INSTYTUT MATEMATYKI

Uniwersytet Kazimierza Wielkiego w Bydgoszczy

Institute of Mathematics

Master degree

BASIC SUBJECTS

Institute of Mathematics

1. Course title	**Real Analysis**
2. Course code	
3. Teaching methods	Lecture, classes
4. Type of course	Obligatory
5. Year of study, semester	First year, first semester
6. Level of course	Master Degree
7. Number of credits	7
8. Language of instruction	English
9. Name of lecturer	dr Paulina Szczuka
10. Prerequisites	Knowledge of basis definitions, theorems and examples from Real Analysis, Introduction to Mathematics and general and metric Topology.
11. Goal of the course	By the end of the course students **should know:** basic notions from Real Analysis such as continuous, semi-continuous, absolutely-continuous functions, convex functions, Baire one functions; **should be able to:** calculate Dini derivative and functions variation, apply achieved knowledge to other fields of mathematics.
12. Course contents	1. Monotonic functions. 2. Dini derivatives. 3. Oscillation of a function. 4. Variation of a function. 5. Semi-continuous function. 6. Baire one functions. 7. Absolutely continuous functions.
13. Assessment methods	**Classes**: test **Lecture**: written exam
14. Recommended reading	1. S. Łojasiewicz, *Wstęp do teorii funkcji rzeczywistych*, PWN, Warszawa 1973, 2. W. Rudin, *Analiza rzeczywista i zespolona*, PWN, Warszawa 1998. 3. A. Bruckner, J. Bruckner, B. Thomson, *Real analysis*, New Jersey 1997.

Institute of Mathematics

1. Course title	**Functional analysis**
2. Course code	
3. Teaching methods	Lectures, classes
4. Type of course	Obligatory
5. Year of study, semester	First year, first and second semester
6. Level of course	MSc Degree
7. Number of credits	7
8. Language of instruction	English
9. Name of lecturer	dr hab. Marek Wójtowicz
10. Prerequisites	Analysis, linear algebra, topology
11. Goal of the course	By the end of the course students **should know:** Basic theorems: Hahn-Banach, Banach-Steinhaus, open mapping, on orthogonal projection, Parseval's identity; Basic examples of Banach spaces: Hilbert, C(K) for K compact, l_p , L_p Basic examples bounded operators; duality and reflexivity **should be able to:** Calculate norm of a given linear operator; Verify completeness of a given normed space; Determine the dual space to a given Banach space; Solve some operator equations.
12. Course contents	1. Linear spaces, Hamel basis, dimension. 2. Finite-dimensional spaces. 3. Norm, metric, and topology on linear spaces. 4. Examples of norms; Minkowski's functional. 5. Hölder and Minkovski's inequalities; l_p-spaces. 6. Completeness of normed spaces. 7. Operators on Banach spaces – examples. 8. Banach-Steinhaus theorem, closed graph and open mapping theorems. 9. Hahn-Banach theorem; applications. 10. Hilbert spaces; complementability of closed subspaces. 11. Bessel's inequality, Parseval's identity. 12. Operators on Hilbert spaces; spectral theorem. 13. Compactness in Banach spaces. 14. Operator's equations ; Fredholm theorems.
13. Assessment methods	**C**urrent classroom assessment: two individual assessments. **Lecture:** Exam.
14. Recommended reading	1. A. Kolmogorov and S. Fomin - *Elements of the Theory of Functions and Functional Analysis,* Dover Publications, New York 1999. 2. W. Rudin – *Functional Analysis,* McGraw-Hill Scence, 1991

INSTYTUT MATEMATYKI

Uniwersytet Kazimierza Wielkiego w Bydgoszczy

Institute of Mathematics

Master degree

MAJOR SUBJECT (MATHEMATICAL ANALYSIS)

Institute of Mathematics

1. Course title	**Partial Differential Equations**
2. Course code	
3. Teaching methods	Lectures
4. Type of course	Obligatory
5. Year of study, semester	First year, second semester
6. Level of course	Master Degree
7. Number of credits	7
8. Language of instruction	English
9. Name of lecturer	dr ZBIGNIEW DUSZYŃSKI
10. Prerequisites	Basics of calculus and ODE
11. Goal of the course	By the end of the course students **should know:** the concept of partial differential equation (PDE); **should be able to:** solve different kinds of partial differential equation and Cauchy problem (first and second order PDE), describe some classical equations of mathematical physics.
12. Course contents	1. The notion of partial differential equation (PDE) and its solution – examples of first and second order equations. 2. The Cauchy problem for PDE. 3. First integrals of a system of ordinary differential equations (ODE) given in the symmetric form – the method of proportions. 4. First integrals of a first order partial linear differential equation – analytic condition (connections to the symmetric form of a system of ODE. 5. Jacobianian independence of a system of functions – two fundamental lemmas. 6. Solvability of linear PDE and the Cauchy problem. 7. Non-homogenous linear PDE – methods of solving (example). 8. Solving non-homogenous linear PDE with the Cauchy problem (including a parameter form of condition). 9. Types of second order PDE: hyperbolic, parabolic, elliptic (examples). 10. Canonic forms of the second order PDE. 11. A brief excursion into mathematical physics: wave equation, termal conduction equation.
13. Assessment methods	**Lecture:** Exam **Classes**: individual problem solving
14. Recommended reading	V. Stepanov *Differential Equations*

INSTYTUT MATEMATYKI

Uniwersytet Kazimierza Wielkiego w Bydgoszczy

Institute of Mathematics

SPECIALIZED SUBJECT (FINANCES AND INSURANCE)

Institute of Mathematics

1. Course title	**Mathematical Foundation of Economy**
2. Course code	
3. Teaching methods	Lectures, Seminar
4. Type of course	Obligatory
5. Year of study, semester	First year, First semester
6. Level of course	Master Degree
7. Number of credits	4
8. Language of instruction	English
9. Name of lecturer	dr hab. Zbigniew Grande, associate professor
10. Prerequisites	
11. Goal of the course	By the end of the course students **should know:** typical applications to constructions of different economical models; **should be able to:** apply methods of prognoses.
12. Course contents	1. Graphs and burdened graphs. Problem of the shortest road. 2. Trees. Directed graphs and relations. 3. Nets and their applications in planning of series of operations. 4. The pace of an increase of functions. 5. Elasticity of functions. 6. Törnquist function. Gauss function and function of logistical trend. 7 Prognoses of economical phenomena. 8. The forecast of vectors. 9. Models of demands vectors. 10. Method of Least Squares and its application. 11. Models of production. 12. Linear and nonlinear programmes. 13. Optimal plan of production. 14. Economical application of the integral.
13. Assessment methods	**Seminar:** Project, **Lecture:** Exam
14. Recommended reading	1) J. Piszczała; Matematyka i jej zastosowanie w naukach ekonomicznych, AE w Poznaniu, 1996. 2) E. Panek; Ekonomia Matematyczna, AE w Poznaniu, 2000. 3) Z. Grande, J. Kwiatkowski; Matematyka i jej zastosowania w ekonomii, WSIiE TWP w Olsztynie, 2001.

INSTYTUT MATEMATYKI
Uniwersytet Kazimierza Wielkiego w Bydgoszczy

Institute of Mathematics

1. Course title	**Probability and Statistical Methods in Economy**
2. Course code	
3. Teaching methods	Lectures, computing with advanced statistical application
4. Type of course	Obligatory
5. Year of study, semester	First year, second semester
6. Level of course	Master Degree
7. Number of credits	8
8. Language of instruction	English
9. Name of lecturer	dr Katarzyna Chmielewska
10. Prerequisites	Basic probability and statistics
11. Goal of the course	By the end of the course students **should know:** methods of a structure analysis, basic distributions, methods of determining the confidence interval, methods of hypothesis testing, methods of correlation and regression analyses, theory of forecasting, theory of Bayesian statistics. **should be able to:** use basic distributions to build confidence intervals for unknown parameters and for testing hypotheses, compare two populations, describe a kind and power of correlation of two or more variables, conduct statistical research and describe its results, analyse time series and prepare an economic forecast.
12. Course contents	1. Introduction and Descriptive Statistics 2. The Normal Distribution 3. Sampling Distributions 4. Confidence Intervals 5. Hypothesis Testing 6. The Comparison of Two Populations 7 Analysis of Variance 8. Simple Linear Regression and Correlation 9. Multiple Regression and Correlation 10. Time Series, Forecasting, and Index Numbers 11. Quality Control and Improvement 12. Nonparametric Methods and Chi-Square Test 13. Bayesian Statistics and Decision Analysis Appendices 14. Sampling Methods 15. Multivariate Analysis
13. Assessment methods	**Computer laboratory:** current classroom assessment, two individual assessments - individual problem solving, Project **Lecture:** Exam
14. Recommended reading	Aczel Amir D., **Complete Business Statistics,** MCGRAW HILL BOOK CO, 2002 McClave James T., **A First Course in Business Statistics**, Prentice Hall, 2000

INSTYTUT MATEMATYKI

Uniwersytet Kazimierza Wielkiego w Bydgoszczy

Institute of Mathematics

SUBJECTS OF GENERAL EDUCATION IN MATHEMATICS

Institute of Mathematics

1. Course title	**Facultative lecture II**
2. Course code	
3. Teaching methods	Lectures, Seminar
4. Type of course	Optional
5. Year of study, semester	Second year, First semester
6. Level of course	Master Degree
7. Number of credits	
8. Language of instruction	English
9. Name of lecturer	dr hab Zbigniew Grande, associate professor
10. Prerequisites	
11. Goal of the course	By the end of the course students **should know:** properties of additive functions and constructions of discontinuous additive functions for the addition and the multiplication and J+convex function; **should be able to:** apply Hamel bases to construction of additive functions and describe how strange properties of additive functions can be.
12. Course contents	1. Additive functions on R, R^n and C. 2. Continuous additive functions and construction of discontinuous additive function. 3. Homogeneity fields. 4. Jensen convex functions. 5. Continuity and boundedness of Jensen convex functions. Theorems of Bernstein-Doetsch. 6. The classes A, B, C. 7. Graphs of additive functions and J-convex functions. 8. Related Cauchy equations for the addition and the multiplication. 9. Properties of Hamel bases. 10. Interval-valued multihomomorphisms from (R,+) to (R, +).
13. Assessment methods	**Seminar:** Project, **Lecture:** Exam
14. Recommended reading	1) M. Kuczma; An introduction to the theory of functional equations and inequalities. Cauchy's equation and Jensen's inequality, PWN, Warszawa-Kraków-Katowice, 1985. 2) S. Chaopraknoi and Y. Kemprasit; On the semigroup of semi-continuous interval-valued multihomomorphisms, Bull. Malaysian Math. Soc., Spec. Issue for AMC 2009.

INSTYTUT MATEMATYKI

Uniwersytet Kazimierza Wielkiego w Bydgoszczy

Institute of Mathematics

Bachelor degree
BASIC SUBJECTS

INSTYTUT MATEMATYKI
Uniwersytet Kazimierza Wielkiego w Bydgoszczy

Institute of Mathematics

1. Course title	**Introduction to Mathematics**
2. Course code	
3. Teaching methods	Lecture, classes
4. Type of course	Obligatory
5. Year of study, semester	Second year, second semester
6. Level of course	Bachelor Degree
7. Number of credits	7
8. Language of instruction	English
9. Name of lecturer	dr Paulina Szczuka
10. Prerequisites	Knowledge of basis definitions, theorems and examples from real analysis and general and metric topology.
11. Goal of the course	By the end of the course students **should know:** basic definitions and theorems of mathematical logic and set theory; **should be able to:** apply mathematical logic and induction to proving theorems, conduct standard operations on sets and functions, interpret issues from different areas of mathematics with in set theory language, distinguish sorts of infinity and types of set orders.
12. Course contents	1. Mathematical logic. Methods of proving theorems. 2. Algebra of sets and set theory axioms. 3. Sentences function. Quantificators. 4. Positive integer numbers and mathematical induction. 5. Recursion. 6. Functions. 7. General sums and multiplications of sets. 8. Cartesian product of sets. 9. Images and invers-images of sets delimited by a function. 10. Relations. Function as a relation. 11. Equivalence relations and the abstraction principle . 12. Equinumerous of sets. Countable and uncoutable sets. 13. Inequalities for cardinal numbers. 14. Cantor-Bernstein theorem. 15. Power set and Cantora thorem. 16. Operation on cardinal numbers. 17. Ordered sets and lemma of Kuratowski-Zorn. 18. Linearly order sets. Well-ordered sets. 19. Ordinal numbers and transfinite induction. 20. Zermelo theorem. 21. Continuum hypothesis.
13. Assessment methods	**Classes**: test **Lecture**: exam
14. Recommended reading	1. H. Rasiowa, *Wstęp do matematyki współczesnej*, PWN, Warszawa 1998, 2. K. Kuratowski, Wstęp do teorii mnogości i topologii, PWN, Warszawa 1975.

Institute of Mathematics

1. Course title	**Algebra with Number Theory**
2. Course code	
3. Teaching methods	Lectures, solving problems
4. Type of course	Obligatory course
5. Year of study, semester	First level, second year
6. Level of course	Bachelor Degree
7. Number of credits	14
8. Language of instruction	English
9. Name of lecturer	Dr hab. Andrzej Prószyński
10. Prerequisites	Basic mathematics, linear algebra
11. Goal of the course	By the end of the course students **should know:** basic facts in the group and in the ring theory, relationship between the commutative algebra and the number theory, examples of unique and non-unique factorization domains **should be able to:** solving standard problems in algebra, in particular, computing quotient groups and rings
12. Course contents	1. Elements of the group theory: normal subgroups, quotient groups, inner automorphisms 2. Rings, ideals, quotient rings, polynomials, rings of fractions 3. Divisibility theory: UFD's, PID's, Euclidean rings 4. Elements of the number theory: linear equations, congruences, Euler theorem, chinese remainder theorem
13. Assessment methods	Current classroom assessment, individual assessments - individual problem solving **Lecture:** Exam
14. Recommended reading	Serge Lang, *Algebra*, Addison-Wesley Publ. Co., Reading, Mass. 1965

Institute of Mathematics

1. Course title	**Introduction to Topology**
2. Course code	
3. Teaching methods	Lectures, exercises
4. Type of course	Obligatory course
5. Year of study, semester	Second year, second semester
6. Level of course	Bachelor Degree
7. Number of credits	6
8. Language of instruction	English
9. Name of lecturer	dr hab. Lech Górniewicz, associate professor
10. Prerequisites	Basic general topology
11. Goal of the course	By the end of the course students **should know:** concept of metric and topological spaces in particular compact , paracompact , normal , separable and connected spaces; concept and properties of continuous mappings and homeomorphisms; **should be able to:** use basic topological notions and results in mathematical analysis , functional analysis and differential equations and other mathematical branches.
12. Course contents	1. Metric spaces and subsets of metric spaces 2. Continuous and uniformly continuous mappings 3. Homeomorphisms 4. Complete spaces ;theorems of Banach , Cantor and Baire 5. Compact and connected metric spaces 6. Topological spaces; methods of generating topologies 7 Continuous mapping . Homeomorphisms 8. Axioms of separation 9. Cartesian products ; quointed spaces 10. Normal spaces ; Urysohn Lemma 11. Compact spaces 12. Paracompact spaces; partition of unity ; Stone Theorem (without proof).
13. Assessment methods	**Exercises – to pass an written exam** **Lecture: oral exam**
14. Recommended reading	1. K. Kuratowski, Wstęp do teorii mnogości i topologii, PWN , Warszawa , 1972 ; 2. R. Engelking, Topologia ogólna, PWN , Warszawa ,1976 ; 3. S. Gładysz, Wstep do topoliogii, PWN, Warszawa,` 1981

Institute of Mathematics

1. Course title	**Ordinary Differential Equations**
2. Course code	
3. Teaching methods	Lectures
4. Type of course	Obligatory
5. Year of study, semester	Third year, second semester
6. Level of course	Bachelor Degree
7. Number of credits	4
8. Language of instruction	English
9. Name of lecturer	dr ZBIGNIEW DUSZYŃSKI
10. Prerequisites	Basics of calculus
11. Goal of the course	By the end of the course students **should know:** the notion of ordinary differential equation (ODE) and its solution; graphical interpretation of solution, theorems on existence and uniqueness of solutions of first order ODE; **should be able to:** solve ordinary differential equation, interpret a graph of solution, describe some classical equations of mathematical physics.
12. Course contents	1. The notion of ordinary differential equation (ODE) and its solution; graphical interpretation of solution (direction field). 2. Theorems on existence and uniqueness of solutions of first order ODE. 3. Separation of variables method. 4. First order linear differential equations. 5. Integrating factors. 6. Basic types of linear equations with undetermined coefficients. 7. Info on some classical equations of mathematical physics.
13. Assessment methods	**Lecture:** Exam **Classes**: individual problem solving
14. Recommended reading	V. Stepanov *Differential Equations*

Institute of Mathematics

1. Course title	**DISCRETE MATHEMATICS**
2. Course code	
3. Teaching methods	lecture (supported with a slideshow; the slideshow shall be available to students in advance) together with a seminar
4. Type of course	Obligatory
5. Year of study, semester	First year, second semester
6. Level of course	Bachelor Degree
7. Number of credits	6
8. Language of instruction	English
9. Name of lecturer	dr Piotr Sworowski
10. Prerequisites	**- mathematical induction,** **- some fundamentals of calculus,** **- fundamentals of group theory**
11. Goal of the course	By the end of the course students **should know:** **several (over those elementary) tools in solving combinatorial problems** **should be able to:** use basic combinatorial and graph theory tools to solve various practical problems
12. Course contents	COMBINATORICS 1 Counting schemes: permutations, variations, combinations, Stirling numbers, Dirichlet rule. 2 Recurrence. 3 Polya theorem. GRAPH THEORY 1 Euler/Hamilton paths and cycles: Euler theorem, Ore theorem, Meyniel theorem. 2 Planarity: Kuratowski criterion of planarity. 3 Trees and forests: spanning trees, Kirchhoff and Cayley formulas. 4 Connectivity: Menger theorem. 5 Independence and colouring: matchings and covers, Berge .theorem, Hall theorem, map colouring, Brooks and Vizing theorems. 6 Flows in digraphs: Ford&Fulkerson theorem.
13. Assessment methods	**Seminar:** solving problems test **Lecture: e**xam
14. Recommended reading	1. Victor Bryant *Aspects of Combinatorics* 2. Béla Bollobás *Modern Graph Theory*, Springer, New York 1998.

Institute of Mathematics

1. Course title	**Probability and Mathematical Statistics**
2. Course code	
3. Teaching methods	Lecture, classes
4. Type of course	Obligatory
5. Year of study, semester	Third year, second semester
6. Level of course	Bachelor degree
7. Number of credits	8
8. Language of instruction	English
9. Name of lecturer	dr Renata Piestrzyńska
10. Prerequisites	Combinatorics, foundation of theory of integral and series
11. Goal of the course	By the end of the course students **should know:** basic concepts of Probability; **should be able to:** compute probability of random events, expected value, variance and standard deviation, analyse basic experiments scheme, e.g. Bernoulli scheme; test random variables independence, conduct simple statistical inference.
12. Course contents	1. Probability 1.1. Probability axioms (a space of random events, Kołmogorow axioms, other probability definitions) 1.2. the Law of Large Numbers (strong and weak laws and their interpretation) 1.3. Conditional probability (definition and basic properties, **Bayesian model**) 2. Random variables 2.1. Distribution of a random variable, distribution and density functions 2.2. Moments of random variables (Stieltjes integral, expected value, moments of higher order; position parameters) 2.3. Discrete distributions (two-point and two-dimentional distributions i dwumianowy; Poisson distribution) 2.4. Continuous distributions (uniform, exponential and normal distributions) 3. Limit theorems 3.1. Czebyszew inequality, Markow inewuality; laws of large numbers 3.2. Characterisric funtions (definition and properties, gamma distribution) 3.3. The Central Limit Theorem (Lindeberg – Levy theorem, chi-square and t-Student distributions) 4. Basic concepts of Statistics 4.1. Definition and basic statistics 4.2. Empirical distribution function and histogram 5. Estimation 5.1. Point estimation (method of moments, maximum-likelihood estimation) 5.2. Interval estimation (confidence intervals for mean and variance) 6. Testing hypotheses 6.1. Parametric tests (tests for mean value and variance; tests for two mean values) 6.2. Nonparametric tests (tests of dependence and tests of independence) 7. **Multivariate Distributions** 7.1. Distribution and density functions (random vectors, **Two-dimensional distributions**) 7.2. **The correlation coefficient** and linear regression (**multivariate normal distribution,** station and testing hypotheses)
13. Assessment methods	**Classes**: active participation and individual problem solving **Lecture**: written exam
14. Recommended reading	1. W. Feller, Wstęp do rachunku prawdopodobieństwa, tomy I i II ,PWN, Warszawa 1966 2. W. Kordecki, Rachunek prawdopodobieństwa i statystyka matematyczna, definicje, twierdzenia, wzory, Oficyna wydawnicza Gis, Wrocław 2001
15. Additional reading	1. H.Jasiulewicz, W, Kordecki, Rachunek prawdopodobieństwa i statystyka matematyczna,Przykłady i zadania, Gis, Wrocław 2001 2. W.Krysicki, J.Bartos, W.Dyczka, K.Królikowska, M. Wasilewski, Rachunek prawdopodobieństwa i statystyka matematyczna w zadanich, części I i II, PWN, Warszawa 1986

Institute of Mathematics

1. Course title	**Facultative lecture**
2. Course code	
3. Teaching methods	Lecture, seminar
4. Type of course	Optional
5. Year of study, semester	First and second semester
6. Level of course	Bachelor Degree
7. Number of credits	2
8. Language of instruction	English
9. Name of lecturer	dr hab. Walentin Skworcow
10. Prerequisites	
11. Goal of the course	By the end of the course students **should know**: notions of integrals in the sense of: Newton and Riemann, Riemann-Darboux, Henstock, Riemann-Stieltjes, Henstock-Stieltjes.; criteria for integrability and properties of integrals; linearity of the class of RD -integrable functions; lemmas concerning the oscillations; the notion of the filter and the limit with respect to a filter; functions of bounded variation; **should be able to:** examine properties of integrals, compare different sorts of integrals.
12. Course contents	1. Newton integral. Comparison with the Riemann integral. Examples. 2. Differentiability of the indefinite Riemann integral. 3. Integrability in the Newton sense of a continuous function. 4. The upper and lower Darboux integrals. Riemann-Darboux Integral. 5. Criterion for integrability in the sense of Riemann-Darboux. 6. Integrability, in the sense of Riemann-Darboux, of continuous and monotonic functions. 7. Properties of the Riemann-Darboux integral. Linearity of the class of RD -integrable functions. 8. Equivalence of the Riemann integral and the Riemann-Darboux integral. 9. The Riemann-Lebesgue criterion for integrability in the sense Riemann integral. 10. Lemmas concerning the oscillations. 11. Corrollarries of the Riemann-Lebesgue criterion. 12. A descriptive definition of the Riemann integral. 13. Definition of the improper integral on an interval. Comparison with the Newton integral. 14. The definition of the Henstock integral. Comparison with the improper integral and the Newton integral. 15. The notion of the filter and the limit with respect to a filter. Examples. 16. Properties of the Henstock integral. 17. Riemann-Stieltjes integral and its properties. 18. Functions of bounded variation. Conditions for integrability in the Riemann-Stieltjes sense. 19. Henstock-Stieltjes integral.
13. Assessment methods	**Seminar:** final test after winter semester **Lecture:** Exam
14. Recommended reading	1. W. Skworcow, P. Sworowski; *Całki uogólnione*, Wydawnictwo UKW, Bydgoszcz, 2010 2. W Rudin, *Podstawy analizy matematycznej*, Warszawa, 1976 3. R. Gordon; *The integrals of Lebesgue*, Denjoy, Perron and Henstock; Providence, 1994

Institute of Mathematics

SPECIALIZED SUBJECT (INFORMATICS AND EDUCATION)

Institute of Mathematics

1. Course title	**Theoretical Foundations of Computer Science**
2. Course code	
3. Teaching methods	Lectures, computer laboratory
4. Type of course	Obligatory
5. Year of study, semester	Second year, first semester
6. Level of course	Bachelor Degree
7. Number of credits	2
8. Language of instruction	English
9. Name of lecturer	dr Karolina Mroczyńska
10. Prerequisites	base logic, basic programming
11. Goal of the course	1. Introduction - essential for the further education, theoretical foundations of many methods of the computer science 2. Presentation the theoretical limits of computer science relating to the problems of complexity and decidability
12. Course contents	1. Forms of computer representation of information 2. Binary system, octal system, hexadecimal system 3. Floating-point representation 4. Representation of an integer 5. Models of calculating machines 6. Formal grammar 7. Finite and infinite automata 8. Deterministic Turing machine (DTM). 9. Non-deterministic Turing machine (NDTM) 10. Computational complexity, complexity class, intractable problems 11. Recursive functions
13. Assessment methods	**Computer laboratory:** current classroom assessment, two individual assessments - individual problem solving **Lecture:** Exam
14. Recommended reading	1. Hopcroft J. E., Ulman J. D.: Formal languages and their relation to automata, Reading, MA: Addison-Wesley, 1969

Institute of Mathematics

1. Course title	**Algorithms and Data Structures**
2. Course code	
3. Teaching methods	Lectures, computing laboratory
4. Type of course	Obligatory
5. Year of study, semester	Third year, first semester
6. Level of course	Bachelor Degree
7. Number of credits	3
8. Language of instruction	English
9. Name of lecturer	dr Mariola Marciniak
10. Prerequisites	Familiarity with any programming language or Matlab.
11. Goal of the course	By the end of the course students **should know:** fundamental data structures (lists, stacks, queues, trees, priority queues, graphs), efficient algorithms for a number of fundamental problems; **should be able to:** use appropriate data structures, prove correctness and analyse running times of algorithms, translate algorithms into computer programs using any software tool (Matlab, C++). Students should also intensify cooperative work and demonstrate positive interpersonal skills.
12. Course contents	1. Abstract data structure as an organization of data with specified properties. 2. Big oh and theta notations, average, the best and the worst case analyses. 3. Simple recurrence relations and their applications to algorithms analyses. 4. Data structures: Arrays, lists, stacks, trees. 5. Algorithm designing techniques : divide and conquer, dynamic programming, recursion . 6. Graphs: representation, breadth and depth first searches, shortest path, minimal spanning tree, Hamiltonian path. 7. Sorting methods: selection (SelectSort), insertion (InsertSort), BubbleSort. QuickSort, MergeSort, HeapSort. 8. The spaces P and NP.
13. Assessment methods	Homeworks, Tests and Final Exam
14. Recommended reading	Mark Allen Weiss, "Data Structures and Algorithm Analysis in C++," Addison-Wesley, 2nd Edition, 1999. ``Introduction to Algorithms,'' T.H. Cormen, C.E. Leiserson ,R.L. Rivest, and C. Stein, Third Edition.

Institute of Mathematics

1. Course title	**Computer Networks**
2. Course code	
3. Teaching methods	Lecture with the use of multimedia techniques, supported by demonstration of practical solutions to the system in different environments
4. Type of course	Obligatory
5. Year of study, semester	Second year, third semester
6. Level of course	Bachelor Degree
7. Number of credits	2
8. Language of instruction	English
9. Name of lecturer	dr Wiesław Urbaniak
10. Prerequisites	Basic knowledge of computer science, operating systems and programming
11. Goal of the course	**At the end of the course students** **should know:** How computer networks are built; Modern solutions used in computer networks; Terminology used in the network. **Should be able to:** Design and build a simple computer network; Install the necessary software; Administer a school network.
12. Course contents	1. Introduction to computer networks: the essence of computer networks, network history, the possibilities of computer networks, network operating systems. 2. Fundamentals of signals: the concept of a signal transmission channel, the base modulation. 3. Media support: wired, wireless. Types and kinds of computer networks: sharing resources, extension of networks, network architecture, and network technologies. 4. OSI reference model: the network layer, the selected web standards. Network Protocols: building a layer of TCP / IP addressing on the Internet and other protocols. 5. Network devices: network cards, repeaters, hubs, switches, bridges, routers. 6. Radio networks: radio network standards, organization of networks based on wireless data transfer, safety radio networks. 7. Design and construction of LAN (Local Area Network in English): wired, wireless (Wi-Fi, Bluetooth, IrDA). **Computer laboratory**: Server installing Win2K, Linux, administers them in the base including: configuring TCP / IP networks, network cabling preparation, sending packages, software updates, remote working and implementation of the project network lab school website.
13. Assessment methods	**Lecture:** Exam **Computer laboratory**: Credit received from classes on the basis of participation in various exercises, completed reports, and test involving the practical exercises.
14. Recommended reading	1. Silberschatz, J. L. Peterson, P. B. Galvin *Podstawy systemów operacyjnych*, WNT, Warszawa, 2000 2. O. Kirch, T. Dawson Linux **Podręcznik administratora sieci**, RM, Warszawa, 2000 3. D. E. Comer **Sieci komputerowe TCP/IP**, WNT, Warszawa, 1998 4. D. E. Comer **Sieci komputerowe i intersieci**, WNT, Warszawa, 2000 5. E. Nemeth, G. Snyder, S.Seebass, T. R. Hein **Przewodnik administratora systemu Unix**, WNT, Warszawa, 2000

Institute of Mathematics

1. Course title	**Numerical Methods**
2. Course code	
3. Teaching methods	Lectures, computing laboratory
4. Type of course	Obligatory
5. Year of study, semester	Third year, first semester
6. Level of course	Bachelor Degree
7. Number of credits	5
8. Language of instruction	English
9. Name of lecturer	dr Mariola Marciniak
10. Prerequisites	For active participation we assume familiarity with linear algebra and calculus. Familiarity with any programming language or MATLAB may help (this course will not teach programming per se, but it will teach and emphasize general principles of programming).
11. Goal of the course	By the end of the course students **should know:** the core ideas and concepts of Numerical Methods, how to use computational tools; **should be able to:** analyse and to describe the initial mathematical problem, show logical thinking in coding it in an algorithmic form; translate numerical algorithms into computer programs using any software tool (Matlab, C++), to estimate the error. Students should also intensify cooperative work and demonstrate positive interpersonal skills.
12. Course contents	1. Binary numbers. 2. Number representation. 3. Error analysis. 4. Locating roots of equations. 5. Numerical interpolation. 6. Gaussian elimination method of solution of a linear systems of equations. 7. LU decomposition, QR decomposition. 8. Eigen value problems 9. Iterative methods of numerical integration: Newton-Cotes Quadrature, Orthogonal Polynomials and Gaussian Quadrature. 10. Approximation. 11. Matrix norms; relation to vector norms 12. Numerical differentiation. 13. Numerical integration of differential equations.
13. Assessment methods	Homework, Tests and Final Exam
14. Recommended reading	1. Kinkaid,D. Cheney,W. Numerical Analysis: Mathematics of Scientific Computing AMS 2002, 2. Numerical Recipes: The Art of Scientific Computing. Third Editions.

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1. Course title	**Database Systems**
2. Course code	
3. Teaching methods	Lectures, computing laboratory
4. Type of course	Obligatory
5. Year of study, semester	Third year, second semester
6. Level of course	Bachelor Degree
7. Number of credits	2
8. Language of instruction	English
9. Name of lecturer	dr Mariola Marciniak
10. Prerequisites	Familiarity with any programming language.
11. Goal of the course	By the end of the course students **should know:** the core ideas and concepts of data modelling and database systems, i.e. basic terminology, formal theory underlying relational database systems, data models, normalization approach, query processing; **should be able to:** design and implement a database using a commercial database management system and associated development tools. Students should also intensify cooperative work and demonstrate positive interpersonal skills.
12. Course contents	1. Database design, entity-relationship and relational models. 2. Relational database design concepts, decomposition and normalization, integrity constraints. 3. Relational algebra. 4. Query languages (SQL): DDL, DML commands, Group Functions, Sub queries, Joins, Transactions. 5. System architectures. 6. Commercial Database Systems: MS-Access, Oracle.
13. Assessment methods	Homeworks, Tests
14. Recommended reading	1. Ullman & Widom, "A First Course in Database Systems", Prentice Hall, 1997. 2. Date & Darwin, "A Guide to the SQL Standard", Fourth Edition, Addison-Wesley, 1993.

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1. Course title	**Software Laboratory (Matlab)**
2. Course code	
3. Teaching methods	Computer laboratory
4. Type of course	Obligatory
5. Year of study, semester	Second year, second semester; Third year, first and second semester
6. Level of course	Bachelor Degree
7. Number of credits	3
8. Language of instruction	English
9. Name of lecturer	
10. Prerequisites	Basic programming
11. Goal of the course	Solving some math problems using the program Matlab
12. Course contents	1. Environment of Matlab – introduction. 2. Calculations: variables, constants, numbers, mathematical operations and functions. 3. Strings. Vectors. Operations with matrices. Solving systems of equations. 4. Programming in Matlab. 5. Graphic in Matlab, 2D and 3D graphs.
13. Assessment methods	**Computer laboratory:** current classroom assessment, four individual assessments - individual problem solving
14. Recommended reading	1. http://www.mathworks.com/ 2. *Mastering MATLAB 7*, Duane C. Hanselman, Bruce L. Littlefield

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SUBJECTS OF TEACHER'S EDUCATION

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1. Course title	**Mathematics Education**
2. Course code	
3. Teaching methods	Lecture, computer laboratory, vocational practice
4. Type of course	Obligatory course
5. Year of study, semester	Second year, first and second semester; Third year, first and second semester;
6. Level of course	Bachelor Degree
7. Number of credits	5
8. Language of instruction	English
9. Name of lecturer	dr Karolina Mroczyńska
10. Prerequisites	Basic course of Psychology, General Pedagogy
11. Goal of the course	By the end of the course students should: distinguish the social, emotional and cognitive dimension of learning mathematics, be making links between reading and experience in school, start to relate various forms of classroom organization to particular pedagogic intentions and tasks, know the roles of exposition, investigation, questioning, listening, explanation, select appropriate teaching strategies and mathematical tasks and resources (including ICT), plan mathematics lessons and units of works, identifying clear objectives and content, plan assessment opportunities, use a range of different methods of assessment and consider when they are appropriate, consider the manageability of assessment in everyday classroom practice, understand the special nature of mathematical communication, be aware of similarities and differences between speech and writing in relation to the mathematics classroom, develop knowledge of particular software to enhance mathematics teaching, including getting access to available resources and support for using ICT in the maths classroom, provide an appropriate environment that will enable pupils to learn from feedback, observe patterns, see connections, work with dynamic images, explore data and „teach" the computer.
12. Course contents	1. Mathematics and education a. The nature of mathematics b. Aims of mathematics education c. Using and applying mathematics d. Social context of learning 2. Theories of learning and knowledge 3. Feeling and motivation, cognitive dimension 4. Different teaching approaches a. Teaching as listening, asking and telling b. Small-group and whole-class ways of working, 5. Planning for mathematics learning a. Levels of planning b. Planning a lesson c. Planning sequences of lessons 6. Assessment and public examinations a. Formative assessment b. Self-assessment and peer assessment c. Oral assessment, questioning and observing d. Tests 7. Mathematical Communications a. Mathematical language b. Non-verbal form of written Communications c. Talking mathematics d. Writing mathematically 8. Using ICT a. Calculating devices b. Spreadsheets c. Graph plotters d. Dynamic geometry packages
13. Assessment methods	**Computer laboratory:** current classroom assessment, assessment of basic teacher's documents prepared by a student, **Lecture:** Exam
14. Recommended reading	1. Johnston-Wilder S., *Learning to Teach Mathematics in the Secondary School*, Routledge T&F Group, London 2007, 2. Gillespie H., *Unlocking Learning and Teaching with ICT*, David Fulton Publishers, Oxon Great Britain 2007

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1. Course title	**Teaching ICT**
2. Course code	
3. Teaching methods	Lecture, computer laboratory, vocational practice
4. Type of course	Obligatory course
5. Year of study, semester	Second year, first and second semester; Third year, first and second semester
6. Level of course	Bachelor Degree
7. Number of credits	4
8. Language of instruction	English
9. Name of lecturer	dr Katarzyna Chmielewska
10. Prerequisites	Basic course of Psychology, General Pedagogy
11. Goal of the course	By the end of the course students should: distinguish the ethical, social, emotional and cognitive dimension of learning ICT, start to relate various forms of classroom organization to particular pedagogic intentions and tasks, know the roles of exposition, investigation, questioning, listening, explanation, select appropriate teaching strategies, tasks and resources, plan ICT lessons and units of works, identifying clear objectives and content, plan assessment opportunities, use a range of different methods of assessment and consider when they are appropriate, consider the manageability of assessment in everyday classroom practice, understand the special nature of ICT communication, develop knowledge of particular software to enhance teaching methods, including getting access to available resources and support for using ICT in other subjects classroom, provide an appropriate environment that will enable pupils to learn from feedback, observe patterns, see connections, work with dynamic images, explore data and „teach" the computer.
12. Course contents	1. ICT and education a. The nature of ICT b. Aims of ICT education c. Using and applying ICT d. Ethical and social context of learning 2. Constructive theories of learning and knowledge 3. Feeling and motivation, cognitive dimension 4. Different teaching approaches a. Teaching as listening, asking and telling b. Individual, Small-group and whole-class ways of working, 5. Planning for ICT learning a. Levels of planning b. Planning a lesson c. Planning sequences of lessons 6. Assessment and public examinations a. Formative assessment b. Self-assessment and peer assessment c. Oral assessment, questioning and observing d. Tests 7. ICT Communications a. ICT language b. Communication tools 8. Using ICT a. Calculating devices b. Spreadsheets c. Graph plotters d. Application supporting other subject teaching
13. Assessment methods	**Computer laboratory:** current classroom assessment, assessment of basic teacher's documents prepared by a student, **Lecture:** Exam
14. Recommended reading	1. Kennevell S., Parkinson J., *Learning to Teach ICT In the Secondary School*, Routledge Falmer, London 2007, 2. Gillespie H., *Unlocking Learning and Teaching with ICT*, David Fulton Publishers, Oxon Great Britain 2007