Course name: **ANALYSIS I - THE FOUNDATIONS OF ANALYSIS**
Number of ECTS credits: **6**

**Content:**
- Functions of real variables, even and odd functions, periodicity. Limits of functions, left and right limits. Continuity. Continuous functions on closed intervals limited. Bisection method for finding zeros.
- The elementary functions. Cyclometric functions.

Course name: **ALGEBRA I - MATRIX CALCULUS**
Number of ECTS credits: **6**

**Content:**
- Vectors, analytic geometry in space.

Course name: **COMPUTER SCIENCE I**
Number of ECTS credits: **6**

**Content:**
Basic building blocks of a computer program (using the syntax of the programming language Java):
Basic data structures:
Algorithms and problem solving:
Programming languages overview:
Declarations and types:
Abstraction mechanisms:
Course name: **DISCRETE MATHEMATICS I - SET THEORY**  
Number of ECTS credits: **6**

Content:  
- Introduction to mathematical theory, logic, truth tables, mathematical logic.  
- Formal Languages.  
- Basic concepts of mathematical logic.  
- Finite and infinite, countable and uncountable sets.  
- Cardinal and ordinal numbers. Peano arithmetic, mathematical induction.  
- The system of axioms of set theory NBG and ZFC. Axiom of choice. Zorn's lemma.  
- Introduction to symbolic computation (Mathematica).

Course name: **COMPUTER PRACTICUM**  
Number of ECTS credits: **6**

Content:  
The faculty network and basic usage rules:  
- Description of the faculty computer network, login methods, password changing procedure, e-mail and mailing list usage, access to e-materials.  
- OS Linux basics:  
- Description of the Linux OS and its Slovenian version - Pingo Linux. BASH shell usage basics.  
- Programming language C:  
- The syntax of the C programming language. Usage of programming language C to solve example problems.

Course name: **MATHEMATICAL PRACTICUM I**  
Number of ECTS credits: **6**

Content:  
- Programs for presentations (eg PowerPoint), spreadsheet (eg Excel)  
- Text editors (eg WinEdt, TextPad, Emacs, Auctech, Open Office, ...)  
- Introduction to TeX and LaTeX-a (MikTeX, tetex, GSview, Acrobat Reader, ...)  
- The basic tools to produce images (pdf, eps), working with the formats of images including images in LaTeX  
- Scanning and use of digital cameras.

Course name: **ALGEBRA II - LINEAR ALGEBRA**  
Number of ECTS credits: **6**

Content:  
- Groups, rings, fields. Ring of polynomials.  
- Vector space. Subspaces, linear operators. Linear independence. Basis and dimension of vector space.  
- Eigenvalues. The characteristic and minimal polynomial.
Course name: **ANALYSIS II - INFINITESIMAL CALCULUS**  
Number of ECTS credits: 6

**Content:**
- The logarithm, the number e, and the definition of exponentiation with the real exponent.
- Drawing planar curves.

Course name: **MATHEMATICAL TOPICS IN ENGLISH I**  
Number of ECTS credits: 6

**Content:**
Lectures are given on the most current research topics in the field of mathematics, which may include the following topics
- History of the concept of number
- Number theory
- Algebra
- Analysis
- Famous planning tasks
- Overview of the history of computing
- History of Slovenian mathematics
- Historical development of mathematical concepts

Course name: **DISCRETE MATHEMATICS II - COMBINATORICS**  
Number of ECTS credits: 6

**Content:**
Course name: PHYSICS
Number of ECTS credits: 6

Content:

Course name: ALGEBRA III - ABSTRACT ALGEBRA
Number of ECTS credits: 6

Content:
- Introduction to number theory, Euclidean algorithm, congruences.
- Grupoids, semigroups and groups. Homomorphisms of groups. Normal subgroups and factor groups. Families of groups. Groups given by generators and relations. Sylow theorems.

Course name: ANALYSIS III - FUNCTIONS OF MANY VARIABLES
Number of ECTS credits: 6

Content:
- Double and multiple integrals. Properties. The conditions on the existence. The introduction of new variables.
- Calculation and application.
- Proper and generalized integrals with parameter. Beta and Gamma functions. Stirling formula.

Course name: INTRODUCTION TO NUMERICAL CALCULATIONS
Number of ECTS credits: 6

Content:

Course name: COMPUTER SCIENCE II
Number of ECTS credits: 6

Content:
- Introduction: Introduction to programming languages, concepts of programming languages, Meta-language, Chomski hierarchy, computability, overview of programming language history.
- Lambda calculus: History of λ-calculus, λ-abstraction, definition of λ-calculus, evaluation, substitution, alpha reductions, beta reductions, programming in λ-calculus, Church numbers, recursion, uses of λ-calculus.
- Syntax: Grammars, parsing, parse trees, BNF, grammar definition, operator, priority of operator, associativity, dangling else, abstract syntax tree, BNF variations.
- Basic structures: Values, basic types, variable declaration, global declaration, local declaration, implementation of variables, symbol tables, name-spaces.
- Functional languages: Mathematical and logic foundations, function expressions, function definition, recursive functions, polymorphism, higher-order functions, examples of functions.
- Imperative languages: Variables, sequential control, structured control, if statement, loops, patterns, function implementation, parameters, activation records, array, functions on arrays.
- Types: Introduction to types, type declaration, products, records, unions, vectors, recursive types, parametrized types, type checking, type inference, examples of use of types.
- **Modules**: Modules as units of compilation, interface and implementation, separate compilation, language of modules, information hiding, sharing types among modules, functors, examples of module implementations.

- **Objects and classes**: Introduction to object-oriented languages, object logic, class definition, aggregation, specialization, inheritance, self and super, object initialization, method overloading, dynamic binding, abstract classes, polymorphism, parametrized classes, introspection, exceptions, implementation of classes and objects.

**Course name: ANALYSIS IV - REAL ANALYSIS**

Number of ECTS credits: 6

Content:
- Fourier series. Bessel inequality of vector spaces with inner product.
- Orthonormal system and ortnormirana base. Fourier integral and Fourier transform.
- Differential geometry of curves in the plane and space. The length of the curve. Natural parameter.

**Course name: ALGEBRA IV - ALGEBRAIC STRUCTURES**

Number of ECTS credits: 6

Content:
- The extension degree. Tower Theorem. Simple algebraic extension. Splitting field.
- Constructions with ruler and compass. Squaring the circle. Trisecting the angle. Doubling the Cube.
- Constructions of regular polygons.

**Course name: PROBABILITY**

Number of ECTS credits: 6

Content:
- Basics of combinatorics
- Fundamental Theorem of combinatorics.
- Variations and variations with repetition.
- Combinations and combinations with repetition.
- Permutations and permutations with repetition.
- The binomial formula and generalizations.
- Outcomes and Events
- The sample space, events, definition of probability.
- Calculations with the events.
- Conditional probability and independence.
- Random Variables
- Random variables and their distributions.
- Overview of some discrete distributions.
- Mathematical expectation and variance.
- Continuous random variables.
- Multidimensional distribution
  - Definition of multi-dimensional discrete distribution.
  - The independence of random variables.
- Covariance, the sum of random variables.
- Conditional distributions and conditional mathematical expectation.
- Multidimensional continuous distributions.
- Generating functions
- Definition and examples.
- The process of diversification.
- Approximations of distributions
- Convergence of random variables in the distribution.
- The normal distribution approximation of sums of random variables.
- Poisson approximation

**Course name: MATHEMATICAL TOPICS IN ENGLISH II**
Number of ECTS credits: 6

**Content:**
- Basic methods of combinatorics: Classification of discrete problems, basic rules of combinatorics, Selections, Inclusion-exclusion principle, generating functions, rook polynomials
- Combinatorics and recursion: Distributions, Polynomial sequences, Descending powers, Stirling number of first and second kind, Lah numbers and antidifferences, Sums, linear recursion
- Theory of discrete probability, experiment, event, conditional probability, independence, Relay experiments, random variables, Mathematical expectation and variance.

**Course name: MATHEMATICAL MODELING**
Number of ECTS credits: 6

**Content:**
- **Introduction.** What is mathematical modeling? The role of mathematical models in natural sciences and economics. Types of mathematical models.
- **Programming tools.** A short overview of Octave/Scilab.
- **Optimization.** Critical point, minimum, maximum, saddle. Taylor's formula for scalar fields. Local extrema and local extrema under constraints. Newton's method. Applications: discrete catenary, truss stability etc.
- **Calculus of variations.** Standard problem of variation calculus. Isoperimetric problems. Applications: catenary, brachistochrone, truss oscillations, etc.
theory. Applications: epidemic models, models of competition, models of symbiosis, predator-prey dynamics, molecular kinetics, basic neurological models, models in economics.

Course name: GEOMETRY
Number of ECTS credits: 6

Content:
- Steiner systems
- Designs
- Almost linear spaces
- Linear spaces
- Configurations, Pappus and Desargues configurations
- Projective spaces
- Affine spaces
- Polar spaces
- Generalized quadrangles
- Partial geometries

Course name: FUNCTIONAL ANALYSIS
Number of ECTS credits: 6

Content:
- Linear operators and linear functionals. Boundedness of the operator.
- Unbounded operators. Closed operator. Adjpoin of densely defined operator.

Course name: STOCHASTIC PROCESSES
Number of ECTS credits: 6

Content:
Stochastic processes are a field of probability important for applications in numerous fields. The starting point for the understanding is the treatment of Markov chains in discrete time. The students will become familiar with concepts like strong Markov property, ergodic properties of Markov chains, reversibility and other. With the introduction of sojourn times we
pass on to Markov chains in continuous time which is a step in the direction of continuous time stochastic processes.

Martingales are a central concept in modern probability theory. Examples of martingales will be presented first followed by the two fundamental theorems on optional stopping and the convergence theorem. These two results in turn lead to many results like martingale inequalities, convergence theorems for random sums and similar.

Brownian motion is a fundamental object in stochastic processes in continuous time. The construction question will be treated, path properties examined, the strong Markov property will be presented along with the reflection principle. In the end we will look at a few continuous time martingales related to Brownian motion.

**Course name: DIFFERENTIAL EQUATIONS**

Number of ECTS credits: 6

**Content:**

- Bessel differential equation. Solution with the series. Representation with series and integrals.
- Numerical solutions.
- Laplace transform. Inverse formula, properties. Application.

**Course name: INTRODUCTION TO STATISTICS**

Number of ECTS credits: 6

**Content:**

**Sampling:**

- The concept of random sampling
- Sampling distribution and standard error
- Examples of sampling and their standard errors
- Stratified sampling and examples of allocations

**Parameter estimation:**

- The concept of a statistical model
- Parameter space, estimators, sampling distribution
- Maximum likelihood method
- Asymptotic properties of the maximum likelihood method
- Rao-Cramér inequality, optimality of estimates, factorization theorem

**Hypothesis testing:**

- Problem formulation
- Statistical tests, test size, power of tests
- Examples of statistical tests
- Wilks' Theorem
- Neyman-Pearson lemma, theory of optimality
Linear models:
- Assumptions of linear models and examples
- Parameter estimation
- Gauss-Markov theorem
- Generalizations of linear models

Applications

Course name: PERMUTATION GROUPS
Number of ECTS credits: 6

Content:
- group action.
- orbits and stabilizers.
- extensions to multiply transitive groups.
- primitivity and imprimitivity.
- permutation groups and graphs.
- graph automorphisms, vertex-transitive and Cayley graphs.
- graphs with a chosen degree of symmetry.
- permutation groups and designs.

Course name: SYMMETRIC CODES
Number of ECTS credits: 6

Content:
- history of the classical symmetric key encryption schemes
- fundamental concepts in the design of block and stream ciphers,
- modes of operation of symmetric key ciphers,
- cryptographic criteria for encryption schemes,
- security evaluation and generic attacks,
- basic building blocks of symmetric key encryption schemes,
- state-of-art ciphers and their security

Course name: ALGEBRAIC GRAPH THEORY
Number of ECTS credits: 6

Content:
- Eigenvalues of the graph;
- Automorphism group of graph;
- Symmetries of the graph;
- Graphs with transitive automorphism group (vertex-transitive graphs, edge-transitive graphs, arc-transitive graphs, distance-transitive graphs);
- Strongly regular graphs.

Course name: TOPOLOGY
Number of ECTS credits: 6

Content:
- Connectedness. An ordinary connectedness and connectedness with paths. Components. Local connectedness.

**Course name: CODING THEORY**

Number of ECTS credits: 6

Content:
- mathematical background (groups, rings, ideals, vector spaces, finite fields);
- basic concepts in coding theory;
- algebraic methods for the construction of error correcting codes;
- Hamming codes;
- Linear codes;
- Binary Golay codes;
- Cyclic codes;
- BCH codes;
- Reed-Solomon codes;
- bounds (Hamming, Singleton, Johnson's bound, ...)

**Course name: NUMBER THEORY**

Number of ECTS credits: 6

Content:
- Prime numbers. Writing numbers in other bases.
- Divisibility criterions. Congruences. Theorems of Fermat and Euler.
- Solving congruence equations. Quadratic reciprocity law.

**Course name: MEASURE THEORY**

Number of ECTS credits: 6

Content:
- Approximation of a measurable function with continuous function. Lusin's theorem.
- Differentiability of measure, symmetrical derivative of a measure. Absolute continuous functions and fundamental theorem of calculus. Theorem on substitution in integration.
- Product measure and Fubini's theorem. Completion of product Lebesgue measures.

**Course name: SEMINAR - INTRODUCTION TO RESEARCH WORK**
Number of ECTS credits: 6

The course consists of the most important research topics from the field of mathematics. Student learns mathematician thinking and comprehends the use of mathematical language. In this way he/she achieves a critical view towards learning various mathematical subjects.

**Course name: CRYPTOGRAPHY AND COMPUTER SECURITY**
Number of ECTS credits: 6

**Content:**
- Classical ciphers and historical development.
- Fiestel's cipher and AES (Advanced Encryption Standard).
- Finite fields and Extended Euclidean algorithm.
- Public crypto systems, one-way functions and related problems from number theory (testing primality, factorization of integers, discrete logarithm problem)
- Hash functions and message integrity (authentication)
- Key exchange protocols and identification protocols
- Pseudo random number generator
- Other protocols (flipping a coin over the telephone, mental poker, secret sharing, verification codes, visual cryptography, zero knowledge proofs)
- Public key infrastructure (PKI), certificate authority (CA)
- Broader view on cryptography - security of information and network security