

**THE CONTENT OF UNDERGRADUATE COURSES OF THE  
DEPARTMENT OF MATHEMATICS  
(2012-2013)**

**FIRST YEAR**

**Fall Semester (1<sup>st</sup> Semester)**

**MATH 111 Calculus I (3, 2, 4) (6 ECTS)**

Functions of One Variable, Limits and Continuity, Derivative and Differentiation, Chain Rule, Implicit Differentiation, Applications of Derivative, Maxima and Minima, The Mean Value Theorem, Integration, Definite Integrals, The Fundamental Theorem of Calculus, Indefinite Integrals, Applications of Definite Integrals.

**MATH 121 Abstract Mathematics I (3, 2, 4) (6 ECTS)**

Propositional Logic; Connectives, Truth Tables, Valid Argument, Predicate Calculus; Quantifiers, Formulas, Relations; Equivalence and Ordering Relations, Partitions, Functions and Types of Functions; One-to-One, Onto Functions, Binary Operations and Some Mathematical Structures, Axiomatic Treatment of Natural Numbers, Construction of Integers.

**EENG 111 Physics I (3, 2, 4) (6 ECTS)**

Measurements, Units and Vectors, Motion in one Dimension, Motion in a Plane, Particle Dynamics, Work and Energy, Conservation of Energy, Conservation of Linear Momentum and Collisions, Rotational Kinematics and Dynamics, Equilibrium of Rigid Bodies, Oscillations and Gravitation, Fluid Mechanics, Waves in Elastic Media and Sound Waves, Temperature, Heat and Thermal Expansion, Thermodynamics.

**CENG 131 Introduction to Computing (3, 2, 4) (6 ECTS)**

Introduction to Computer Systems and Computer Languages, Introduction to Algorithms and Flow Diagrams, Introduction to C, Components of a C Program, Basic Data Types, Variables and Constants, Basic Arithmetic Operations, Basic Input / Output, Statements, Expressions and Operators, Program Flow Control, Functions.

**SOFL 101 English for Academic Purposes I (3, 0, 3) (3 ECTS)**

Topics Include; Revision of Grammatical Structures; Practice of the Four Skills, Namely Speaking, Listening, Reading and Writing; Academic Skills such as Critical Thinking, Note-Taking and Academic Writing; Language Learning Strategy Training.

**TURK 011 Turkish I (2, 0, 2) (1 ECTS)**

Historical Development of Turkish Language. Morphologic Properties of Turkey Turkish. Written and Oral Composition, Exercises on Oral Composition, Exercises on Written Composition.

### **Spring Semester (2<sup>nd</sup> Semester)**

#### **MATH 112 Calculus II (3, 2, 4) (6 ECTS)**

Length of Curves, Area, Volumes of Revolution, Transcendental Functions, Integration Techniques, L'Hospital Rule, Improper Integrals, Sequences; Limits, Monotone Sequences, Series with Positive Terms, Series with Arbitrary Terms, Absolute and Conditional Convergence, Power Series, Taylor and Mac Lauren Series.

#### **MATH 122 Abstract Mathematics II (3, 2, 4) (6 ECTS)**

Construction of Rational Numbers, Two equivalent Approach to the Construction of Real Numbers, Fundamental Properties of Real Numbers; Upper Bound, Lower Bound and Concepts of Supremum and Infimum, Size of Sets; Cardinal Numbers, Countability, Uncountability.

#### **MATH 124 Analytic Geometry (4, 0, 4) (6 ECTS)**

Coordinate Systems, Line, Plane and Trigonometry, Vectors in the Plane, The Line and Plane Equations, The Circle and Sphere Equations, Conics and Conic Sections, Transformation of Coordinates, Curve Sketching, Polar Coordinates and Parametric Equations, Solid Analytic Geometry.

#### **CENG 132 Computer Programming (3, 2, 4) (6 ECTS)**

This Course is the Continuation of CE 131 Introduction to Programming Course. So, the Fundamentals of a Basic C Knowledge are required as prerequisite of this course.

Review of Functions, String and Character Information, Array Structures and Using Arrays in Functions, Pointers, File Reading and Writing.

#### **SOFL 102 English for Academic Purposes II (3, 0, 3) (3 ECTS)**

Topics Include: Revision of Grammatical Structures; Practice of the Four Skills, Namely Speaking, Listening, Reading and Writing; Academic Skills such as Critical Thinking, Note-Taking and Academic Writing; Lexis Acquisition with a Particular Focus on Pre-fixes and Suffixes; Language Learning Strategy Training.

#### **TURK 012 Turkish II (2, 0, 2) (1 ECTS)**

Historical Development of Turkish Language. Morphologic Properties of Turkey Turkish. Written and Oral Composition, Exercises on Oral Composition, Exercises on Written Composition.

### **SECOND YEAR**

#### **Fall Semester (3<sup>rd</sup> Semester)**

#### **MATH 211 Advanced Calculus I (3, 2, 4) (6 ECTS)**

Vector-Valued Functions, Limits, Derivatives and Integrals of Vector-Valued Functions, Curves and Parameterizations, Functions of Several Variables, Limits and Continuity, Partial Derivatives, Increments and Differentials, Mac - Lauren and Taylor Series.

**MATH 221 Linear Algebra I (4, 0, 4) (6 ECTS)**

Systems of linear equations, Gauss- Jordan elimination methods, matrices and matrix operations, special types of matrices and partitioned matrices, inverse of a matrix, determinants, properties of determinants, determinants and systems of linear equations, vectors, dot product, norm, angle and distance, vector spaces, subspaces, linear combination of vectors, linear dependence and independence, basis and dimension, rank of a matrix, orthonormal vectors and projections in  $\mathbb{R}^n$ .

**MATH 231 Discrete Mathematics (3, 0, 3) (5 ECTS)**

Basic Counting: The Sum and Product Rules, the Pigeonhole Principle, Generalized Permutations and Combinations, The Binomial Theorem, Discrete Probability, Inclusion-Exclusion, Recurrence Relations, Introduction to Graphs and Trees.

**MATH 241 Introduction to Ordinary Differential Equations (4, 0, 4) (6 ECTS)**

First Order Differential Equations, Second Order Linear Equations, Higher Order Linear Equations, Series Solutions of Second Order Linear Equations, The Laplace Transform.

**STAT 250 Probability Theory (4, 0, 4) (6 ECTS)**

The Classical Finite Space Approach to Probability, Axiomatic Approach to Probability, Conditional Probability, Bayes Theorem, Independence of Events, Repeated Trials and Product Spaces, Some Probability Models, Measurable Functions and Random Variables, Distributions, Discrete and Absolutely Continuous Distributions, Transformations of Random Variables, Convolutions, Conditional Distributions, Generating Functions in General: Moment and Probability Generating Functions, Characteristics Functions, Conditional Expectation, Limit and Convergence Concepts, Modes of Convergence, Some Inequalities Useful for Finding Limits, Weak and Strong Laws of Large Numbers, Central Limit Theorems and Approximate Distributions.

**HIST 011 Principles of Atatürk and History of Revolution I (2, 0, 2) (1 ECTS)**

The reasons and forms of New Turkish Republic from Ottoman Empire, the revolutions related to New Republic, the reasons that led Turkish Revolution and research of the important stages of Independence War, baseline of Turkish Republic Government and scientific interpretation of the basic principles in Constitution.

**Spring Semester (4<sup>th</sup> Semester)****MATH 212 Advanced Calculus II (3, 2, 4) (6 ECTS)**

Chain Rules, Directional Derivatives and Gradients, Tangent Planes, Line integral, Multiple integral, Green, Stokes theorems, Divergence Theorem, The Inverse Fourier Transform, Gamma and Beta Functions, Analysis of Advanced Ordinary Differential Equations, Analysis of Advanced Partial Differential Equations, Fourier and Elliptic Integral.

**MATH 222 Linear Algebra II (4, 0, 4) (6 ECTS)**

Eigenvalues and Eigenvectors, Diagonalization and diagonalization of matrices, quadratic forms and surfaces, linear transformations and matrix transformations, kernel and range of a linear transformation, inner product spaces, the methods of Gaussian elimination and LU

decomposition, iterative methods, linear programming, simplex method, applications of matlab.

**MATH 232 Numerical Analysis (2, 2, 3) (5 ECTS)**

Operators, Collocation Polynomials, The Taylor Polynomials, Interpolation and Prediction, Some Methods of Numerical Integration, Gaussian Integration, Singular Integrals, Sums and Series, Difference and Differential Equations, Least-Squares Polynomial Approximation, Min-Max Polynomial Approximation, Nonlinear Algebra.

**HIST 012 Principles of Atatürk and History of Revolution II (2, 0, 2) (1 ECTS)**

The revolutions which are actualized on political, legal, social, economical and cultural fields, foreign policy of Atatürk's period; determining the new economy policy; Armenian issue, domestic and foreign developments between 1938-1945 and 1945-1950.

**THIRD YEAR**

**Fall Semester (5<sup>th</sup> Semester)**

**MATH 311 Algebra I (4, 0, 4) (6 ECTS)**

Elementary Properties of Groups; Permutation groups, Subgroups, Cyclic groups, Lagrange's Theorem, Normal Subgroups and Quotient Groups, Homomorphisms of Groups, Isomorphism Theorems, The Groups  $D_4$  and  $Q_8$ .

**MATH 331 Introduction to Topology I (4, 0, 4) (6 ECTS)**

Topological spaces, subspaces and relative topologies, accumulation points, closed sets, closure, interior, exterior and boundary of a set, neighborhood and neighborhood systems, bases and subbases for topology, metric spaces, metric topologies, normed spaces, continuity on topological spaces and homeomorphism, topologies induced by function.

**MATH 341 Complex Analysis I (4, 0, 4) (6 ECTS)**

Complex Numbers and Algebraic Properties, Functions of a Complex Variable, Limit, Continuity, Derivatives, Cauchy-Riemann Equations, Polar Coordinates, Analytic Functions, Harmonic Functions, Elementary Functions, Contour Integrals, Cauchy-Goursat Theorem for Simply and Multiply Connected Domains, Cauchy Integral Formula, Morera's and Liouville's Theorem, The Maximum Moduli Principle, Taylor Series, Absolute and Uniform Convergence of Power Series, Laurent Series, Residue Theorems, Classification of The Singular Points, Applications of Residue Theorem.

**Spring Semester (6<sup>th</sup> Semester)**

**MATH 312 Algebra II (4, 0, 4) (6 ECTS)**

Rings and Fields, Integral Domains, Fermat's and Euler's Theorems, The Field of Quotients of an Integral Domain, Rings of Polynomials, Factorization of Polynomials over a Field, Non Commutative Examples, Ordered Rings and Fields, Homomorphism and Factor Rings, Prime and Maximal Ideals, Introduction to Extension Fields, Isomorphism Theorems, Sylow Theorem and Application, Free Groups.

**MATH 322 Graph Theory (3, 0, 3) (5 ECTS)**

Graphs, Digraphs and Networks, Subgraphs, Paths and Cycles, Common Families of Graphs, Walks and Distance, Trees, Graph Operations, Graph Isomorphisms, Matrix Representations, Vertex and Edge Connectivity, Eulerian Graphs, Hamiltonian Graphs, Graph Coloring, Planar Graphs.

**MATH 332 Introduction to Topology II (4, 0, 4) (6 ECTS)**

Product spaces, quotient spaces, countability, connectedness, locally connectedness and compactness.

**MATH 314 Introduction to Partial Differential Equations (4, 0, 4) (6 ECTS)**

Examples on PDE, Strategies for studying PDE, Transport equation, Laplace equation, Heat Equation, Wave equation, Nonlinear first-order PDE, Characteristics, Hamilton-Jacobi equations, Second order PDE.

**FOURTH YEAR****Fall Semester (7<sup>th</sup> Semester)****MATH 411 Real Analysis (4, 0, 4) (6 ECTS)**

Sets of real numbers. Limits and continuity in  $\mathbb{R}$ . Countable and uncountable sets. Cantor set. Monotone functions. Metric spaces, normed vector spaces. Useful inequalities. Limits in metric spaces. Topology of metric spaces. Continuous functions of metric spaces. The space of continuous functions. Connectedness. Completeness. Compactness.

**Spring Semester (8<sup>th</sup> Semester)****MATH 402 Graduation Project (4, 0, 4) (6 ECTS)**

Literature Search, Topic Selection, Study and Determines the Name of Topic and Making a Detailed Schedule of Thesis, Study and Determine Writing Format and the Style of Thesis, Study and Writing an Abstract for Thesis, Study Writing Format of Thesis and Designing one Proper Format for the Thesis for Approval, Document Writing, Study and Understanding Good Document Writing, Study How One Can Prepare a Good References Format, Study and Prepare the Content, Figures, Tables, etc. of Thesis, Bounding Thesis, Checking the Content of the Thesis, Design of a Cover Thesis, Filling the Content of the Thesis Properly in the Given Format.

**MATH 412 Functional Analysis (4, 0, 4) (7 ECTS)**

Metric spaces of functions and sequences, Separable spaces, Completeness of function and sequence spaces, Banach spaces, Compactness and finite dimension, Linear operators and linear functional, Normed spaces of operators, Inner product space, Hilbert Space, Orthogonal complements and direct sums.

## SERVICE COURSES

### Fall Semester

#### **MATH 113 Mathematics For Social Sciences (4, 0, 4) (6 ECTS)**

Sets, basic counting: the sum and product rules, permutations and combinations, probability, relations and functions, linear equations and inequalities, matrices, applications of matrices to linear systems of equations, determinants, applications of determinant.

#### **MATH 115 Basic Mathematics I (3, 0, 3) (3 ECTS)**

The Distance and Midpoint Formulas, Functions, Properties of Functions, The Graph of a Function, Intercepts, Symmetry, Lines, Circles, Piecewise Defined Functions, Transformations, Vectors, Analytic geometry, Conics, Parabola, Hyperbola, Parametric Equations.

#### **MATH 213 Linear Algebra (2, 2, 3) (5 ECTS)**

Systems of linear equations, Gauss-Jordan elimination methods, matrices and matrix operations, special types of matrices and partitioned matrices, inverse of a matrix, determinants, properties of determinants, determinants and systems of linear equations, vectors, dot product, norm, angle and distance, vector spaces, subspaces, linear combination of vectors, linear dependence and independence, basis and dimension, eigenvalues and eigenvectors.

#### **MATH 215 Engineering Mathematics (2, 2, 3) (6 ECTS)**

Complex Numbers, Analytic and Elementary Functions, Mathematical Residue and Polars, Z and Laplace Transformations, Fourier Analysis.

#### **MATH 210 Differential Equations (2, 2, 3) (5 ECTS)**

First Order Differential Equations, Linear Differential Equations with Constant Coefficients, Bernoulli Equations, Linear Differential Equations, D Operator, Homogenous Linear Differential Equations, Simultaneous Linear Differential Equations with Constant Coefficients, Laplace Transformations, Inverse Laplace Transform, Heaviside's Expansion Formula, Application to Differential Equations, Simultaneous Ordinary Differential Equations, The Solution of Ordinary Differential Equations by the Laplace Transforms.

### Spring Semester

#### **MATH 114 Mathematics for Law (2, 0, 2) (3 ECTS)**

Logic, Natural Numbers, Integers, Rational Numbers, Problem Solving Techniques (Rational Problems, Percentage Problems), Plane Geometry: Triangle, Square, Rectangle, Parallelogram, Polygon, Circle.

#### **MATH 116 Basic Mathematic II (3, 0, 3) (2 ECTS)**

Composite functions, Exponential functions, Logarithmic functions, Trigonometric functions, Limits, Continuity, Derivative and Application of Derivatives, Integration and Integration techniques.

## **ELECTIVES**

### **Fall Semester**

**ERAS 300 Erasmus Placement (10 ECTS)**

**MATH 300 Internship (3 ECTS)**

**MATH 351 Programming Language (2, 2, 3) (5 ECTS)**

Evolution of the Major Programming Languages, Describing Syntax and Semantics, Lexical and Syntax Analysis, Names, Bindings, Type Checking, and Scopes, Data Types, Expressions and Assignment Statements, Statement-Level Control Structures, Subprograms, Implementing Subprograms, Abstract Data Types and Encapsulation Constructs, Support for Object-Oriented Programming, Concurrency, Exception Handling and Event Handling, Functional Programming Languages, Logic Programming Languages.

**MATH 355 Special Topics in Pure Mathematics (2,2,3) (5 ECTS)**

The contents of this lecture will be determined by the department of mathematics according to the conditions of the year.

**MATH 357 Analytical Methods in Geometry (3, 0, 3) (5 ECTS)**

Coordinate Systems, Line, Plane and Trigonometry, Vectors in the Plane, The Line and Plane Equations, The Circle and Sphere Equations, Conics and Conic Sections, Transformation of Coordinates, Curve Sketching, Polar Coordinates and Parametric Equations, Solid Analytic Geometry.

**MATH 361 Theory of Algorithms (2, 2, 3) (5 ECTS)**

Introduction to algorithms, Insertion Sort, Heapsort, Quicksort, Binary Search Tree, Breadth First search, Depth First search, Minimum Spanning Tree, Shortest Path Algorithm, Maximum Flow, Number Theoretic Algorithms, NP Completeness.

**MATH 451 Convex Analysis ve Optimization (3,0,3) (5 ECTS)**

Introduction to Optimization, Structure of Convex Sets and Convex Functions, Duality Theory, Formulations of Convex Optimization Problem, Generalized Differential, Subgradients, Fixed Point Theorem and Applications, Karush-Kuhn-Tucker Theory.

**MATH 453 Fourier Analysis and Wavelets (3, 0, 3) (5 ECTS)**

Formulation of Fourier Series, Fourier Series in  $L_2$ , Norm Convergence and Summability, Improved Trigonometric Approximation, Fourier Transforms on the Line and Space, Motivation and Heuristics, Basic Properties of the Fourier Transform, Fourier Inversion in One Dimension,  $L_2$  Theory in  $\mathbb{R}^n$ , Spherical Fourier Inversion in  $\mathbb{R}^n$ , The Method of Stationary Phase, A Class of Singular Integrals, Properties of Harmonic Functions, Poisson Summation Formula and Multiple Fourier Series, Application to Lattice Points, Schrödinger Equation and Gauss Sums, Recurrence of Random Walk, Applications to Probability Theory, Convolution Semi groups, Introduction to Wavelets, Wavelet Transform, Multiresolution Analysis, Wavelets with Compact Support, Convergence Properties of Wavelet Expansions, Wavelets in Several Variables.

**MATH 455 Vector Analysis (2, 2, 3) (5 ECTS)**

Scalar and vector valued functions. Differentiation and integration of vector valued functions. The gradient. The potential. Line and surface integrals. Gauss' and Stokes' theorems. Nabla operators. Index operations. Integral theorems. Coordinate transformations. Important vector fields. The equations of Laplace and Poisson.

**MATH 457 Seminar in Mathematics I (2, 2, 3) (5 ECTS)**

The contents of this lecture will be determined by the department of mathematics according to the conditions of the year.

**MATH 461 Computational Mathematics I (3, 2, 4) (6 ECTS)**

Mathematical Preliminaries and Notations, Languages, Grammars, Automata, Deterministic Acceptor, Transition Graphs, Graph and Languages, Language and DFA's, Nondeterministic Acceptor, Regular Expressions, Connection Between Regular Expressions and Regular Languages, Regular Grammars, Closure Properties of Regular Languages.

**MATH 463 Introduction to Abelian Groups (3, 0, 3) (5 ECTS)**

Abelian groups, Quotient groups, Isomorphism theorems, Torsion part of the group, Decomposition of torsion groups into direct sum of primary groups, Divisibility, Injective groups, Structure of divisible groups, Projective groups, Free groups.

**MATH 465 Techniques for Solving Olympiad Problems I (3, 0, 3) (5 ECTS)**

Divisibility of integers, Euclidean algorithm, Congruence, Chinese remainder theorem, Fermat's and Euler's theorems, Quadratic residues, Diophantine equations, Two basic counting principles, Arrangements and selections, Distributions, The pigeonhole and invariance principles, Coloring proofs, The extremal principle.

**Spring Semester****MATH 252 Ordinary Differential Equations (4, 0, 4) (6 ECTS)**

Systems of First Order Linear Equations, Numerical Methods, Nonlinear Differential Equations and Stability, Partial Differential Equations and Fourier Series: Boundary Value Problems and Sturm-Liouville Theory.

**MATH 254 Calculus on Time Scales (4, 0, 4) (6 ECTS)**

The Time Scale Calculus: Basic Definitions, Differentiation, Integration, Chain Rules, Further Basic Results, First Order Linear Equations: The Exponential Function, Initial Value Problems, Second Order Linear Equations: Wronskians, Reduction of Order, Method of Factoring, Nonconstant Coefficients, Cauchy-Euler Equations, Variation of Parameter, Annihilator Method, Laplace Transform, Self-Adjoint Equations: Riccati Equation, Disconjugacy, Boundary Value Problems and Green's Function, Eigenvalue Problems.

**MATH 256 Number Theory (4, 0, 4) (6 ECTS)**

Divisibility, gcd, linear equation. Congruences, Fermat's, Euler's theorems, Chinese Remainder theorem. Mersenne and Fermat primes. Carmichael numbers. Perfect numbers.



Roots modulo  $m$  and coding. Primitive roots. Quadratic residues modulo  $p$ . Pell's Equations. The Gaussian integers.

**MATH 352 Differential Geometry (4, 0, 4) (6 ECTS)**

Calculus on Euclidean Space, Tangent Vectors, Directional Derivatives, 1-Forms, Differential Forms, Mappings, Covariant Derivatives, Curves, The Frenet Formulas, Arbitrary-Speed Curves, Calculus on a surface. Surfaces in Real 3-Space, Patch Computations, Gaussian Curvature, Mean Curvature, Principal Curvatures.

**MATH 354 Complex Analysis II (4, 0, 4) (6 ECTS)**

Conformal Mapping, Analytic Continuation, Fractional Linear Transformations, Exponential, Logarithmic, Trigonometric Transformations, Riemann Surface, Transformations of Harmonic Functions, Trans. of Boundary Conditions, Applications of Conformal Mapping, Schwarz Reflection, Poisson Kernel, Dirichlet Problem, Neumann Problem, Elliptic Functions, The Gamma and Zeta Functions.

**MATH 356 Special Topics in Applied Mathematics (2,2,3) (5 ECTS)**

The contents of this lecture will be determined by the department of mathematics according to the conditions of the year.

**MATH 456 Advanced Topology (3,0,3) (5 ECTS)**

$T_0$ ,  $T_1$ , hausdorff, regular, normal and completely regular spaces, path and path connected spaces, homotopic paths, simply connected spaces, sequentially and countably compact sets, locally compact spaces and compactification.

**MATH 458 Seminar in Mathematics II (2, 2, 3) (5 ECTS)**

The contents of this lecture will be determined by the department of mathematics according to the conditions of the year.

**MATH 462 Computational Mathematics II (3, 2, 4) (6 ECTS)**

Computing Systems and the Language of Programming, A Simple Computing Machine, Flowcharts, Loops-Printing Table, Loops-Generating a Sequence, Conditional Jump Operations, Divisors and Prime Numbers, Computing with Fractions, BASIC- An Algorithmic Language, Some BASIC Functions, Decision Making and Looping, Sequences and Series, Summarizing Data, Sorting Data, Polynomial Functions, Polynomial Algebra, Two Dimensional Arrays, Systems of Linear Equations-Exact Solutions, Time- Sharing FORTRAN, Writing a FROTRAN Program, Functions.

**MATH 464 Measure Theory (3, 0, 3) (5 ECTS)**

The real number system, Lebesgue measure, Lebesgue integral, differentiation and integration, The classical Banach spaces, Banach Spaces, Brief review of general Measure and integration theory.

**MATH 466 Techniques for Solving Olympiad Problems II (3, 0, 3) (5 ECTS)**

Famous inequalities, Sequences of real numbers, Functional equations, Polynomials, Angles, Triangles, Famous theorems, Quadrilaterals, Circle, Combination with polygons, Trigonometric methods, Geometric inequalities.