İSTİNYE UNIVERSITY

FACULTY OF ART and SCIENCE - MATHEMATICS BACHELOR PROGRAM

COURSE DESCRIPTION

1th SEMESTER

Calculus 1 | ECTS (3+1+0) 6

Functions, limits, continuity, differentiation and applications, integration, fundamental theorem of calculus, techniques and applications of integration, improper integrals and series, Taylor polynomials, power series, basic transcendental functions.

Computational Thinking | ECTS (3+0+0) 5

Introduction to the central idea of computational thinking as it applies to a wide variety of human endeavours, including natural and physical sciences; computational mathematics with Sage, Matlab, and Mathematica; introduction to programming with Python.

Analytic Geometry | ECTS (3+0+0) 5

Foundations of Analytic Geometry: points, lines in two-dimensional space; points, lines and planes in three- dimensional space; Cartesian and polar coordinates; equations of subspaces; circles, hyperbola, parabola, ellipses, and their equations; cylinders and spheres; distances and angles between subspaces.

Physics 1 | ECTS (3+1+0) 6

Vectors. Motion in one and two dimensions. Newton's laws and its applications. Work and energy. Conservation of mechanical energy. Momentum and motion of systems. Static equilibrium of rigid bodies. Rotation and angular momentum. Newton's law of universal gravitation.

Turkish Language | ECTS (2+0+0) 2

The relationship between language and thought, the relationship between language and culture, the importance of language in social life, the languages of the world and the place of Turkish among these languages; Turkish situation and problems; Turkish spelling rules; effective reading and listening; general rules of written and oral expression; intellectual order, paragraph and forms of expression; official correspondence.

2nd SEMESTER

Calculus 2 | ECTS (3+1+0) 6

Vector calculus, functions of several variables, directional derivatives, gradient, Lagrange multipliers, multiple integrals and applications, change of variables, coordinate systems, line integrals, Green's theorem and its applications.

Computational Mathematics | ECTS (3+2+0) 7

Introduction to the theoretical underpinnings of computer science and engineering. Topics include propositional predicate logic, set theory, functions and relations, counting, mathematical induction, recursion, generating functions, graph theory and algorithms. Fundamentals of groups, rings, fields, number theory and cryptography. Computational tools such as Python, Sage, and Mathematica will be used to illustrate properties of the mathematical objects and structures.

Analytic Geometry 2 | ECTS (3+0+0) 5

Quadratic forms, bilinear forms, variation of variables, spectral theorems, affine geometry, affine transformations, projective geometry, configurations (Desargues, Pappus, Pascal), conics, projections, polarities, quadrics and other basic algebraic types.

Turkish Language 2 | ECTS (2+0+0) 2

Types of written expression, types of oral expression, scientific research methods, oral presentation types.

3rd SEMESTER

Atatürk's Principles and History of Turkish Revolution 1 | ECTS (2+0+0) 2

The Collapse of the Ottoman Empire, Tanzimat and Reform Edict, I. and II. Constitutional Era, Tripoli and Balkan Wars, World War I, Mudros Armistice, War of Independence; Amasya Circular, National Congresses, Establishment of Turkish Grand National Assembly, Declaration of Republic

General English 1 | ECTS (2+0+0) 2

Students will be able to use basic daily expressions, to introduce themselves and second and third person, to ask and answer personal questions.

Advanced Calculus 1 | ECTS (3+1+0) 6

Sequences and functions, compact sets, continuity, uniform continuity, limits of functions, discontinuities, differentiation, derivatives for functions of several variables, differentiation of composite functions, Taylor's Theorem, definite integrals, substitution in multiple integrals, improper integrals.

Linear Algebra 1 | ECTS (3+1+0) 6

Systems of linear equations, matrices, row echelon and reduced row echelon forms, matrix multiplication, invertible matrices, vector spaces : subspaces, basis, dimension. Linear transformations : matrix representation of linear transformations. Inverses of linear transformations, determinants, properties of determinant, Cramer's rule.

Probability | ECTS (3+1+0) 6

Sample space, sample point and events, counting rules of sample points, permutations, combinations, binomial theorem, probability of an event, probability axioms, some probability rules, conditional probability, independent events, Bayes's theorem, discrete and continuous random variables, two dimensional random variables, expected value, variance and properties, Chebyshev's inequality, some special discrete distributions; Bernoulli, binomial, geometric, negative binomial, hypergeometric, poisson and uniform distributions, continuous uniform distribution, normal distribution, areas under the normal curve, applications of normal distributions.

Computer Algebra Systems | ECTS (3+2+0) 7

Computational tools such as Python, Sage, Magma, Matlab and Mathematica will be used to illustrate properties of the mathematical objects and structures.

Manifest of İstinye | ECTS (0+1+0) 1

4th SEMESTER

Atatürk's Principles and History of Turkish Revolution 2 | ECTS (2+0+0) 2

Political revolutions, political parties and attempts to transition to multi - party political life, revolutions in the field of law, regulation of social life, innovations in economic field, Turkish foreign policy in the period 1923-1938, Post-Atatürk Turkish Foreign Policy

General English 2 | ECTS (2+0+0) 2

Students will be able to use basic structure about personal information, jobs, asking and giving directions, public transportation.

Advanced Calculus 2 | ECTS (3+1+0) 6

Infinite series, conditional convergent series, double series, uniform convergence, series and series of functions, power series, improper integrals with parameters, differentiation of transformations, linear functions, differentials and inverses of transformations, inverse and implicit function theorems.

Linear Algebra 2 | ECTS (3+2+0) 7

Eigenvalues, eigenvectors, diagonalization, inner product spaces, Gram-Schmidt orthogonalization process, singular value decomposition, Jordan canonical form, minimal polynomial, Rational canonical forms, multilinear maps and tensors.

Differential Equations | ECTS (3+1+0) 6

Some definitions, terminology and mathematical models. First-order and higher-order differential equations, along with the methods of solutions and their applications. Modeling with higher-order, Laplace transform, and systems of linear first-order differential equations. Series solutions of linear equations. Numerical methods.

Statistics | ECTS (3+2+0) 7

Data analysis and data presentation methods, sampling distributions, point estimators and properties of estimators, Cramer Rao inequality, parameter estimation, maximum probability and moment agreement, interval estimation, hypothesis tests, Newman-Pearson lemma, probability ratio tests, goodness of fit tests, linear regression, analysis of variance, nonparametric tests.

Manifest of İstinye 2 | ECTS (0+1+0) 1

5th SEMESTER

Complex Calculus | ECTS (3+1+0) 6

Geometry of the complex plane, triangle inequalities, geometric proof of the fundamental theorem of algebra. Analytic functions: continuity and differentiability, the Cauchy-Riemann equations. Complex functions in one variable. Elementary analytic functions, for example the logarithm. Line integrals, the Cauchy integral formula. Morera's theorem. Series: Taylor and Laurent expansions. Residue calculus for definite integrals. Harmonic functions and analytic functions: conjugate harmonics, conformal invariance of Laplace's equation in the plane, the Cauchy-Riemann equations and conformal maps, Poisson kernel derived from Cauchy's formula; solution of boundary value problems for Laplace's equation by conformal mapping.

Abstract Algebra | ECTS (3+2+0) 7

Groups: definition and examples, homomorphisms, subgroups, normal subgroups, quotient groups, cyclic groups, symmetric group, group actions, Sylow subgroups, direct sums, free abelian groups, finitely generated abelian groups, free groups, solvable groups, finite simple groups. Rings: definitions and examples, homomorphisms, ideals, commutative rings, factorization, polynomial rings, formal power series, groups rings, localization, Groebner bases.

6th SEMESTER

Metric Spaces | ECTS (3+1+0) 6

Metric spaces : definition, examples, open sets, closed sets, interior, closure, limit points, equivalent metrics, product metrics. Completeness: limits, continuity, Cauchy sequence, complete sets, isometries, completion of a metric space, contraction mapping theorem. Compactness: definition, examples, continuous functions, uniform continuity, Heine-Borel theorem, Arzela- Ascoli theorem. Connectedness: definition, examples, R^n, components, continuous functions, path connectedness. Introduction to point set topology.

Abstract Algebra 2 | ECTS (3+2+0) 7

Modules over principal ideal domains, algebraic field extensions, splitting fields, algebraic closures, separable and inseparable extensions, cyclotomic extensions, automorphisms, Galois theory, finite fields.

Elementary Number Theory | ECTS (4+0+0) 6

Divisibility theory, Euclidean algorithm, congruences, solutions of polynomial congruences, primitive roots, power residues, quadratic reciprocity law, arithmetical functions, distribution of prime numbers, Pell's equation, quadratic forms, some diophantine equations.

7th SEMESTER

Seminar 1 | ECTS (4+0+0) 6

Individual research supervised by a member of the department.

Manifest of Istinye 3 | ECTS (1+0+0) 1

8th SEMESTER

Seminar 2 | ECTS (4+0+0) 6

Individual research supervised by a member of the department.

Manifest of İstinye 4 | ECTS (0+1+0) 1

AREA ELECTIVE COURSES

Introduction to Set Theory | ECTS (3+1+0) 6

Sets, relations, functions and orderings. Natural numbers. Finite, countable and uncountable sets. Cardinal numbers. Ordinal numbers. The Axiom of Choice. Arithmetic of cardinal numbers. Sets of real numbers. Axiomatic set theory.

Commutative Algebra | ECTS (3+1+0) 6

Noetherian rings and modules, Hilbert basis theorem, Cayley-Hamilton theorem, integral dependence, Noether normalization, the Nullstellensatz, localization, primary decomposition, DVRs, filtrations, length, Artin rings, Hilbert polynomials, tensor products, and dimension theory.

Introduction to Algebraic Geometry | ECTS (3+1+0) 6

Projective and affine algebraic varieties, Zariski topology, coordinate rings, function fields, rational maps, birational equivalence, Hilbert's nullstellensatz, tangent spaces, singular locus of a variety, dimension and degree, algebraic curves.

Error-Correcting Codes 1 | ECTS (3+1+0) 6

Hamming distance. Error-detection, correction and decoding. Linear codes: length, weight, generator and parity check matrices, dual code, cosets, nearest neighbour decoding, syndrome decoding.

Bounds in coding theory. Construction of linear codes. Cyclic codes. Some special cyclic codes: BCH codes, Reed-Solomon codes, Quadratic-residue codes. Weight distributions.

Error-Correcting Codes 2 | ECTS (3+1+0) 6

Designs. Self-dual codes. Some favourite self-dual codes: binary Golay, ternary Golay codes. Codes over some special rings. Algebraic geometry codes. Convolutional codes. Turbo codes. LDPC codes.

Algebraic Number Theory | ECTS (3+1+0) 6

Some basic commutative algebra. Rings of integers, Dedekind domains, ideals and factorization. Discriminants, ramification, structure of Galois groups. Quadratic and cyclotomic fields. Valuations, local fields. Class groups, Dirichlet's unit theorem. Some basic theory of quadratic forms. Class field theory.

Finite Fields | ECTS (3+1+0) 6

Structure of finite fields. Polynomials over finite fields: irreducible polynomials, linearized polynomials, binomials, trinomials. Factorization of polynomials. Exponential sums: characters, Gaussian sums, Jacobi sums. Permutation polynomials. Linear recurring sequences: feedback shift registers, impulse response sequences, generating functions.

Combinatorics | ECTS (3+1+0) 6

Sieve methods, lattices, distributive lattices, incidence algebra, Mobius inversion formula, Mobius algebras, generating functions, exponential formula, Lagrange inversion formula, matrix tree theorem.

Graph Theory | ECTS (3+1+0) 6

Fundamental concepts of graphs and digraphs, trees, matchings, factorizations, connectivity, networks, graph colorings, planar graphs, and Eulerian and Hamiltonian graphs.

Cryptography | ECTS (3+1+0) 6

History and overview of cryptography. Introduction to simple crypto systems, public key cryptography, discrete logarithms and Diffie-Hellman key exchange, primality, factoring and RSA. Basics of symmetric ciphers: block ciphers and stream ciphers. Basics of asymmetric ciphers.

Elliptic Curve Cryptoraphy | ECTS (3+1+0) 6

Fundamentals of elliptic curves: computing on elliptic curves, isomorphisms of elliptic curves, endomorphisms and torsion. Elliptic curves over finite fields: size and structure of E(F_q), determining the group order and structure. Elliptic curve cryptosystems. Discrete logarithm attacks. Pairing-based cryptography. Homomorphic encryption. Algorithms for ECC.

Post Quantum Cryptography | ECTS (3+1+0) 6

Public key cryptosystems, multivariate public key cryptosytems, Matsumato-Imai system, lattice-based cryptography, hashed-based cryptography, isogeny-based cryptography, efficient implementation techniques.

Introduction to Optimal Control Theory | ECTS (3+1+0) 6

Basic optimization and the principles of optimal control. Deterministic and stochastic problems for both discrete and continuous systems. Solution methods including numerical search algorithms, model predictive control, dynamic programming, variational calculus, and approaches based on Pontryagin's maximum principle. Examples and applications of the theory.

Dynamical Systems | ECTS (3+1+0) 6

Dynamical systems with discrete and continuous time, differential equations on torus, invariant sets, topological dynamics, topological recurrence and entropy, expansive maps, homeomorphisms and diffeomorphisms of the circle, periodic orbits, hyperbolic dynamics, Grobman-Hartman and Hadamard-Perron theorems, geodesic flows, topological Markov chains, zeta functions, invariant measures and the ergodic theorem.

Machine Learning Algorithms | ECTS (3+1+0) 6

The basics of machine learning; supervised learning referring to the regression and classification algorithms including linear regression, logistic regression, support vector machines (SVM), k-nearest neighbours (kNN), random forests and artificial neural networks; unsupervised learning through clustering via k-means and dimensionality reduction through principal component analysis (PCA); reinforcement learning with markov decision processes and Q-learning.

Deep Learning Algorithms | ECTS (3+1+0) 6

Deep learning (DL) architectures, convolutional neural networks (CNNs), image classification and object detection by cnns, recurrent neural networks (RNNs), long short-term memory (LSTM) as an RNN algorithm, sequential/temporal prediction applications by LSTM, autoencoders for unsupervised learning consisting of dimensionality reduction and automated feature extraction, practical insights of using different DL architectures.