DISCRETE MATHEMATICS AND ITS APPLICATIONS

CURRICULUM

L – lectures, E – exercises, S – seminars (contact hours)

ECTS – European Credit Transfer and Accumulation System points

STATUS: C – compulsory, CM – compulsory for the module Optimization

Year of study: 1					
Semester 1					
	L	E	S	ECTS	STATUS
Vector spaces 1	30	30	0	6	C
After completing this course, the students will be able to: - describe basic examples of vector spaces and linear operators, - solve problems related to the calculation of the rank, - solve problems related to adjoint spaces, - construct Jordan basis, - apply and explain the procedure of reduction of an operator on finite dimensional vector spaces in particular problems, - describe bacis examples of unitary spaces, - classify main properties of bilinear forms, - classify main properties and examples of normal operators.					
Measure and Integral	30	30	0	6	C
After completing this course, the students will be able to: - explain and use the properties of a measure and integral, - analyse examples of a measure with a special emphasis on the Lebesgue measure, - use and explain the convergence theorems in problem solving, - use and explain the Fubini's theorem in problem solving, - analyse the notions of absolute continuity and singularity of a measure and the relations between them, - analyse the connections and differences between Riemann and Lebesgue integral.					
Algebra 1	30	30	0	6	C
After completing this course, the students will be able to: - define and analyse properties of free groups, apply an adequate method while solving problems, - differentiate and analyse different categories, apply an adequate method while solving problems, - define and analyse properties of modules, apply an adequate method while solving problems, - define solvable groups and characterize them using different methods, apply an adequate method while solving problems, - define nilpotent groups and characterize them using different methods, apply an adequate method while solving problems.					

Linear programmning	30	30	0	6	C
After completing this course, the students will be able to: - classify basic convex sets of points in n-dimensional Euclidean space and proper analytical methods of solving linear programming problems, - apply properties of a linear (affine) function to a linear programming problem, - define the goal function in simple linear programming problems, - apply and explain various algorithms for finding extreme values of a linear function on a convex set, - solve the dual problem of linear programming, - apply and explain the Simplex algorithm, - analyse the concept of matrix games, - solve problems of integer programming, - analyse the basics of convex programming.					
Graph theory	30	15	15	6	C
After completing this course, the students will be able to: - differentiate the basic properties of graphs and use them in solving problems, - analyse problems of graph connectivity and related properties, - analyse Eulerian and Hamiltonian graphs and apply the definitions and properties in solving problems, - solve problems related to a matching in graphs.					
Semester 2					
	L	E	S	ECTS	STATUS
Statistics	30	30	0	6	C
After completing this course, the students will be able to: - present statistical data in tabular and graphical form, - explain the classification of statistical variables, - analyse continuous random variables and vectors that are used in statistics, - use estimators and their properties within the specific statistical models, - using a computer, construct confidence intervals and conduct a procedure of testing statistical hypotheses, - using a computer, apply methods of statistical data analysis.					
Algebra 2	30	30	0	6	C
After completing this course, the students will be able to: - define, give examples and recognise basic algebraic structures with two operations, - explain the concept of ring, ideal and ring homomorphism, - explain the basic theorems of polynomial theory, - explain and apply various types of field extensions, - successfully solve problems of determining Galois group, - explain the basics of Galois theory.					
Probability theory	30	30	0	6	C
After completing this course, the students will be able to: - apply random variables and their properties in solving problems, - explain the classification of random variables, - apply limit theorems for mathematical expectation, - apply basic probability inequalities, - explain basic types of convergence of random variables and their relations, - explain weak and strong laws of large numbers, and convergence of series of random variables, - apply properties of characteristic functions in solving problems, - explain inversion and continuity theorems for characteristic functions, - explain weak convergence of sequence of distribution functions, - apply the central limit theorem.					

Artificial intelligence	30	30	0	6	C
After completing this course, the students will be able to: - analyse different perspectives on what are the problems of artificial intelligence, - explain the basic knowledge representation, problem solving, and learning methods of artificial Intelligence, - assess the applicability, strengths, and weaknesses of the basic knowledge representation, problem solving, and learning methods in solving particular problems, - develop intelligent systems through examples of concrete computational problems, - design basic problem solving methods based on artificial intelligence - based search, reasoning, planning, and learning algorithms, - describe logic programming language associated with artificial intelligence.					
Coding theory and cryptography	30	15	15	6	C
After completing this course, the students will be able to: - differentiate and analyse cryptography systems and apply an adequate procedure in problem solving, - analyse and differentiate type of codes and apply an adequate procedure in problem solving, - differentiate ways of detecting errors in data transfer with a particular coding method and analyse the conditions for correcting these errors.					

Year of study: 2.					
Semester 3					
	L	E	S	ECTS	STATUS
Permutation groups	30	15	15	6	C
After completing this course, the students will be able to: - differentiate and analyse various actions of a group on a set, explain and apply adequate methods while solving problems, - differentiate and analyse various examples of permutation groups, explain and apply adequate procedures while solving problems, - construct various finite structures from permutation groups and analyse their properties, - explain and apply O'Nan-Scott theorem and its consequences, - describe the classification of finite simple groups.					
Number theory	30	30	0	6	C
After completing this course, the students will be able to: - analyse basic properties of integers and apply those properties to simple problems in the number theory related to divisibility and divisibility algorithms, - calculate using modular arithmetics, solve congruency equations and systems of congruencies, - explain and apply the quadratic law of reciprocity and formulas for calculating the Legendre symbol, to solve quadratic congruencies, - describe a display of integers by using quadratic forms in simple cases, compare and classify different quadratic forms, - show and analyse basic multiplicative functions and their properties, check and show connections between them, - define basic types of Diophantine equations and describe the methods of solving them, - define elliptic curves, analyse their basic properties and describe important open problems, - explain and apply the methods in the number theory in analysis of the public-key cryptosystem, - describe and analyse algebraic and analytical methods in the number theory and apply them to important problems in the number theory.					

Introduction to design theory	30	15	15	6	C
After completing this course, the students will be able to: - define the basic concepts of the design theory, - explain and apply the basic theorems of the design theory, - construct examples of block designes and related combinatorial structures, - apply the design theory in the elementary problems of the coding theory, threshold schemes, visual cryptography and group testing.					
Design and analysis of experiments	30	15	15	6	C
After completing this course, the students will be able to: - describe and apply the basic principles and methods for designing and analysing experiments to particular examples, - analyse the model for designs with one source of variation, - analyse and apply the methods of multiple comparisons, - analyse models for two treatment factors, - use the appropriate software package for solving problems, - analyse basic notions in statistical design theory, - apply the basic notions in statistical design theory to particular examples.					
Nonlinear optimization	30	30	0	6	CM
After completing this course, the students will be able to: - list different methods of nonlinear optimization, - formulate problems in nonlinear optimization and appreciate their assumptions and limitations, - choose an appropriate method for solving nonlinear optimization problem using modern optimization methods and software.					
Semester 4					
	L	E	S	ECTS	STATUS
Seminar of M.Sc. thesis	0	0	30	4	C
After completing this course, the students will be able to: - present mathematical concepts using teaching aids and facilities, - express correctly and fluently in speaking communication in the language of teaching, - use different communication types and forms, - use relevant and recent professional literature independently and critically.					
Combinatorial optimization	30	30	0	6	CM
After completing this course, the students will be able to:: - list different mehods of combinatorial optimization, - differ optimal and heuristic methods of combinatorial optimization (i.e. optimal and near-optimal solutions), - formulate problems in combinatorial optimization and appreciate their assumptions and limitations, - choose appropriate method for solving combinatorial optimization problem using modern optimization methods and software.					
Machine learning	30	30	0	6	CM
After completing this course, the students will be able to: - describe machine learning techniques and computing environment that are suitable for the applications, - analyse various types of learning algorithms, - develop machine learning techniques and associated computing techniques and technologies for various applications, - identify current real world problems that can benefit from emerging machine learning techniques, - design machine learning and associated algorithms that can address real problem.					

Optimization techniques for data mining	30	15	15	5	CM
After completing this course, the students will be able to: - describe data mining techniques, - analyse different types of algorithms in data mining, - use some techniques of data mining in practice, - design algorithms in data mining that can address real problem.					
Optimization methods in finance	30	15	15	5	CM
After completing this course, the students will be able to: - define basic terms related to financial mathematics, - list different optimization mehods in finance, - formulate problems in financial mathematics and appreciate their assumptions and limitations, - solve practical problems arising in finance using modern optimization methods and software.					
Graduation				4	C

While creating a study program, the following resource was considered:
Tuning Educational Structures in Europe http://www.unideusto.org/tuningeu/ , especially the part that refers to the study of mathematics. **http://www.unideusto.org/tuningeu/subject-areas/mathematics.html**