration of monitoring and evaluation of students’ work will be described in the course curriculum.

1.10. Required literature (when proposing the program)


1.11. Recommended literature (when proposing the program)

1. N.Sarapa, Vjerojatnost i statistika, II dio, Školska knjiga, Zagreb, 1996.

1.12. Number of copies of required literature in relation to the number of students currently attending classes of the course

<table>
<thead>
<tr>
<th>Title</th>
<th>Number of copies</th>
<th>Number of students</th>
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</thead>
</table>

1.13. Quality assurance which ensure acquisition of knowledge, skills and competencies

In the last week of this course, the students will evaluate the quality of the lectures. Additionally, the analysis of the exam results will be conducted.

$s$ IMPORTANT: Fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.
## 1. COURSE DESCRIPTION

### 1.1. Course objectives

The main course objective is to get students acquainted with:
- basic notions of ring theory, especially theory of polynomial rings,
- basic notions of field theory and field extension theory,
- basic notions of Galois theory.

### 1.2. Course prerequisite

None.

### 1.3. Expected outcomes for the course

After completing this course, the students are expected to:
- define, give examples and recognise basic algebraic structures with two operations (A7, B7),
- have knowledge of the concept of ring, ideal and ring homomorphism (A7, B7),
- have knowledge of basic theorems of polynomial theory and be able to prove them (F3, B7),
- have knowledge of various types of field extensions and properly apply them (A7, B7, C7),
- successfully solve problems of determining Galois group (A7, B7),
- have knowledge of basics of Galois theory (A7, B7).

### 1.4. Course content


### 1.5. Modes of instruction

- lectures
- seminars and workshops
- exercises
- e-learning
- independent work
- multimedia and the internet
- laboratory
- tutorials
- field work
- other

### 1.6. Comments

### 1.7. Student requirements

Students are required to attend classes and actively participate in them. They are required to achieve a certain number of points during the semester and to pass the final exam (details will be described in the course curriculum).
### 1.8. Evaluation of assessment

<table>
<thead>
<tr>
<th>Category</th>
<th>Weight</th>
<th>Category</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class attendance &amp; class participation</td>
<td>2</td>
<td>Seminar paper</td>
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<tr>
<td>Written exam</td>
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</tr>
<tr>
<td>Project</td>
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<td>Continuous assessment</td>
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### 1.9. Assessment and evaluation of students' work during the semester and on the final exam

Students' work will be evaluated and assessed during the semester (e.g. preliminary exams, tests, seminars, online tests, homework etc.) and on the final exam.

Total number of points student can earn during the semester is 70, while on the final exam student can achieve 30 points.

The detailed elaboration of monitoring and evaluation of students' work will be described in the course curriculum.

### 1.10. Required literature (when proposing the program)

2. H. Kraljević: Algebra, Notes for the lectures held during 2006/07 at the University of Osijek.

### 1.11. Recommended literature (when proposing the program)

2. B. Širola: Rings, fields and algebras, Notes on Algebraic Structures, PMF, Zagreb.

### 1.12. Number of copies of required literature in relation to the number of students currently attending classes of the course

<table>
<thead>
<tr>
<th>Title</th>
<th>Number of copies</th>
<th>Number of students</th>
</tr>
</thead>
<tbody>
<tr>
<td>T.W. Hungerford: Algebra, Reinhart and Winston, NY, 1989.</td>
<td>2</td>
<td>15</td>
</tr>
</tbody>
</table>

### 1.13. Quality assurances which ensure acquisition of knowledge, skills and competencies

In the last week of this course, the students will evaluate the quality of the lectures. Additionally, the analysis of the exam results will be conducted.

---

9 IMPORTANT: Fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.
General information

<table>
<thead>
<tr>
<th>Lecturer</th>
<th>Probability theory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course title</td>
<td>Probability theory</td>
</tr>
<tr>
<td>Program</td>
<td>Graduate course in Discrete mathematics and its applications</td>
</tr>
<tr>
<td>Course status</td>
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<td>ECTS credits / student workload 6</td>
</tr>
<tr>
<td></td>
<td>Hours (L+E+S) 30 + 30 + 0</td>
</tr>
</tbody>
</table>

1. COURSE DESCRIPTION

1.1. Course objectives
The main course objective is to get students familiar with basic concepts, methods and results in probability theory. For that purpose, it is necessary within the course to:
- define random variables and analyse their basic properties
- define distribution functions and describe the classification of random variables
- define mathematical expectation and prove limit theorems for mathematical expectation
- define variance and moments of random variables
- prove basic inequalities in probability
- describe basic types of convergence of random variables and their relations
- prove weak and strong laws of large numbers
- describe convergence of series of random variables
- define notion of characteristic function of random variable and analyse basic properties of characteristic functions
- prove inversion theorems and continuity theorems for characteristic functions
- describe weak convergence of sequences of distribution functions
- prove central limit theorem

1.2. Course prerequisite
None.

1.3. Expected outcomes for the course
After completing this course, the students are expected to:
- apply and understand random variables and their properties in solving problems (A7, B7, E4, F5)
- explain the classification of random variables (A7, B7, E4, F5)
- apply and understand limit theorems for mathematical expectation (A7, B7, E4, F5)
- apply and understand basic probability inequalities (A7, B7, E4, F5)
- know basic types of convergence of random variables and their relations (A7, B7, E4, F5)
- know weak and strong laws of large numbers, and convergence of series of random variables (A7, B7, E4, F5)
- apply properties of characteristic functions in solving problems (A7, B7, E4, F5)
- explain inversion and continuity theorems for characteristic functions (A7, B7, E4, F5)
- explain weak convergence of sequence of distribution functions (A7, B7, E4, F5)
- apply and understand the central limit theorem (A7, B7, E4, F5)
- mathematically prove validity of all procedures and formulas that are used within the course (A7, B7, E4, F5)

1.4. Course content
1.5. Modes of instruction

- Lectures
- Seminars and workshops
- Exercises
- E-learning
- Fieldwork
- Practice
- Practicum
- Independent work
- Multimedia and the internet
- Laboratory
- Tutorials
- Consultations
- Other

1.6. Comments

1.7. Student requirements

Students are required to attend classes and actively participate in them. They are required to achieve a certain number of points during the semester and to pass the final exam (details will be described in the course curriculum).

1.8. Evaluation of assessment

| Class attendance & class participation | 2 | Seminar paper | Experiment |
| Written exam | 2 | Oral exam | 1.5 | Essay | Research work |
| Project | Continuous assessment | 0.5 | Presentation | Practical work |
| Portfolio | |

1.9. Assessment and evaluation of students' work during the semester and on the final exam

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1.13. Quality assurance which ensure acquisition of knowledge, skills and competencies

In the last week of this course, the students will evaluate the quality of the lectures. Additionally, the analysis of the exam results will be conducted.

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<thead>
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<th>Lecturer</th>
<th>Harmonic analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course title</td>
<td>Harmonic analysis</td>
</tr>
<tr>
<td>Program</td>
<td>Graduate course in Discrete mathematics and its applications</td>
</tr>
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<td>Course status</td>
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<tr>
<td></td>
<td>Hours (L+E+S)</td>
</tr>
</tbody>
</table>

1. COURSE DESCRIPTION

1.1. Course objectives

The main course objective is to get students familiar with basic ideas and concepts of harmonic analysis, elements of functional analysis and their application. For that purpose, it is necessary within the course to:

- define Hilbert spaces and analyse their structure and properties
- determine orthonormal systems in a Hilbert space and analyse their completeness
- calculate and analyse Fourier series, and compare them to their original functions
- analyse the consequences of the Banach-Steinhaus theorem and the open mapping theorem related to Fourier series
- calculate and analyse Fourier transforms
- analyse the inversion theorem and compare Fourier transform to its original function
- analyse Plancherel theorem and its consequences
- compare Fourier transform with other integral transforms: for example Laplace, Mellin, discrete Fourier transform
- calculate and analyse those other integral transforms

1.2. Course prerequisite

None.

1.3. Expected outcomes for the course

After completing this course, the students are expected to:

- understand and determine the properties of Hilbert spaces, analyse linear independence, orthogonality, orthonormality, completeness of the sets in them (A7, B7, C7)
- calculate and understand Fourier series and analyse their connection with the original functions (A7, B7, C7, F7)
- apply and understand the above mentioned theorems about the Banach spaces and analyse their consequences related to Fourier series (A7, B7, C7, F7)
- calculate and understand the Fourier transform (A7, B7, C7)
- analyse the inversion theorem and compare Fourier transform with the original function (A7, B7, C7, F7)
- analyse and apply Plancherel theorem (A7, B7, C7, F7)
- calculate and apply other integral transforms (A7, B7, C7)

1.4. Course content

1.5. Modes of instruction

☒ lectures
☒ seminars and workshops
☒ exercises
☒ e-learning
☐ field work
☐ practice
☐ practicum

☒ independent work
☒ multimedia and the internet
☐ laboratory
☒ tutorials
☒ consultations
☐ other

1.6. Comments

1.7. Student requirements

Students are required to attend classes and actively participate in them. They are required to achieve a certain number of points during the semester and to pass the final exam (details will be described in the course curriculum).

1.8. Evaluation of assessment

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<tr>
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<td>Essay</td>
</tr>
<tr>
<td>Project</td>
<td></td>
<td>Continuous assessment</td>
<td>2.5</td>
<td>Presentation</td>
</tr>
<tr>
<td>Portfolio</td>
<td></td>
<td></td>
<td></td>
<td>Practical work</td>
</tr>
</tbody>
</table>

1.9. Assessment and evaluation of students' work during the semester and on the final exam

Students' work will be evaluated and assessed during the semester (e.g. preliminary exams, tests, seminars, online tests, homework etc.) and on the final exam.

Total number of points student can earn during the semester is 70, while on the final exam student can achieve 30 points. The detailed elaboration of monitoring and evaluation of students' work will be described in the course curriculum.

1.10. Required literature (when proposing the program)


1.11. Recommended literature (when proposing the program)


1.12. Number of copies of required literature in relation to the number of students currently attending classes of the course

<table>
<thead>
<tr>
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<th>Number of students</th>
</tr>
</thead>
</table>

1.13. Quality assurance which ensure acquisition of knowledge, skills and competencies

In the last week of this course, the students will evaluate the quality of the lectures. Additionally, the analysis of the exam results will be conducted.

\*IMPORTANT: Fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.
**General information**

<table>
<thead>
<tr>
<th>Lecturer</th>
<th>Coding theory and Cryptography</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course title</td>
<td>Coding theory and Cryptography</td>
</tr>
<tr>
<td>Program</td>
<td>Graduate course in Discrete mathematics and its applications</td>
</tr>
<tr>
<td>Course status</td>
<td>Compulsory</td>
</tr>
<tr>
<td>Year</td>
<td>1</td>
</tr>
<tr>
<td>Credit values and modes of instruction</td>
<td>ECTS credits / student workload 6</td>
</tr>
<tr>
<td></td>
<td>Hours (L+E+S) 30 + 0 + 15</td>
</tr>
</tbody>
</table>

**1. COURSE DESCRIPTION**

**1.1. Course objectives**

The main course objective is to get students acquainted with basic cryptography systems and basic methods in the coding theory. The content that will be held in this course:

- various cryptography systems will be described, compared and applied,
- the basic principles of cryptanalysis will be analysed,
- the basic principles of coding theory will be analysed,
- various coding methods will be defined, differentiated and applied,
- the methods of detecting errors in coding theory will be analysed,
- the methods of correcting errors in coding theory will be described.

**1.2. Course prerequisite**

None.

**1.3. Expected outcomes for the course**

After completing this course, the students are expected to:

- differentiate and analyse cryptography systems, apply and understand adequate methods while solving problems (A7, B7, C7, D7, E5, F7, G7),
- analyse and differentiate different types of codes, apply and understand adequate methods while solving problems (A7, B7, C7, D7, E5, F7, G7),
- differentiate methods of detecting errors in data transfer with particular coding method, and analyse the conditions under which it is possible to correct the errors (A7, B7, C5, D5, E5, F5, G5),
- mathematically prove validity of all procedures and formulas that are used within the course (B7, F4).

**1.4. Course content**


**1.5. Modes of instruction**

- lectures
- seminars and workshops
- exercises
- e-learning
- independent work
- multimedia and the internet
- laboratory
- tutorials
- field work

**1.6. Comments**

**1.7. Student requirements**

Students are required to attend classes and actively participate in them. They are required to achieve a certain number of points during the semester and to pass the final exam (details will be described in the course curriculum).
1.8. Evaluation of assessment

<table>
<thead>
<tr>
<th>Class attendance &amp; class participation</th>
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<th>Seminar paper</th>
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<td>Project</td>
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<td>Continuous assessment</td>
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<td>Presentation</td>
</tr>
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1.10. Required literature (when proposing the program)

1. Dujella: Kriptografija (available online: http://web.math.hr/~duje/kript/kriptografija.html)

1.11. Recommended literature (when proposing the program)


1.12. Number of copies of required literature in relation to the number of students currently attending classes of the course

<table>
<thead>
<tr>
<th>Title</th>
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<th>Number of students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Igor S. Pandžić, Alen Bažant, Željko Ilić, Zdenko Vrdoljak, Mladen Kos, Vjekoslav Sinković: Uvod u teoriju informacija i kodiranja, Element, 2009</td>
<td>3</td>
<td>25</td>
</tr>
</tbody>
</table>

1.13. Quality assurance which ensure acquisition of knowledge, skills and competencies

In the last week of this course, the students will evaluate the quality of the lectures. Additionally, the analysis of the exam results will be conducted.

---

12 IMPORTANT: Fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.
### General information

<table>
<thead>
<tr>
<th>Lecturer</th>
<th>Permutation groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course title</td>
<td>Permutation groups</td>
</tr>
<tr>
<td>Program</td>
<td>Graduate course in Discrete mathematics and its applications</td>
</tr>
<tr>
<td>Course status</td>
<td>Compulsory</td>
</tr>
<tr>
<td>Year</td>
<td>2</td>
</tr>
<tr>
<td>Credit values and modes of instruction</td>
<td>ECTS credits / student workload</td>
</tr>
<tr>
<td></td>
<td>Hours (L+E+S)</td>
</tr>
</tbody>
</table>

### 1. COURSE DESCRIPTION

#### 1.1. Course objectives

The main course objective is to get students acquainted with the advanced theory of the permutation groups. For this purpose it is necessary within the course to:
- define the action of a group on a set, differentiate various actions and analyse their properties,
- define a permutation group, differentiate various examples of a permutation group and analyse its properties,
- declare and prove O'Nan-Scott theorem and analyse its consequences,
- provide a short introduction into the theory of finite simple groups.

#### 1.2. Course prerequisite

None.

#### 1.3. Expected outcomes for the course

After completing this course, the students are expected to:
- differentiate and analyse various actions of a group on a set, apply and understand adequate methods while solving problems (A7, B7, C7, D7, E5, F7, G7),
- differentiate and analyse various examples of permutation groups, apply and understand adequate procedures while solving problems (A7, B7, C7, D7, E5, F7, G7),
- construct different finite structures from permutation groups and analyse their properties (A7, B7, C7, D7, E5, F7, G7),
- apply and understand O'Nan-Scott theorem and its consequences (A7, B7, C7, D7, E5, F7, G7),
- describe classification of finite simple groups (A5, B5, C5, D5, E5, F4, G4),
- mathematically prove validity of all procedures and formulas that are used within the course (B7, F4).

#### 1.4. Course content

Transitive and k-transitive groups. Regular groups. Primitive groups. O'Nan-Scott theorem and consequences. Simple groups. Construction of incidence structures from groups.

#### 1.5. Modes of instruction

- lectures
- seminars and workshops
- exercises
- e-learning
- field work
- independent work
- multimedia and the internet
- laboratory
- practicum
- tutorials
- other

#### 1.6. Comments

#### 1.7. Student requirements
Students are required to attend classes and actively participate in them. They are required to achieve a certain number of points during the semester and to pass the final exam (details will be described in the course curriculum).

1.8. Evaluation of assessment

<table>
<thead>
<tr>
<th>Class attendance &amp; class participation</th>
<th>1.5</th>
<th>Seminar paper</th>
<th>2</th>
<th>Experiment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Written exam</td>
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<td>Oral exam</td>
<td>1</td>
<td>Essay</td>
</tr>
<tr>
<td>Project</td>
<td></td>
<td>Continuous assessment</td>
<td>2</td>
<td>Presentation</td>
</tr>
<tr>
<td>Portfolio</td>
<td></td>
<td></td>
<td></td>
<td>Practical work</td>
</tr>
</tbody>
</table>

1.9. Assessment and evaluation of students’ work during the semester and on the final exam

Students’ work will be evaluated and assessed during the semester (e.g. preliminary exams, tests, seminars, online tests, homework etc.) and on the final exam. Total number of points student can earn during the semester is 70, while on the final exam student can achieve 30 points. The detailed elaboration of monitoring and evaluation of students’ work will be described in the course curriculum.

1.10. Required literature (when proposing the program)


1.11. Recommended literature (when proposing the program)

1.12. Number of copies of required literature in relation to the number of students currently attending classes of the course

<table>
<thead>
<tr>
<th>Title</th>
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<th>Number of students</th>
</tr>
</thead>
<tbody>
<tr>
<td>P. J. Cameron, Permutation groups, Cambridge University Press, 1999.</td>
<td>1</td>
<td>15</td>
</tr>
<tr>
<td>J. D. Dixon, B. Mortimer, Permutation groups, Springer, New York, 1996.</td>
<td>1</td>
<td>15</td>
</tr>
</tbody>
</table>

1.13. Quality assurance which ensure acquisition of knowledge, skills and competencies

In the last week of this course, the students will evaluate the quality of the lectures. Additionally, the analysis of the exam results will be conducted.
General information

<table>
<thead>
<tr>
<th>Lecturer</th>
<th>Number theory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course title</td>
<td>Number theory</td>
</tr>
<tr>
<td>Program</td>
<td>Graduate course in Discrete mathematics and its applications</td>
</tr>
<tr>
<td>Course status</td>
<td>Compulsory</td>
</tr>
<tr>
<td>Year</td>
<td>2</td>
</tr>
<tr>
<td>Credit values and modes of instruction</td>
<td>ECTS credits / student workload: 6, Hours (L+E+S): 30 + 30 + 0</td>
</tr>
</tbody>
</table>

1. COURSE DESCRIPTION

1.1. Course objectives

Number theory is a branch of mathematics which has always been considered as a motivation and foundation of all mathematics because of its simply formulated, but very difficult problems (some of which have been attempted to get solved for centuries). In solving these problems, the newest results in the fields of algebra, analysis and geometry are being applied. The main course objective is to get students familiar with the way of thinking and proving statements in the number theory, and especially with the algebraic and analytical methods in the number theory. For that purpose, it is necessary within the course to:

- analyse basic properties of integers: divisibility, prime numbers, prime factorization, Euclidean algorithm, congruencies
- describe the solutions of quadratic congruency by using the Legendre symbol and compare those congruencies by using the quadratic law of reciprocity
- analyse quadratic forms and display of integers by using quadratic forms, and specifically compare display of integers as sums of a fixed number of perfect squares
- define arithmetic functions and compare basic examples
- differentiate basic types of Diophantine equations and describe the methods of solving them
- define elliptic curves, analyse their properties and applications in the number theory
- apply the number theory in the public-key cryptography
- describe algebraic methods in the number theory and their application
- describe analytical methods in the number theory and their application

1.2. Course prerequisite

None.

1.3. Expected outcomes for the course

After completing this course, the students are expected to:

- analyse basic properties of integers and apply those properties to simple problems in the number theory related to divisibility and divisibility algorithms (A6, B7, D6, E6, F6)
- calculate using modular arithmetics, solve congruency equations and systems of congruencies (A6, B7, D6, E6, F6)
- apply and understand the quadratic law of reciprocity and formulas for calculating the Legendre symbol, to solve quadratic congruencies (A6, B7, D6, E6, F6)
- describe the display of integers by using quadratic forms in simple cases, compare and classify different quadratic forms (A6, B7, D6, E6, F6)
- show and analyse basic multiplicative functions and their properties, check and show connections between them (A6, B6, D6, E6, F6)
- define basic types of Diophantine equations and describe the methods of solving them (A6, B7, D6, E6, F6)
- define elliptic curves, analyse their basic properties and describe important open problems (A6, B6, D6, E6, F6)
- apply and understand the methods in the number theory in analysis of the public-key cryptosystem (A6, B7, D6, E6, F6)
- describe algebraic and analytical methods in the number theory and apply them to important problems in the number theory (A6, B6, D6, E6, F6)

1.4. Course content


1.5. Modes of instruction

☒ lectures
☒ seminars and workshops
☒ exercises
☒ e-learning
☐ field work
☐ practice
☐ practicum

☒ independent work
☒ multimedia and the internet
☐ laboratory
☐ tutorials
☐ consultations
☐ other

1.6. Comments

1.7. Student requirements

Students are required to attend classes and actively participate in them. They are required to achieve a certain number of points during the semester and to pass the final exam (details will be described in the course curriculum).

1.8. Evaluation of assessment

14

Class attendance & class participation 2.1 Seminar paper Experiment
Written exam 1 Oral exam 1 Essay Research work
Project Continuous assessment 1.9 Presentation Practical work
Portfolio

1.9. Assessment and evaluation of students' work during the semester and on the final exam

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1.13. **Quality assurance which ensure acquisition of knowledge, skills and competencies**

In the last week of this course, the students will evaluate the quality of the lectures. Additionally, the analysis of the exam results will be conducted.
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<thead>
<tr>
<th>Lecturer</th>
<th></th>
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<tbody>
<tr>
<td>Course title</td>
<td>Introduction to Design Theory</td>
</tr>
<tr>
<td>Program</td>
<td>Graduate course in Discrete mathematics and its applications</td>
</tr>
<tr>
<td>Course status</td>
<td>Compulsory</td>
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<tr>
<td>Year</td>
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</tr>
<tr>
<td></td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>30 + 15 + 15</td>
</tr>
</tbody>
</table>

### 1. COURSE DESCRIPTION

#### 1.1. Course objectives

The main course objective is to get students acquainted with:
- the basic definitions, concepts, procedures and theorems of the design theory
- the relation between different combinatorial structures, link designs with codes, graphs, differential sets, latin squares
- basic applications of a combinatorial design in the coding theory, to threshold schemes, visual cryptography and group testing.

#### 1.2. Course prerequisite

None.

#### 1.3. Expected outcomes for the course

After completing this course, the students are expected to:
- define the basic concepts of the design theory, apply and understand some basic procedures in the design theory (A7, B7);
- have knowledge of the basic theorems of the design theory and be able to prove them (B7, F4);
- construct examples of block designs and related combinatorial structures (C7, D7, E5, F7, G7);
- apply the design theory in the elementary problems of the coding theory, threshold schemes, visual cryptography and group testing (A7, B7, C7).

#### 1.4. Course content

Basic definitions and properties of combinatorial designs; incidence matrices, isomorphisms and automorphisms, Fisher's inequality. Symmetric designs; differential sets, construction of differential sets, residual and derived designs, Hadamard matrices and designs, Bruck-Ryser-Chowla theorem. Resolvable designs; affine plane, projective plane, Bose's inequality, affine resolvable design. Steiner triple system; quasigroups, the Bose construction, the Skolem construction, cyclic Steiner triple systems. Orthogonal latin squares; mutually orthogonal latin squares, orthogonal arrays and transversal designs. Applications of combinatorial designs; codes, threshold scheme, visual cryptography, group testing.

#### 1.5. Modes of instruction

- lectures
- seminars and workshops
- exercises
- e-learning
- field work
- practice
- practicum
- Independent work
- multimedia and the internet
- laboratory
- project strategies
- tutorials
- other
- consultations

#### 1.6. Comments
### 1.7. Student requirements

Students are required to attend classes and to do homework and project assignment. They are required to fulfill all obligations in accordance with the course curriculum.

### 1.8. Evaluation of assessment

<table>
<thead>
<tr>
<th>Category</th>
<th>Weight</th>
<th>Description</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class attendance &amp; class participation</td>
<td>1.5</td>
<td>Seminar paper</td>
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<tr>
<td>Written exam</td>
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<tr>
<td>Project</td>
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### 1.9. Assessment and evaluation of students' work during the semester and on the final exam

Students' work will be evaluated and assessed during the semester (e.g. preliminary exams, tests, seminars, online tests, homework etc.) and on the final exam.

Total number of points student can earn during the semester is 70, while on the final exam student can achieve 30 points. The detailed elaboration of monitoring and evaluation of students' work will be described in the course curriculum.

### 1.10. Required literature (when proposing the program)


### 1.11. Recommended literature (when proposing the program)


### 1.12. Number of copies of required literature in relation to the number of students currently attending classes of the course

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</thead>
<tbody>
<tr>
<td>E.F. Assmus, J. D. Key: Designs and their Codes, Cambridge University Press, 1992.</td>
<td>2</td>
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</table>

### 1.13. Quality assurance which ensure acquisition of knowledge, skills and competencies

In the last week of this course, the students will evaluate the quality of the lectures. Additionally, the analysis of the exam results will be conducted.

---

**IMPORTANT:** Fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.
1. COURSE DESCRIPTION

1.1. Course objectives

The main course objective is to get students familiar with the procedures for designing and analysing experiments and enable them to carry out these procedures in specific situations. For this purpose, it is necessary within the course to:

- describe basic principles and methods for designing experiments
- define and analyse some standard experimental designs
- describe and analyse a model for designs with one source of variation
- describe and analyse contrasts
- define and compare methods of multiple comparisons
- analyse methods for checking model assumptions
- analyse experiments with two or more crossed treatment factors
- define and analyse complete block designs
- update the knowledge about basic notions from design theory
- describe and analyse basic notions in statistical design theory

1.2. Course prerequisite

None.

1.3. Expected outcomes for the course

After completing this course, the students are expected to:

- describe and apply with understanding the basic principles and methods for designing and analysing experiments to particular examples in this field (A7, B7, E5, F5)
- analyse the model for designs with one source of variation (A7, B7, E4, F5)
- analyse and apply with understanding the methods of multiple comparisons (A7, B7, E4, F5)
- analyse models for two treatment factors (A7, B7, E4, F5)
- use the appropriate software package for solving problems in this field (A7, B7, E4, F5)
- analyse basic notions in statistical design theory (A7, B7, E4, F5)
- apply and use basic notions in statistical design theory to particular examples (A7, B7, E4, F5)
- mathematically prove validity of all procedures and formulas that are used within the course (A7, B7, E4, F5)

1.4. Course content

1.5. Modes of instruction

☒ lectures
☒ seminars and workshops
☒ exercises
☒ e-learning
☐ field work
☐ practice
☐ practicum
☒ independent work
☒ multimedia and the internet
☐ laboratory
☐ project strategies
☐ tutorials
☐ consultations
☐ other

1.6. Comments

1.7. Student requirements

Students are required to attend classes and actively participate in them. They are required to achieve a certain number of points during the semester and to pass the final exam (details will be described in the course curriculum).

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<td>Essay</td>
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<td>Project</td>
<td>1</td>
<td>Continuous assessment</td>
<td>0.5</td>
<td>Presentation</td>
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<td>Portfolio</td>
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<td>Practical work</td>
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1.10. Required literature (when proposing the program)


1.11. Recommended literature (when proposing the program)

2. N.Sarapa, Vjerojatnost i statistika, II dio, Školska knjiga, Zagreb, 1996.

1.12. Number of copies of required literature in relation to the number of students currently attending classes of the course

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<tr>
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<th>Number of students</th>
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1.13. Quality assurance which ensure acquisition of knowledge, skills and competencies

In the last week of this course, the students will evaluate the quality of the lectures. Additionally, the analysis of the exam results will be conducted.

IMPORTANT: Fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.
### General Information

<table>
<thead>
<tr>
<th>Lecturer</th>
</tr>
</thead>
</table>
| Course title | Introduction to databases  
| Program | Graduate course in Discrete mathematics and its applications  
| Course status | Elective  
| Year | 2  
| Credit values and modes of instruction | ECTS credits / student workload: 5  
| Hours (L+E+S) | 30 + 30 + 0  

### 1. COURSE DESCRIPTION

#### 1.1. Course objectives
- Introduce students to basic concepts of database theory with emphasis on relational databases
- Make students competent for independent work with relational databases (SQL)

#### 1.2. Course prerequisite
None.

#### 1.3. Expected outcomes for the course
After completing the course and meeting requirements in respect to course Introduction to Databases, students are expected to be capable of:
- Defining and updating relational database (SQL)
- Conducting relational algebra operation in relational database model
- Access database using various program tools

#### 1.4. Course content

#### 1.5. Modes of instruction
- Lectures
- Seminars and workshops
- Exercises
- E-learning
- Field work
- Practice
- Practicum
- Independent work
- Multimedia and the internet
- Laboratory
- Tutorials
- Consultations
- Other

#### 1.6. Comments
During exercises, students are introduced to relational database - Oracle SQL. Students are prepared to independently produce an application along with drawing up and producing a relational database.

#### 1.7. Student requirements
Students must satisfy the requirements for obtaining the signature (listed in the executive program) and to pass the final exam (written and oral).
1.8. Evaluation of assessment:

| Class attendance & class participation | 1.75 | Seminar paper | Experiment |
| Written exam | 0.5 | Oral exam | 0.5 | Essay | Research work |
| Project | | Continuous assessment | 1.25 | Presentation | Practical work | 1 |
| Portfolio | | |

1.9. Assessment and evaluation of students' work during the semester and on the final exam

Students' work will be evaluated and assessed during the semester and in the final exam. The total number of points a student can achieve during the semester is 70 (to assess the activities listed in the table), while in the final exam a student can achieve 30 points.

The detailed work out of monitoring and evaluation of students' work will appear in the executive program.

1.10. Required literature (when proposing the program)


1.11. Recommended literature (when proposing the program)


1.12. Number of copies of required literature in relation to the number of students currently attending classes of the course

| Title | Number of copies | Number of students |

1.13. Quality assurance which ensure acquisition of knowledge, skills and competencies

In the last week of the semester students will evaluate the quality of the lectures. At the end of each semester (March 1 and September 30 of the current academic year) results of the exams will be analysed.

IMPORTANT: Fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.
### Lecturer

<table>
<thead>
<tr>
<th>Course title</th>
<th>Computer networks 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Program</td>
<td>Graduate course in Discrete mathematics and its applications</td>
</tr>
<tr>
<td>Course status</td>
<td>Elective</td>
</tr>
<tr>
<td>Year</td>
<td>2</td>
</tr>
<tr>
<td>Credit values and modes of instruction</td>
<td>ECTS credits / student workload 5; Hours (L+E+S) 30 + 30 + 0</td>
</tr>
</tbody>
</table>

### 1. COURSE DESCRIPTION

#### 1.1. Course objectives

- Presenting to students the fundamental knowledge about the structure and architecture of computer networks and communication systems
- Teaching students to understand the basic principles of computer networks' implementation
- Training students for using Internet services

#### 1.2. Course prerequisite

None.

#### 1.3. Expected outcomes for the course

Upon completion of course, students will be able to do the following:

- Describe and classify the structure and architecture of computer networks and communication systems
- Identify the basic principles of computer networks' implementation
- Develop skills for using basic network protocols and Internet services.

#### 1.4. Course content


#### 1.5. Modes of instruction

- Lectures
- Seminars and workshops
- Exercises
- E-learning
- Field work
- Practice
- Practicum
- Independent work
- Multimedia and the internet
- Laboratory
- Tutorials
- Consultations
- Other

#### 1.6. Comments

During exercises the students should acquire editing multimedia elements and development of simple multimedia forms by using appropriate software tools for producing images, sound, animation, and video.

#### 1.7. Student requirements
Students should actively participate in all forms of works, perform practical exercises and produce seminar papers. They should pass the exam consisting of practical and oral part.

The practical part of the exam regards the exercises by using computer. This practical exam and seminar papers are the prerequisite for the oral part of the exam where the complete knowledge of the student is examined and evaluated.

1.8. Evaluation of assessment

| Class attendance & class participation | 1 | Seminar paper | Experiment |
| Written exam | 1 | Oral exam | 1 | Essay | Research work |
| Project | Continuous assessment | 2 | Presentation | Practical work |
| Portfolio | 1 | 1 | 1 | 1 | 1 |

1.9. Assessment and evaluation of students' work during the semester and on the final exam

Students' work will be evaluated and assessed during the semester and in the final exam. Total number of points student can achieve during the semester is 70 (to assess the activities listed in the table), while in the final exam student can achieve 30 points.

The detailed work out of monitoring and evaluation of students' work will appear in the executive program.

1.10. Required literature (when proposing the program)


1.11. Recommended literature (when proposing the program)


1.12. Number of copies of required literature in relation to the number of students currently attending classes of the course

<table>
<thead>
<tr>
<th>Title</th>
<th>Number of copies</th>
<th>Number of students</th>
</tr>
</thead>
</table>

1.13. Quality assurance which ensure acquisition of knowledge, skills and competencies

In the last week of the semester students will evaluate the quality of the lectures. At the end of each semester (March 1 and September 30 of the current academic year) results of the exams will be analysed.

---

18 IMPORTANT: Fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.
General information

<table>
<thead>
<tr>
<th>Lecturer</th>
<th>Introduction to combinatorial topology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course title</td>
<td>Introduction to combinatorial topology</td>
</tr>
<tr>
<td>Program</td>
<td>Graduate course in Discrete mathematics and its applications</td>
</tr>
<tr>
<td>Course status</td>
<td>Elective</td>
</tr>
<tr>
<td>Year</td>
<td>2</td>
</tr>
<tr>
<td>Credit values and modes of instruction</td>
<td>5</td>
</tr>
<tr>
<td>Hours (L+E+S)</td>
<td>15 + 15 + 15</td>
</tr>
</tbody>
</table>

1. COURSE DESCRIPTION

1.1. Course objectives

The main course objective is to get students acquainted with:
- elements of combinatorial topology and counting problems.
- classification convex polytopes according to their „combinatorial properties”.

1.2. Course prerequisite

None.

1.3. Expected outcomes for the course

After completing the course, the students are expected to:
- define basic concepts of combinatorial topology of convex polytopes, apply and understand basic procedures for determining number of faces (A7, B7)
- have knowledge of basic theorems in the field of combinatorial topology of convex polytopes and be able to prove them (B7, F4)
- draw Schlegel diagrams for 3-polytopes (B5, C7, D7, F7)
- independently or in groups examine a given problem (C7, E7, F7, G7)

1.4. Course content


1.5. Modes of instruction

- Lectures
- Seminars and workshops
- Exercises
- E-learning
- Independent work
- Multimedia and the internet
- Laboratory
- Tutorials
- Other
- Consultations, project strategies

1.6. Comments

1.7. Student requirements

Students are required to attend classes, to do homework and to create seminar on an assigned topic. Furthermore, they are required to fulfil all the obligations described in the course curriculum.
1.8. Evaluation of assessment

<table>
<thead>
<tr>
<th>Class attendance &amp; class participation</th>
<th>1.4</th>
<th>Seminar paper</th>
<th>1.2</th>
<th>Experiment</th>
<th>Oral exam</th>
<th>1.2</th>
<th>Essay</th>
<th>Research work</th>
<th>Continuous assessment</th>
<th>1.2</th>
<th>Presentation</th>
<th>Practical work</th>
</tr>
</thead>
</table>

1.9. Assessment and evaluation of students' work during the semester and on the final exam

Students' work will be evaluated and assessed during the semester (e.g. preliminary exams, tests, seminars, online tests, homework etc.) and on the final exam.

Total number of points student can earn during the semester is 70, while on the final exam student can achieve 30 points.

The detailed elaboration of monitoring and evaluation of students' work will be described in the course curriculum.

1.10. Required literature (when proposing the program)

3. materijali dostupni u okviru e-kolegija

1.11. Recommended literature (when proposing the program)


1.12. Number of copies of required literature in relation to the number of students currently attending classes of the course

<table>
<thead>
<tr>
<th>Title</th>
<th>Number of copies</th>
<th>Number of students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Darko Veljan: D. Veljan, Kombinatorna i diskretna matematika, Algoritam, Zagreb, 2001</td>
<td>5</td>
<td>10</td>
</tr>
</tbody>
</table>

1.13. Quality assurance which ensure acquisition of knowledge, skills and competencies

In the last week of this course, the students will evaluate the quality of the lectures. Additionally, the analysis of the exam results will be conducted.

---

19 IMPORTANT: Fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.
### General Information

<table>
<thead>
<tr>
<th>Lecturer</th>
<th>Mathematics education 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course title</td>
<td>Mathematics education 1</td>
</tr>
<tr>
<td>Program</td>
<td>Graduate course in Discrete mathematics and its applications</td>
</tr>
<tr>
<td>Course status</td>
<td>Elective</td>
</tr>
<tr>
<td>Year</td>
<td>2</td>
</tr>
<tr>
<td>Credit values and modes of instruction</td>
<td>ECTS credits / student workload: 6 Hours (L+E+S): 30 + 0 + 30</td>
</tr>
</tbody>
</table>

### 1. COURSE DESCRIPTION

#### 1.1. Course objectives

The main course objective is to get students acquainted with practical and theoretical aspects of the methods for teaching mathematics in higher grades of elementary schools and in secondary schools. For this purpose it is necessary within the course to:

- define and analyse basic and special theories of teaching mathematics in higher grades of elementary schools and in secondary schools,
- prepare students for organizing a math teaching class in accordance with teaching principles,
- introduce the national curriculum for mathematics in higher grades of elementary schools and in secondary schools,
- acquaint students with the mathematical knowledge that is necessary for effective teaching of mathematics in higher grades of elementary schools and in secondary schools.

#### 1.2. Course prerequisite

None.

#### 1.3. Expected outcomes for the course

After completing this course, the students are expected to:

- quote the principles of mathematics education and their basic properties, and use them with understanding (A7, B6, C6, D6, E6, F6),
- differentiate several forms of defining mathematical terms and highlight their advantages and deficiencies in school mathematics (A7, B6, C6, D6, E6, F6),
- interpret and compare different ways of proving mathematical theorems (A7, B6, C6, D6, E6, F6),
- analyse the national curriculum of mathematics in higher grades of elementary schools and in secondary schools (A6, B6, C5, D6, E5, F5),
- in accordance with the principles of teaching mathematics, clearly and precisely present mathematical content using teaching aids and facilities (A6, B6, C6, D6, E7, F7),
- use relevant and recent professional literature independently and critically (A6, B6, C6, D5, E7, F7),
- cooperate with colleagues to acquire and develop professional competences, and use the feedback in the aim of improving the teaching process (A6, B6, C5, D6, E7, F7),
- use the basic communication principles and techniques of effective professional communication, and express themselves accurately and fluently in spoken and written forms of communication in the language of teaching and in the official language (A6, B6, C6, D6, E6, F6).

#### 1.4. Course content

The subject of teaching mathematics. The objectives and tasks of teaching mathematics. Principles of teaching mathematics – scientific approach (an axiom, a mathematical definition, the definition of a term, a theorem, a proof), activity, independence and awareness (a formalism in mathematics class), motivation (games in teaching mathematics, mathematical billboard), individualization, visualization, suitability (factors that affect on the process of learning mathematics, degrees of knowing the mathematics, mathematical personality), systematicity, stability (remembering mathematical facts and
procedures). In seminars, students will become familiar with the mathematical curriculum in the higher grades of elementary school and present selected topics in mathematics that are processed in the higher grades of elementary schools or in secondary school.

1.5. Modes of instruction

- lectures
- seminars and workshops
- exercises
- e-learning
- field work
- independent work
- multimedia and the internet
- laboratory
- tutorials
- other

1.6. Comments

1.7. Student requirements

Students are required to attend classes and actively participate in them. They are required to achieve a certain number of points during the semester and to pass the final exam (details will be described in the course curriculum).

1.8. Evaluation of assessment

| Class attendance & class participation | 2 | Seminar paper | 0.8 | Experiment |
| Written exam | 0.4 | Oral exam | 1.2 | Essay | Research work |
| Project | | Continuous assessment | 1.6 | Presentation | Practical work |
| Portfolio | |

1.9. Assessment and evaluation of students' work during the semester and on the final exam

Students' work will be evaluated and assessed during the semester (e.g. preliminary exams, tests, seminars, online tests, homework etc.) and on the final exam.

Total number of points student can earn during the semester is 70, while on the final exam student can achieve 30 points. The detailed elaboration of monitoring and evaluation of students' work will be described in the course curriculum.

1.10. Required literature (when proposing the program)

1. Current textbooks for elementary and secondary schools
6. Literature available in the e-library of the course

1.11. Recommended literature (when proposing the program)

2. XXX: Matematika i škola, časopis za nastavu matematike, Element, Zagreb
3. Available methodical and science popularization journals (printed or online form)

1.12. Number of copies of required literature in relation to the number of students currently attending classes of the course

<table>
<thead>
<tr>
<th>Title</th>
<th>Number of copies</th>
<th>Number of students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aktualni udžbenici iz matematike o osnovnim i srednjim školama i odgovarajući priručnici za učitelje</td>
<td>20</td>
<td>15</td>
</tr>
<tr>
<td>Kurnik: Oblici matematičkog mišljenja, Element, Zagreb, 2013</td>
<td>1</td>
<td>15</td>
</tr>
<tr>
<td>Kurnik: Posebne metode rješavanja matematičkih problema, Element, Zagreb, 2010</td>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td>Kurnik: Znanstveni okvir nastave matematike, Element, Zagreb, 2009</td>
<td>2</td>
<td>15</td>
</tr>
</tbody>
</table>

1.13. Quality assurance which ensure acquisition of knowledge, skills and competencies
In the last week of this course, the students will evaluate the quality of the lectures. Additionally, the analysis of the exam results will be conducted.
### General information

<table>
<thead>
<tr>
<th>Lecturer</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Course title</td>
<td>Finite geometries</td>
</tr>
<tr>
<td>Program</td>
<td>Graduate course in Discrete mathematics and its applications</td>
</tr>
<tr>
<td>Course status</td>
<td>Elective</td>
</tr>
<tr>
<td>Year</td>
<td>2</td>
</tr>
<tr>
<td>Credit values and modes of instruction</td>
<td>ECTS credits / student workload: 6 Hours (L+E+S): 30 + 0 + 15</td>
</tr>
</tbody>
</table>

### 1. COURSE DESCRIPTION

#### 1.1. Course objectives

The main course objective is to get students acquainted with the finite geometry theory. For this purpose it is necessary within the course to:

- define affine and projective spaces over finite fields, a finite projective and a finite affine geometry, analyse properties of the mentioned spaces (geometries),
- analyse relationship between affine and projective spaces,
- introduce the coordinatization of a projective space,
- define and analyse a transformation of a projective space, especially dualities and polarities,
- define a dual and a polar space and analyse their properties,
- describe quadratics in projective spaces,
- analyse properties of finite projective planes,
- describe, analyse and differentiate Desargues and non-Desargues projective planes,
- describe, analyse and differentiate polarities and quadratics in finite projective planes.

#### 1.2. Course prerequisite

None.

#### 1.3. Expected outcomes for the course

After completing this course, the students are expected to:

- define basic concepts of finite geometry theories, apply and understand basic procedures in problem solving (A7, B7, C5, D5, E5, F5, G5),
- differentiate and analyse transformations of a projective space, apply and understand appropriate procedures in problem solving (A7, B7, C5, D5, E5, F5, G5),
- analyse and differentiate various finite projective planes, apply and understand appropriate procedures in problem solving (A7, B7, C7, D7, E5, F7, G7),
- analyse and differentiate polarities and quadratics in finite projective planes, apply and understand appropriate procedures in problem solving (A7, B7, C7, D7, E5, F7, G7),
- mathematically prove validity of all procedures and formulas that are used within the course (B7, F4).

#### 1.4. Course content

#### 1.5. Modes of instruction

- lectures
- seminars and workshops
- exercises
- e-learning
- independent work
- multimedia and the internet
- laboratory
- tutorials
- other
1.6. Comments

1.7. Student requirements

Students are required to attend classes and actively participate in them. They are required to achieve a certain number of points during the semester and to pass the final exam (details will be described in the course curriculum).

1.8. Evaluation of assessment:

<table>
<thead>
<tr>
<th>Class attendance &amp; class participation</th>
<th>1.5</th>
<th>Seminar paper</th>
<th>1.5</th>
<th>Experiment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Written exam</td>
<td>0.5</td>
<td>Oral exam</td>
<td>1</td>
<td>Essay</td>
</tr>
<tr>
<td>Project</td>
<td></td>
<td>Continuous assessment</td>
<td>1.5</td>
<td>Presentation</td>
</tr>
<tr>
<td>Portfolio</td>
<td></td>
<td></td>
<td></td>
<td>Practical work</td>
</tr>
</tbody>
</table>

1.9. Assessment and evaluation of students' work during the semester and on the final exam

Students' work will be evaluated and assessed during the semester (e.g. preliminary exams, tests, seminars, online tests, homework etc.) and on the final exam. Total number of points student can earn during the semester is 70, while on the final exam student can achieve 30 points. The detailed elaboration of monitoring and evaluation of students' work will be described in the course curriculum.

1.10. Required literature (when proposing the program)

1. P. J. Cameron, Projective and Polar Spaces (available online: http://www.maths.qmul.ac.uk/~pjc/pps/)
2. C. D. Godsil, Finite geometry (available online: http://quoll.uwaterloo.ca/mine/Notes/fgeom.pdf)

1.11. Recommended literature (when proposing the program)

2. V. Krčadinac, Unitali (available online: http://web.math.hr/~krcko/radovi/unitali10.pdf)

1.12. Number of copies of required literature in relation to the number of students currently attending classes of the course

<table>
<thead>
<tr>
<th>Title</th>
<th>Number of copies</th>
<th>Number of students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Literature is available to students on-line (in the e-course).</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1.13. Quality assurance which ensure acquisition of knowledge, skills and competencies

In the last week of this course, the students will evaluate the quality of the lectures. Additionally, the analysis of the exam results will be conducted.

**IMPORTANT:** Fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.
### General information

<table>
<thead>
<tr>
<th>Lecturer</th>
</tr>
</thead>
</table>
| **Course title** | Seminar / M.Sc. thesis  
| **Program** | Graduate course in Discrete mathematics and its applications  
| **Course status** | Compulsory  
| **Year** | 2  
| **Credit values and modes of instruction** | ECTS credits / student workload: 4, Hours (L+E+S): 0 + 0 + 30 |

### 1. COURSE DESCRIPTION

#### 1.1. Course objectives

This seminar is the first step towards graduate thesis. The objective of the seminar is to enable students for:
- independent research and work with mathematical literature,
- presentation of mathematical contents.

#### 1.2. Course prerequisite

None.

#### 1.3. Expected outcomes for the course

After completing this course, the students are expected to:
- present mathematical concepts using teaching aids and facilities (B7, C6, D6, E6, F6),
- express correctly and fluently in speaking communication in the language of teaching and official language (D6),
- use different communication types and forms (D5),
- use relevant and recent professional literature independently and critically (B7, C6, D6, E6, F6).

#### 1.4. Course content

All lecturers of the compulsory mathematics courses will participate in determining the content of this seminar by proposing the themes for the seminars (according to Regulations on graduate work and the final exam for the university graduate studies at the Department of mathematics, University of Rijeka). Each student will publicly present the theme and submit the work in the written form to the mentor. The work will present the basis for the graduate thesis which will be elaborated in conjunction with the mentor.

#### 1.5. Modes of instruction

- lectures
- seminars and workshops
- exercises
- e-learning
- independent work
- multimedia and the internet
- laboratory
- tutorials
- field work
- other

#### 1.6. Comments

#### 1.7. Student requirements

Students are required to attend classes and actively participate in them. They are required to prepare and publicly present their seminar. Students are required to attend presentations of other students and actively participate in their analysis.
## 1.8. Evaluation of assessment

<table>
<thead>
<tr>
<th>Class attendance &amp; class participation</th>
<th>1.5</th>
<th>Seminar paper</th>
<th>2.5</th>
<th>Experiment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Written exam</td>
<td>Oral exam</td>
<td>Essay</td>
<td>Research work</td>
<td></td>
</tr>
<tr>
<td>Project</td>
<td>Continuous assessment</td>
<td>Presentation</td>
<td>Practical work</td>
<td></td>
</tr>
<tr>
<td>Portfolio</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## 1.9. Assessment and evaluation of students' work during the semester and on the final exam

Students' work will be evaluated and assessed during the semester. Total number of points student can earn during the semester is 100. The detailed elaboration of monitoring and evaluation of students' work will be described in the course curriculum.

### 1.10. Required literature (when proposing the program)

Literature for each seminar will be proposed by the mentor - proponent of the topic.

### 1.11. Recommended literature (when proposing the program)

### 1.12. Number of copies of required literature in relation to the number of students currently attending classes of the course

<table>
<thead>
<tr>
<th>Title</th>
<th>Number of copies</th>
<th>Number of students</th>
</tr>
</thead>
</table>

### 1.13. Quality assurance which ensure acquisition of knowledge, skills and competencies

In the last week of this course, the students will evaluate the quality of the lectures. Additionally, the analysis of the exam results will be conducted.

---

22 **IMPORTANT**: Fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.
### 1. COURSE DESCRIPTION

#### 1.1. Course objectives

The main course objective is to get students familiar with the basics of the theory of normed and topological vector spaces. For this purpose it is necessary within the course to:

- define topological vector spaces
- define normed space and describe typical examples of normed spaces
- define and analyse local convexity, metrizability and completeness of spaces
- analyse linear functionals

#### 1.2. Course prerequisite

None.

#### 1.3. Expected outcomes for the course

After completing this course, the students are expected to:

- formulate examples of topological vector spaces (A6, B6, C6, D4, E4, F3)
- analyse the connection between linear and topological structure (A6, B6, C6, D4, E5, F3)
- formulate examples of normed spaces (A6, B6, C6, D4, E4, F3)
- analyse local convexity, metrizability and completeness of spaces (A6, B6, C6, D4, E4, F3)
- mathematically prove validity of all procedures and formulas that are used within the course (A6, B6, D4, E5, F3)

#### 1.4. Course content


#### 1.5. Modes of instruction

- lectures
- seminars and workshops
- exercises
- e-learning
- field work
- practice
- practicum
- independent work
- multimedia and the internet
- laboratory
- tutorials
- consultations
- other

#### 1.6. Comments

#### 1.7. Student requirements

Students are required to attend classes and actively participate in them. They are required to achieve a certain number of points during the semester and to pass the final exam (details will be described in the course curriculum).
### 1.8. Evaluation of assessment

<table>
<thead>
<tr>
<th>Category</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class attendance &amp; class participation</td>
<td>1.5</td>
</tr>
<tr>
<td>Written exam</td>
<td>2</td>
</tr>
<tr>
<td>Oral exam</td>
<td>2</td>
</tr>
<tr>
<td>Project</td>
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</tr>
<tr>
<td>Continuous assessment</td>
<td>0.5</td>
</tr>
<tr>
<td>Portfolio</td>
<td></td>
</tr>
<tr>
<td>Seminar paper</td>
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<tr>
<td>Experiment</td>
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</tr>
<tr>
<td>Experiment</td>
<td></td>
</tr>
<tr>
<td>Essay</td>
<td></td>
</tr>
<tr>
<td>Research work</td>
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<tr>
<td>Essay</td>
<td></td>
</tr>
<tr>
<td>Research work</td>
<td></td>
</tr>
<tr>
<td>Practical work</td>
<td></td>
</tr>
<tr>
<td>Continuous assessment</td>
<td></td>
</tr>
<tr>
<td>Presentation</td>
<td></td>
</tr>
</tbody>
</table>

### 1.9. Assessment and evaluation of students' work during the semester and on the final exam

Students' work will be evaluated and assessed during the semester (e.g. preliminary exams, tests, seminars, online tests, homework etc.) and on the final exam. The detailed elaboration of monitoring and evaluation of students' work will be described in the course curriculum.

### 1.10. Required literature (when proposing the program)


### 1.11. Recommended literature (when proposing the program)


### 1.12. Number of copies of required literature in relation to the number of students currently attending classes of the course

<table>
<thead>
<tr>
<th>Title</th>
<th>Number of copies</th>
<th>Number of students</th>
</tr>
</thead>
</table>

### 1.13. Quality assurance which ensure acquisition of knowledge, skills and competencies

In the last week of this course, the students will evaluate the quality of the lectures. Additionally, the analysis of the exam results will be conducted.

**IMPORTANT:** Fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.
# General information

<table>
<thead>
<tr>
<th>Lecturer</th>
<th>History of mathematics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course title</td>
<td>History of mathematics</td>
</tr>
<tr>
<td>Program</td>
<td>Graduate course in Discrete mathematics and its applications</td>
</tr>
<tr>
<td>Course status</td>
<td>Elective</td>
</tr>
<tr>
<td>Year</td>
<td>2</td>
</tr>
<tr>
<td>Credit values and modes of instruction</td>
<td>ECTS credits / student workload 3</td>
</tr>
<tr>
<td></td>
<td>Hours (L+E+S) 15 + 0 + 30</td>
</tr>
</tbody>
</table>

## 1. COURSE DESCRIPTION

### 1.1. Course objectives

- an introduction to the development of mathematical theories and fundamental branches of mathematics, as well as with work and historical significance of some mathematicians,
- analysis of the ways in which certain branches of mathematics developed.

### 1.2. Course prerequisite

None.

### 1.3. Expected outcomes for the course

- indicate problems from the everyday life that can be solved using mathematics and point out a relation with other subjects (A7, B5, E5, F5),
- present used mathematical knowledge in the historical and mathematical context (A7, B5, C7, D5, E7, F7, G7),
- relate and explain causes and effects of the development of mathematical ideas and methods, the role of mathematics in science, art and society (A6, B7),
- use different types and forms of communication including information and communication technology (A3, B3, C3, E7, F7),
- mathematically prove validity of all procedures and formulas that are used within the course (A7, B5, E5, F5).

### 1.4. Course content


### 1.5. Modes of instruction

- lectures
- seminars and workshops
- exercises
- e-learning
- field work
- independent work
- multimedia and the internet
- laboratory
- tutorials
- other

### 1.6. Comments

### 1.7. Student requirements

Students are required to attend classes and actively participate in them. They are required to achieve a certain number of points during the semester and to pass the final exam (details will be described in the course curriculum).
1.8. Evaluation of assessment:

<table>
<thead>
<tr>
<th>Class attendance &amp; class participation</th>
<th>0.5</th>
<th>Seminar paper</th>
<th>1</th>
<th>Experiment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Written exam</td>
<td>0.5</td>
<td>Oral exam</td>
<td>1</td>
<td>Essay</td>
</tr>
<tr>
<td>Project</td>
<td></td>
<td>Continuous assessment</td>
<td></td>
<td>Presentation</td>
</tr>
<tr>
<td>Portfolio</td>
<td></td>
<td></td>
<td></td>
<td>Practical work</td>
</tr>
</tbody>
</table>

1.9. Assessment and evaluation of students' work during the semester and on the final exam

Students' work will be evaluated and assessed during the semester (e.g. preliminary exams, tests, seminars, online tests, homework etc.) and on the final exam.

Total number of points student can earn during the semester is 70, while on the final exam student can achieve 30 points. The detailed elaboration of monitoring and evaluation of students' work will be described in the course curriculum.

1.10. Required literature (when proposing the program)


1.11. Recommended literature (when proposing the program)


1.12. Number of copies of required literature in relation to the number of students currently attending classes of the course

<table>
<thead>
<tr>
<th>Title</th>
<th>Number of copies</th>
<th>Number of students</th>
</tr>
</thead>
</table>

1.13. Quality assurance which ensure acquisition of knowledge, skills and competencies

In the last week of this course, the students will evaluate the quality of the lectures. Additionally, the analysis of the exam results will be conducted.
General information

<table>
<thead>
<tr>
<th>Lecturer</th>
<th>Science popularization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course title</td>
<td>Science popularization</td>
</tr>
<tr>
<td>Program</td>
<td>Graduate course in Discrete mathematics and its applications</td>
</tr>
<tr>
<td>Course status</td>
<td>Elective</td>
</tr>
<tr>
<td>Year</td>
<td>2</td>
</tr>
<tr>
<td>Credit values and modes of instruction</td>
<td>ECTS credits / student workload 2 Hours (L+E+S) 15 + 15 + 0</td>
</tr>
</tbody>
</table>

1. COURSE DESCRIPTION

1.1. Course objectives

Science popularization is an integral part of teacher’s and scientist’s profession in any subject. The main course objective is to:
- develop the consciousness of the social context for the science and the need for its popularization,
- train for active professional popularization,
- develop the abilities for planning and conducting activities for popularization of science, scientific topics and scientific research results.

1.2. Course prerequisite

None.

1.3. Expected outcomes for the course

After completing the course, the students are expected to:
- describe and analyse the need and importance of the science popularization,
- differentiate and analyse the channels for the science popularization,
- describe types of popularization activities and their extent, scope, advantages and disadvantages,
- describe the influence of public media on the promotion of scientific activities,
- describe and analyse the interaction between social structures and the promotion of science
- (local community, educational system, the strategy of the University)
- create a plan for the popularization contributions and activities,
- implement the plan within the field work and within the Rijeka Science Festival.

1.4. Course content


1.5. Modes of instruction

- lectures
- seminars and workshops
- exercises
- e-learning
- field work
- independent work
- multimedia and the internet
- laboratory
- tutorials
- other
Consultations, project strategies
### 1.6. Comments

### 1.7. Student requirements

Students are required to participate in a field work and to participate in the popularization of science.

### 1.8. Evaluation of assessment

<table>
<thead>
<tr>
<th>Class attendance &amp; class participation</th>
<th>0.5</th>
<th>Seminar paper</th>
<th>Experiment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Written exam</td>
<td>Oral exam</td>
<td>Essay</td>
<td>Research work</td>
</tr>
<tr>
<td>Project</td>
<td>0.5</td>
<td>Continuous assessment</td>
<td>Presentation</td>
</tr>
<tr>
<td>Portfolio</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 1.9. Assessment and evaluation of students' work during the semester and on the final exam

Students' work will be evaluated and assessed during the semester. There is no final exam within the course. The detailed elaboration of monitoring and evaluation of students' work will be described in the course curriculum.

### 1.10. Required literature (when proposing the program)

3. Aktivnosti Udruge Zlatni rez www.zlatnirez.hr

### 1.11. Recommended literature (when proposing the program)

4. S.M. Cutlip, A.H. Center, G.M. Broom: Odnosi s javnošću (prijedor ‘Effective public relations’). Mate, Zagreb, 2003

### 1.12. Number of copies of required literature in relation to the number of students currently attending classes of the course

<table>
<thead>
<tr>
<th>Title</th>
<th>Number of copies</th>
<th>Number of students</th>
</tr>
</thead>
<tbody>
<tr>
<td>B.Jergović (ur.): Znanost i javnost, Izvori, Zagreb, 2002.</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>Znanstveno-popularne radio emisije «Baltazar», CD</td>
<td>2</td>
<td>10</td>
</tr>
</tbody>
</table>

### 1.13. Quality assurance which ensure acquisition of knowledge, skills and competencies

Student's Portfolio: Monitoring students' work while giving them a feedback on their success and improvement.

Questionnaire: Introductory questionnaire on student's expectations. At the end of the course, anonymous questionnaire of the course quality will be conducted. After the passing the oral exam, the professor requires the feedback for achieved learning objectives: learning methods, potential difficulties while learning the course content, and suggestions for the course.

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25 IMPORTANT: Fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.
1. COURSE DESCRIPTION

1.1. Course objectives

The main course objective is to get students acquainted with practical and theoretical aspects of the methods for teaching mathematics in higher grades of elementary schools and in secondary schools. For this purpose it is necessary within the course to:

- introduce the national curriculum for mathematics in higher grades of elementary schools and in secondary schools,
- prepare students for choosing the appropriate methods in the process of teaching mathematics,
- acquaint students with the mathematical knowledge that is necessary for effective teaching of mathematics in higher grades of elementary schools and in secondary schools,
- prepare students for organizing a math teaching class in higher grades of elementary schools and in secondary schools.

1.2. Course prerequisite

Mathematics education 1.

1.3. Expected outcomes for the course

After completing this course, the students are expected to:

- analyse the mathematical curriculum in higher grades of elementary schools and in secondary schools (A6, B6, C5, D6, E5, F5),
- differ and valorise different methods of teaching mathematics, especially methods according to the mathematical topics (A7, B6, C6, D6, E7, F7),
- organize a mathematics teaching class in higher grades of elementary schools and in secondary schools in accordance with contemporary teaching methods and principles while using suitable teaching strategies (A7, B6, C6, D6, E7, F7),
- plan and organize a mathematics teaching class in accordance with contemporary teaching methods and principles while using suitable teaching strategies, with the aim of developing mathematical processes and better understanding of mathematical concepts (A7, B6, C6, D6, E7, F7),
- present mathematical content using the teaching aids and facilities (e.g. informational communicational technology) with the proper use of mathematical terminology and language (A6, B6, C6, D6, E7, F7),
- independently create teaching materials in mathematics with or without using the advanced tools of ICT (A6, B6, C6, D6, E7, F7),
- independently adjust current teaching materials in mathematics for becoming motivational for learning and suitable for accomplishing the planned learning outcomes (A6, B5, C5, D6, E5, F5),
- use relevant and recent professional literature independently and critically (A6, B6, C6, D5, E7, F7),
- cooperate with colleagues to acquire and develop professional competences, and use the feedback in the aim of improving the teaching process (A6, B6, C5, D6, E7, F7),
- use the basic communication principles and techniques of effective professional communication, and express themselves accurately and fluently in spoken and written forms of communication in the language of teaching and in the official language (A6, B6, C6, D6, E6, F6).
### 1.4. Course content

Methods of teaching mathematics (methods according to the source of knowledge and methods according to the mathematical topics). Empirical methods, induction, deduction, analysis and synthesis, generalization, abstraction, concretion, problem-solving methods (heuristics, solving problems), analogy and comparison, special mathematical cases. Methods for specific mathematical topics. In seminars, students will become familiar with the mathematical curriculum in the higher grades of elementary school and in secondary schools. Students will present selected topics in mathematics that are processed in higher grades of elementary school or in secondary schools.

### 1.5. Modes of instruction

- ☒ lectures
- ☒ seminars and workshops
- ☐ exercises
- ☒ e-learning
- ☐ field work
- ☒ independent work
- ☒ multimedia and the internet
- ☐ laboratory
- ☐ tutorials
- ☐ other

### 1.6. Comments

### 1.7. Student requirements

Students are required to attend classes and actively participate in them. They are required to achieve a certain number of points during the semester and to pass the final exam (details will be described in the course curriculum).

### 1.8. Evaluation of assessment

<table>
<thead>
<tr>
<th>Class attendance &amp; class participation</th>
<th>2</th>
<th>Seminar paper</th>
<th>1.5</th>
<th>Experiment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Written exam</td>
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<td>1</td>
<td>Essay</td>
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<tr>
<td>Project</td>
<td></td>
<td>Continuous assessment</td>
<td>1</td>
<td>Presentation</td>
</tr>
<tr>
<td>Portfolio</td>
<td></td>
<td></td>
<td></td>
<td>Practical work</td>
</tr>
</tbody>
</table>

1.9. Assessment and evaluation of students' work during the semester and on the final exam

Students' work will be evaluated and assessed during the semester (e.g. preliminary exams, tests, seminars, online tests, homework etc.) and on the final exam.

Total number of points student can earn during the semester is 70, while on the final exam student can achieve 30 points. The detailed elaboration of monitoring and evaluation of students' work will be described in the course curriculum.

### 1.10. Required literature (when proposing the program)

1. Current textbooks for elementary and secondary schools and teachers' manuals
6. Literature available in the e-library of the course

### 1.11. Recommended literature (when proposing the program)

2. XXX: Matematika i škola, časopis za nastavu matematike, Element, Zagreb
3. Available methodical and science popularization journals (printed or online form)

### 1.12. Number of copies of required literature in relation to the number of students currently attending classes of the course

<table>
<thead>
<tr>
<th>Title</th>
<th>Number of copies</th>
<th>Number of students</th>
</tr>
</thead>
</table>

### 1.13. Quality assurance which ensure acquisition of knowledge, skills and competencies

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**IMPORTANT:** Fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.
In the last week of this course, the students will evaluate the quality of the lectures. Additionally, the analysis of the exam results will be conducted.
### General information

**Lecturer**

**Course title** Computer networks 2

**Program** Graduate course in Discrete mathematics and its applications

**Course status** Elective

**Year** 2

**Credit values and modes of instruction**

<table>
<thead>
<tr>
<th>Credit values</th>
<th>student workload</th>
<th>ECTS</th>
<th>Hours (L+E+S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td></td>
<td></td>
<td>30 + 30 + 0</td>
</tr>
</tbody>
</table>

### 1. COURSE DESCRIPTION

#### 1.1. Course objectives

This course is a continuation of the course "Computer networks 1". The aims of the course are:

1) to present the methods of recording of the contents of various kinds, the methods of data compression and the transmission protocols;
2) to present the basic elements of the protection of secrecy and integrity of contents, and of the authenticity of communicators in computer networks;
3) to present the main network services of the application level. In the framework of the exercises, students have to learn to use the main network services and the language HTML.

#### 1.2. Course prerequisite

In this course it is continued with the presentation of the basic knowledge of the computer networks and communication systems. The content of this course draws on those courses that deal with information systems, computer architecture and computer programming, and it directly extends the content of the course "Computer networks 1".

#### 1.3. Expected outcomes for the course

Students are expected to acquire the basic knowledge about the methods of recording of the information contents of various kinds, about the methods of data compression and about the transmission protocols. They have to get familiar with the basic methods of the protection of secrecy and integrity of contents, and of the authenticity of communicators in computer networks, as well as with the network services of the application level, as specified in the "Course content" below. In the framework of the exercises, students have to learn to use the main network services and the language HTML.

#### 1.4. Course content


The application layer. The Internet applications (services) and their protocols. Domain name system (DNS), electronic mail system (SMTP), web page system (HTTP), multimedia and interactive applications (VIP, VIC).

Controlling the functioning of a compound computer network. Administration and optimization; a system for managing of the functioning of computer network (SNMP).

#### 1.5. Modes of instruction

- lectures
- seminars and workshops
- exercises
- e-learning
- field work
- practice
- practicum
- independent work
- multimedia and the internet
- laboratory
- tutorials
- consultations
- other
1.6. Comments

1.7. Student requirements

Students should actively participate in all forms of works, perform practical exercises and produce seminar papers. They should pass the exam consisting of practical and oral part. The practical part of the exam regards the exercises by using computer. This practical exam and seminar papers are the prerequisite for the oral part of the exam where the complete knowledge of the student is examined and evaluated.

1.8. Evaluation of assessment

<table>
<thead>
<tr>
<th>Class attendance &amp; class participation</th>
<th>1</th>
<th>Seminar paper</th>
<th>Experiment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Written exam</td>
<td>1</td>
<td>Oral exam</td>
<td>Essay</td>
</tr>
<tr>
<td>Project</td>
<td></td>
<td>Continuous assessment</td>
<td>Presentation</td>
</tr>
<tr>
<td>Portfolio</td>
<td></td>
<td></td>
<td>Practical work</td>
</tr>
</tbody>
</table>

1.9. Assessment and evaluation of students' work during the semester and on the final exam

Students' work will be evaluated and assessed during the semester and in the final exam. Total number of points student can achieve during the semester is 70 (to assess the activities listed in the table), while in the final exam student can achieve 30 points. The detailed work out of monitoring and evaluation of students' work will appear in the executive program.

1.10. Required literature (when proposing the program)


1.11. Recommended literature (when proposing the program)


1.12. Number of copies of required literature in relation to the number of students currently attending classes of the course

<table>
<thead>
<tr>
<th>Title</th>
<th>Number of copies</th>
<th>Number of students</th>
</tr>
</thead>
</table>

1.13. Quality assurance which ensure acquisition of knowledge, skills and competencies

In the last week of the semester students will evaluate the quality of the lectures. At the end of each semester (March 1 and September 30 of the current academic year) results of the exams will be analysed.

27 IMPORTANT: Fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.
### General information

<table>
<thead>
<tr>
<th>Lecturer</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Course title</td>
<td>Databases</td>
</tr>
<tr>
<td>Program</td>
<td>Graduate course in Discrete mathematics and its applications</td>
</tr>
<tr>
<td>Course status</td>
<td>Elective</td>
</tr>
<tr>
<td>Year</td>
<td>2</td>
</tr>
<tr>
<td>Credit values and modes of instruction</td>
<td>ECTS credits / student workload: 5</td>
</tr>
<tr>
<td>Hours (L+E+S)</td>
<td>30 + 30 + 0</td>
</tr>
</tbody>
</table>

### 1. COURSE DESCRIPTION

#### 1.1. Course objectives
- Extend students’ knowledge acquired on course Introduction to databases
- Train students for independent work with relational databases (SQL)

#### 1.2. Course prerequisite
Introduction to databases.

#### 1.3. Expected outcomes for the course
After completing the course and meeting requirements in respect to course Databases, students are expected to be capable of:
- Defining and updating relational database (SQL)
- Producing a object-oriented database model (UML)
- Designing database using CASE tool.

#### 1.4. Course content
Semi-structured databases - text and multimedia databases, web as a semi-structured database. Computer aided data and database design – CASE, review of CASE tools.

#### 1.5. Modes of instruction
- lectures
- seminars and workshops
- exercises
- e-learning
- field work
- practice
- practicum
- independent work
- multimedia and the internet
- laboratory
- tutorials
- consultations
- other

#### 1.6. Comments
During exercises, students continue with hands-on work on computers (connected to course Introduction to databases) using Oracle SQL / PLSQL. Also, students are introduced to some CASE tools and usage of these tools.

#### 1.7. Student requirements
Students should actively participate in all forms of works, pass the exam consisting of written and oral part. During exercises, students should produce a complete work, proving their capabilities in using software independently.
1.8. Evaluation of assessment

<table>
<thead>
<tr>
<th>Category</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class attendance &amp; class participation</td>
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</tr>
<tr>
<td>Written exam</td>
<td>0.5</td>
</tr>
<tr>
<td>Oral exam</td>
<td>0.5</td>
</tr>
<tr>
<td>Project</td>
<td>Continuous assessment</td>
</tr>
<tr>
<td>Essay</td>
<td>0.5</td>
</tr>
<tr>
<td>Research work</td>
<td></td>
</tr>
<tr>
<td>Experiment</td>
<td></td>
</tr>
<tr>
<td>Seminar paper</td>
<td>1.75</td>
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<tr>
<td>Experiment</td>
<td></td>
</tr>
<tr>
<td>Written exam</td>
<td>0.5</td>
</tr>
<tr>
<td>Oral exam</td>
<td>0.5</td>
</tr>
<tr>
<td>Essay</td>
<td>0.5</td>
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<tr>
<td>Research work</td>
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</tr>
<tr>
<td>Continuous assessment</td>
<td>1.25</td>
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<tr>
<td>Presentation</td>
<td>1.25</td>
</tr>
<tr>
<td>Practical work</td>
<td>1</td>
</tr>
<tr>
<td>Portfolio</td>
<td></td>
</tr>
</tbody>
</table>

1.9. Assessment and evaluation of students' work during the semester and on the final exam

Students' work will be evaluated and assessed during the semester (e.g. preliminary exams, tests, seminars, online tests, homework etc.) and on the final exam. Total number of points student can earn during the semester is 70, while on the final exam student can achieve 30 points. The detailed elaboration of monitoring and evaluation of students' work will be described in the course curriculum.

1.10. Required literature (when proposing the program)


1.11. Recommended literature (when proposing the program)

1. R. Simon; Strategic Database Technology, Morgan Kaufmann Publishers, 1995

1.12. Number of copies of required literature in relation to the number of students currently attending classes of the course

<table>
<thead>
<tr>
<th>Title</th>
<th>Number of copies</th>
<th>Number of students</th>
</tr>
</thead>
</table>

1.13. Quality assurance which ensure acquisition of knowledge, skills and competencies

In the last week of this course, the students will evaluate the quality of the lectures. Additionally, the analysis of the exam results will be conducted.

---

**IMPORTANT:** Fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.
General information

<table>
<thead>
<tr>
<th>Lecturer</th>
<th>Statistical practicum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course title</td>
<td>Statistical practicum</td>
</tr>
<tr>
<td>Program</td>
<td>Graduate course in Discrete mathematics and its applications</td>
</tr>
<tr>
<td>Course status</td>
<td>Elective</td>
</tr>
<tr>
<td>Year</td>
<td>2</td>
</tr>
<tr>
<td>Credit values and modes of instruction</td>
<td>ECTS credits / student workload 6  Hours (L+E+S) 15 + 30 + 15</td>
</tr>
</tbody>
</table>

1. COURSE DESCRIPTION

1.1. Course objectives

The main course objective is to train students for application of numerical and statistical software packages in mathematical modeling. For that purpose, it is necessary within the course to:
- describe the simulation of outcomes of discrete and continuous random variables and vectors
- describe the selection of parametric model and execute the adaptation to data
- define the point and interval methods for parameter estimation
- describe the statistical hypothesis testing
- define the Kolmogorov - Smirnov test
- define the c²-test
- describe the estimation of distribution and parameters of statistics by using Monte Carlo method
- describe methods of comparing two or more populations
- describe methods of testing hypotheses of independence and correlation tests on two-dimensional statistical features
- describe methods of estimation and model selection in regression analysis

1.2. Course prerequisite

None.

1.3. Expected outcomes for the course

After completing this course, the students are expected to:
- select and understand the parametric model and adapt to data (A7, B7, E4, F5)
- apply the Kolmogorov - Smirnov and c² - test (A7, B7, E4, F5)
- estimate the distribution and parameters of statistics by using Monte Carlo method (A7, B7, E4, F5)
- apply the methods of comparing two or more populations (A7, B7, E4, F5)
- apply the methods of testing hypotheses of independence and correlation tests on the two-dimensional statistical characteristics (A7, B7, E4, F5)
- apply the methods of estimation and model selection in regression analysis (A7, B7, E4, F5)
- use numerical and statistical software packages in the mathematical modeling (A7, B7, E4, F5)
- mathematically prove validity of all procedures and formulas that are used within the course (A7, B7, E4, F5)

1.4. Course content

1.5. Modes of instruction

☒ lectures
☒ seminars and workshops
☒ exercises
☒ e-learning
☐ field work
☐ practice
☐ practicum

☒ independent work
☒ multimedia and the internet
☐ laboratory
☐ tutorials
☐ consultations
☐ other

1.6. Comments

1.7. Student requirements

Students are required to attend classes and actively participate in them. They are required to achieve a certain number of points during the semester and to pass the final exam (details will be described in the course curriculum).

1.8. Evaluation of assessment:

<table>
<thead>
<tr>
<th>Class attendance &amp; class participation</th>
<th>2</th>
<th>Seminar paper</th>
<th>1.5</th>
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</thead>
<tbody>
<tr>
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<td>Continuous assessment</td>
<td>0.8</td>
<td>Presentation</td>
<td>Practical work</td>
</tr>
<tr>
<td>Portfolio</td>
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1.9. Assessment and evaluation of students' work during the semester and on the final exam

Students’ work will be evaluated and assessed during the semester (e.g. preliminary exams, tests, seminars, online tests, homework etc.) and on the final exam. Total number of points student can earn during the semester is 70, while on the final exam student can achieve 30 points. The detailed elaboration of monitoring and evaluation of students’ work will be described in the course curriculum.

1.10. Required literature (when proposing the program)


1.11. Recommended literature (when proposing the program)


1.12. Number of copies of required literature in relation to the number of students currently attending classes of the course

<table>
<thead>
<tr>
<th>Title</th>
<th>Number of copies</th>
<th>Number of students</th>
</tr>
</thead>
</table>

1.13. Quality assurance which ensure acquisition of knowledge, skills and competencies

In the last week of this course, the students will evaluate the quality of the lectures. Additionally, the analysis of the exam results will be conducted.

**IMPORTANT:** Fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.
1. COURSE DESCRIPTION

1.1. Course objectives

The main course objective is to get students familiar with basic concepts of theory of stochastic processes. For that purpose, it is necessary within the course to:

- define generating functions and convolutions, and analyze their basic properties
- describe a simple branching process
- describe limit distributions and prove the continuity theorem
- define a simple random walk and analyze its basic properties
- describe the construction of Markov chains
- describe the decomposition of state space of Markov chain
- define transience, recurrence and periodicity
- describe invariant measures and stationary distributions
- define and analyze Markov chains with continuous time
- give the basics of renewal theory

1.2. Course prerequisite

None.

1.3. Expected outcomes for the course

After completing this course, the students are expected to:

- use and understand generating functions and their properties in study of stochastic processes (A7, B7, E4, F5)
- analyse simple branching processes and their properties (A7, B7, E4, F5)
- analyse limit distributions and continuity theorem (A7, B7, E4, F5)
- analyse and understand the properties of simple random walks (A7, B7, E4, F5)
- carry out and understand the construction of a Markov chain (A7, B7, E4, F5)
- describe the decomposition of state space of a Markov chain (A7, B7, E4, F5)
- investigate properties of transience, recurrence and periodicity for Markov chains (A7, B7, E4, F5)
- analyse Markov chains with continuous time and their properties (A7, B7, E4, F5)
- describe basic concepts and results of the renewal theory (A7, B7, E4, F5)
- mathematically prove validity of all procedures and formulas that are used within the course (A7, B7, E4, F5)

1.4. Course content


1.5. Modes of instruction

☒ lectures
☐ seminars and workshops
☒ independent work
☒ multimedia and the internet
1.6. Comments

1.7. Student requirements

Students are required to attend classes and actively participate in them. They are required to achieve a certain number of points during the semester and to pass the final exam (details will be described in the course curriculum).

1.8. Evaluation of assessment

<table>
<thead>
<tr>
<th>Class attendance &amp; class participation</th>
<th>2</th>
<th>Seminar paper</th>
<th>Experiment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Written exam</td>
<td>2</td>
<td>Oral exam</td>
<td>1.5</td>
</tr>
<tr>
<td>Essay</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project</td>
<td>1.5</td>
<td>Experiment</td>
<td></td>
</tr>
<tr>
<td>Continuous assessment</td>
<td>0.5</td>
<td>Presentation</td>
<td></td>
</tr>
<tr>
<td>Practical work</td>
<td></td>
<td>Research work</td>
<td></td>
</tr>
<tr>
<td>Portfolio</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1.9. Assessment and evaluation of students' work during the semester and on the final exam

Students' work will be evaluated and assessed during the semester (e.g. preliminary exams, tests, seminars, online tests, homework etc.) and on the final exam. Total number of points student can earn during the semester is 70, while on the final exam student can achieve 30 points. The detailed elaboration of monitoring and evaluation of students' work will be described in the course curriculum.

1.10. Required literature (when proposing the program)


1.11. Recommended literature (when proposing the program)


1.12. Number of copies of required literature in relation to the number of students currently attending classes of the course

<table>
<thead>
<tr>
<th>Title</th>
<th>Number of copies</th>
<th>Number of students</th>
</tr>
</thead>
</table>

1.13. Quality assurance which ensure acquisition of knowledge, skills and competencies

In the last week of this course, the students will evaluate the quality of the lectures. Additionally, the analysis of the exam results will be conducted.

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**IMPORTANT:** Fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.
### General information

<table>
<thead>
<tr>
<th>Lecturer</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Course title</td>
<td>Seminar 3 – Foundations of mathematics</td>
</tr>
<tr>
<td>Program</td>
<td>Graduate course in Discrete mathematics and its applications</td>
</tr>
<tr>
<td>Course status</td>
<td>Elective</td>
</tr>
<tr>
<td>Year</td>
<td>2</td>
</tr>
<tr>
<td>Credit values and modes of instruction</td>
<td>ECTS credits / student workload</td>
</tr>
<tr>
<td></td>
<td>Hours (L+E+S)</td>
</tr>
<tr>
<td></td>
<td>0 + 0 + 30</td>
</tr>
</tbody>
</table>

### 1. COURSE DESCRIPTION

#### 1.1. Course objectives

The main course objective is to get students acquainted with the basic concepts of the foundations of mathematics. For this purpose it is necessary within the course to:
- describe the axiomatic method and analyse mathematical-logical-philosophical reasons for its introduction to mathematics,
- describe and analyse Euclidean geometry and its logical shortcomings,
- analyse the problem of "obviously true" statements,
- use visualization in the proof of theorems,
- have knowledge of the paradoxes introduced in mathematics at the beginning of the 20th century and their influence on further development of mathematics,
- describe and analyse Hilbert axiomatic system, Principia Mathematica and Gödel theorems,
- describe the ZFC system of axioms and the theory of categories as an alternative way of foundation of mathematics.

#### 1.2. Course prerequisite

None.

#### 1.3. Expected outcomes for the course

After completing this course, the students are expected to:
- describe and analyse some axiomatic systems (A6, B7),
- relate and explain causes and consequences of the development of mathematical ideas and methods, and the role of mathematics in science, art and society (A6, B7),
- use different communication types and forms, including information and communication technology (A6, B6, C6, E7, F7),
- use relevant and recent professional literature independently and critically (A6,B7,E6),
- express yourself accurately and fluently in spoken and written communication in the correct official language (D6).

#### 1.4. Course content


#### 1.5. Modes of instruction

- ☐ lectures
- ☒ seminars and workshops
- ☐ exercises
- ☒ e-learning
- ☐ field work
- ☒ independent work
- ☐ multimedia and the internet
- ☐ laboratory
- ☐ tutorials
- ☐ other
1.6. Comments

1.7. Student requirements

Students are required to attend classes and actively participate in them. They are required to achieve a certain number of points during the semester and to pass the final exam (details will be described in the course curriculum).

1.8. Evaluation of assessment

<table>
<thead>
<tr>
<th>Class attendance &amp; class participation</th>
<th>0.5</th>
<th>Seminar paper</th>
<th>3.5</th>
<th>Experiment</th>
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<tbody>
<tr>
<td>Written exam</td>
<td>Oral exam</td>
<td>Essay</td>
<td>Research work</td>
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<td>Project</td>
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<td>Presentation</td>
<td>Practical work</td>
<td></td>
</tr>
<tr>
<td>Portfolio</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

1.9. Assessment and evaluation of students' work during the semester and on the final exam

Students' work will be evaluated and assessed during the semester (seminars) and on the final exam. Total number of points student can earn during the semester is 100. The detailed elaboration of monitoring and evaluation of students' work will be described in the course curriculum.

1.10. Required literature (when proposing the program)


1.11. Recommended literature (when proposing the program)


1.12. Number of copies of required literature in relation to the number of students currently attending classes of the course

<table>
<thead>
<tr>
<th>Title</th>
<th>Number of copies</th>
<th>Number of students</th>
</tr>
</thead>
</table>

1.13. Quality assurances which ensure acquisition of knowledge, skills and competencies

In the last week of this course, the students will evaluate the quality of the lectures. Additionally, the analysis of the exam results will be conducted.

IMPORTANT: Fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.
## General information

<table>
<thead>
<tr>
<th>Lecturer</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Course title</td>
<td>Topics in contemporary mathematics</td>
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<tr>
<td>Program</td>
<td>Graduate course in Discrete mathematics and its applications</td>
</tr>
<tr>
<td>Course status</td>
<td>Elective</td>
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<tr>
<td>Year</td>
<td>2</td>
</tr>
<tr>
<td>Credit values and modes of instruction</td>
<td>ECTS credits / student workload: 3 Hours (L+E+S): 15 + 0 + 15</td>
</tr>
</tbody>
</table>

## 1. COURSE DESCRIPTION

### 1.1. Course objectives

Objective of this course is to familiarize students with selected topics and current problems of contemporary mathematics.

### 1.2. Course prerequisite

None.

### 1.3. Expected outcomes for the course

After completing this course students will be prepared for independent research, for working with professional literature and research papers and for mathematical topics presentation.

### 1.4. Course content

### 1.5. Modes of instruction

- ☒ lectures
- ☒ seminars and workshops
- ☐ exercises
- ☒ e-learning
- ☐ field work
- ☐ practice
- ☒ practicum
- ☒ independent work
- ☒ multimedia and the internet
- ☐ laboratory
- ☐ tutorials
- ☐ consultations
- ☐ other

### 1.6. Comments

### 1.7. Student requirements

Students are required to attend classes and actively participate in them. They are required to achieve a certain number of points during the semester and to pass the final exam (details will be described in the course curriculum).

### 1.8. Evaluation of assessment

<table>
<thead>
<tr>
<th>Class attendance &amp; class participation</th>
<th>0.6</th>
<th>Seminar paper</th>
<th>2</th>
<th>Experiment</th>
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<td>0.4</td>
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<td>Portfolio</td>
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**IMPORTANT**: Fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.
1.9. Assessment and evaluation of students' work during the semester and on the final exam

Students' work will be evaluated and assessed during the semester (e.g. preliminary exams, tests, seminars, online tests, homework etc.) and on the final exam. Total number of points student can earn during the semester is 70, while on the final exam student can achieve 30 points. The detailed elaboration of monitoring and evaluation of students' work will be described in the course curriculum.

1.10. Required literature (when proposing the program)

4. Literature for each seminar will be determined according to the topic of the seminar.

1.11. Recommended literature (when proposing the program)


1.12. Number of copies of required literature in relation to the number of students currently attending classes of the course

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1.13. Quality assurance which ensure acquisition of knowledge, skills and competencies

In the last week of this course, the students will evaluate the quality of the lectures. Additionally, the analysis of the exam results will be conducted.
General information

<table>
<thead>
<tr>
<th>Lecturer</th>
<th>Partial differential equations</th>
</tr>
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<tbody>
<tr>
<td>Course title</td>
<td>Partial differential equations</td>
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<tr>
<td>Program</td>
<td>Graduate course in Discrete mathematics and its applications</td>
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<tr>
<td></td>
<td>Hours (L+E+S)</td>
</tr>
</tbody>
</table>

1. COURSE DESCRIPTION

1.1. Course objectives
The main course objective is to get students familiar with the basics of the theory of partial differential equations. With that purpose the students are presented the following units:
- classification of second order equations: elliptic, hyperbolic and parabolic equations and examples
- Laplace equation, wave equation and equation of heat conducting
- Dirichlet’s and Green’s representation
- Cauchy’s problem
- Fourier’s method, principle of maximum

1.2. Course prerequisite
None.

1.3. Expected outcomes for the course
After completing this course, the students are expected to:
- analyse partial differential equations in the sense of their classifications (A7, B7, E4, F5)
- differentiate boundary and initial conditions (A7, B7, E4, F5)
- apply different theorems in analyzing elliptic, hyperbolic and parabolic equations (A7, B7, E4, F5)
- solve Laplace equation, analyse Dirichle’s and Neumann’s problem and apply maximum principle (A7, B7, E4, F5)
- apply Poisson’s formula and Green’s function (A7, B7, E4, F5)
- solve the heat equation with different initial-boundary conditions (A7, B7, E4, F5)
- solve the wave equation and analyse Cauchy’s problem (A7, B7, E4, F5)
- apply Fourier’s method in solving partial differential equations (A7, B7, E4, F5)
- mathematically prove validity of all procedures and formulas that are used within the course (A7, B7, E4, F5)

1.4. Course content

1.5. Modes of instruction

- lectures
- seminars and workshops
- exercises
- e-learning
- independent work
- field work
- practice
- tutorials
- consultations
- other
### 1.6. Comments

### 1.7. Student requirements

Students are required to attend classes and actively participate in them. They are required to achieve a certain number of points during the semester and to pass the final exam (details will be described in the course curriculum).

### 1.8. Evaluation of assessment

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<th>Experiment</th>
</tr>
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<td>2.4</td>
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Students' work will be evaluated and assessed during the semester (e.g. preliminary exams, tests, seminars, online tests, homework etc.) and on the final exam.

Total number of points student can earn during the semester is 70, while on the final exam student can achieve 30 points. The detailed elaboration of monitoring and evaluation of students' work will be described in the course curriculum.

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### 1.13. Quality assurance which ensure acquisition of knowledge, skills and competencies

In the last week of this course, the students will evaluate the quality of the lectures. Additionally, the analysis of the exam results will be conducted.

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