<table>
<tr><td colspan="4">*Subject*: Coding theory</td></tr>
<tr><td colspan="4">*Field of study*: Mathematics</td></tr>
<tr><td>*Form of classes*</td><td>*Class hours*</td><td>*ECTS*</td><td>*Language*</td></tr>
<tr><td>Lecture</td><td>15</td><td rowspan="2">4</td><td rowspan="2">English</td></tr>
<tr><td>Laboratory</td><td>15</td></tr>
<tr><td>*Coordinator:*</td><td colspan="3">dr Lucjan Szymaszkiewicz</td></tr>
<tr><td>*Objectives of the subject:*</td><td colspan="3">The course is designed to familiarize students with the basic problems of coding theory.</td></tr>
<tr><td>*Requirement:*</td><td colspan="3">Introduction to computer science and programming
Linear algebra</td></tr>
<tr><td colspan="4">*Program content*</td></tr>
<tr><td colspan="4">1. Elements of information theory
2. Prefix codes
3. Error correcting codes
4. Linear codes
5. Cyclic codes</td></tr>
<tr><td>*Educational methods*</td><td colspan="3">Lectures, Laboratory exercises</td></tr>
<tr><td>*Form and conditions of passing the subject*</td><td colspan="3">The grade for the subject is issued on the basis of the arithmetic average of all the grades obtained from all forms of classes.</td></tr>
<tr><td>*Literature*</td><td colspan="3">G.A. Jones and J. M. Jones: Information and Coding Theory, Springer
S. Roman: Coding and Information Theory, Springer</td></tr>
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<table>
<tr><td colspan="4">*Subject*: Probabilistic methods</td></tr>
<tr><td colspan="4">*Field of study*: Mathematics</td></tr>
<tr><td>*Form of classes*</td><td>*Class hours*</td><td>*ECTS*</td><td>*Language*</td></tr>
<tr><td>lecture</td><td></td><td rowspan="2"></td><td rowspan="2">English</td></tr>
<tr><td>workshop</td><td>15</td></tr>
<tr><td>*Coordinator:*</td><td colspan="3">dr Andrzej Wiśniewski</td></tr>
<tr><td>*Objectives of the subject:*</td><td colspan="3">The purpose of the course is getting the ability to conduct probabibility and statistical inference and to learn of using computer programmes for basic statistical computations.</td></tr>
<tr><td>*Requirement:*</td><td colspan="3">Knowledge of basics of probability theory and descriptive and mathematical statistics.</td></tr>
<tr><td colspan="4">*Program content*</td></tr>
<tr><td colspan="4">1. Reminding the most important notions, statements and methods of the probability calculus and mathematical statistics.
2. Testing of statistical hypotheses. Nonparametric tests of significance. Tests of the normality and tests of goodnes of fit. Chi-squared test. Kolmogorov test. Testing the hypothesis about the agreement of distributions in two populations. Test of series. Kolmogorov-Smirnov test. Sign test. Test of the sum of ranks.
3. Tests of independence of two variables.
4. Elements of the analysis of variance.</td></tr>
<tr><td>*Educational methods*</td><td colspan="3">Lecture, explanation, statistical computations with the use of computer programmes, discussion.</td></tr>
<tr><td>*Form and conditions of passing the subject*</td><td colspan="3">To pass the course a student needs to pass the in-class test.</td></tr>
<tr><td>*Literature*</td><td colspan="3">S. M. Ross, *Introduction to Probability Models*, Academic Press 2000
C. H. Brase, C. P. Brase, *Understable Statistics Concepts and Methods*, D. C. Heath and Company, Lexington 1990
T. Sincich, *Statistics by Examples*, Dellen Publishng Company,San Francisco 1990</td></tr>
</table>

<table>
<tr><td colspan="4">*Subject*: Elements of topology</td></tr>
<tr><td colspan="4">*Field of study*: mathematics</td></tr>
<tr><td>*Form of classes*</td><td>*Class hours*</td><td>*ECTS*</td><td>*Language*</td></tr>
<tr><td>lectures</td><td>30</td><td rowspan="2">4</td><td rowspan="2">English</td></tr>
<tr><td>tutorials</td><td>30</td></tr>
<tr><td>*Coordinator:*</td><td colspan="3"></td></tr>
<tr><td>*Objectives of the subject:*</td><td colspan="3">To familiarize students with the basics of metric spaces.</td></tr>
<tr><td>*Requirement:*</td><td colspan="3">Knowledge of basic logic, set theory and calculus.</td></tr>
<tr><td colspan="4">*Program content*</td></tr>
<tr><td colspan="4">1. Metric spaces - basic concepts and examples.
2. Bounded sets.
3. Convergent sequences.
4. Open and closed sets. Interior and closure. Accumulation points.
5. Equivalent metrics.
6. Separable spaces.
7. Complete spaces.
8. Compact spaces.
9. Connected spaces.
10. Normed spaces.
11. Limit of a function.
12. Continuous mappings.
13. Continuous mappings on compact sets.
14. Continuous mappings on connected sets.</td></tr>
<tr><td>*Educational methods*</td><td colspan="3">Lectures: conducted by a traditional method at the blackboard;
Tutorials: joint solving of the problems, student's presentations of the solutions of exercises on the blackboard.</td></tr>
<tr><td>*Form and conditions of passing the subject*</td><td colspan="3">The grade is issued on the basis of the exercises presented in the classes, and written test</td></tr>
<tr><td>*Literature*</td><td colspan="3">Satish Shirali, Harkrishan Lal Vasudeva „Metric spaces", Springer, London, 2006
James R. Munkers „Topology – the first course" Prentice-Hall, London, 1974</td></tr>
</table>

<table>
<tr><td colspan="4">*Subject*: Mathematics</td></tr>
<tr><td colspan="4">*Field of study*: Elements of Group Theory</td></tr>
<tr><td>*Form of classes*</td><td>*Class hours*</td><td>*ECTS*</td><td>*Language*</td></tr>
<tr><td>lectures</td><td>30</td><td rowspan="2">5</td><td rowspan="2">English</td></tr>
<tr><td>exercises</td><td>30</td></tr>
<tr><td>*Coordinator:*</td><td colspan="3">Professor Dr. Andrzej Dąbrowski</td></tr>
<tr><td>*Objectives of the subject:*</td><td colspan="3">mastering basis knowledge of the theory of group theory</td></tr>
<tr><td>*Requirement:*</td><td colspan="3">passing the exam</td></tr>
<tr><td colspan="4">*Program content*</td></tr>
<tr><td colspan="4">1. Basic definitions and examples. Cyclic, commutative and noncommutative groups. Permutation groups. Factor groups, direct sums, isomorphic groups.
2. The isomorphism theorems. Classification of cyclic groups. The Sylow theorems. Classification of finite commutative groups. Classification of finitely generated commutative groups.
3. Introduction to simple and solvable groups. More on permutation groups.
4. Linear groups.</td></tr>
<tr><td>*Educational methods*</td><td colspan="3">traditional or independent study of the subject</td></tr>
<tr><td>*Form and conditions of passing the subject*</td><td colspan="3">solving problems, written or oral</td></tr>
<tr><td>*Literature*</td><td colspan="3">1. S. Lang, Algebra
2. J.S. Milne, Group Theory
3. J.J. Rotman, An Introduction to the Theory of Groups</td></tr>
</table>

Subject: Mathematics			
Field of study: The Theory of Elliptic Curves			
Form of classes	*Class hours*	*ECTS*	*Language*
lectures	30	5	English
exercises	30		
Coordinator:	Professor Dr. Andrzej Dąbrowski		
Objectives of the subject:	mastering basic knowledge of the theory of elliptic curves, including arithmetical applications		
Requirement:	passing the exam		
Program content			
1. The geometry and algebra of elliptic curves. Elliptic curves over the rational and complex numbers, and over finite fields. 2. The Mordell-Weil group. Theorems of Mordell-Weil, Lutz-Nagell and Mazur. 3. Canonical heights on elliptic curves, L-series, the Birch and Swinnerton-Dyer conjecture, modularity of elliptic curves defined over the rationals. Applications to Diophantine equations and to the problem of congruent numbers. 4. Factorization using elliptic curves. 5. Pari/GP and Magma packets.			
Educational methods	tradidional or independent study of the subject		
Form and conditions of passing the subject	solving problems, written or oral form		
Literature	1. N. Koblitz, Introduction to elliptic curves and modular forms, Graduate Texts in Mathematics, 1984 2. A.W. Knapp, Elliptic curves, Princeton University Press, 1992 3. J. Silverman, The arithmetic of elliptic curves, Graduate Texts in Mathematics, 1986		

<table>
<tr><td colspan="4">*Subject*: Ring theory</td></tr>
<tr><td colspan="4">*Field of study*: Mathematics</td></tr>
<tr><td>*Form of classes*</td><td>*Class hours*</td><td>*ECTS*</td><td>*Language*</td></tr>
<tr><td>Lecture</td><td>15</td><td rowspan="2">3</td><td rowspan="2">English</td></tr>
<tr><td>Recitation hours</td><td>15</td></tr>
<tr><td>*Coordinator:*</td><td colspan="3">Dr hab. math., dr hab. eng. Piotr Krasoń</td></tr>
<tr><td>*Objectives of the subject:*</td><td colspan="3">The aim of the subject is to introduce students to the basic theory of rings. In particular various rings will be defined: integral domains, principle ideal domains, universal factorization domains and some of their applications in mathematics. Recitation hours will allow a student to gain fluency in operating with these notions and let tchem solve some problems.</td></tr>
<tr><td>*Requirement:*</td><td colspan="3">Basic facts from linear algebra and group theory.</td></tr>
<tr><td colspan="4">*Program content*</td></tr>
<tr><td colspan="4">1. Rings. Definition and examples.
2. Subrings ideals, quotient rings, homomorphisms
3. prime ideals, maximal ideals
4. polynomial rings, divisibility
5. universal factorization domains, principle ideal domains, Euclidean rings.
6. cyclotomic polynomials
7. Noetherian and Artinian rings.
8. Modules over rings
…</td></tr>
<tr><td>*Educational methods*</td><td colspan="3">Lecture , explanation and discussion</td></tr>
<tr><td>*Form and conditions of passing the subject*</td><td colspan="3">Final written exam, 1 mid-term written exam</td></tr>
<tr><td>*Literature*</td><td colspan="3">1. M. Atiyah, I. MacDonald Introduction to commutative algebra
2. N. Jacobson Basic algebra I</td></tr>
</table>

<table>
<tr><td colspan="4">*Subject*: Elements of Control Theory for Infinite Dimensional Systems</td></tr>
<tr><td colspan="4">*Field of study*:</td></tr>
<tr><td>*Form of classes*</td><td>*Class hours*</td><td>*ECTS*</td><td>*Language*</td></tr>
<tr><td>Lectures</td><td>15</td><td rowspan="2">4</td><td rowspan="2">English</td></tr>
<tr><td>seminar</td><td>15</td></tr>
<tr><td>*Coordinator:*</td><td colspan="3">Prof. Dr. Grigorij Sklyar</td></tr>
<tr><td>*Objectives of the subject:*</td><td colspan="3">To familiarize students with the elements of control theory of infinite dimensional systems and with corresponding examples. Prepare them for the practical application of given concepts</td></tr>
<tr><td>*Requirement:*</td><td colspan="3">Fundamentals of differential and integral calculus, functional analisys and differential equations theory</td></tr>
<tr><td colspan="4">*Program content*</td></tr>
<tr><td colspan="4">1. Spectral theory of operators in infinite dimensional spaces
2. Operator semigroups and their generators. Theorems of Hille-Yosida and Philips
3. Images and kernels of operators, the operator of controllability
4. Controllability of systems with self adjoint operators. Controllability of the wave equation
…</td></tr>
<tr><td>*Educational methods*</td><td colspan="3">Lectures: conducted by a traditional method at the blackboard; Tutorials: joint solving of the problems, student’s presentations of the solutions of exercises on the blackboard.</td></tr>
<tr><td>*Form and conditions of passing the subject*</td><td colspan="3">The grade is issued on the basis of the exercises presented in the classes, and written test.</td></tr>
<tr><td>*Literature*</td><td colspan="3">1. R.F. Curtain, H.J. Zwart (1995): An Introduction to In?nite-Dimensional Systems Theory, Springer Verlag, New York;
2. Zabczyk J. (1985): Mathematical Control Theory. An Introduction. Birkhauser</td></tr>
</table>

<table>
<tr><td colspan="4">*Subject*: Elements of operator theory</td></tr>
<tr><td colspan="4">*Field of study*:</td></tr>
<tr><td>*Form of classes*</td><td>*Class hours*</td><td>*ECTS*</td><td>*Language*</td></tr>
<tr><td>Lectures</td><td>15</td><td rowspan="2">4</td><td rowspan="2">English</td></tr>
<tr><td>seminar</td><td>15</td></tr>
<tr><td>*Coordinator:*</td><td colspan="3">Prof. Dr. Grigorij Sklyar</td></tr>
<tr><td>*Objectives of the subject:*</td><td colspan="3">To familiarize students with the fundamental concepts of functional analysis including operator theory and with corresponding examples. Prepare them for the practical application of given concepts</td></tr>
<tr><td>*Requirement:*</td><td colspan="3">Fundamentals of differential and integral calculus, functional analysis and differential equations theory</td></tr>
<tr><td colspan="4">*Program content*</td></tr>
<tr><td colspan="4">1. Compact operators
2. Self adjoint operators, spectrum of self- adjoint operators
3. Project operators. Positive operators.
4. Spectral decomposition. Functions of operators, resolvent.
…</td></tr>
<tr><td>*Educational methods*</td><td colspan="3">Lectures: conducted by a traditional method at the blackboard; Tutorials: joint solving of the problems, student’s presentations of the solutions of exercises on the blackboard.</td></tr>
<tr><td>*Form and conditions of passing the subject*</td><td colspan="3">The grade is issued on the basis of the exercises presented in the classes, and written test.</td></tr>
<tr><td>*Literature*</td><td colspan="3">1. K. Yosida: Functional anlysis
2.</td></tr>
</table>

Subject: **Arithmetics**

Field of study: Mathematics

Form of classes	*Class hours*	*ECTS*
lectures	15	
workshops	15	

Coordinator:	Dr hab. Tomasz Jędrzejak
Objectives of the subject:	The lecture aims to familiarize students with the notions and theorems of number theory with appropriate examples
Requirement:	Mathematics on the level of high school

Program content

1. Peano axioms. Properties of natural numbers.
2. Divisibility of integers. Greatest common divisor. Euclid's algorithm.
3. Congruences. Theorems of Euler, Fermat and Wilson.
4. Quadratic residues. Reciprocity laws.
5. Dirichlet's convolution. Multiplicative functions.
6. Elementary diophantine equations.

…

Educational methods	Conversing lecture, explanations, discussion
Form and conditions of passing the subject	Passing the subject (obtaining the grade) is based on colloquium and written test results and activity during the class
Literature	K. Ireland, M. Rosen (1982): A classical introduction to modern number theory, Springer S. Yan (2002): Number theory for Computing, Springer

<table>
<tr><td colspan="4">*Subject*: Introduction to biomathematics</td></tr>
<tr><td colspan="4">*Field of study*: Mathematics</td></tr>
<tr><td>*Form of classes*</td><td>*Class hours*</td><td>*ECTS*</td><td>*Language*</td></tr>
<tr><td>laboratories</td><td>15</td><td>1</td><td>English</td></tr>
<tr><td colspan="2">*Coordinator:*</td><td colspan="2">Dr. Jarosław Woźniak</td></tr>
<tr><td colspan="2">*Objectives of the subject:*</td><td colspan="2">Objectives of the subjects are introducing the notions and models of biomathematics to the students, presenting proper examples.</td></tr>
<tr><td colspan="2">*Requirement:*</td><td colspan="2">Basics of calculus, functional analysis and ordinary and partial differential equations.</td></tr>
<tr><td colspan="4">*Program content*</td></tr>
<tr><td colspan="4">1. One dimensional models of population growth, Malthus equation, logistic equation.
2. Two dimensional models of population growth, Lotka-Volterra equations.
3. Epidemiological models.</td></tr>
<tr><td colspan="2">*Educational methods*</td><td colspan="2">Informational lecture, conversing lecture, explanations, discussion</td></tr>
<tr><td colspan="2">*Form and conditions of passing the subject*</td><td colspan="2">Passing the subject (obtaining the grade) is based on written test results and activity during the class.</td></tr>
<tr><td colspan="2">*Literature*</td><td colspan="2">Basic:
James D. Murray*, Mathematical Biology: I. An Introduction*, Springer Science & Business Media, 2007.
Supplementary:
James D. Murray, Mathematical Biology II: Spatial Models and Biomedical Applications, Springer, 2011.</td></tr>
</table>