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I. DESCRIPTION OF STUDY PROGRAMME FORM

BASIC INFORMATION	
Title of study programme	**Undergraduate course in Mathematics**
study programme coordinator	**University of Rijeka**
Study programme implementor	**Department of Mathematics – University of Rijeka**
Type of study programme	**University**
Level of study programme	**Undergraduate**
Academic/professional degree awarded upon completion of study	**Bachelor of Science in Mathematics**

1. INTRODUCTION

1.1. Reasons for initiating the study

The four year studies of mathematics, as a single major or in a combination with physics and computer science have been carried out at the Faculty of Humanities and Social Sciences in Rijeka (i.e. its predecessors) since 1964. In October 2004 the Ministry of Science, Education and Sports issued the accreditation which verified that the studies carried out at the Department of Mathematics of the Faculty of Humanities and Social Sciences in Rijeka were at the desired level. After that, in accordance with the Bologna process, in June 2005 the accreditations for carrying out the Undergraduate course in Mathematics, the Graduate course in Mathematics (teacher training) and the Graduate course in Mathematics and Computer Science (teacher training) at the Department of Mathematics of the Faculty of Humanities and Social Sciences in Rijeka were issued. Upon the foundation of the Department of Mathematics at the University of Rijeka, the Ministry of Science, Education and Sports in its declaration from 16th January 2009 (class: 602-04/08-13/00041, reg. no.: 533-07-09-0002) stated that the change of the legal successor has not influenced the content and legal validity of the previously issued accreditations and that the Department of Mathematics will keep the accreditations for carrying out the given study programmes, about which a certain recordation in the Register of Higher Education Institutions is going to be made.

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

The results of the analysis of labour market carried out previously by the Croatian Employment Service indicate that in the area under the Area office Rijeka of the Croatian Employment Service there are no unemployed bachelors of science in mathematics. As the evidence of the deficit of mathematicians there are numerous scholarships for deficit occupations that are offered to the students of mathematics both on local and national levels.
Although the Undergraduate course in Mathematics has been developed as a part of the integrated study of teacher training profiles, the course is organized to offer basic knowledge in the field of mathematics so afterwards it is possible to continue to study mathematics even on the profile that is not in the teacher training field.

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

Although the profession of mathematician is currently not recognized as the profession that significantly influences the improvement of work process due to current economic situation, this profession has been classified as one of the best professions that guarantee employment, which can be seen in the annual reports issued by CareerCast.com (http://www.careercast.com/jobs-rated/best-jobs-2014).

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

When the study programme concept was made, special attention was given to the source:
Tuning Educational Structures in Europe (http://www.unideusto.org/tuningeu/), especially the part that refers to the following competences: basic competences (http://www.unideusto.org/tuningeu/competences/generic.html) and specific competences in the field of mathematics (http://www.unideusto.org/tuningeu/competences/specific/mathematics.html). Besides, the recommendations for

designing the study programmes in mathematics were taken into account (http://www.unideusto.org/tuningeu/subject-areas/mathematics.html). Apart from the recommendations from national professional associations, the Department of Mathematics follows modern trends and recommendations for higher education of the professional associations such as:

- **European Mathematical Society (EMS) (http://www.ems-ph.org/journals/journal.php?jrn=news),**
- **Société Mathématique de France (SMF) (http://smf.emath.fr/content/enseignement) and**
- **American Mathematical Society (AMS) (http://www.ams.org/profession/leaders/emp-articles).**

1.2.3. List of the possible partners outside the higher education system who expressed interest for study program

The partners outside the higher education system that have expressed interest for the given study programme are elementary schools and high schools.

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)

The proposed syllabuses of the majority of courses coincides with the syllabuses of the undergraduate course in mathematics at other Croatian universities, which enables transfer of the students of mathematics between the University of Rijeka and other Croatian universities. As an example the comparison of the Undergraduate course in Mathematics at the University of Rijeka and the University of Osijek (http://www.mathos.unios.hr/index.php/en/study-programmes/undergraduate-university-study-programme-in-mathematics/study-programme-undergraduate) can be taken. Basic mathematical courses of the same or similar name and of the similar content constitute the study programmes of mathematics at the majority of European universities, such as:

- **Queen Mary University of London (http://qmplus.qmul.ac.uk/course/view.php?id=1530),**
- **Ruprecht-Karls-Universität Heidelberg (http://www.mathematik.uni-heidelberg.de/).**

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

The Undergraduate course in Mathematics is open to the horizontal and vertical student mobility in national and international higher education system. The horizontal linkage with all undergraduate courses in mathematics in the Republic of Croatia that are constituted under the principles of the Bologna process has been assured. The syllabuses of the majority of courses coincides with the syllabuses of the undergraduate courses in mathematics at other Croatian universities, which allows the student mobility between the Department of Mathematics, University of Rijeka, the Faculty of Science, University of Zagreb, the of Mathematics, University of Josip Juraj Strossmayer in Osijek and the Faculty of Science, University of Split. The vertical mobility manifests through the possibility of enrolment of the bachelors of science in mathematics who finished the Undergraduate course in Mathematics at the Department of Mathematics, University of Rijeka, on some of the graduate courses at the Department of Mathematics or on another graduate courses in mathematics. The bachelors of science in mathematics can enrol the graduate courses in related fields by eventually passing the necessary examinations. The course is also open to the horizontal and vertical student mobility in international higher education system (Erasmus, CEEPUS). The basic courses in mathematics and computer science of this programme with the same or similar names and with the similar content are a part of the study programmes in mathematics at the majority of European universities and if necessary they can be carried out in English.
Considering the currently signed agreements as a part of the Erasmus programme with Karl-Franzens-Universitaet Graz, University of Ghent, St. Cyril and St. Methodius University of Veliko Turnovo and University of Ljubljana, the students of the Department of Mathematics have a possibility of international mobility. Furthermore, if necessary, the teaching in course can be carried out in English, which opens a possibility of arrival of foreign students.

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

The study programme is thoroughly in accordance with the University of Rijeka Strategy 2007-2013, since according to the Strategy special attention is going to be given to the development of natural sciences.
This study programme contributes to the following goals of the Strategy:

- **All study programmes at the University are structured in a way that at least 20% of learning outcomes in each programme develop generic competencies**

Apart from professional competencies, this study programme develops generic competencies such as IT and information literacy, presentation skills through presentation of seminars and final works in front of groups, communication skills though teaching practice in elementary and high schools, teamwork and collaborative work

through common works. Through professional courses logical thinking as well as reasoned presentation and work are developed. Furthermore, the students often use sources in English.

- **E-learning tools are used in at least 50% courses of each study programme (hybrid teaching or completely on-line teaching).**

The majority of course programmes list e-learning and/or multimedia and on-line learning as a way of teaching.

- **To increase the number of institutional popularization activities as well as the number of teaching staff and students who participate in them.**

The significant projects carried out in collaboration with community and directed towards community are participation in and organization of the Science Festival in Rijeka, organization of several workshops and lectures for pupils in elementary and high schools in Rijeka and wider area, organization of the Open Days of the University departments of the University of Rijeka and the Evening of Mathematics.

In 2004 the Dublin Descriptors (http://archive.ehea.info/getDocument?id=2117) set learning outcomes for all three levels of university education. The Descriptors are given in general, for a single educational level and not for a single discipline or the field of study. They are given in five dimensions: knowledge and understanding which students should posses in order to gain a certain qualification, application of knowledge and understanding, inference and reasoning, communication and teaching skills. In accordance with the University of Rijeka Strategy 2007-2013 the University started the reform of the curriculum based on learning outcomes on the 31st session of the Senate at the end of 2007. The Draft of the Croatian Qualifications Framework was relevant during the curriculum reform (the Croatian Qualifications Framework was adopted in February 2013). The Dublin Descriptors were used as foundation for determining learning outcomes. From these outcomes the learning outcomes of each course were determined (by using Bloom's Taxonomy of Educational Objectives, which is the world's most widespread taxonomy). The learning outcomes of each course are in line with the content of courses, the methods of teaching and the methods of grading achievements on courses. The described methodology was used to derive learning outcomes for all study programmes (undergraduate, graduate, postgraduate specialistic and postgraduate doctoral studies) and for all lifelong learning programmes.

1.6. Institutional development strategy of study programs (compatibility with the mission and strategic aims of the institution)

The Department of Mathematics, University of Rijeka, is a member institution of the University of Rijeka which does both research and professional work in the field of mathematics and assures the development of the personnel in mathematics at the University of Rijeka. The Department of Mathematics organizes and carries out courses from its field and also participates in the organization and performance of study programmes at other institutions of the University of Rijeka. Striving towards excellence in science and teaching both on national and international levels, the Department of Mathematics contributes to the development of the University of Rijeka and to the development of the whole society.

1.7. Other important information - in the opinion of the proposer

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2. GENERAL PART

2.1. Title of study programme

Undergraduate course in Mathematics

2.1.1. Type of study programme

University

2.1.2. Level of study programme

Undergraduate

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 6 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

180 ECTS

2.5. Enrolment requirements and selection procedure

The undergraduate course can be enrolled by a person who has finished a four year high school and who has satisfied classification procedure conditions for enrolment of new students.

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)

After finishing this study, the students will:

- **be able to define and differentiate basic mathematical and ICT concepts,**
- **have knowledge about basic theories in the field of mathematics,**
- **be able to practically use and apply ICT,**
- **be able to apply theoretical knowledge with arguments in order to set and creatively solve mathematical problems,**
- **be able to continually educate themselves in the field of mathematics and computer science.**

Through this study, the students develop independence and responsibility, especially through seminar works and projects and by solving tasks independently.

2.6.2. Employment possibility (list of possible employers and compliance with professional association's requirements)

The profession of mathematician has been classified as one of the best professions that guarantee employment, which can be seen in the annual reports issued by CareerCast.com.

2.6.3. Possibility of continuation of study on higher level

The bachelors of science in mathematics who finished the Undergraduate course in Mathematics at the Department of Mathematics, University of Rijeka, can enrol some of the graduate courses at the Department of Mathematics or other graduate courses in mathematics. The bachelors of science in mathematics can enrol the graduate courses in related fields by eventually

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passing the necessary examinations.
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
2.8. Upon application of integrated studies - name reasons for integration of undergraduate and graduate level of study programme

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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

Table 1

3.2. Description of each subject

Table 2

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

The study programme consists of the larger number of compulsory subjects (163 ECTS) and the smaller number of elective subjects (17 ECTS, i.e. 9.44% of the total number of ECTS on the study).
The rhythm of the study is defined by the Study regulations at the University of Rijeka as well as general obligations, while specific obligations of the students are given in description of each subject and its syllabus that is given out annually at the beginning of a 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

Course title (course status within the proposed program)	***The existing program in which the course is taught (course status within the other program)***	***Note***
Information systems (elective)	*Undergraduate single major program of Informatics (compulsory)* *Undergraduate double major program of Informatics (compulsory)*	*DI*
Operating systems (elective)	*Undergraduate double major program of Informatics (compulsory)* *Undergraduate double major program of Informatics (compulsory)*	*DI*
Programming (compulsory)	*Undergraduate course in Physics (compulsory)*	*DI*
Algorithms and Data Structures (compulsory)	*Undergraduate course in Physics (compulsory)*	*DI*

DI – Department of Informatics

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 is open to the student mobility on all related studies of national and international universities.

3.7. Multidisciplinarity/interdisciplinarity of study programme

The study programme covers courses in mathematics and computer science.

3.8. Mode of study programme completion

A student completes the study programme by taking the final exam in front of a three member committee. A part of the final exam is presentation and defence of the work that the student does during the last semester of the study. The student gains a right to access the final exam after he has taken all exams and has done all obligations

proscribed by the study programme.
3.8.1. Conditions of approval of final work /thesis and/or final/thesis exam application
Conditions for approval of application for the final exam are assigned by the Regulation of thesis and final exam at the university undergraduate courses of Department of Mathematics, University of Rijeka (http://www.math.uniri.hr/hr/propisi/propisi-i-dokumenti.html).
3.8.2. Composing and furnishing of final work/thesis
Forming thesis is defined by the Regulation of thesis and final exam at the university undergraduate courses of Department of Mathematics, University of Rijeka (http://www.math.uniri.hr/hr/propisi/propisi-i-dokumenti.html).
3.8.3. Final work/thesis assessment procedure and evaluation and defence of final work/thesis
Evaluation process of thesis and final exam is defined by the Regulation of thesis and final exam at the university undergraduate courses of Department of Mathematics, University of Rijeka (http://www.math.uniri.hr/hr/propisi/propisi-i-dokumenti.html).

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Table 1

3.1. List of compulsory and elective courses and/or modules with teaching hours required and ECTS credits allocated

LIST OF MODULES / COURSES							
Semester: 1							
MODULE	COURSE	COURSE ORGANISER	L	E	S	ECTS	STATUS[1]
	Analysis I		45	45	0	8	C
	Linear Algebra I		45	45	0	8	C
	Elementary Mathematics I		45	30	0	7	C
	Computer Laboratory I		0	30	0	5	C
	Foreign language I		0	30	0	2	C
Semester: 2							
MODULE	COURSE		L	E	S	ECTS	STATUS[2]
	Analysis II		45	45	0	8	C
	Linear Algebra II		45	45	0	8	C
	Elementary Mathematics II		45	30	0	7	C
	Computer Laboratory II		15	30	0	5	C
	Foreign language II		0	30	0	2	C

Semester: 3							
MODULE	COURSE	COURSE ORGANISER	L	E	S	ECTS	STATUS[3]
	Analysis III		45	45	0	7	C
	Combinatorics		30	30	0	5	C
	Differential Equations		30	30	0	5	C
	Euclidean Spaces		30	30	0	5	C
	Seminar I		0	0	30	3	C
	Internal elective B1> number of elective courses to be selected: at least 5 ECTS						
	Information Systems		30	15	0	5	E
	Operating Systems		30	30	0	5	E
Semester: 4							
MODULE	COURSE	COURSE ORGANISER	L	E	S	ECTS	STATUS[4]
	Complex Analysis		45	30	0	5	C
	Discrete Mathematics		30	30	0	5	C

[1] **IMPORTANT:** Put C for compulsory course or E for elective course.
[2] **IMPORTANT:** Put C for compulsory course or E for elective course.
[3] **IMPORTANT:** Put C for compulsory course or E for elective course.
[4] **IMPORTANT:** Put C for compulsory course or E for elective course.

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	Programming		30	30	0	5	C
	Set Theory		30	30	0	5	C
	Geometry		30	30	0	5	C
	Using Computers in Mathematics		15	30	15	5	C

Semester: 5							
MODULE	COURSE	COURSE ORGANISER	L	E	S	ECTS	STATUS[5]
	Metric Spaces		30	30	0	5	C
	Introduction to Probability and Mathematical Statistics		30	45	0	6	C
	Mathematical logic		30	30	0	6	C
	Introduction to Numerical Mathematics		30	30	0	5	C
	Seminar II		0	0	30	3	C
	Internal elective A1> number of elective courses to be selected: at least 5 ECTS						
	Projective Geometry		30	30	0	5	E
	Introduction to Number theory		30	30	0	5	E
Semester: 6							
MODULE	COURSE	COURSE ORGANISER	L	E	S	ECTS	STATUS[6]
	Algebraic Structures		30	30	0	7	C
	Introduction to Differential Geometry		45	30	0	7	C
	Algorithms and Data Structures		30	30	0	5	C
	Seminar / B. Sc. thesis		0	0	30	3	C
	Final exam					1	C
	Internal elective A2 > number of elective courses to be selected: at least 7 ECTS		45	30	0	7	E
	Introduction to Topology		45	30	0	7	E
	Hyperbolic balance laws and applications		45	30	0	7	E
	Numerical Linear Algebra		45	30	0	7	E
	Theoretical Computer Science		45	30	0	7	E

Table 2

[5] **IMPORTANT:** Put C for compulsory course or E for elective course.
[6] **IMPORTANT:** Put C for compulsory course or E for elective course.

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General Information		
Course organiser		
Course title	Analisys I	
Program	Undergraduate course in Mathematics	
Course status	Compulsory	
Year	I	
Credits and Teaching	ETCS credits / student workload	8
	Hours (L+E+S)	45+45+0

1. COURSE DESCRIPTION

1.1. Course objectives

This course aims to give students the basic knowledge about:
- field of real numbers and field of complex numbers,
- numerical sequences and convergence criteria,
- functions of a real variable and their properties (function limit, continuity, etc.),
- differential calculus and its applications

1.2. Correspondence and correlation with the program

Course program is correspondent to the program of similar courses in mathematics' studies. There exists a correlation with the following courses: Analysis II and III, Complex Analysis, Differential Geometry, Differential Equations and Numerical Mathematics.

1.3. Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

After completing this class, students are expected to know the basis of real numbers, field of complex numbers, limit of function in a point, derivative rules and applications. Students have to be able to use learned material for doing exercises.

1.4. Course content

Real numbers. Axioms of real numbers. Supremum and infimum. Field of complex numbers. Trigonometric form of a complex number. Binomial theorem. Function, bijection, inverse function and composite functions. Sequence and limit. Limit of function in a point. Continuity of function in a point and on closed interval. Continuous and monotone functions. Derivative, basic rules and applications. The intermediate value theorem. Local maximum and minimum. Concavity. Points of inflection. Asymptotes.

1.5. Modes of instruction (mark in bold)		
	☒ **Lectures** ☐ Seminars and workshops ☒ **Exercises** ☒ **Distance learning** ☐ Field work	☒ **Independent work** ☒ **Multimedia and the Internet** ☐ Laboratory work ☐ Tutorials ☐ Other ☒ **Consultations**

1.6. Comments

1.7. Student requirements

Attendance at all classes and active participation is expected.
Student gets a grade after the final exam.

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1.8. Evaluation[7] and Assessment

Class attendance and class participation			**1.6**	Seminar paper		Experiment	
Written exam (preliminary exam)	**4**	Oral exam	**1.7**	Essay		Research work	
Project work		Continuous assessment	**0.7**	Presentation		Practical work	
Portfolio							

1.9. Assessment and grade of student's work during the class and after the final exam

Attendance at all classes and active participation is expected. The total number of points a student can achieve during the class is 70 (assessed activities are indicated in the table above). Student gets a grade after the exam. The exam is scored with a maximum of 30 points.

1.10. Required literature

1. S. Kurepa: Matematička analiza I, II, Tehnička knjiga , Zagreb (više izdanja)
2. B: P. Demidovič: Zadaci i riješeni primjeri iz više matematike, Tehnička knjiga, Zagreb (više izdanja)

1.11. Recommended literature

1. S. Lang: A first Course in Calculus 5th ed. Springer !986.

1.12. Number of copies of recommended literature in regard to the number of students who attend the class

Title	*Number of copies*	*Number of students*

1.13. Quality assurance of course and/or module

- questionnaire at the end of the course aimed to assess students' understanding,
- questionnaire designed to evaluate course program, lectures and lecture materials, teaching methods and interaction with students

[7] Mark in bold only the relevant categories and 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.

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General Information		
Course organiser		
Course title	Linear Algebra I	
Program	Undergraduate course in Mathematics	
Course status	Compulsory	
Year	I	
Credits and Teaching	ETCS credits / student workload	8
	Hours (L+E+S)	45+45+0

1. COURSE DESCRIPTION

1.1. Course objectives

This course aims to give students the basic knowledge about:
- basic algebraic structures,
- dot and cross product,
- vector spaces,
- characteristics of matrices and determinants (rank of matrix, inverse matrix, similar matrices, etc.)
- characteristics of linear operators

1.2. Correspondence and correlation with the program

Course program is correspondent to the program of other mathematics' courses, especially Linear Algebra II, Euclidean Spaces and Analysis I.

1.3. Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

After completing this class, students are expected to know the basic properties of basic algebraic structures, to calculate dot and cross product, to operate with matrices, to know the basis of vector spaces and linear operators, to be able to mathematically prove procedures and formulas defined within this course. Students have to be able to use learned material for doing exercises.

1.4. Course content

Groups, homomorphisms of groups, fields, vectors, vector spaces, matrices, basic operations with matrices, determinants, inverse matrix, rank of matrix, linear operator, vector space base transformation, similar matrices.

1.5. Modes of instruction (mark in bold)	☒ **Lectures** ☐ Seminars and workshops ☒ **Exercises** ☒ **Distance learning** ☐ Field work	☒ **Independent work** ☒ **Multimedia and the Internet** ☐ Laboratory work ☐ Tutorials ☐ Other ☒ **Consultations**
1.6. Comments		

1.7. Student requirements

Every student have to satisfy student's obligations: attendance at all classes and active participation.

1.8. Evaluation[8] and Assessment

Class attendance and class participation			**1.7**	Seminar paper		Experiment	
Written exam (preliminary exam)	**3**	Oral exam	**2**	Essay		Research work	
Project work		Continuous assessment	**1.3**	Presentation		Practical work	
Portfolio							

1.9. Assessment and grade of student's work during the class and after the final exam

Students' work is monitored continuously. The main part of the evaluation and assessment of students is the quality of active participation in lectures and exercises. The total number of points a student can achieve during the class is 70 (assessed activities are indicated in the table above). The complete knowledge of students is evaluated in the exam scored with maximum of 30 points.

1.10. Required literature

1. S.Kurepa: Uvod u linearnu algebru, Školska knjiga, Zagreb, 1975.
2. K.Horvatić: Linearna algebra I, II i III, Sveučilište u Zagrebu, PMF, Matematički odjel, Zagreb, 1995.izdanja)

1.11. Recommended literature

1. J. Dieudonne: Linearna algebra i elementarna geometrija, Školska knjiga, Zagreb, 1977.
2. L. Čaklović: Zbirka zadataka iz linearne algebre, Školska knjiga, Zagreb, 1976.
3. S.Kurepa: Konačnodimenzionalni vektorski prostori, Liber, Zagreb, 1992.

1.12. Number of copies of recommended literature in regard to the number of students who attend the class

Title	*Number of copies*	*Number of students*

1.13. Quality assurance of course and/or module

After the last lecture of the course students will be asked to fulfill a questionnaire about the quality of the lectures. At the end of each semester results of the exams will be analized.

[8] Mark in bold only the relevant categories and 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.

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General information		
Lecturer		
Course title	Elementary Mathematics I	
Program	Undergraduate course in Mathematics	
Course status	Compulsory	
Year	I	
Credit values and modes of instruction	***ECTS credits / student workload***	7
	Hours (L+E+S)	45+30+0

1. COURSE DESCRIPTION

1.1. Course objectives

This course aims to acquaint students with basis of Elementary Mathematics, i.e.:
- define basic elements of mathematical logic and analyse basic mathematical proofs
- define sets, relations and functions; analyse their properties,
- learn basic properties of polynomials, rational, exponential and logarithmic functions and solving equations and inequalities,
- define basic concepts about arithmetic and geometric sequences,
- Analyse basic properties of trigonometric functions; solving trigonometric equations and inequalities.

1.2. Correspondence and correlation with the program

Course program is in correlation with other mathematical courses, especially with Elementary Mathematics II, Analysis I and Set theory.

1.3. Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

After completing this course students will learn basic concepts of mathematical logic and properties of sets, relations and functions and also arithmetic and geometric sequences. Students will learn basic properties of polynomials, rational, exponential, logarithmic and trigonometric functions and be able to solve equations and inequalities in which these functions appear. Students will know how to do partial fractions decomposition of a rational functions. Students will know and understand theorems and their proofs.

1.4. Course content

Elements of Mathematical logic. Sets, relations and functions. Polynomials. Graphs of polynomials. Rational functions. Equations and inequalities. Exponential and logarithmic functions. Exponential and logarithmic equations and inequalities. Arithmetic and geometric sequences. Trigonometric functions. Graphs of trigonometric functions. Properties of trigonometric functions. Arcus functions. Trigonometric equations and inequalities.

1.5. Modes of instruction (mark in bold)	☒ **Lectures** ☐ Seminars and workshops ☒ **Exercises** ☐ Distance learning ☐ Field work	☒ **Independent work** ☒ **Multimedia and the Internet** ☐ Laboratory work ☐ Tutorials ☐ Other ☒ **Consultations**
1.6. Comments		

1.7. Student requirements

Every student is obliged to satisfy conditions for obtaining the signature for the course Elementary Mathematics I and pass the exam.
Conditions for obtaining the signature:
Attendance at all forms of classes and active participation in all forms of work required for this course is expected.

1.8. Evaluation[9] and Assessment

Class attendance and class participation			**1.4**	Seminar paper		Experiment	
Written exam (preliminary exam)	**3**	Oral exam	**1.6**	Essay		Research work	
Project work		Continuous assessment	**1**	Presentation		Practical work	
Portfolio							

1.9. Assessment and grade of student's work during the class and after the final exam

Student's activities in the subject will be evaluated and assessed during the semester and final exam. Total number of points a student can achieve during the semester is 70 (evaluating the activities identified in table above), while in the final examination can achieve 30 points.

1.10. Required literature

1. B.Pavković, D.Veljan: Elementarna matematika I, Tehnička knjiga, Zagreb, 1992.
2. S.Kurepa: Uvod u matematiku, Tehnička knjiga, Zagreb, 1975.

1.11. Recommended literature

1. H.Kruglak, J.T.Moore: Schaum's outline series, Theory and Problems of Basic Mathematics, McGraw-Hill, New York, 1973.
2. B. Rich: Schaum's outline series, Theory and Problems of Review of Elementary Mathematics, McGraw-Hill, New York, 1977.
3. D. Palman: Trokut i kružnica, Element, Zagreb, 1994.
4. D. Palman: Geometrijske konstrukcije, Element, Zagreb
5. Corresponding textbooks and collections of problems for high school mathematics are recommended

1.12. Number of copies of recommended literature in regard to the number of students who attend the class

Title	*Number of copies*	*Number of students*

1.13. Quality assurance of course and/or module

After the last lecture of the course students will be asked to fulfill a questionnaire about the quality of the lectures. At the end of each semester results of the exams will be analyzed.

[9] Mark in bold only the relevant categories and 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.

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General Information		
Course organiser		
Course title	Computer Laboratory I	
Program	Undergraduate course in Mathematics	
Course status	Compulsory	
Year	I	
Credits and Teaching	ETCS credits / student workload	5
	Hours (L+E+S)	0+30+0

1. COURSE DESCRIPTION

1.1. Course objectives

This course aims to develop the skills for practical usage of theoretical knowledge of computer science and abilities of problem solving with the aid of a computer.

1.2. Correspondence and correlation with the program

This course is in the correlation with most of the other courses, in sense that most of the other courses will use a computer for problem solving.

1.3. Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

After completing this course, it is expected from students to have a basic theoretical knowledge of computer science and skills for solving basic problems with the aid of a computer (they will be able to use and understand e-mail services, Internet and its architecture, an operating system, a word processor made for text formatting, a spreadsheet application used for dealing with calculations, data processing, organizing data in chart forms, etc. They will be able to use an application for creating presentations and to make a static (personal) webpage in HTML with CSS).

1.4. Course content

Computer architecture: processor, memory, motherboard, input-output units, how parts of computer work and communicate; operating systems and applications, graphic user interface.

Getting started: operating systems, text editing, files, folders, saving the data on various media, graphical interface.

Use of computers: formatting and editing text in a document, spreadsheets used for calculations and for organizing data in chart forms, presentations, basic Internet services, electronical mail, Internet connection, searching Internet, making websites and dealing with basic concepts of web design. Media for storing image and sound.

1.5. Modes of instruction (mark in bold)	☐ Lectures ☐ **Seminars and workshops** ☒ **Exercises** ☒ **Distance learning** ☐ Field work	☒ **Independent work** ☒ **Multimedia and the Internet** ☐ Laboratory work ☐ Tutorials ☐ Other ☒ **Consultations**
1.6. Comments		

1.7. Student requirements

Students are obligated to attend classes, actively participate in any form of work that is required and pass the exam.

1.8. Evaluation[10] and Assessment

Class attendance and class participation			**0.75**	Seminar paper		Experiment	
Written exam (preliminary exam)	**3**	Oral exam		Essay		Research work	
Project work		Continuous assessment	**1.25**	Presentation		Practical work	
Portfolio							

1.9. Assessment and grade of student's work during the class and after the final exam

Student's activities will be evaluated and graded during the semester. Total number of points a student can achieve during the semester is 100 (evaluating the activities identified in table above).

1.10. Required literature

- Grundler, Grozdanović, Ikica, Kos, Miljaš, Srnec, Širanović, Zvonarek: Europska računalna diploma; ECDL European Driving Licence, PRO-MIL d.o.o., Varaždin, lipanj 2010., http://e-knjiznica.carnet.hr/e-knjige/ecdl_5/knjiga
- Vučina: Pretraživanje i vrednovanje informacija na Internetu, Edupoint, Zagreb 2006., http://e-knjiznica.carnet.hr/e-knjige/pretrazivanje
- D. Sušanj: PC računala izvana i iznutra, BUG i SysPrint, Zagreb, 2002.
- D. Petric: Internet uzduž i poprijeko, BUG i SysPrint, Zagreb, 2002.

1.11. Recommended literature

- HTML I CSS tutorial, http://www.w3.org/Style/Examples/011/firstcss.en.html
- V. Galešev, L. Kralj, G. Sokol, Z. Soldo, D. Kovač: Informatika i računalstvo, SysPrint, 2006.
- Journals (Bug, Enter,...)
- Original product handbooks and tutorials for operating systems and programs that are used in class.

1.12. Number of copies of recommended literature in regard to the number of students who attend the class

Title	*Number of copies*	*Number of students*
Grundler, Grozdanović, Ikica, Kos, Miljaš, Srnec, Širanović, Zvonarek: Europska računalna diploma; ECDL European Driving Licence, PRO-MIL d.o.o., Varaždin, lipanj 2010.	1	15
Vučina: Pretraživanje i vrednovanje informacija na Internetu, Edupoint, Zagreb 2006.	0	45
D. Sušanj: PC računala izvana i iznutra, BUG i SysPrint, Zagreb, 2002.	1	45
D. Petric: Internet uzduž i poprijeko, BUG i SysPrint, Zagreb, 2002.	0	45
V. Galešev, L. Kralj, G. Sokol, Z. Soldo, D. Kovač: Informatika i računalstvo, SysPrint, 2006.	0	45

1.13. Quality assurance of course and/or module

After the last lecture of the course students will be asked to fulfill a questionnaire about the quality of the lectures. At the end of each semester results of the exams will be analized.

[10] Mark in bold only the relevant categories and 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.

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General Information		
Course organiser		
Course title	Foreign language I English for specific purposes (Information technology)	
Program	Undergraduate course in Mathematics	
Course status	Compulsory	
Year	I	
Credits and Teaching	ETCS credits / student workload	2
	Hours (L+E+S)	0+30+0

1. COURSE DESCRIPTION

1.1. Course objectives

This is an upper-intermediate English course covering a wide range of current Information Technology topics. Its aims are: to develop the skill of reading for information from a wide variety of authentic IT texts; to develop the ability to understand native speakers talking about IT; to develop the ability to participate in exchanges of information and opinions in the context of IT; to write instructions, descriptions and explanations about topics in computing and IT.

1.2. Correspondence and correlation with the program

The program of this course corresponds with similar course programs at: University of Zagreb, Faculty of Philosophy; University of Zadar, Faculty of Philosophy; University of Split, Humanities; University of Osijek, Faculty of Pedagogy.
The program correlates with some programs of Informatics.
Prerequisites: knowledge of English at intermediate level.

1.3. Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

Students are expected to:
- know most vocabulary and grammar structures relating to Information Technology;
- be able to read and understand authentic texts from newspapers, popular computing magazines, Internet, web pages;
- be able to give information and express opinions about IT;
- write instructions, descriptions and explanations concerning IT and computing.

1.4. Course content

Computer Users; Computer Architecture; Computer Applications; Peripherals; Operating Systems; Graphical User Interfaces; Applications Programs; Multimedia; Networks; The Internet; The World Wide Web; Websites; Webpage Creator; Communications Systems; Computing Support; Data Security; Software Engineering; People in Computing; Recent Developments in IT; Electronic Publishing.

1.5. Modes of instruction (mark in bold)		
	☒ **Lectures** ☐ Seminars and workshops ☒ **Exercises** ☐ Distance learning ☐ Field work	☒ **Independent work** ☒ **Multimedia and the Internet** ☐ Laboratory work ☐ Tutorials ☐ Other ☒ **Consultations**
1.6. Comments	The number of students should be limited to 20 per group. The classes should be held in a computer-equipped classroom.	

1.7. Student requirements

Students should attend all classes.
Students are expected to participate in class activities and to carry out all required tasks.

Students should hand in papers by the due date.
At the end of the course students should take a written exam.

1.8. Evaluation[11] and Assessment

Class attendance and class participation			**0.5**	Seminar paper	**0.3**	Experiment	
Written exam (preliminary exam)	**0.6**	Oral exam		Essay		Research work	
Project work		Continuous assessment	**0.5**	Presentation	**0.1**	Practical work	
Portfolio							

1.9. Assessment and grade of student's work during the class and after the final exam

Student's activities in the subject will be evaluated and assessed during the semester and final exam. Total number of points a student can achieve during the semester is 70 (evaluating the activities identified in table above), while the final examination can achieve 30 points.

1.10. Required literature

1. Glendinning, E., H., McEwan, J., *Oxford English for Information Technology*, Oxford University Press, Oxford, 2002
2. Eastwood, J., *Oxford Practice Grammar*, Oxford University Press, Oxford, 2003
3. *Oxford Advanced Learner's Dictionary*, Oxford University Press, Oxford, 2004
4. Panian, Ž., *Informatički enciklopedijski rječnik*, Europapress holding d.o.o. Zagreb, 2005.
5. http://encyclopedia2.thefreedictionary.com/
6. www.dictionary.cambridge.org

1.11. Recommended literature

1. Esteras, S.,R., *Infotech, English for computer users*, Cambridge University Press, Cambridge, 2004
2. Murphy, R., *English Grammar in Use*, Cambridge University Press, Cambridge, 2000
3. Filipović, R., *Englesko – hrvatski rječnik*, Školska knjiga, Zagreb, 1999.
4. Bujas, Ž. *Hrvatsko – engleski rječnik*, Nakladni zavod Globus, Zagreb, 2001.
5. *Longman Dictionary of English Language and Culture*, Longman, Harlow, Essex, 2003
6. http://www.webopedia.com
7. www.m-w.com

1.12. Number of copies of recommended literature in regard to the number of students who attend the class

Title	*Number of copies*	*Number of students*

1.13. Quality assurance of course and/or module

Students' work and development will be monitored by means of:
- Group and individual discussions after each lesson (when necessary);
- Questionnaires after each unit and at the end of the course ;
- Portfolios

[11] Mark in bold only the relevant categories and 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.

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General Information		
Course organiser		
Course title	Analysis II	
Program	Undergraduate course in Mathematics	
Course status	Compulsory	
Year	I	
Credits and Teaching	ETCS credits / student workload	8
	Hours (L+E+S)	45+45+0

1. COURSE DESCRIPTION

1.1. Course objectives

This course aims to give students the basic knowledge on real analysis, ie:
- indefinite integrals and integration methods,
- definite integral and applications,
- numeric series and convergence criteria,
- sequences and series of functions, convergence and uniform convergence,
- power series and Fourier series

1.2. Correspondence and correlation with the program

Program of Analysis II is correlated with other mathematical courses, especially Analysis I and III, Complex Analysis, Differential Geometry, Differential Equations and Numerical Mathematics.
Prerequisite courses: Analysis I.

1.3. Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

After completing this course students will be able to:
- apply methods of integration in calculation of integrals,
- know and understand notions of numeric series and convergence of series,
- apply integral calculus in calculating area between curves, volume of solids,
- analyze sequence convergence and function series,
- express functions as a power series
- form Fourier series expansion of a function
- know and understand theorems and its proofs

1.4. Course content

Indefinite integral. Integration methods. Definite integral. Newton-Leibniz formula. Integrability of monotone and continuous functions. Applications of integration. Improper integrals. Numeric series and convergence criteria. Sequences and series of functions. Convergence and uniform convergence of function series. Taylor's Theorem. Power series and Taylor series of elementary functions. Fourier series.

1.5. Modes of instruction (mark in bold)	☒ **Lectures** ☐ Seminars and workshops ☒ **Exercises** ☒ **Distance learning** ☐ Field work	☒ **Independent work** ☒ **Multimedia and the Internet** ☐ Laboratory work ☐ Tutorials ☐ Other ☒ **Consultations**
1.6. Comments		

1.7. Student requirements

Every student is obliged to fulfil conditions for signature in Analysis II and to pass the exam.
Conditions for signature: Students are expected to attend and actively participate at all classes.

1.8. Evaluation[12] and Assessment

Class attendance and class participation			**1.6**	Seminar paper		Experiment	
Written exam (preliminary exam)	**4**	Oral exam	**1.7**	Essay		Research work	
Project work		Continuous assessment	**0.7**	Presentation		Practical work	
Portfolio							

1.9. Assessment and grade of student's work during the class and after the final exam

Students' work is continually observed. Integral part of observing and evaluating of students is the quality of active contribution in work on the lectures and exercises. The total number of points a student can achieve during the class is 70 (assessed activities are indicated in the table above). Student's knowledge is evaluated in the exam scored with maximum of 30 points.

1.10. Required literature

1. S. Kurepa: Matematička analiza I, II, Tehnička knjiga , Zagreb (više izdanja)
2. B: P. Demidovič: Zadaci i riješeni primjeri iz više matematike, Tehnička knjiga, Zagreb (više izdanja)

1.11. Recommended literature

1. S. Lang: A first Course in Calculus 5th ed. Springer !986.

1.12. Number of copies of recommended literature in regard to the number of students who attend the class

Title	*Number of copies*	*Number of students*

1.13. Quality assurance of course and/or module

After the last lecture of the course students will be asked to fulfill a questionnaire about the quality of the lectures.
At the end of each semester results of the exams will be analyzed.

[12] Mark in bold only the relevant categories and 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.

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General Information		
Course organiser		
Course title	Linear Algebra II	
Program	Undergraduate course in mathematics	
Course status	Compulsory	
Year	I	
Credits and Teaching	ETCS credits / student workload	8
	Hours (L+E+S)	45+45+0

2. COURSE DESCRIPTION

1.1. Course objectives

This course aims to give students the basic knowledge on linear algebra, ie:

- analyze the solvability of systems of linear equations and the structure of the solution set;
- define a linear manifold;
- identify and apply different ways of solving systems of linear equations;
- define the characteristic and minimal polynomial and analyze their properties;
- define the eigenvalues of the linear operator, analyze their properties and describe methods for determining the eigenvalues;
- with arguments apply the diagonalisation criteria of a linear operator;
- define the Jordan form of a matrix;
- define a unitary spaces and norm; analyze Cauchy-Schwartz inequality;
- define the orthonormal base and orthogonal complement; describe Gram – Schmidt orthogonalisation process;
- the introduction of the concepts of linear mappings on unitary spaces;
- define the main features of the unitary, orthogonal, hermitian, symmetric and antihermitian matrices;
- analyze quadratic forms.

1.2. Course prerequisite

1.3. Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

After completing this course students should be able to:

- be able to analyze and successfully solve systems of linear equations;
- be able to identify and apply different ways of solving linear systems;
- be able to determine the characteristic and minimal polynomial;
- be able to explain the procedure diagonalization;
- be able to apply the diagonalisation criteria of a linear operator
- be able to state the definition and examples of inner product;
- be able to the use the Gram - Schmidt orthogonalization procedure;
- recognize some special types of vector space (unitary, standardized and metric);
- recognize some special types of linear mappings on unitary spaces;
- recognize the properties of the unitary, orthogonal, symmetric, hermitian and antihermitian matrices;
- recognize the properties of quadratic forms;
- to define mathematical terms pressented in this course,
- to state and understand theorems and its proofs which are used in this course.

1.4. Course content

Characteristic and minimal polynomial. The invariant subspaces. Eigenvalues of linear operator. Jordan form of a matrix. Systems of linear equations. The Cramer's rule. Homogeneous and non-homogeneous systems. Solving s Systems of linear equations. Unitary spaces, Schwartz-Cauchy-Bunjakovki inequality. Norm. Metric functions. Gram-Schmidt method

of orthogonalization. Linear mappings on unitary spaces. Unitary operators. Selfadjoint operators. Hermitian operators. Symmetric operators and assigned quadratic forms.

1.5. Modes of instruction (mark in bold)	☒ **Lectures** ☐ Seminars and workshops ☒ **Exercises** ☒ **Distance learning** ☐ Field work	☒ **Independent work** ☒ **Multimedia and the Internet** ☐ Laboratory work ☐ Tutorials ☐ Other ☒ **Consultations**
1.6. Comments		

1.7. Student requirements

Students must satisfy requirements for obtaining the Signature (listed in the executive program) and to pass the final exam.

1.8. Evaluation[13] and Assessment

Class attendance and class participation			**1.7**	Seminar paper		Experiment	
Written exam (preliminary exam)	**3**	Oral exam	**2**	Essay		Research work	
Project work		Continuous assessment	**1.3**	Presentation		Practical work	
Portfolio							

1.9. Assessment and grade of student's work during the class and after 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. K. Horvatić*: Linearna algebra*, Sveučilište u Zagrebu, PMF, Matematički odjel, Zagreb, 2001.
2. S. Kurepa: *Uvod u linearnu lgebra*, Školska knjiga, Zagreb, 1975.

1.11. Recommended literature (when proposing the program)

1. S. Kurepa, *Konačnodimenzionalni vektorski prostori i primjene*, Lider, Zagreb, 1976.
2. N. Elezović, *Linearna algebra*, Element, Zagreb, 2001.
3. N. Bakić, A. Milas, *Zbirka zadataka iz linearne algebre*, PMF – Matematički odjel, Zagreb, 1996.
4. J. Dieudonne, *Linearna algebra i elementarna geometrija*, Školska knjiga, Zagreb, 1977.
5. L. Čaklović, *Zbirka zadataka iz linearne algebre*, Školska knjiga, Zagreb, 1992.
6. J. Hefferon, *Linear Algebra*, http://joshua.smcvt.edu/linearalgebra/

1.12. Number of copies of recommended literature in regard to the number of students who attend the class

Title	*Number of copies*	*Number of students*

1.13. Quality assurance of course and/or module

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 analyzed.

[13] Mark in bold only the relevant categories and 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.

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General Information		
Course organiser		
Course title	Elementary Mathematics II	
Program	Undergraduate course in Mathematics	
Course status	Compulsory	
Year	I	
Credits and Teaching	ETCS credits / student workload	7
	Hours (L+E+S)	45+30+0

1. COURSE DESCRIPTION

1.1. Course objectives

- defining the sets of natural numbers, integers, rational, real and complex numbers,
- learning basic concepts and knowledge about triangle
- learning concepts about mappings in plane
- getting acquainted with basic properties of conics
- learning concepts about mappings in space
- learning basic knowledge about polyhedrons

1.2. Correspondence and correlation with the program

Course program is in correlation with other mathematical courses, especially with Elementary Mathematics I, Analysis I, Linear algebra I and Linear algebra II.
Predecessor course: Elementary Mathematics I.

1.3. Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

After completing this course students will learn to define the sets of natural numbers, integers, rational, real and complex numbers. Students will learn basic concepts and properties of triangle, conics, polyhedrons and mappings in plane and in space. Students will know and understand theorems and its proofs.

1.4. Course content

Peano axioms. The set of natural numbers. The set of integers. The set of rational numbers. Dedekind cuts. The set of real numbers. The set of complex numbers. Complex numbers and trigonometry. Classical triangle geometry. Polygons and areas. Isometries of the plane. Homotety, inversion. Conics. Equations of line and conics in polar coordinates. Isometries and some mappings in space. Polyhedrons.

1.5. Modes of instruction (mark in bold)		
	☒ **Lectures** ☐ Seminars and workshops ☒ **Exercises** ☐ Distance learning ☐ Field work	☒ **Independent work** ☒ **Multimedia and the Internet** ☐ Laboratory work ☐ Tutorials ☐ Other ☒ **Consultations**

1.6. Comments

1.7. Student requirements

Every student is obliged to satisfy conditions for obtaining the signature for the course Elementary Mathematics II and pass the exam.

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Conditions for obtaining the signature: Attendance at all forms of classes and active participation in all forms of work required for this course is expected.

1.8. Evaluation[14] and Assessment

Class attendance and class participation			**1,4**	Seminar paper		Experiment	
Written exam (preliminary exam)	**2.5**	Oral exam	**2.5**	Essay		Research work	
Project work		Continuous assessment	**0.6**	Presentation		Practical work	
Portfolio							

1.9. Assessment and grade of student's work during the class and after the final exam

Student's activities in the subject will be evaluated and assessed during the semester and in the final exam. Total number of points a student can achieve during the semester is 70 (evaluating the activities identified in table above), while in the final examination can achieve 30 points.

1.10. Required literature

1. B.Pavković, D.Veljan: Elementarna matematika II, Tehnička knjiga, Zagreb, 1995.
2. S.Kurepa: Uvod u matematiku, Tehnička knjiga, Zagreb, 1975.

1.11. Recommended literature

1. H.Kruglak, J.T.Moore: Schaum's outline series,Theory and Problems of Basic Mathematics, McGraw-Hill, New York, 1973.
2. B. Rich: Schaum's outline series,Theory and Problems of Review of Elementary Mathematics, McGraw-Hill, New York, 1977.
3. Corresponding textbooks and collections of problems for high school mathematics are recommended

1.12. Number of copies of recommended literature in regard to the number of students who attend the class

Title	*Number of copies*	*Number of students*

1.13. Quality assurance of course and/or module

After the last lecture of the course students will be asked to fulfill a questionnaire about the quality of the lectures. At the end of each semester results of the exams will be analyzed.

[14] Mark in bold only the relevant categories and 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.

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General Information		
Course organiser		
Course title	Computer Laboratory II	
Program	Undergraduate course in Mathematics	
Course status	Core	
Year	I.	
Credits and Teaching	ETCS credits / student workload	5
	Hours (L+E+S)	15+30+0

1. COURSE DESCRIPTION

1.1. Course objectives

This course aims to develop the skills for practical use of a general purpose programing language. The course introduces basics concepts of the programing language to the students. Furthermore, students are given basic information about scientific modules that are useful for problem solving and daily use of a computer during the entire study program.

1.2. Correspondence and correlation with the program

This course is in correlation with most of other courses, in sense that most of other courses will use a computer. There are no prerequisites for this course.

1.3. Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

After completing this course students will be able to:

- execute basic commands in the programing environment
- use operators, basic data types and write logical statements
- test a simple code and to correct basic syntactic and logical errors
- read and write data to a file
- write a computer code with proper documentation that follows a given standard
- independently write a simple code that demonstrates knowledge of basic programing techniques
- manipulate with dynamically allocated arrays
- use additional external modules, functions and sub routines

1.4. Course content

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Basic history of a programing language and working environment.
Sintax and semantics of the programing language.
Loops and basic flow of a program
Use of functions, modules and external packages.
Data structuring, filtrating and visualization

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General Information		
Course organiser		
Course title	Foreign language II Internet-based language learning	
Program	Undergraduate course in Mathematics	
Course status	Compulsory	
Year	I	
Credits and Teaching	ETCS credits / student workload	2
	Hours (L+E+S)	0+30+0

1. COURSE DESCRIPTION

1.1. Course objectives

This course helps students take full advantage of the Internet as a classroom resource. Its objectives are: to introduce computer terminology, Web-surfing and e-mail and to enable students to extend all their language skills through Internet-based activities. By searching the Web students will be able to read a variety of texts on various topics; they will be given an opportlessony to listen native speakers. Pair work and group work activities will give them the chance to share information and opinions and practice their speaking skills. Following useful instructions on the Web, students will also complete various writing assigments.

1.2. Correspondence and correlation with the program

The program of this course corresponds with similar course programs at: University of Zagreb, Faculty of Philosophy; University of Zadar, Faculty of Philosophy; University of Split, Humanities; University of Osijek, Faculty of Pedagogy.
The program correlates with some programs of Informatics.
Prerequisites: knowledge of English at intermediate level.

1.3. Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

Students are expected to:
- know most words and expressions they may encounter on the Internet;
- be able to surf the Web independently;
- receive and send e-mail and take part in chat programs;
- use the Internet as a materials resource;
- read and understand authentic texts in various genres;
- engage in conversation relating to different topics;
- write information, concepts and opinion about a variety of situations and topics;
- use the Internet in order to manage their own learning.

1.4. Course content

Computers today; Surfing the Web; Electronic Mail; Famous People; Web Cards; Study Abroad; Eating Out; Shopping Spree; Watching Movies; Vacation Abroad; Cyber C@fes; Working Abroad; News Online.

1.5. Modes of instruction (mark in bold)	☒ **Lectures** ☐ Seminars and workshops ☒ **Exercises** ☒ **Distance learning** ☐ Field work	☒ **Independent work** ☒ **Multimedia and the Internet** ☐ Laboratory work ☐ Tutorials ☐ Other ☒ **Consultations**
1.6. Comments	The number of students should be limited to 16 per group.	

	The classes should be held in a computer-equipped classroom.

1.7. Student requirements

Students should attend all classes.
Students are expected to participate in class activities and to carry out all required tasks.
Students should hand in papers by the due date.
At the end of the course students should take a written exam.

1.8. Evaluation[15] and Assessment

Class attendance and class participation			**0.5**	Seminar paper		Experiment	
Written exam (preliminary exam)	**0.6**	Oral exam		Essay	**0.2**	Research work	
Project work		Continuous assessment	**0.5**	Presentation	**0.1**	Practical work	
Portfolio		Prezentacija	**0.1**				

1.9. Assessment and grade of student's work during the class and after the final exam

Student's activities in the subject will be evaluated and assessed during the semester and final exam. Total number of points a student can achieve during the semester is 70 (evaluating the activities identified in table above), while the final examination can achieve 30 points.

1.10. Required literature

1. Gitsaki, C., Taylor, R., T., *Internet English*, Oxford University Press, Oxford, 2004
2. Murphy, R., *English Grammar in Use*, Cambridge University Press, Cambridge, 2000
3. *Oxford Advanced Learner's Dictionary*, Oxford University Press, Oxford, 2004
4. www.englishpage.com
5. www.englishclub.com
6. http://news.bbc.co.uk
7. www.cnn.com
8. http://www.nypost.com/eedition/
9. www.dictionary.cambridge.org

1.11. Recommended literature

1. Eastwood, J., *Oxford Practice Grammar*, Oxford University Press, Oxford, 2003
2. Filipović, R., *Englesko – hrvatski rječnik*, Školska knjiga, Zagreb, 1999.
3. Bujas, Ž. *Hrvatsko – engleski rječnik*, Nakladni zavod Globus, Zagreb, 2001.
4. www.eudict.com
5. www.rd.com
6. http://www.rjecnik.net/

1.12. Number of copies of recommended literature in regard to the number of students who attend the class

Title	*Number of copies*	*Number of students*

1.13. Quality assurance of course and/or module

Students' work and development will be monitored by means of:
- Group and individual discussions after each lesson (when necessary);
- Questionnaires after each unit and at the end of the course ;
- Portfolios

[15] Mark in bold only the relevant categories and 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.

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General Information		
Course organiser		
Course title	Analysis III	
Program	Undergraduate course in Mathematics	
Course status	Compulsory	
Year	II	
Credits and Teaching	ETCS credits / student workload	7
	Hours (L+E+S)	45+45+0

1. COURSE DESCRIPTION

1.1. Course objectives

This course aims to give students the basic knowledge about:
- Euclidean spaces,
- sequence convergence in $\cdot^n$,
- real functions of several variables; continuity and limit of function,
- differential calculus and its application,
- implicit function theorem,
- multiple Riemann integral and application,
- vector functions,
- curves,
- line integral,
- surface integral,
- functions of bounded variation,
- Green's theorem

1.2. Correspondence and correlation with the program

Course program is correspondent to the program of similar courses in the mathematics studies.
There exists a correlation with the following courses: Analysis I and Analysis II, Complex Analysis.
Predecessor courses: Analysis I and Analysis II.

1.3. Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

After completing this course students will be able to define Euclidean space and calculate with vectors, analyze convergence of sequences in $\cdot^n$, analyze the function properties, use differential and integral calculus, calculate line and surface integrals, know and understand theorems and their proofs.

1.4. Course content

Limit and continuity of real and vector functions of one or several variables. Differential and partial derivations. Schwartz's theorem. The intermediate value theorem and its consequences. The implicit function theorem. The inverse function theorem. Maximum and minimum of a function. Taylor's theorem. Sequences and compact sets in $\cdot^n$. Continuous functions on a compact. Multiple Riemann's integrals. Vector functions. Curves and integrals by curves. Vector and scalar fields. Green's theorem.

1.5. Modes of instruction (mark in bold)		
	☒ **Lectures** ☐ Seminars and workshops ☒ **Exercises** ☒ **Distance learning** ☐ Field work	☒ **Independent work** ☒ **Multimedia and the Internet** ☐ Laboratory work ☐ Tutorials

		☐ Other ☒ **Consultations**

1.6. Comments

1.7. Student requirements

Attendance at all classes and active participation is expected.
Student gets a grade after finale exam.

1.8. Evaluation[16] and Assessment

Class attendance and class participation			**1.6**	Seminar paper		Experiment	
Written exam (preliminary exam)	**3.4**	Oral exam	**1.5**	Essay		Research work	
Project work		Continuous assessment	**0.5**	Presentation		Practical work	
Portfolio							

1.9. Assessment and grade of student's work during the class and after the final exam

Student's active participation at a class influences the final grade.
The total number of points a student can achieve during the class is 70 (assessed activities are indicated in the table above). Final examination is scored with a maximum of 30 points.

1.10. Required literature

1. S. Kurepa: Matematička analiza III, Tehnička knjiga , Zagreb (više izdanja)
2. S. Mardešić: Matematička analiza, I. dio, Školska knjiga, Zagreb, 1974.

1.11. Recommended literature

1. V.A. Zoric: Matematiceskih analiz, I. dio, Nauka, Moskva, 1981.

1.12. Number of copies of recommended literature in regard to the number of students who attend the class

Title	*Number of copies*	*Number of students*

1.13. Quality assurance of course and/or module

- questionnaire at the end of the course aimed to assess students' understanding,
- questionnaire designed to evaluate course program, lectures and lecture materials, teaching methods and interaction with students .

[16] Mark in bold only the relevant categories and 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.

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General Information		
Course organiser		
Course title	Combinatorics	
Program	Undergraduate course in Mathematics	
Course status	Compulsory	
Year	II	
Credits and Teaching	ETCS credits / student workload	5
	Hours (L+E+S)	30+30+0

1. COURSE DESCRIPTION

1.1. Course objectives

In this course students will study and apply combinatorial techniques in a variety of settings (Pigeonhole principle, counting problems, recursive relations, generating functions, binomial and multinomial coefficients, Möbius inversion formula, combinatorial structures).

1.2. Correspondence and correlation with the program

The program is correspondent to the program of other mathematical courses, especially to Discrete mathematics.

1.3. Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

After completing this class, students should be able to:

- describe and compare various forms of the Pigeonhole principle,
- discuss and solve different counting problems,
- apply recursive relations and generating functions in solving mathematical problems,
- analyse problems; formulate them into mathematical terms and use the appropriate strategies to solve them; verify and interpret the solutions; present their mathematical arguments and solutions in a logical and clear fashion.

1.4. Course content

Pigeonhole principle. Ramsey theorem. Basic counting techniques. Permutations and combinations of the sets and multisets. Binomial and multinomial coefficients. Including-excluding principle and applications. Möbius inversion. Reccurence relations. Generating functions. Some combinatorial structures.

1.5. Modes of instruction (mark in bold)	☒ **Lectures** ☐ Seminars and workshops ☒ **Exercises** ☒ **Distance learning** ☐ Field work	☒ **Independent work** ☒ **Multimedia and the Internet** ☐ Laboratory work ☐ Tutorials ☐ Other ☒ **Consultations**
1.6. Comments		

1.7. Student requirements

Attendance at all classes and active participation is expected.

1.8. Evaluation[17] and Assessment

Class attendance and class participation			**1.1**	Seminar paper		Experiment	
Written exam (preliminary exam)	**2**	Oral exam	**1.3**	Essay		Research work	
Project work		Continuous assessment	**0.6**	Presentation		Practical work	
Portfolio							

1.9. Assessment and grade of student's work during the class and after the final exam

Student's activities are evaluated during the semester. Final exams are written and oral.
The total number of points a student can achieve during the class is 70 (assessed activities are indicated in the table above). Maximum number of points at final exam is 30.

1.10. Required literature

1. D.Veljan, Kombinatorna i diskretna matematika, Algoritam, Zagreb, 2001.
2. M.Cvitković, Kombinatorika, zbirka zadataka, Element, Zagreb, 2001.

1.11. Recommended literature

1. D. Žubrinić, Diskretna matematika. Element, Zagreb, 1997.
2. D.Veljan, Kombinatorika s teorijom grafova, Školska knjiga, Zagreb, 1989.

1.12. Number of copies of recommended literature in regard to the number of students who attend the class

Title	*Number of copies*	*Number of students*

1.13. Quality assurance of course and/or module

After the last lecture of the course students will be asked to fulfill a questionnaire about the quality of the lectures. At the end of each semester results of the exams will be analyzed.

[17] Mark in bold only the relevant categories and 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.

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General Information		
Course organiser		
Course title	Differential Equations	
Program	Undergraduate course in Mathematics	
Course status	Compulsory	
Year	II	
Credits and Teaching	ETCS credits / student workload	5
	Hours (L+E+S)	30+30+0

1. COURSE DESCRIPTION

1.1. Course objectives

This course aims to give students the basic knowledge about:
- existence and uniqueness of a solution of ordinary differential equations,
- ordinary differential equations of the first order (separation of variables, homogenous and exact equations, linear equations, Bernoulli, Ricatti and Lagrange equations),
- ordinary differential equations of higher orders,
- systems of differential equations,
- applications in the physical sciences

1.2. Correspondence and correlation with the program

Course program is correspondent to the program of similar courses in mathematical courses, particularly with Differential Geometry.
The mathematical tools that we use for this course include elements of Analysis I, Analysis II and Analysis III.

1.3. Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

After completing this course students will be able to:
- use differential equations in the physical and other sciences,
- to analyze solvability of differential equations and the uniqueness of solution
- to know different types of differential equations and methods for finding their solutions

1.4. Course content

Basic concepts and definitions. Solution of a differential equation of the first order:
Existence and uniqueness of the solution. Equations with variables separable. Homogeneous equations. Linear equations. Total differential equations. The integrating factor. Problems in trajectories.
Equations of higher orders: Equations solvable by a highest derivative. Linear differential equations of the n-th order. The Lagrange method. Homogeneous and nonhomogeneous linear equations with constant coefficients.
Systems of differential equations: Normal systems. Existence and uniqueness of the solution.
Equations in the mathematical physics.

1.5. Modes of instruction (mark in bold)		
	☒ **Lectures** ☐ Seminars and workshops ☒ **Exercises** ☒ **Distance learning** ☐ Field work	☒ **Independent work** ☒ **Multimedia and the Internet** ☐ Laboratory work ☐ Tutorials ☐ Other ☒ **Consultations**

1.6. Comments

1.7. Student requirements

Attendance at all classes and active participation is expected. Student gets a grade after finale exam.

1.8. Evaluation[18] and Assessment

Class attendance and class participation			**1**	Seminar paper		Experiment	
Written exam (preliminary exam)	**2.1**	Oral exam	**1.3**	Essay		Research work	
Project work		Continuous assessment	**0.6**	Presentation		Practical work	
Portfolio							

1.9. Assessment and grade of student's work during the class and after the final exam

Students active participation at a class influences the grade.
The total number of points a student can achieve during the class is 70 (assessed activities are indicated in the table above).
Student's knowledge is evaluated in the exam scored with maximum of 30 points.

1.10. Required literature

1. Pontrjagin: obyknovennye differencialnye uravnenina, Nauka, Moskva, 1970.
2. G. Birkhoff, G.C. Rota: Ordinary differential equations, Blaisdell, Waitham, Mass, 1969.

1.11. Recommended literature

1. C. R. Wylie: Differential equations, Mc Graw Hill, New York , 1979.
2. I. Aganović, K. Veselić: Linearne diferencijalne jednadžbe, Element, Zagreb, 1997.
3. Shair Ahmad, Antonio Ambrosetti: A Textbook on Ordinary Differential Equations, Springer, 2014

1.12. Number of copies of recommended literature in regard to the number of students who attend the class

Title	*Number of copies*	*Number of students*

1.13. Quality assurance of course and/or module

- questionnaire at the end of the course after aimed to assess students' understanding,
- questionnaire designed to evaluate course program, lectures and lecture materials, teaching methods and interaction with students .

[18] Mark in bold only the relevant categories and 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.

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General Information		
Course organiser		
Course title	Euclidean Spaces	
Program	Undergraduate course in Mathematics	
Course status	Compulsory	
Year	II	
Credits and Teaching	ETCS credits / student workload	5
	Hours (L+E+S)	30 +30 + 0

1. COURSE DESCRIPTION

1.1. Course objectives

Objective of this course is to introduce basic properties of affine spaces and Euclidean spaces, ie. to:
- define and distinguish notions of affine and Euclidean spaces,
- define various forms of plane equation,
- analyze analytic geometry of affine space,
- define convex sets,
- define parallelotopes and simplexes,
- analyze affine transformation,
- calculate the volume of parallelotopes and simplexes,
- define isometries

1.2. Correspondence and correlation with the program

The program is correspondent to the program of other mathematical courses, especially to Geometry and Vector spaces.

1.3. Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

After completing this course students will be able to understand basic properties of affine and Euclidean spaces, to define basic notions of these spaces and to apply adoppted procedures in exercises.

1.4. Course content

Definition of affine and Euclidean spaces. Affine subspaces (k-planes). Intersection and sum of affine subspaces and their dimension. Parallel planes. Coordinates. Transformation of coordinates. Convexity. Half spaces. Parallelotops. Simplexes. Affine mappings. Translation. Euclidean spaces. Distance and angle between planes. Orthogonal planes. Volume of parallelotop and simplex. Isometries. Classification of isometries of Euclidean space.

1.5. Modes of instruction (mark in bold)	☒ **Lectures** ☐ Seminars and workshops ☒ **Exercises** ☒ **Distance Learning** ☐ Field work	☒ **Independent work** ☒ **Multimedia and the Internet** ☐ Laboratory work ☐ Tutorials ☐ Other ☒ **Consultations**
1.6. Comments		

1.7.Student requirements

Students must attend the lectures and participate in all activities required for the course.

1.8. Evaluation[19] and Assessment

Class attendance and class participation			**1.1**	Seminar paper		Experiment	
Written exam (preliminary exam)	**2.0**	Oral exam	**1.3**	Essay		Research work	
Project work		Continuous assessment	**0.6**	Presentation		Practical work	
Portfolio							

1.9. Assessment and grade of student's work during the class and after the final exam

Student's activities are evaluated during the semester. The total number of points student may collect during the class is 70 and the total number of points student may achieve on the final exam is 30.

1.10. Required literature

1. S.Kurepa: Konačno dimenzionalni vektorski prostori i primjene, Liber, Zagreb, 1992.
2. M. Polonije et al., Euklidski prostori, skripta, http://web.math.hr/nastava/eukl/EP.pdf

1.11.Recommended literature

1. M.Audin: Geometry, Springer-Verlag, Heidelberg, 2002.
2. D.M.Bloom: Linear Algebra and Geometry, Cambridge University Press, Cambridge, 1988.
3. K.W.Gruenberg, A.J.Weir: Linear Geometry, Springer, New York, 1977.
4. P. J. Rayan: Euclidean and non-Euclidean Geometry-an analytic approach, Cambridge Univ. Press; Cambridge, 1991

1.12. Number of copies of recommended literature in regard to the number of students who attend the class

Title	*Number of copies*	*Number of students*

1.13. Quality assurance of course and/or module

After the last lecture of the course students will be asked to fulfill a questionnaire about the quality of the lectures. At the end of each semester results of the exams will be analyzed.

[19] Mark in bold only the relevant categories and 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.

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General Information		
Course organiser		
Course title	Seminar I - Geometrical constructions	
Program	Undergraduate course in Mathematics	
Course status	Compulsory	
Year	II	
Credits and Teaching	ETCS credits / student workload	3
	Hours (L+E+S)	0+0+30

1. COURSE DESCRIPTION

1.1. Course objectives

This course aims:
- to extend students' vocabulary of mathematical expressions
- to teach how to use geometrical tools

1.2. Correspondence and correlation with the program

Course program is correspondent to the program of other mathematics' courses, especially to Euclidean Spaces and Geometry.

1.3. Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

Students are expected to have the basic knowledge of geometry, to extend their vocabulary of mathematical expressions and to learn how to use geometrical tools. After this course students will be able to define and describe methods of locuses, reflections, central symmetries, rotations, translations, inverses and algebraic method. They will be able to describe the constructions of regular polygons, conics, and constructions based on Hilbert's, Mohr-Mascheroni and Poncelet-Steiner theorem.

1.4. Course content

Elementary constructions with ruler and compass, Method of locus, Method of reflection, Method of central symmetry, Method of rotation, Method of translation, Method of inverse, Algebraic method, Constructions of regular polygons, Conics, Geometrical constructions in bounded plain, Hilbert's constructions, Mohr-Mascheroni's constructions, Poncelet Steiner's constructions, Classical problems, Solvability constructions with ruler and compasses, Solvability constructions of regular polygons.

1.5. Modes of instruction (mark in bold)	☐ Lectures ☒ **Seminars and workshops** ☐ Exercises ☐ Distance learning ☐ Field work	☒ **Independent work** ☐ Multimedia and the Internet ☐ Laboratory work ☐ Tutorials ☐ Other ☒ **Consultations**
1.6. Comments		

1.7. Student requirements

Students are obligated to write and explain to the class their own seminars. For evaluation is important that the student know how to use geometrical tools correctly. Student has to be present at ¾ of another students' displays and has to participate actively at seminar's analysis. Public display, presence on seminars and active participation in analysis are the

base for evaluation of students.

1.8. Evaluation[20] and Assessment

Class attendance and class participation			**1**	Seminar paper	**2**	Experiment	
Written exam (preliminary exam)		Oral exam		Essay		Research work	
Project work		Continuous assessment		Presentation		Practical work	
Portfolio							

1.9. Assessment and grade of student's work during the class and after the final exam

Students are encouraged to active participate at a class and it influences the final assessment. Total number of points a student can achieve during the semester is 100 (evaluating the activities identified in table above).

1.10. Required literature

1. D. Palman: Geometrijske konstrukcije, Element, Zagreb
2. D. Palman: Trokut i kružnica, Element , Zagreb, 1994.

1.11. Recommended literature

1. B. Pavković, D. Veljan: Elementarna matematika I, Tehnička knjiga, Zagreb, 1992.
2. B. Pavković, D. Veljan: Elementarna matematika II, Školska knjiga, Zagreb, 1995.

1.12. Number of copies of recommended literature in regard to the number of students who attend the class

Title	*Number of copies*	*Number of students*

1.13. Quality assurance of course and/or module

After the last lecture of the course students will be asked to fulfill a questionnaire about the quality of the lectures. At the end of each semester results of the exams will be analyzed.

[20] Mark in bold only the relevant categories and 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.

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Basic description		
Course coordinator		
Course title	Information Systems	
Study programme	Undergraduate course in Mathematics	
Course status	optional	
Year	II	
ECTS credits and teaching	ECTS student 's workload coefficient	5
	Number of hours (L+E+S)	30+15+0

1. COURSE DESCRIPTION

1.1. Course objectives

- Defining basic concepts in respect to information systems (IS), their development, application, types, authors and users
- Motivating students for further work in the field of IS development,
- Taking part in researches on conditions of IS in organizations.

1.2. Course enrolment requirements

1.3. Expected course learning outcomes

After completing the course and meeting requirements in respect to course Information system, students are expected to be capable of:

- Analyzing company operations
- Defining company's IS architecture
- Defining application subsystems and their relations

1.4. Course content

System theory, organization theory, business system, information system, information technology, management and decision making, models, impact of introducing information technology on organization and individuals, centralization-decentralization, dialogue human-program, database, IS planning, problems in IS development, users, program languages, information technology engineering, 4GL, programming standardization, documenting.
Role of IS and information technology in organizations, business strategies and their impact on IS and information technology, comprehension of present situation, strategies of business information system, application management, technological infrastructure and investment planning, protection of IS.
Quality, ISO 9000, Quality management documentation, quality rules of procedure, quality of software product, configuration management, verification, validation, testing of software product. Models, stages of life cycle, methodologies, IS development methodology, Methods, ISAC, HIPO, SADT, SDM, prototype, interview, SEI-CMM, ESPRIT-BOOTSTRAP. Information technology center, information technology staff, information project management, manager's characteristics, management and control of team, communication. Provision of computers. Problems in IS. Drawing up of questionnaire for researching conditions in IS.

1.5. Teaching methods	☒ lectures ☐ seminars and workshops ☒ exercises ☒ long distance education ☐ fieldwork	☒ individual assignment ☐ multimedia and network ☐ laboratories ☐ mentorship ☒ other - consultations
1.6. Comments	Students will be presented with various IS, both with their internal structure and input/output interface	

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1.7. Student's obligations

Students should actively participate in all forms of works, produce a seminar paper and pass the exam consisting of written and oral part.

1.8. Evaluation of student's work

Course attendance	0.5	Activity/Participation	0.5	Seminar paper	1	Experimental work	
Written exam	0.5	Oral exam	0.5	Essay		Research	
Project		Sustained knowledge check	2	Report		Practice	
Portfolio							

1.9. Assessment and evaluation of student's work during classes and on final exam

Continuous cooperation with students and continuous monitoring of their engagements and advancement in mastering required knowledge provide continuous follow-up of students' works and activities.
Knowledge of student is evaluated at the exam.

1.10. Assigned reading (at the time of the submission of study programme proposal)

1. Pavlić, M.: Informacijski sustavi, Školska knjiga, Zagreb, 2011.
2. Pavlić, M.: Informacijski sustavi, Odjel za informatiku, Sveučilište u Rijeci, Rijeka, 2009.

1.11. Elective / additional reading (at the time of proposing study programme)

1. Strahonja,V., Varga, M., Pavlić, M.: Projektiranje informacijskih sustava, INA-INFO, Zagreb, 1992.
2. Srića, V., Treven, S., Pavlić, M.: Menedžer i informacijski sustavi, Poslovna knjiga, Zagreb, 1994.
3. Tudor, G., Srića, V.: Menedžer i pobjednički tim, MEP Consult&CROMAN, Zagreb, 1996.
4. Avison D.E., Fitzgerald, G.: Information System Development: Methodologies, Techniques and Tools, McGraw-Hill, London, 1995.
5. Simon, J. C.: Introduction to Information Systems, John Wiley and sons, New York, 2001.
6. Panian, Ž.: Kontrola i revizija informacijskih sustava, Sinergija-nakladništvo d.o.o., Zagreb, 2001.

1.12. Number of assigned reading copies with regard to the number of students currently attending the course

Title	*Number of copies*	*Number of students*

1.13. Quality monitoring methods which ensure acquirement of output knowledge, skills and competences

During the last week of classes, a poll will be conducted, where students would evaluate the quality of classes. Students' achievements will be analyzed.

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BASIC INFORMATION		
Course instructor		
Course title	Operating Systems	
Study program	Undergraduate course in Mathematics	
Course status	optional	
Year	II	
Credits and teaching	ECTS credits of student workload	5
	Hours (L+E+S)	30+30+0

1. COURSE DESCRIPTION

1.1. Course objectives

The objectives of this course are:
- to familiarise students with operating systems and processes within operating systems;
- to acquire knowledge regarding basic concepts related to operating systems - process, communication, data management, memory management;
- to acquire knowledge and skills needed for advanced use of operating systems.

1.2. Enrolment requirements

1.3. Expected learning outcomes for the course

After successfully passing the final exam, the student will be able to:
- describe the role of the operating system as a part of a computer system;
- define and differentiate between operating system architectures;
- define what process is and describe the states of process execution;
- apply the knowledge about processes to problems of process management: concurrency, synchronisation, deadlocks and processor management;
- differentiate between memory management techniques;
- explain the differences in virtual memory management techniques (paging and segmentation) and their modifications;
- define what directory is and describe the ways of allocating external memory;
- describe what security and protection are, and how they are implemented.

1.4. Course content

Introduction to operating systems: operating systems development, operating systems hierarchy structure, interaction between operating systems and hardware.
Process management: process concurrency, synchronisation, deadlocks and processor management.
Memory management: paging, segmentation, allocation strategies, memory protection, resource allocation.
Data management: files and directories.
Security and protection.

1.5. Modes of instruction	☒ lectures ☐ seminars and workshops ☒ exercises ☐ distance learning ☐ field work	☐ independent work ☐ multimedia and the Internet ☐ laboratory work ☐ mentoring ☒ other ____consultation___
1.6. Comments		

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1.7. Student requirements

Students have to actively participate in all modes of instruction, prepare an individual or team seminar paper, and pass the couse exam that consists of a written (practical) and an oral part.
Student work is monitored and continuously evaluated. At the end of the course, the student is required to take and pass a written and an oral exam, which is used to evaluate her overall knowledge.

1.8. Evaluation

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

1.9. Evaluation and assessment during the course and on the final exam

Student work during the course will be evaluated and assessed continuously drung classes and on the final exam. The maximum number of points a student can be awarded during classes is 70 (activities marked in the table above are assessed), while the maximum number of points on the final exam is 30.
A detailed account of evaluation and assessment will be given in the course plan.

1.10. Required literature

1. Tanenbaum A., Woodhull A., *Modern Operating systems, Desing & Implementation*, Prentice Hall, 2006
2. Tanenbaum A., Woodhull A., *Operating systems, Desing & Implementation*, Prentice Hall, 1997

1.11. Recommended literature

1. Stalling S., *Operating systems*, Macmillan, 1992
2. Silberschatz A., Galvin P. B., *Operating system concepts*, Addison Wesley, 2007

1.12. Number of copies of required literature compared to the number of students currently enrolled in the course

Naslov	*Broj primjeraka*	*Broj studenata*

1.13. Quality assurance of course related to the acquisition of knowledge, skills and competences upon course completion

During the last week of classes, an anonymous questionnaire will be given out, in which students will evaluate the quality of classes. There will also be an ysis of student success on exams and on in-class practical activities.

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General Information		
Course organiser		
Course title	Complex Analysis	
Program	Undergraduate course in Mathematics	
Course status	Compulsory	
Year	II	
Credits and Teaching	ETCS credits / student workload	5
	Hours (L+E+S)	45+30+0

1. COURSE DESCRIPTION

1.1. Course objectives

This course aims to give students the basic knowledge about the theory of holomorphic functions and basis of complex analysis (sequences and series of complex numbers, limit, continuity, differentiation and integration of complex functions, conformal maps, Taylor and Laurent series, theory of residue).

1.2. Correspondence and correlation with the program

Program of Complex Analysis is correlated with other mathematical courses, especially with Analysis I, II and III.

1.3. Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

After completing this course students will be able to:
- differ various forms of complex numbers
- know the properties of complex numbers,
- define holomorphic functions, state their properties and cite examples,
- apply Cauchy's integral formula,
- classify singularities and calculate residue,
- expand analytic function in Taylor and Laurent series,
- define Möbius transformation and its properties,
- know and understand presented theorems and their proofs

1.4. Course content

Field of complex numbers. Holomorphic functions. Cauchy- Riemann's conditions. Elementary functions. Cauchy's Theorem. Curve index. Cauchy's Integral Formula. Morera's Theorem. Function series. Derivation and integration of function series. Series expansion of holomorphic function and power series. Liouville's Theorem. Laurent series. Singularities and their classification. Residue Theorem and applications. Poles of meromorphic finctions. Rouche's Theorem. Open Map Theorem. Maximum modules principle. Schwartz's Lemma. Conformal map. Mobius transformation.

1.5. Modes of instruction (mark in bold)		
	☒ **Lectures** ☐ Seminars and workshops ☒ **Exercises** ☐ Distance learning ☐ Field work	☒ **Independent work** ☐ Multimedia and the Internet ☐ Laboratory work ☐ Tutorials ☐ Other ☒ **Consultations**

1.6. Comments

1.7. Student requirements

Every student is obliged to fulfill conditions for signature in Complex Analysis and to pass the exam. Conditions for signature: Students are expected to attend and actively participate at all classes.

1.8. Evaluation[21] and Assessment

Class attendance and class participation			**1.3**	Seminar paper		Experiment	
Written exam (preliminary exam)	**0.9**	Oral exam	**2.5**	Essay		Research work	
Project work		Continuous assessment	**0.3**	Presentation		Practical work	
Portfolio							

1.9. Assessment and grade of student's work during the class and after the final exam

Students' work is continually observed. Integral part of observing and evaluating of students is the quality of active contribution in work on the lectures and exercises. The total number of points a student can achieve during the class is 70 (assessed activities are indicated in the table above). Student's knowledge is evaluated in the exam scored with a maximum of 30 points.

1.10. Required literature

1. H. Kraljević, S. Kurepa, Matematička analiza IV (funkcije kompleksne varijable), Tehnička 2. knjiga, Zagreb, 1984.
2. M.J. Albowitz, A.S.Fokas,Complex variables, Introduction and application, Cambridge University Press, 2003.

1.11. Recommended literature

1. J.Bak, D.J.Newman, Complex Analysis, Springer, 2010.

1.12. Number of copies of recommended literature in regard to the number of students who attend the class

Title	*Number of copies*	*Number of students*
H. Kraljević, S. Kurepa, Matematička analiza IV		
M.J. Albowitz, A.S.Fokas,Complex variables, Introduction and application		
J.Bak, D.J.Newman, Complex Analysis		

1.13. Quality assurance of course and/or module

After the last lecture of the course students will be asked to fulfill a questionnaire about the quality of the lectures. At the end of each semester results of the exams will be analyzed.

[21] Mark in bold only the relevant categories and 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.

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General Information		
Course organiser		
Course title	Discrete Mathematics	
Program	Undergraduate course in Mathematics	
Course status	Compulsory	
Year	II	
Credits and Teaching	ETCS credits / student workload	5
	Hours (L+E+S)	30+30+0

1. COURSE DESCRIPTION

1.1. Course objectives

Introduction to:
- basic definitions from graph theory
- planar, Eulerian, and Hamiltonian graphs
- Kruskal's and Dijkstra's algorithms
- colouring vertices and edges

1.2. Correspondence and correlation with the program

The program is correspondent to the program of other mathematical courses, especially to Combinatorics and Set Theory. The program is also correlated with courses of computer science: Algorithms and data structures and Formal languages and compilers.

1.3. Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

After completing this course students will be able to understand and apply basic theorems of graph theory, to distinguish terms and graph properties, to analyze Eulerian and Hamiltonian graphs, to analyze shortest path problem and coloring graph problems. They will be acquainted with some algorithms.

1.4. Course content

Introduction. Basic definitions and properties of graphs. Incidence and adjacency matrices. Vertex degree. Walks, paths and cycles. Trees. Eulerian and Hamiltonian graphs. Connectivity. Coloring. Chromatic polynomial. Planar graphs. Euler's formula. Plato's solids.

1.5. Modes of instruction (mark in bold)	☒ **Lectures** ☐ Seminars and workshops ☒ **Exercises** ☒ **Distance learning** ☐ Field work	☒ **Independent work** ☒ **Multimedia and the Internet** ☐ Laboratory work ☐ Tutorials ☐ Other ☒ **Consultations**
1.6. Comments		

1.7. Student requirements

Students must attend the lectures and participate in all activities required for the course.

1.8. Evaluation[22] and Assessment

[22] Mark in bold only the relevant categories and 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.

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Class attendance and class participation			**1.1**	Seminar paper		Experiment	
Written exam (preliminary exam)	**2**	Oral exam	**1.3**	Essay		Research work	
Project work		Continuous assessment	**0.6**	Presentation		Practical work	
Portfolio							

1.9. Assessment and grade of student's work during the class and after the final exam

Student's activities are evaluated during the semester. The total number of points a student can achieve during the class is 70 (assessed activities are indicated in the table above).
Student's knowledge is evaluated in the oral exam scored with maximum of 30 points.

1.10. Required literature

1. D.Veljan: Kombinatorika i diskretna matematika, Algoritam, Zagreb, 2001.

1.11. Recommended literature

1. N.Biggs: Discrete Mathematics, Clarendon Press, Oxford, 1989.
2. R.Diestel: Graph Theory, Second edition, Springer-Verlag, New York, 2000.
3. R.Balakrishnan, K.Ranganathan: A Textbook of Graph Theory, Springer-Verlag, Heidelberg, 2000.
4. R.Balakrishnan: Schaum's outline of Graph Theory: Included Hundreds of Solved Problems, McGraw-Hill, New York, 1997.
5. C.L. Liu: Elements of Discrete Mathematics, McGraw-Hill, New York, 1987.
6. L.Lovasz: Combinatorial Problems and Exercises, North-Holland, Amsterdam, 1979.
7. F.Robert: Applied Combinatorics, Prentice Hall, Englewood Cliffs, 1984.

1.12. Number of copies of recommended literature in regard to the number of students who attend the class

Title	*Number of copies*	*Number of students*

1.13. Quality assurance of course and/or module

After the last lecture of the course students will be asked to fulfill a questionnaire about the quality of the lectures. At the end of each semester results of the exams will be analyzed.

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General Information		
Course organiser		
Course title	Programming	
Program	Undergraduate course in Mathematics	
Course status	Compulsory	
Year	II	
Credits and Teaching	ETCS credits / student workload	5
	Hours (L+E+S)	30+30+0

1. COURSE DESCRIPTION

1.1. Course objectives

This course provides basic comprehension of approaches, concepts and methods in programming and gives an introduction to modular program construction.
The course familiarises the student with commonly used algorithms, using the C++ programming language.

1.2. Correspondence and correlation with the program

Course program is in correlation with the program of the course Algorithms and Data Structures.
This course provides the necessary background for that course.

1.3. Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

The student should become familiar with the:
- basic operation of the programming environment and computer literacy,
- Boolean expressions, variable types and memory storage

The student should learn:
- how to develop an algorithm and implementation to compute a mathematical function,
- to convert a set of Mathematical statements into a C++ Boolean expression,
- to develop an algorithm using programming language selection constructs,
- to develop an algorithm and implementation that repeatedly executes a sequence of steps,
- to debug a simple program and remove all syntax errors and all logic errors,
- to use preprogrammed functions to implement an algorithm,
- to implement a hierarchical design using methods/functions,
- to properly document code to a given standard,
- to develop and write a program that uses one or more array structures to store information,
- to develop and write a program that uses simple data files to store and retrieve information

1.4. Course content

Historical survey of programming languages. Procedural and object-oriented languages. General or multipurpose languages. Special-purpose languages. The software development process. Developing programs interactively. Concepts of imperative, structured programming. The notion of the algorithm. Syntax and semantix of C++. Types, values and declarations: Names. Declarations. Type definitions. Numeric data types. Logical types. Character types. Enumeration types. Expressions and statements: Expressions. Statements. Sequencing and control. Iterative statements. Program structure: Procedural architecture. Alternative program architectures. Simple algorithms for search and sort. Parameters. Functions. Separate Compilation. Modules. Storage management. Recursion. Structured data: Arrays. Records. Strings. Files. Pointers. Dynamic data structures.

1.5. Modes of instruction (mark in bold)		
	☒ **Lectures** ☐ Seminars and workshops ☐ Exercises ☐ Distance learning ☐ Field work	☐ Independent work ☐ Multimedia and the Internet

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		☒ **Laboratory work** ☐ Tutorials ☐ Other ☐ Consultations

1.6. Comments

1.7. Student requirements

Students are expected to:
- attend classes regularly
- make necessary preparations for classes
- do practical work
- present seminar paper
- pass two midterm exams and a final exam

1.8. Evaluation[23] and Assessment

Class attendance and class participation			**1**	Seminar paper		Experiment	
Written exam (preliminary exam)	**1.5**	Oral exam	**1.5**	Essay		Research work	
Project work		Continuous assessment		Presentation		Practical work	**1**
Portfolio							

1.9. Assessment and grade of student's work during the class and after the final exam

Students are encouraged to active participate at a class and it influences the final assessment. The maximum of points student can get during the class is 70. Final exam is scored with maximum of 30 points.

1.10. Required literature

1. Julijan Šribar, Boris Motik: Demistificirani C++, Dobro upoznajte protivnika da biste njime ovladali,

   Element, Zagreb, 2001.

1.11. Recommended literature

1. Jesse Liberty, Teach Yourself C++ in 24 Hours, SAMS, 1999.
2. Leslie B.Wilson and Robert G.Clark: Comparative Programming Languages, Third Edition, Addison-Wesley, 2001.

1.12. Number of copies of recommended literature in regard to the number of students who attend the class

Title	*Number of copies*	*Number of students*

1.13. Quality assurance of course and/or module

Quality of the course will be monitored and measured through the success of examinations and through the anonymous inquiry reflecting students opinions regarding the course.

[23] Mark in bold only the relevant categories and 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.

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General information		
Lecturer		
Course title	Set Theory	
Program	Undergraduate course in Mathematics	
Course status	Compulsory	
Year	II	
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

This course aims to acquaint students with:
- basic notions of intuitive set theory
- basic notions of infinity in set theory
- basic notions and principles of cardinal arithmetic
- basic notions of ordinal numbers
- problematics of the intuitive set theory (paradoxes)

1.2. Course prerequisite

None.

1.3. Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

After completing this course students will be able to understand and apply basic notions of set theory, i.e.:
- to know and understand notion of set and basic set operations
- to know and understand notion of relation, types of relations and cite examples
- to know and understand notion of function, difference between relation and function and properties of functions
- to know and understand notion of infinite set, denumerable and non-denumerable sets and use them accordingly
- to know and understand notion of cardinal numbers and determine cardinality of different examples of sets
- to be capable of argumented application of theorems from arithmetics and ordering of cardinal numbers
- to know and understand notion of well-ordered set and identify their examples
- to know and understand notion and properties of similarities mappings and ordering characterization of some of the well known sets of numbers
- to know and understand notion of ordinal number, differentiate and compare ordinal numbers
- to be capable of argumented application of theorems of arithmetic and ordering of ordinal numbers
- to be aware of and understand the problematics of the intuitive set theory and the need for axiomatization in set theory
- mathematically prove procedures and formulas used within this course

1.4. Course content

Introduction. Intuitive notion of set. Sets and classes. Algebra of sets. Set operations of union and intersection. Complement and De Morgan laws. Power set. Cartesian product. Relations. Binary relations. Equivalence relation. Partial order relation. Well-ordered sets. Transfinite induction principle. Functions. Equivalent sets. Finite and infinite sets. Denumerable and non-denumerable sets. Cardinal numbers. Ordering of cardinal numbers. Cardinal arithmetic. Similarity mappings and order types. Similarity mapping on well-ordered sets. Ordinal numbers. Ordinal arithmetic and ordering of ordinal numbers. Paradoxes in intuitive set theory and the need for axiomatization of the set theory.

1.5. Modes of instruction		
	☒ **lectures**	☒ **independent work**
	☐ seminars and workshops	☒ **multimedia and the internet**
	☒ **exercises**	☐ laboratory

	☒ **e-learning** ☐ field work ☐ practice ☐ practicum	☐ project strategies ☐ tutorials ☒ **consultations** ☐ other _____

1.6. Comments

1.7. Student requirements

Students' work will be evaluated and assessed during the semester and at the final exam. The total number of points a student can earn during the semester is 70 (the activities listed in the table are assessed), while at the final exam, a student can achieve 30 points.
The detailed elaboration of the monitoring and evaluation of students' work will be presented in the course curriculum.

1.8. Evaluation and assessment[24]

Class attendance & class participation			0.7	Seminar paper		Experiment	
Written exam	2	Oral exam	1.3	Essay		Research work	
Project		Continuous assessment	1	Presentation		Practical work	
Portfolio							

***Comment*:** ECTS distribution from above is made for studies and/or modules with courses which have 7 ECTS. For studies and/or modules with different number of total ECTS the distribution should be used for calculating percentages.

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

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

1.10. Required literature (when proposing the program)

1. P. Papić: Uvod u teoriju skupova, HMD, Zagreb, 2000.
2. S. Lipschutz: Set Theory and Related Topics, McGraw Hill, New York, 1964.

1.11. Recommended literature (when proposing the program)

1. M. Vuković: Teorija skupova, skripta PMF, Zagreb, 2013.
2. H.B. Enderton: Elements of Set Theory, Academic press, New York, 1977.
3. A. Levy: Basic Set Theory, Springer 1979.

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*
P. Papić: Uvod u teoriju skupova, HMD, Zagreb, 2000.		
S. Lipschutz: Set Theory and Related Topics, McGraw Hill, New York, 1964.		

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. At the end of each semester (1st March and 30th September of the current academic year) the analysis of the exam results will be conducted.

[24] **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.

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General Information		
Course organiser		
Course title	Geometry	
Program	Undergraduate course in Mathematics	
Course status	Compulsory	
Year	II	
Credits and Teaching	ETCS credits / student workload	5
	Hours (L+E+S)	30+30+0

1. COURSE DESCRIPTION

1.1. Course objectives

The aim of this course is to acquaint the students with certain geometrical facts and to provide a link between classical geometry and modern geometry, with the aim of preparing students for further study and research.

1.2. Correspondence and correlation with the program

The program is correspondent to the program of other mathematical courses, especially to Euclidean Spaces and elective course Projective geometry.

1.3. Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

After completing this class, students should be able to:
- recognize and compare different geometries,
- analyze problems; formulate them into mathematical terms and use the appropriate strategies to solve them; verify and interpret the solutions and present their mathematical arguments and solutions in a logical and clear fashion.

1.4. Course content

Historical introduction. Three approaches to the study of geometry.
Plane Euclidean geometry. Geometry on the sphere. Incidence. Distance. Perpendicular lines. The projective plane. Incidence. Homogeneous coordinates. Desargues' theorem. The projective group. Elliptic geometry. The hyperbolic plane. Incidence. Distance. Klein's model.

1.5. Modes of instruction (mark in bold)		
	☒ **Lectures** ☐ Seminars and workshops ☒ **Exercises** ☒ **Distance learning** ☐ Field work	☒ **Independent work** ☒ **Multimedia and the Internet** ☐ Laboratory work ☐ Tutorials ☐ Other ☒ **Consultations**

1.6. Comments

1.7. Student requirements

Attendance at all classes and active participation is expected.

1.8. Evaluation[25] and Assessment

Class attendance and class participation			**1.1**	Seminar paper		Experiment	
Written exam (preliminary exam)	**2**	Oral exam	**1.3**	Essay		Research work	
Project work		Continuous assessment	**0.6**	Presentation		Practical work	
Portfolio							

1.9. Assessment and grade of student's work during the class and after the final exam

Student's activities are evaluated during the semester, the total number of points student can gain during the class is 70 and in the exam is 30.

1.10. Required literature

1. A. I. Fetisov, O euklidskoj i neeuklidskim geometrijama, Školska knjiga, Zagreb, 1981.
2. P.J.Ryan, Euclidean and non-Euclidean Geometry – an Analytic Approach, Cambridge Univ. Press, Cambridge, 1991.

1.11. Recommended literature

1. Euclides, Elementi 1-6, prevela M. Hudoletnjak Grgić, Kruzak d.o.o., Zagreb, 1999.
2. K. Horvatić, Linearna algebra, I. dio, Matematički odjel PMF-a Sveučilišta u Zagrebu i Hrvatsko matematičko društvo, Zagreb, 1995.
3. Znam, Š, i ostali, Pogled u povijest matematike, Tehnička knjiga, Zagreb, 1989.

1.12. Number of copies of recommended literature in regard to the number of students who attend the class

Title	*Number of copies*	*Number of students*

1.13. Quality assurance of course and/or module

After the last lecture of the course students will be asked to fulfill a questionnaire about the quality of the lectures. At the end of each semester results of the exams will be analyzed.

[25] Mark in bold only the relevant categories and 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.

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General Information		
Course organiser		
Course title	Using Computers in Mathematics	
Program	Undergraduate course in Mathematics	
Course status	Compulsory	
Year	II	
Credits and Teaching	ETCS credits / student workload	**5**
	Hours (L+E+S)	**15+30+15**

1. COURSE DESCRIPTION

1.1. Course objectives

Development of the mathematical and logical thinking, learning and using packages in mathematics: Mathematica for mathematical expressions manipulation, differential and integral calculus, graph constructions and LaTeX for text and mathematical formulas and symbols writting, table constructions, new commands definition.

1.2. Correspondence and correlation with the program

Prerequisite for this course is Computer Laboratory I, II.

1.3. Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

After completing this course, it is expected students can use packages for writing seminars and for advance problems solving with the aid of a computer (Mathematica and LaTeX).

1.4. Course content

Practical intoduction to Mathematica: interface and mathematica kernel, numerical computation, symbolic computation, functions and programs, lists, graphics and sound, files. Principles of Mathematica: expressions, functional operations, patterns, transformations rules and definitions, additional packages. Advanced mathematics in Mathematica: numbers, algebraic manipulation, calculus, series, linear algebra.
TeX, LaTeX, AMS-LaTeX, versions of LaTeX, distributions (MikTeX), the structure of a LaTeX document, from input file to final document. LaTeX basics: The anatomy of an article, typing text and math, error messages, document classes, fonts. Texts and math: Boxes, footnotes, spliting up the file, text environments, tables, theorem like structure, AMS-LaTeX, math simbols, math environments, multiline math displays. Additional possibilities: Bibliographies and indexes, new commands and environments, including (EPS) graphics.

1.5. Modes of instruction (mark in bold)		
	☒ **Lectures** ☒ **Seminars and workshops** ☒ **Exercises** ☒ **Distance learning** ☐ Field work	☒ **Independent work** ☒ **Multimedia and the Internet** ☐ Laboratory work ☐ Tutorials ☐ Other ☒ **Consultations**

1.6. Comments

1.7. Student requirements

Students are obligated to attend classes, actively participated in any form of work that is required and pass the exam.

1.8. Evaluation[26] and Assessment

Class attendance and class participation			**1**	Seminar paper	**1**	Experiment	
Written exam (preliminary exam)	**2**	Oral exam		Essay		Research work	
Project work		Continuous assessment	**1**	Presentation		Practical work	
Portfolio							

1.9. Assessment and grade of student's work during the class and after the final exam

Students' activities are monitored continuously. During the semester students can get 70 points for their activities in class. The final exam is oral, valued with maximum of 30 points.

1.10. Required literature

1. Ungar Š., Ne baš tako kratak Uvod u TeX, PMF-Zagreb, 1998. (dostupno na: http://web.math.hr/~ungar/NASTAVA/RP3/lkratko2e_internet.pdf)
2. Originalni priručnici i sustavi pomoći za pojedine programske alate koji su dostupni on-line.

1.11. Recommended literature

1. Gratzer G., *Math into LaTeX*, Birkhauser, Boston-Basel-Berlin, 1996.

1.12. Number of copies of recommended literature in regard to the number of students who attend the class

Title	*Number of copies*	*Number of students*

1.13. Quality assurance of course and/or module

After the last lecture of the course students will be asked to fulfill a questionnaire about the quality of the lectures. At the end of each semester results of the exams will be analyzed.

[26] Mark in bold only the relevant categories and 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.

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General Information		
Course organiser		
Course title	Metric Spaces	
Program	Undergraduate course in Mathematics	
Course status	Compulsory	
Year	III	
Credits and Teaching	ETCS credits / student workload	5
	Hours (L+E+S)	30+30+0

1. COURSE DESCRIPTION

1.1. Course objectives

Course objective is to demonstrate the basis of mathematical analysis in metric and topological spaces. In this course student will learn basic notions and properties of metric and topological spaces, understand the term of sequence convergence and continuity of function.

1.2. Correspondence and correlation with the program

Program of course Metric Spaces is correlated with other mathematical courses, especially with Analysis I, Analysis II and Analysis III.

1.3. Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

After completing this course students will be able to:
- define metric and cite examples of metric spaces,
- know and understand elementary notions and characteristics of metric and topological spaces,
- classify topological spaces based on axioms of separation,
- know and understand notion of uniformly continuous function and convergence of functional sequence,
- define Cauchy sequence and complete metric space; know and understand Banach's Fix Point Theorem,
- describe compact spaces

1.4. Course content

Metric spaces, definition and examples. Bounded and completely bounded spaces. Topological structure. Equivalent metrics. Direct product of spaces. Subspace. Topological space. Basis of topology. Interior and closure of the set. Closed sets. Separability. Product and quotient of spaces. Axioms of separation. Convergence of sequences. Accumulation point. Bolzano-Weierstrass Theorem. Sequences of functions, uniform convergence. Cauchy's sequence. Complete metric space. Banach's Fix Point Theorem. Continuous maps. Characterizations. Homeomorphism. Uniform continuity. Connected spaces. Compactness. Characterization of compact sets in $\cdot^n$. Tychonoff Theorem. Continous functions on the compact.

1.5. Modes of instruction (mark in bold)	☒ **Lectures** ☐ Seminars and workshops ☒ **Exercises** ☐ Distance learning ☐ Field work	☐ Independent work ☐ Multimedia and the Internet ☐ Laboratory work ☐ Tutorials ☐ Other ☒ **Consultations**
1.6. Comments		

1.7. Student requirements

Every student is obliged to fulfill conditions for signature in Metric Spaces and to pass the exam.
Conditions for signature: Students are expected to attend and actively participate at all classes.

1.8. Evaluation[27] and Assessment

Class attendance and class participation			**1.2**	Seminar paper		Experiment	
Written exam (preliminary exam)	**2.4**	Oral exam	**1.4**	Essay		Research work	
Project work		Continuous assessment		Presentation		Practical work	
Portfolio							

1.9. Assessment and grade of student's work during the class and after the final exam

Students' work is continually observed. Integral part of observing and evaluating of students is the quality of active work contribution at the lectures and exercises (70 points). Student's knowledge is evaluated in the exam (30 points).

1.10. Required literature

1. S. Mardešić, Matematička analiza u *n*-dimenzionalnom realnom prostoru I, Školska knjiga, Zagreb, 1974.
2. M. Mršević, Zbirka rešenih zadataka iz topologije, Naučna knjiga, Beograd, 1977.

1.11. Recommended literature

1. Schaum's outline series, Theory and Problems of General Topology, McGraw-Hill book company, USA, 1965.

1.12. Number of copies of recommended literature in regard to the number of students who attend the class

Title	*Number of copies*	*Number of students*

1.13. Quality assurance of course and/or module

After the last lecture of the course students will be asked to fulfill a questionnaire about the quality of the lectures. At the end of each semester results of the exams will be analyzed.

[27] Mark in bold only the relevant categories and 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.

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General information		
Lecturer		
Course title	Introduction to Probability and Mathematical Statistics	
Program	Undergraduate course in Mathematics	
Course status	Compulsory	
Year	III	
Credit values and modes of instruction	***ECTS credits / student workload***	6
	Hours (L+E+S)	30 + 45 + 0

1. COURSE DESCRIPTION

1.1. Course objectives

Main course objective is to get students acquainted with basic ideas, results and methods of probability theory and mathematical statistics. For that purpose it is necessary within the course to:

- define probability and analyse its properties
- describe basic examples of probability spaces
- define conditional probability and analyse its properties
- describe Bernoulli trials
- define random variables and their probability density and distribution functions
- describe various examples of probability distributions
- define and analyse numerical characteristics of probability distributions
- enable students to apply tools for statistical data processing (MS Excel)

1.2. Course prerequisite

1.3. Expected outcomes for the course

After completing this course students should be able to:

- distinguish probabilistic and deterministic experiments
- apply probability properties in problem solving
  apply combinatorial methods in solving probability problems
- know probability models: classical model and Bernoulli trials
- use random variables and their properties in problem solving
- know basic examples of probability distributions
- apply statistical data processing using software package MS Excel
- mathematically prove foundation of procedures and formulas which they use within the course

1.4. Course content

Probability space. Conditional probability. Independence of events. Total probability theorem. Bayes' theorem. Geometric probability. Bernoulli trials. Random variables. Mathematical expectation and variance. Density functions. Distribution functions. Random vectors. Laws of large numbers. Probability generating functions. Continuous random variables. Descriptive statistics. Measures of central tendency. Measures of dispersion. Measures of shape. Time series. Hypothesis testing.

1.5. Modes of instruction	X lectures ☐ seminars and workshops X exercises X e-learning ☐ field work	X independent work X multimedia and the internet ☐ laboratory ☐ project strategies ☐ tutorials

	☐ practice ☐ practicum	X consultations ☐ other _____
1.6. Comments	15 hours of exercises will be performed on the computers.	

1.7. Student requirements

Students must satisfy requirements for obtaining the signature and pass the final exam from the course (details will be listed in the executive program).

1.8. Evaluation and assessment[28]

Class attendance & class participation			1.2	Seminar paper		Experiment	
Written exam	2.0	Oral exam	1.6	Essay		Research work	
Project		Continuous assessment	1.2	Presentation		Practical work	
Portfolio							

Comment: ECTS distribution from above is made for studies and/or modules with courses which have 6 ECTS. For studies and/or modules with different number of total ECTS the distribution should be used for calculating percentages.

1.9. Assessment and evaluation of students' work during the semester and in 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. N. Sarapa, *Teorija vjerojatnosti,* Školska knjiga, Zagreb, 2002.
2. N. Sarapa, *Vjerojatnost i statistika,I i II dio,* Školska knjiga, Zagreb, 1993.

1.11. Recommended literature (when proposing the program)

1. W. Feller, *An Introduction to Probability Theory and Its Application,* J.Wiley, New York, 1966.
2. M. Papić, *Primijenjena statistika u MS Excelu*, Zoro, Zagreb, 2012.
3. I. Sošić, *Primijenjena statistika*, Školska knjiga, Zagreb, 2004.
4. T. Pogany, *Teorija vjerojatnosti, zbirka riješenih ispitnih zadataka*, Sveučilište u Rijeci, Odjel za pomorstvo, Rijeka, 1999.
5. M. Spiegel, J. Schiller, R. A. Srinivasan, *Probability and Statistics, Schaum's outline series*, McGraw-Hill Book Company, New York, 2000.

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 wich ensure acquisition of knoxledge, 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 analyzed.

[28] **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.

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General Information		
Course organiser		
Course title	Mathematical logic	
Program	Undergraduate course in Mathematics	
Course status	Compulsory	
Year	III	
Credits and Teaching	ETCS credits / student workload	6
	Hours (L+E+S)	30+30+0

1. COURSE DESCRIPTION

1.1. Course objectives

The objective of this course is to acquaint the students with basic notions of mathematical logic; to define syntax and semantics in the first-order logic and classical sentential logic, to analyze normal form and its properties and application, to analyze a base of truth-functional connectives, to analyze propositional calculus, to differ validity tests in first-order logic and classical sentential logic, to analyze Hilbert system and its properties, to review natural deduction system for first-order logic, to describe and compare interpretations and models, the first-order logic calculus and generalized completness and soundness theorem.

1.2. Correspondence and correlation with the program

The program of the course Mathematical logic is in correlation with the other mathematical courses, especially Set theory and Computer organization and architecture.

1.3. Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

After completing this course students will be able to understand and apply basic notions of mathematical logic: to apply syntax and semantics of sentential and first-order logic, to analyze and apply normal form, to differ validity tests in first-order and sentential logic, to use the propositional calculus in problem solving, to apply the natural deduction system, to give examples of first-order theory and to prove mathematically procedures and formulas given in this course.

1.4. Course content

Syntax and semantics in the first-order and sentential logic. Alternational and conjunctional normal form. Craig lemma. Compactness theorem. Validity tests. Hilbert's formal system for the first order and sentential logic (deduction theorem, soundness theorem). Generalized completeness theorem (sketch of Henkin's proof). Gödel's completeness theorem. Compactness theorem. Limits of first order logic.

1.5. Modes of instruction (mark in bold)	☒ **Lectures** ☐ Seminars and workshops ☒ **Exercises** ☐ Distance learning ☐ Field work	☒ **Independent work** ☒ **Multimedia and the Internet** ☐ Laboratory work ☐ Tutorials ☐ Other ☒ **Consultations**
1.6. Comments		

1.7. Student requirements

Students must attend the lectures and participate in all activities required for the course.

1.8. Evaluation[29] and Assessment

Class attendance and class participation			**1.1**	Seminar paper		Experiment	
Written exam (preliminary exam)	**1.7**	Oral exam	**2.8**	Essay		Research work	
Project work		Continuous assessment	**0.4**	Presentation		Practical work	
Portfolio							

1.9. Assessment and grade of student's work during the class and after the final exam

Student's activities are continuously being monitored. Quality of student's active participation during classes and exercises is a component of the monitoring and evaluation scored with maximum of 70 points. Complete knowledge of the student is evaluated at the exam scored with maximum of 30 points.

1.10. Required literature

1. M.Vuković: Matematička logika ,Element, 2009.

1.11. Recommended literature

1. A.G.Hamilton: Logic for Mathematicians ,Cambridge, University Press, 1988.
2. E.Mendelson: Introduction to Mathematical Logic ,(D.van Nostrand Reihold Company,New York),1964.
3. Joel V.Robbin: Mathematical Logic(W.A.Benjamin Inc.,New York),1969.

1.12. Number of copies of recommended literature in regard to the number of students who attend the class

Title	*Number of copies*	*Number of students*
M.Vuković: Matematička logika ,Element, 2009.		
A.G.Hamilton: Logic for Mathematicians ,Cambridge, University Press, 1988.		
E.Mendelson: Introduction to Mathematical Logic ,(D.van Nostrand Reihold Company, New York),1964.		
Joel V.Robbin: Mathematical Logic(W.A.Benjamin Inc., New York),1969.		

1.13. Quality assurance of course and/or module

After the last lecture of the course students will be asked to fulfill a questionnaire about the quality of the lectures. At the end of each semester results of the exams will be analyzed.

[29] Mark in bold only the relevant categories and 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.

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General Information		
Course organiser		
Course title	Introduction to Numerical Mathematics	
Program	Undergraduate course in Mathematics	
Course status	Compulsory	
Year	III	
Credits and Teaching	ETCS credits / student workload	5
	Hours (L+E+S)	30+30+0

1. COURSE DESCRIPTION

1.1. Course objectives

This course aims to acquaint students with:
- numerical errors,
- theoretical knowledge of polynomial interpolation of function and practical usage of learned methods,
- theoretical knowledge about numerical solution of non-linear and algebraic equations and practical usage of learned methods,
- theoretical knowledge of numerical integration and practical usage of learned methods,
- theoretical knowledge of differential equations and practical usage of learned methods

1.2. Correspondence and correlation with the program

Program of the course Introduction to Numerical Mathematics is in correlation with the other courses of mathematics and with the courses of computer science.

1.3. Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

After completing this course, it is expected from students to understand numerical methods for polynomial interpolation, spline interpolation (linear and cubic), non-linear equations, integrals and differential equations and to be able to apply those methods in practice.

1.4. Course content

Errors, estimation of error, floating-point arithmetic, stability of numerical algorithms on computer. Interpolation, polynomial interpolation, cubic spline interpolation, convergence, estimation of error. Determination of solutions of non-linear equations, Newton's method, function iteration method. Numerical methods for polynomial equations. Numerical integration. Newton-Cotes's formulas, Gauss's formulas, convergence, estimation of error.

1.5. Modes of instruction (mark in bold)	☒ **Lectures** ☒ **Seminars and workshops** ☒ **Exercises** ☒ **Distance learning** ☐ Field work	☒ **Independent work** ☒ **Multimedia and the Internet** ☐ Laboratory work ☐ Tutorials ☐ Other ☒ **Consultations**
1.6. Comments		

1.7. Student requirements

Students are obligated to attend classes, actively participated in any form of work that is required and pass the exam.

1.8. Evaluation[30] and Assessment

Class attendance and class participation			**1.4**	Seminar paper	**1.2**	Experiment	
Written exam (preliminary exam)	**0.6**	Oral exam	**0.6**	Essay		Research work	
Project work		Continuous assessment	**1.2**	Presentation		Practical work	
Portfolio							

1.9. Assessment and grade of student's work during the class and after the final exam

Student's work and activity in class are constantly monitored; the total number of points achieved during the class is 70. Knowledge of student is evaluated at the exam scored with maximum of 30 points.

1.10. Required literature

1. J.Stoer, R. Bulirsch: Introduction to Numerical Analysis, Second edition, Springer-Verlag, New York, 1991.
2. W.A.Smith: Elementary numerical analysis, Harper Row Publishers, New York, 1979.

1.11. Recommended literature

1. H.Rutishauser: Vorlesungen uber numerische Mathematik I, Birkhauser, Verlag, Basel, 1976.
2. I.Ivanšić: Numerička matematika, Element, Zagreb, 1998.
3. R. Scitovski: Numerička matematika, Odjel za matematiku Sveučilište u Osijeku, 1999.

1.12. Number of copies of recommended literature in regard to the number of students who attend the class

Title	*Number of copies*	*Number of students*

1.13. Quality assurance of course and/or module

After the last lecture of the course students will be asked to fulfill a questionnaire about the quality of the lectures. At the end of each semester results of the exams will be analyzed.

[30] Mark in bold only the relevant categories and 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.

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General Information		
Course organiser		
Course title	Seminar II – Applied mathematics in engineering	
Program	Undergraduate course in Mathematics	
Course status	Compulsory	
Year	III	
Credits and Teaching	ETCS credits / student workload	3
	Hours (L+E+S)	0+0+30

1. COURSE DESCRIPTION

1.1. Course objectives

On the contemporary projects in different technical areas (civil engineering, mechanical engineering, naval architecture etc.) teamwork of mathematicians, programmers, physicists and engineers of the appropriate calling is needed. The objective of this course is to prepare students for such teamwork. In particular, the objective is to introduce mathematicians, programmers, and physicists to the typical engineering problems so that they are prepared to work in industry, and on the other hand, to prepare engineers of different branches, with the scientific language and methods o mathematics and physics.

1.2. Correspondence and correlation with the program

Elementary knowledge in linear algebra and differential and integral calculus is necessary. Some experience in programming, numerical methods or particular technical field can facilitate the learning process. However, everything that is new to students is presented through lectures. This course can be part of the education of mathematicians, programmers, physicists, and engineers of different technical specializations.

1.3. Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

It is expected that the student, which attends this course acquires knowledge needed to deal with some of the practical engineering problems in all the phases of this process: defining the problem, problem modeling, solving it with the aid of existing software or by programming new software, and presenting simulations, i.e., computed results.

1.4. Course content

Projective geometry in computational graphics. Curves and surfaces in computational graphics. Fluid flow in pipelines. Open-channel flow. Simulation of flooding. Water flow around ship. Water flow in turbomachinery. Heat equations. Elasticity problems. Vibrations. Optimal control in production. Optimal design problems.

1.5. Modes of instruction (mark in bold)	☐ Lectures ☒ **Seminars and workshops** ☐ Exercises ☒ **Distance learning** ☐ Field work	☒ **Independent work** ☒ **Multimedia and the Internet** ☐ Laboratory work ☐ Tutorials ☐ Other ☒ **Consultations**
1.6. Comments		

1.7. Student requirements

The student is required to attend class, to participate in all the forms of the work during lectures and to present a seminar paper.

1.8. Evaluation[31] and Assessment

Class attendance and class participation			**1**	Seminar paper	**1.5**	Experiment	
Written exam (preliminary exam)	**0.5**	Oral exam		Essay		Research work	
Project work		Continuous assessment		Presentation		Practical work	
Portfolio							

1.9. Assessment and grade of student's work during the class and after the final exam

Students' activities will be assessed during the semester and in the exam. Student can achieve the maximum of 70 points during the class and the maximum of 30 points in the exam.

1.10. Required literature

1. Chapra S. C., Channale R. P.: Numerical methods for engineers, McGrowHill Inc., 1988.
2. Numerical Recipes in C, Cambridge University Press, 1992.
3. Kreyszig E., Advanced engineering mathematics, John Wiley & Sons, 9th ed., 2006

1.11. Recommended literature

1. Strang G., Introduction to Applied mathematics, Wellesley-Cambridge Press, 1986.
2. Winston L.W., Operational Research – Applications and Algorithms, Duxbury Press, Belmont, 1994.
3. Yamagochy F., Curves and surfaces in computer aided geometric design, Springer-Verlag 1988.

1.12. Number of copies of recommended literature in regard to the number of students who attend the class

Title	*Number of copies*	*Number of students*

1.13. Quality assurance of course and/or module

Quality and success of the realization of the course are evaluated primarily through continuous supervision of the quality of the seminar papers of the students. Continuous consultations and dialog with students are applied, and particular teaching content is adjusted to students' interests.

[31] Mark in bold only the relevant categories and 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.

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General Information		
Course organiser		
Course title	Projective Geometry	
Program	Undergraduate course in Mathematics	
Course status	Elective	
Year	III	
Credits and Teaching	ETCS credits / student workload	5
	Hours (L+E+S)	30+30+0

1. COURSE DESCRIPTION

1.1. Course objectives

- learn basic facts and properties of projective geometry
- learn Desargues' and Pappus' theorem
- learn properties of perspectivities, projectivities, correlations and polarity

1.2. Correspondence and correlation with the program

Program of course Projective Geometry is in correlation with the other courses of mathematics, especial with courses Linear algebra I and II, Euclidian spaces, Geometry and Vectors spaces I.

1.3. Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

After completing this course, it is expected from students to know definition, axioms and properties of projective geometry, Desargues' and Pappus' theorem and basic facts and properties of perspectivities, projectivities, correlations and polarity. Student will differ axiomatic from analytic approach to study of Projective Geometry and be able to interpret mathematical terms defined in this course.

1.4. Course content

Introduction. Incidence axioms. Desargues' theorem. Pappus' theorem and the fundamental theorems of a projective geometry. Quadrangles and harmonic quadruples. Configurations and projective planes. Analytic geometry of projective plane. Projective coordinates of line and plane. Perspectivities and projectivities of points. Involutions. Projective transformations of plane. Correlations and polarity. Projective spaces. Definition of projective spaces based on the vectors space. Projective transformations, correlations and polarities.

1.5. Modes of instruction (mark in bold)		
	☒ **Lectures** ☐ Seminars and workshops ☒ **Exercises** ☒ **Distance learning** ☐ Field work	☒ **Independent work** ☒ **Multimedia and the Internet** ☐ Laboratory work ☐ Tutorials ☐ Other ☒ **Consultations**

1.6. Comments

1.7. Student requirements

Students are obligated to attend classes, actively participated in any form of work that is required and pass the exam.

1.8. Evaluation[32] and Assessment

Class attendance and class participation			**1.1**	Seminar paper		Experiment	
Written exam (preliminary exam)	**1**	Oral exam	**1.2**	Essay		Research work	
Project work		Continuous assessment	**1.7**	Presentation		Practical work	
Portfolio							

1.9. Assessment and grade of student's work during the class and after the final exam

Student's work and activity in class are constantly monitored and scored with maximum of 70 points during the class. Knowledge of student is evaluated at the exam scored with maximum of 30 points.

1.10. Required literature

1. D.Palman: Project workivna geometrija, Školska knjiga, Zagreb, 1984.

1.11. Recommended literature

1. M.Audin: Geometry, Springer Verlag, Heidelberg, 2002.
2. H.S.M.Coxeter: Project workivna geometrija, Školska knjiga, Zagreb, 1982.
3. O.Veblen, J.W.Young: Projective geometry, I,II, Ginn & co., Bossyton, 1910.

1.12. Number of copies of recommended literature in regard to the number of students who attend the class

Title	*Number of copies*	*Number of students*

1.13. Quality assurance of course and/or module

After the last lecture of the course students will be asked to fulfill a questionnaire about the quality of the lectures. At the end of each semester results of the exams will be analyzed.

[32] Mark in bold only the relevant categories and 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.

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General Information		
Course organiser		
Course title	Introduction to Number theory	
Program	Undergraduate course in Mathematics	
Course status	Elective	
Year	III.	
Credits and Teaching	ETCS credits / student workload	5
	Hours (L+E+S)	30+30+0

1. COURSE DESCRIPTION

1.14. Course objectives

The Number theory is the field of mathematics known for simplicity in statements but complexity in problems, whose solving demands theory of algebra, analysis and geometry. This course aims to:

- analyze basic properties of integers (divisibility, prime numbers, integer factorization, Euclidean algorithm, congruence),
- analyze solvability of quadratic congruence using Legendre symbols; law of quadratic reciprocity,
- analyze quadratic forms,
- define arithmetical function and compare basic examples,
- differ various types of diophantine equations and describe the solving methods,
- define elliptic curves, analyze their properties and application in number theory,
- describe algebraic methods in number theory and their application,
- describe analytic methods in number theory and their application.

1.15. Correspondence and correlation with the program

Program of the course is in correlation with other mathematical courses, especially with the courses: Elementary Mathematics I, II, Algebraic structures, Algebra and Complex Analysis.

1.16. Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

After completing this course students will be able to:

- analyze basic properties of integers and to apply them in the number theory problems, - analyze quadratic forms and apply the law of quadratic reciprocity,
- analyze basic arithmetical functions, state their properties and compare them,
- define basic types of diophantine equations and describe the solving methods,
- define elliptic curves, analyze their properties and application in number theory,
- describe and analyze algebraic methods in number theory and application,
- describe and analyze analytic methods in number theory and application.

1.17. Course content

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Divisibility. Greatest common divisor. Euclidean algorithm. Prime numbers.
Congruence. Euler theorem. Chinese remainder theorem. Primitive roots and indices.
Quadratic remainders. Legendre symbol. Law of quadratic reciprocity. Fibonacci numbers.
Quadratic forms. Binary quadratic form reduction. Sums of two and four squares.
Arithmetic functions. Euler and Möbius function. Distribution of primes.
Diophantine equations. Pythagorean triple. Pell's equation. Elliptic curve.
Quadratic fields. Units and prime elements in quadratic fields. Application to diophntine equations.

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General Information		
Course organiser		
Course title	Algebraic Structures	
Program	Undergraduate course in mathematics	
Course status	Compulsory	
Year	III	
Credits and Teaching	ETCS credits / student workload	7
	Hours (L+E+S)	30 + 30 + 0

1.COURSE DESCRIPTION

1.1. Course objectives

The aim of the course is to give students the basic knowledge on algebraic structures. For that purpose it is necessary within the course to:

- describe and distinguish algebraic structures with one and two binary operations,
- describe and distinguish different examples of some algebraic structures and analyze their properties,
- for a specific algebraic structure describe and distinguish the substructure and distinguish the other structures associated with the initial structure and analyze their properties,
- define and describe algebraic structures mappings and analyze the properties of these mappings,
- define Sylow subgroups and analyze the properties of these subgroups,
- define group action and permutation group and analyze their properties,
- define and distinguish modules and algebras.

1.2. Course prerequisite

1.3. Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

After completing this course students should be able to:

- distinguish and analyze certain algebraic structures and to argumentedly execute mathematical procedures in problem solving,
- argumentedly use properties of certain algebraic structures in problem solving,
- argumentedly apply the theorems of homomorphisms,
- argumentedly apply Sylow theorems,
- distinguish and describe the action on the set and can apply appropriate procedures in problem solving,
- use the classical results in the theory of groups and rings, such as Lagrange's theorem and Chinese remainder theorem to describe the group structure and ring structure,
- mathematically prove the states and procedures stated in this course.

1.4. Course content

Definition of group and basic concepts. Examples of groups. Group homomorphisms and examples. Cosets. Lagrange's theorem. Normal subgroups. Factor groups. The isomorphism theorems, examples of factor groups. The action of a group on a set. The Sylow theorems. Definition of rings and fields and basic concepts. Examples of rings and fields. Finite fields. Ring homomorphisms and examples. The ideals and examples. Quotient rings. The isomorphism theorems for rings. Maximal and prime ideals. The Chinese Remainder theorem. Definitions of modules and algebras.

1.5. Modes of instruction (mark in bold)		
	☒ **Lectures**	☒ **Independent work**
	☒ Seminars and workshops	
	☒ **Exercises**	
	☒ **Distance learning**	☒ **Multimedia and**

	☐ Field work	**the Internet** ☐ Laboratory work ☐ Tutorials ☐ Other ☒ **Consultations**
1.6. Comments		

1.7. Student requirements

It is compulsory for students to satisfy requirements (listed in the executive program) and to pass the final exam.

1.8. Evaluation[33] and Assessment

Class attendance and class participation			**1.7**	Seminar paper		Experiment	
Written exam (preliminary exam)	**2.3**	Oral exam	**1.8**	Essay		Research work	
Project work		Continuous assessment	**1.2**	Presentation		Practical work	
Portfolio							

1.9. Assessment and grade of student's work during the class and after 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. N.Grbac, V.Mikulić-Crnković, Algebarske strukture, skripta, zima 2010/11 http://www.math.uniri.hr/~ngrbac/alg_str_web.pdf
2. K. Horvatić, Linearna algebra I, II, III, Golden marketing - Tehnička knjiga, I, Zagreb, 2004.
3. S.Lang, Undergraduete algebra, Springer Science & Business Media, Mar 21, 2005.
4. B. Širola, Algebarske strukture. Grupe, PMF - Matematički odjel, Zagreb, 2008, http://web.math.hr/nastava/alg/2007-08/predavanjaGRUPE.pdf
5. B. Širola, Algebarske strukture. Prsteni, polja i algebre, PMF –Matematički odjel, Zagreb, 2008, http://web.math.hr/nastava/alg/200708/predavanjaPRSTENI.pdf

1.11. Recommended literature (when proposing the program)

1. G.Birkhoff, S.MacLane: A Survey of Modern Algebra, MacMillan, New York, 1985.

1.12. Number of copies of recommended literature in regard to the number of students who attend the class

Title	*Number of copies*	*Number of students*

1.13. Quality assurance of course and/or module

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 analyzed.

[33] Mark in bold only the relevant categories and 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.

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General Information		
Course organiser		
Course title	Introduction to Differential Geometry	
Program	Undergraduate course in Mathematics	
Course status	Compulsory	
Year	III	
Credits and Teaching	ETCS credits / student workload	7
	Hours (L+E+S)	45+30+0

1. COURSE DESCRIPTION

1.1. Course objectives

This course aims:
- acquisition a fundamental terms of curves in the plane and in the space and theirs differential attributes
- acquisition a fundamental terms of surface, differential attributes and a special category of surfaces
- acquisition a types of curves on surfaces

1.2. Correspondence and correlation with the program

Program of the course Introduction to Differential Geometry is in the correlation with other mathematical courses, especially with the courses Analysis I, Analysis II, Analysis III, Linear Algebra I and Linear Algebra II.

1.3. Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

After completing this course students will be able to understand basic properties of curves and surfaces and to apply this knowledge. They will be capable of:
- distinguishing curves in the plane and in the space,
- explaining and applying Frenet's formulas,
- stating Fundamental theorem of the theory of curves, Theorema Egregium and Fundamental theorem of curves,
- explaining and applying the three fundamental forms,
- stating Meusnier's theorem,
- explaning and comparing the total and mean curvatures

1.4. Course content

Vector fields. Covariant derivatives. Curves in the plane and in the space. Curvature of curves. Frenet's formulas. Fundamental theorems of theory of curves. Surfaces. The tangent plane to surface. The first and the second quadratic form of a surface. The shape operator of a surface. The spectar of shape operator. The total (Gaussian) and mean curvatures. The three fundamental forms. The types of curves on surfaces: asymptotic curves, geodesic curves. A special category of surfaces: surfaces of constant curvature, ruled surfaces, revolution surfaces.

1.5. Modes of instruction (mark in bold)	☒ **Lectures** ☒ **Seminars and workshops** ☒ **Exercises** ☐ Distance learning ☐ Field work	☒ **Independent work** ☒ **Multimedia and the Internet** ☐ Laboratory work ☐ Tutorials ☐ Other ☒ **Consultations**
1.6. Comments		

1.7. Student requirements

Attendance at all classes and active participation is expected.

1.8. Evaluation[34] and Assessment

Class attendance and class participation			**1.4**	Seminar paper	**0.35**	Experiment	
Written exam (preliminary exam)	**2.1**	Oral exam	**2.1**	Essay		Research work	
Project work		Continuous assessment	**1.05**	Presentation		Practical work	
Portfolio							

1.9. Assessment and grade of student's work during the class and after the final exam

Students' activities are monitored continuously. During the semester students can get 70 points for their activities in class. The final exam is oral, valued with maximum of 30 points.

1.10. Required literature

1. R. S. Miliman, G. D. Parker, Elements of Differential Geometry, Prentice-Hall, Engelwood Cliffs - New Yersey, 1997.
2. A. Gray, Modern Differential Geometry of Curves and Surfaces with *Mathematica*, CRC Press, Boca Raton-Boston-London-New York-Washington, 1998.

1.11. Recommended literature

1. B. O'Neill, Elementary Differential Geometry, Academic Press, New York-San Francisko-London, 1966.
2. I. Kamenarović, Diferencijalna geometrija, Sveučilište u Rijeci, Pedagoški fakultet, Rijeka, 1990.
3. B. Žarinac-Frančula, Diferencijalna geometrija, Zbirka zadataka i repetitorij, Sveučilište u Zagrebu, Geodetski fakultet, Zagreb, 1980.
4. M. P. do Carmo, Differential Geometry of Curves and Surfaces, Prentice Hall, 1976.
5. J. A. Thorpe, Elementary Topics in Differential Geometry, Undergraduate Texts in Mathematics, Springer Verlag, 1994.
6. A. Pressley, Elementary Differential Geometry, Undergraduate Mathematics Series, Springer Verlag, 2001.
7. W. Kuhnel, Differential Geometry: Curves - Surfaces - Manifolds, American Mathematical Society, 2002.
8. J. Oprea, Differential Geometry and Its Applications, 2nd edition, Prentice Hall, 2003.
9. D. W. Henderson, Differential Geometry: A Geometric Introduction, Prentice Hall, 1998.
10. S.-S. Chern, W. H. Chen, K. S. Lan, Lectures on Differential Geometry, World Scientific Publishing, 1999.
11. M. Berger, Panoramic View of Riemannian Geometry, Springer Verlag, 2003.

1.12. Number of copies of recommended literature in regard to the number of students who attend the class

Title	*Number of copies*	*Number of students*

1.13. Quality assurance of course and/or module

After the last lecture of the course students will be asked to fulfill a questionnaire about the quality of the lectures. At the end of each semester results of the exams will be analyzed.

[34] Mark in bold only the relevant categories and 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.

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General Information		
Course organiser		
Course title	Algorithms and Data Structures	
Program	Undergraduate course in Mathematics	
Course status	Compulsory	
Year	III	
Credits and Teaching	ETCS credits / student workload	5
	Hours (L+E+S)	30+30+0

1. COURSE DESCRIPTION

1.1. Course objectives

The course studies the concept of an algorithm, some basic algorithms commonly used in programming, and the efficiency of these algorithms. It introduces abstract data types and the data structures commonly used to represent them. The student should become familiar with the basic data structures, the operations that are naturally connected to these structures and how they can be used in solving a number of algorithmic problems.

1.2. Correspondence and correlation with the program

Course program is in correlation with the program of the course Programming which provides the necessary background for this course.

1.3. Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

The student should become familiar with the:
- fundamental data types of computing (lists, stacks, queues, priority queues, sets, maps, trees, etc.)
- major techniques for implementing the fundamental data types (linked lists, binary search trees, hashing, heaps, etc.)
- fundamental sorting and searching algorithms of computing and how to analyze them.

The student should understand how recursion works and how to write recursive algorithms.
The student should learn:
- to use language-provided data structure libraries
- basic algorithm analysis
- to identify the most important abstract data types and the ways in which they may be implemented
- to describe an implementation using plain natural language or pseudocode.

1.4. Course content

Abstract Data Type. Algorithm Efficiency. Searching. Linear Lists. Stacks. Queues. Recursion. Introduction to Trees. Search Trees. Heaps. Advanced Sorting Concepts. Graphs.

1.5. Modes of instruction (mark in bold)	☒ **Lectures** ☒ **Seminars and workshops** ☐ Exercises ☒ **Distance learning** ☐ Field work	☒ **Independent work** ☒ **Multimedia and the Internet** ☐ Laboratory work ☐ Tutorials ☐ Other ☒ **Consultations**
1.6. Comments	Laboratory work will be done in a computer laboratory.	

1.7. Student requirements

Students are expected to:
- attend classes regularly
- make necessary preparations for classes
- do practical work
- present seminar paper
- pass a final exam.

1.8. Evaluation[35] and Assessment

Class attendance and class participation			**1**	Seminar paper	**0,5**	Experiment	
Written exam (preliminary exam)	**1**	Oral exam	**1**	Essay		Research work	
Project work		Continuous assessment	**1**	Presentation		Practical work	**0,5**
Portfolio							

1.9. Assessment and grade of student's work during the class and after the final exam

Students' activities are monitored continuously. During the semester students can get 70 points for their activities in class. The final exam is oral, valued with maximum of 30 points.

1.10. Required literature

1. Richard F. Gilberg, Behrouz A. Forouzan: Data Structures: A Psuedocode approachwith C, Brooks/Cole, 1998.
2. Robert Sedgewick: Algorithms in C, Parts 1-5 (Bundle): Fundamentals, Data Structures, Sorting, Searching, and Graph Algorithms, Addison-Wesley Professional, 2001.

1.11. Recommended literature

1. Mark Allen Weiss: Data Structures and Algorithm Analysis in C, Addison Wesley,1996.

1.12. Number of copies of recommended literature in regard to the number of students who attend the class

Title	*Number of copies*	*Number of students*

1.13. Quality assurance of course and/or module

Quality of the course will be monitored and measured through the success of examinations and through the anonymous inquiry reflecting students opinions regarding the course.

[35] Mark in bold only the relevant categories and 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.

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General Information		
Course organiser		
Course title	Seminar / B. Sc. thesis	
Program	Undergraduate course in Mathematics	
Course status	Compulsory	
Year	III	
Credits and Teaching	ETCS credits / student workload	3
	Hours (L+E+S)	0 + 0 + 30

1. COURSE DESCRIPTION

1.1. Course objectives

This seminar is the first step towards elaboration of undergraduate thesis. The seminar objective is to further enable students for independent research and work with mathematical reading, and also for presentation of mathematical contents.

1.2. Correspondence and correlation with the program

The program of the course is in correlation with the other mathematical courses. Depending on the subject of the seminar there is a closer correlation with the specific mathematical course.

1.3. Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

This seminar will enable students to do independent research and work with mathematical reading and presentation of mathematical contents.

1.4. Course content

All lecturers will participate in determining the content of this seminar by proposing the themes for the seminars. Every student will present the theme in public and hand over the work in written form to the mentor. The work will present the basis for the undergraduate thesis which will be elaborated in conjunction with the mentor.

1.5. Modes of instruction (mark in bold)	☐ Lectures ☒ **Seminars and workshops** ☐ Exercises ☐ Distance learning ☐ Field work	☐ Independent work ☒ **Multimedia and the Internet** ☐ Laboratory work ☒ **Tutorials** ☐ Other ☒ **Consultations**
1.6. Comments	U ovisnosti o temi seminara, prisutna je čvrsta korelacija s određenim matematičkim kolegijem.	

1.7. Student requirements

Students must prepare the seminar, hand over the work in written form and present the work in public. Also students have to attend ¾ of all other public presentations. Students will be evaluated on the basis of written work, public presentation, attendence of the seminar and participation in discussions.

1.8. Evaluation[36] and Assessment

[36] Mark in bold only the relevant categories and 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.

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Class attendance and class participation			**1**	Seminar paper	**2**	Experiment	
Written exam (preliminary exam)		Oral exam		Essay		Research work	
Project work		Continuous assessment		Presentation		Practical work	
Portfolio							

1.9. Assessment and grade of student's work during the class and after the final exam

The total number of points student can achieve is 100.

1.10. Required literature

To be assigned by the mentor on the basis of theme of the work.

1.11. Recommended literature

1.12. Number of copies of recommended literature in regard to the number of students who attend the class

Title	*Number of copies*	*Number of students*

1.13. Quality assurance of course and/or module

After the last lecture of the course students will be asked to fulfill a questionnaire about the quality of the lectures.

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General Information		
Course organiser		
Course title	Introduction to Topology	
Program	Undergraduate course in Mathematics	
Course status	Elective	
Year	III.	
Credits and Teaching	ETCS credits / student workload	7
	Hours (L+E+S)	45+30+0

1. COURSE DESCRIPTION

1.1. Course objectives

Primary objective of this course is introducing students to standard ways of analysing problems and proving facts in topology. Therefore, the course includes:

- Definition of topological spaces and analysis of different ways of defining topology on a set
- Comparison of basis, subbasis and open set families in a topological space
- Comparison of different concepts of connectedness of a topological space
- Definition of compactness
- Construction of new topological spaces using products, coproducts, subspaces, quotient spaces
- Analysis of hereditary properties of topological spaces in these constructions
- Definition of separation axioms
- Definition and description of homeomorphisms, as well as continuous, open, closed functions and analysis of their properties

1.2. Correspondence and correlation with the program

Program of the course Introduction to Topology is in correlation with other mathematical courses, especially with the courses: Vector spaces II, Set theory and Metric spaces.

1.3. Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

Students will acquire fundamental terms and properties of topological spaces. The expected outcomes, after students complete the course and pass the exam, are for the students to be able to:

- Analyse spaces endowed with families of open or closed sets, or families of neighbourhoods, and be able to determine which of these are topological spaces, using characterisations of topological spaces, basis or subbasis;
- Describe, with argumentation, the properties of a topological space: connectedness, compactness, separability;
- Analyse if a topological space fulfils a particular separation axiom property and compare these properties on
  various examples of topological spaces;
- Compare, with argumentation, the properties of topological spaces with the properties of their products, coproducts, subspaces, quotient spaces;
- Apply Urysohn Lemma, Tietze's extension of maps Theorem and Tikhonov Theorem to examples;
- Analyse homeomorphisms, continuous, open, closed maps of topological spaces, and describe their properties;

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- Examine continuity of the binary operation and operation of taking inverses in a topological group, analyse relationship between algebraic and topological properties of a topological group.

1.4. Course content

Topological spaces. Open and closed sets. Bases and subbases. Interior, closure, boundary, accumulation points of a set. Subspace and product topologies. Continuous functions and homeomorphisms. Open and closed maps. Quotient spaces. Connectedness, local connectedness and path connectedness. Separation axioms. Urysohn Lemma, metrization theorems, Tietze's theorem. Countability axioms. Compactness and local compactness. Tikhonov theorem. Topological groups.

1.5. Modes of instruction	☒ Lectures ☒ Seminars and workshops ☒ Exercises ☐ Distance learning ☐ Field work	☒ Independent work ☐ Multimedia and internet ☐ Laboratory work ☐ Tutorials ☐ Other ☒ Consultations

1.6. Comments

1.7. Student requirements

Attendance of all classes and active participation is expected.
Students are expected to solve homework, take all written tests and short quizzes, and take the final oral exam.

1.8. Evaluation and Assessment

Class attendance and class participation			***2***	Seminar paper		Experiment	
Written exam (preliminary exam)	***2.5***	Oral exam	***1.5***	Essay		Research work	
Project work		Continuous assessment	***1***	Presentation		Practical work	
Portfolio							

1.9. Assessment and grading of student's work during class and the final exam

Students' progress will be monitored continuously. The total number of points student can achieve during class (evaluated activities are indicated in the table above) is 70; the end of semester (oral) exam is scored with maximum of 30 points.

1.10. Required literature

1. J. Munkres : *Topology,* Pearson international 2nd ed, 2014.
2. O.Ya.Viro, O.A. Ivanov, V.M. Kharlamov, N.Yu. Netsvetaev *: Elementary topology: problem textbook*, AMS 2008

1.11. Recommended literature

1. S. Willard, *General Topology,* Addison-Wesley, Reading, 1970.
2. J. Dugundji, *Topology,* Callyn and Bacon, Boston, 1966

1.12. Number of copies of required literature books compared to the number of students in class

Title	*Number of copies*	*Number of students*
1. J. Munkres : *Topology,* Pearson international 2nd ed, 2014	1	20

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1.13. Quality assurance of course and/or module
After the last lecture of the course students will be asked to fulfil a questionnaire about the quality of the lectures. At the end of each semester results of the exams will be analized.

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General Information		
Course organiser		
Course title	Hyperbolic balance laws and applications	
Program	Undergraduate course in Mathematics	
Course status	Elective	
Year	III	
Credits and Teaching	ETCS credits / student workload	7
	Hours (L+E+S)	45 + 30 + 0

1. COURSE DESCRIPTION

1.1. Course objectives

A course objective is to teach students the basics of the theory of hyperbolic conservation and balance laws, and to introduce them to the state of the art numerical schemes for these types of PDE. In particular, the course objective is to give them the knowledge about the broad variety of applications, from simulations of water flow in rivers and flooding to elastic wave propagation etc.

1.2. Correspondence and correlation with the program

Knowledge in linear algebra (eigenvalues and eigenvectors of matrices) and in mathematical analysis (differential and integral calculus, basics about partial differential equations, and similar) is necessary. Knowledge about some numerical methods for PDE and about physics of the fluid dynamics can facilitate the process of learning, but it is not necessary.

1.3. Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

The course program enables the student to acquire knowledge in the area of hyperbolic conservation laws. Introducing the student to some basic conservation laws and numerical methods needed to compute numerical solutions, enables him to independently work on projects concerning related problems.

1.4. Course content

Conservation laws and balance laws. Hyperbolicity. Linear scalar equation. Nonlinear scalar equation. Linear systems. Nonlinear systems. Characteristics and Riemann invariants. Shock and Rankine-Hugoniot relations. Rarefaction waves and integral curves. The solution of Riemann problem. Numerical schemes for hyperbolic conservation laws. First order schemes. Second order flux limited schemes. High-resolution schemes. Numerical schemes for balance laws. The geometrical type source term. Application. Euler equations. Shallow water equations. Elastic wave equations.

1.5. Modes of instruction (mark in bold)	☒ **Lectures** ☒ **Seminars and workshops** ☒ **Exercises** ☒ **Distance learning** ☐ Field work	☒ **Independent work** ☒ **Multimedia and the Internet** ☐ Laboratory work ☐ Tutorials ☐ Other ☒ **Consultations**
1.6. Comments		

1.7. Student requirements

Students are required to actively participate in all the forms of work that are present in the course and in particular to finish a seminar paper (70 points). The acquired knowledge of the students is evaluated through exams (30 points).

1.8. Evaluation[37] and Assessment

Class attendance and class participation			**3**	Seminar paper	**2**	Experiment	
Written exam (preliminary exam)	**2**	Oral exam		Essay		Research work	
Project work		Continuous assessment		Presentation		Practical work	
Portfolio							

1.9. Assessment and grade of student's work during the class and after the final exam

Students' activities are monitored continuously. During the semester students can get 70 points for their activities in class. The final exam is oral, valued with maximum of 30 points.

1.10. Required literature

1. LeVeque R.J., Finite Volume Methods for Hyperbolic Problems, Cambridge University Press, 2002.

1.11. Recommended literature

1. Godlewski E., Raviart P.A., Hyperbolic systems of conservation laws, Mathematiques & Applications 3/4, 1991.
2. Godlewski E., Raviart P.A., Numerical approximation of hyperbolic systems of conservation laws, Springer-Verlag New York Inc., 1996.
3. Chorin, A. J. and Marsden, J. E. A Mathematical Introduction to Fluid Mechanics, *3rd ed.* New York: Springer-Verlag, 1993
4. Serre, Systems of Conserwation Laws, Cambridge University Press, 1999.

1.12. Number of copies of recommended literature in regard to the number of students who attend the class

Title	*Number of copies*	*Number of students*

1.13. Quality assurance of course and/or module

Quality and success of the course outcomes from the quality of the seminar papers and oral exam of the students. Adaptation to the interests of students is carried out continuously, and it is based on the dialog with students and inquiries.

[37] Mark in bold only the relevant categories and 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.

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General Information		
Course organiser		
Course title	Numerical Linear Algebra	
Program	Undergraduate course in Mathematics	
Course status	Elective	
Year	III	
Credits and Teaching	ETCS credits / student workload	7
	Hours (L+E+S)	45+30+0

1. COURSE DESCRIPTION

1.1. Course objectives

The objective of the course is to learn about different approaches in the linear systems solving; to analyze the errors of the considered methods and their price; to solve the overdetermined systems. Moreover, the iterative methods are considered, in particular their convergence and error analysis. Furthermore, the objective is to get familiar with numerical methods for solving symmetrical and nonsymmetrical eigenvalue problems, to learn about the consequences of the perturbation of eigenvalues and eigenvectors, and the errors appearing in that case. The generalization of the eigenvalue problem is considered.

1.2. Correspondence and correlation with the program

The course is in correlation with Linear algebra I, Linear algebra II and Numerical mathematics.

1.3. Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

Course program enables the student to acquire knowledge in numerical linear algebra, i.e., in methods and algorithms needed to solve related problems, which are often the outcome of a practical engineering problem. Furthermore, the accent is on the advantages and shortcomings of the presented methods in specific situations, and on the errors that appear in numerical computations.

1.4. Course content

Introduction into numerical computations.
Solving linear systems: Gauss elimination, LR factorization. Perturbation of systems and round off errors. Overdetermined systems and least square method. QR factorization and Cholesky method. Iterative methods.
Eigenvalue problems: Different methods for symmetric and nonsymetric eigenvalue problems. Perturbation of eigenvalue and eigenvectors. SVD decomposition.

1.5. Modes of instruction (mark in bold)	☒ **Lectures** ☒ **Seminars and workshops** ☒ **Exercises** ☒ **Distance learning** ☐ Field work	☒ **Independent work** ☒ **Multimedia and the Internet** ☐ Laboratory work ☐ Tutorials ☐ Other ☒ **Consultations**
1.6. Comments		

1.7. Student requirements

Students are required to attend lectures and exercises, to solve given individual tasks and to pass the exam.

1.8. Evaluation[38] and Assessment

Class attendance and class participation			**3**	Seminar paper	**2**	Experiment	
Written exam (preliminary exam)	**2**	Oral exam		Essay		Research work	
Project work		Continuous assessment		Presentation		Practical work	
Portfolio							

1.9. Assessment and grade of student's work during the class and after the final exam

Students' activities are monitored continuously. During the semester students can get 70 points for their activities in class. The final exam is oral, valued with maximum of 30 points.

1.10. Required literature

1. J.W. Demmel: Applied numerical Linear Algebra, SIAM, 1997.
2. G.H. Golub, C.F. van Loan: Matrix computations, The John Hopkins University Press, Baltimore,1989.

1.11. Recommended literature

1. B.N. Datta: Numerical Linear Algebra and Applications, Brooks/Cole, 1995.
2. L.N. Trefethen, D.Bau, Numerical Linear Algebra, SIAM, 1997.
3. W. Press et al: Numerical Recipes for C/Pascal/Fortra

1.12. Number of copies of recommended literature in regard to the number of students who attend the class

Title	*Number of copies*	*Number of students*

1.13. Quality assurance of course and/or module

Quality assurance of the course includes supervision of the lecture realization and attendance, supervision of the realization of the course program and in particular it is tested through students inquiry. The success of the course realization is evaluated on the basis of the quality and accuracy of the individual student's tasks, and through knowledge tests.

[38] Mark in bold only the relevant categories and 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.

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General Information		
Course organiser		
Course title	Theoretical Computer Science	
Program	Undergraduate course in Mathematics	
Course status	Elective	
Year	III	
Credits and Teaching	ETCS credits / student workload	7
	Hours (L+E+S)	45+30+0

1. COURSE DESCRIPTION

1.1. Course objectives

- to acquaint students with basic notions of induction and recursion
- to acquaint students with basic notions of grammar, automata, semantics and λ-calculus

1.2. Correspondence and correlation with the program

The programme of the course Set theory is in correlation with the other mathematical courses, especially Mathematical Logic and Set theory.

1.3. Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

After completing this course students will be able to understand and apply basic notions of theoretical computer science; to define the principle of induction, grammar, language and automata; to know relations between grammar and automata classes; to apply λ-calculus.

1.4. Course content

Principle of induction, definitions by induction and proofs. Complete partial orders and fixed point. Grammar, language, automata. Finite automata and regular expressions. Push-down automata and context free grammar. Syntactic analysis. Language of while-programs and operational semantics. Hoare logic. Denotational semantics. Recursive functions as programming languages. Eager and lazy operational semantics. Programming with infinite objects. Denotational semantics of recursive functions. Finite types and typed λ-calculus. Fixed-point operators. Infinite types, untyped λ-calculus.

1.5. Modes of instruction (mark in bold)	☒ **Lectures** ☐ Seminars and workshops ☒ **Exercises** ☐ Distance learning ☐ Field work	☒ **Independent work** ☒ **Multimedia and the Internet** ☐ Laboratory work ☐ Tutorials ☐ Other ☒ **Consultations**
1.6. Comments		

1.7. Student requirements

Students must attend the lectures and participate in all activities required for the course.

1.8. Evaluation[39] and Assessment

Class attendance and class participation			**1.4**	Seminar paper		Experiment	
Written exam (preliminary exam)	**2.8**	Oral exam	**2.8**	Essay		Research work	
Project work		Continuous assessment		Presentation		Practical work	
Portfolio							

1.9. Assessment and grade of student's work during the class and after the final exam

Student's activities are continuously being monitored. Quality of student's active participation during classes and exercises is a component of the monitoring and evaluation (70 points). Complete knowledge of the student is evaluated at the exam (30 points).

1.10. Required literature

1. G.Winskel, The Formal Semantics of Programming Languages, MIT Press, 1993.
2. Moll, Arbib, Kfoury, Introduction to Formal Language Theory, Springer 1988.

1.11. Recommended literature

1. H.P.Barendregt, The Lambda Calculus, North-Holland Publishing Complany, 1981.
2. J.R.Shoenfield, Recursion Theory, Springer, 1993.
3. K.R.Apt, E.-R.Olderog, Verification of Sequential and Concurrent Programs, Springer 1991.

1.12. Number of copies of recommended literature in regard to the number of students who attend the class

Title	*Number of copies*	*Number of students*

1.13. Quality assurance of course and/or module

After the last lecture of the course students will be asked to fulfill a questionnaire about the quality of the lectures. At the end of each semester results of the exams will be analyzed.

[39] Mark in bold only the relevant categories and 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.