University of Debrecen
Faculty of Science and Technology
Institute of Mathematics

MSc Program

APPLIED MATHEMATICS

Applied Mathematics MSc

Name of the MSc Program: *Applied Mathematics*
Person in charge of the Program: *Prof. Dr. Ákos Pintér*

Type of degree and qualification:
Type of degree: *Master of Science (MSc)*
Qualification: *Applied Mathematician*

Requirements for the acquisition of the degree

1. A total of 120 credit points according to the following list:
   - Basics/Elective courses 20 credit points
   - Advanced prof module 74 credit points
   - Thesis 20 credit points
   - Elective courses 6 credit points
2. Attending physical education for at least one semester

Entrance exam: All students who have a BSc degree in Mathematics may apply for admission to the Applied Mathematics MSc Program. Students who have a science, technical, informatics or economics BSc degree can apply only under additional conditions. They must have at least 65 credit points in algebra, analysis, geometry, set theory, combinatorics, mathematical logic, operations research, number theory, probability theory or statistics. At most 10 credit points from other courses using an extensive mathematical apparatus can be counted in these 65 credit points. They must have at least 50 credit points during their BSc studies, and they must acquire the remaining credit points according to the general rules of the university.
Students must sit an oral entrance exam before a committee. The aim of the entrance exam is to assess the candidates' knowledge, motivation and professional activity.

Basics: Students with a BSc degree in Mathematics are exempted from these courses. Other students submit a credit acceptance form, and a committee will decide which basic courses they will have to attend. Students must choose from the free optional courses in place of the basic courses from which they were exempted.

Optional courses: A student in Applied Mathematics MSc has to acquire 6 credit points of optional courses. All non-mathematical courses taught at the University of Debrecen count as optional courses.

Thesis: Students have to choose a topic for their thesis in the 2nd semester. They have to write it in two semesters. The thesis should be about 25–40 pages long, and using the LaTeX document preparation system is recommended. The cover page has to contain the name of the institute, the title of the thesis, the name and the degree program of the student, the name and the university rank of the supervisor. Besides the detailed discussion of the topic, the thesis should contain an introduction, a table of contents and a bibliography. Further formal requirements and recommended style files can be found on the homepage of the Institute of Mathematics. The thesis has to be defended in the final exam.

Final exam: The final exam is an oral exam before a committee designated by the Director of the Institute of Mathematics and approved by the leaders of the Faculty of Science and Technology. The process of the final exam is the same in both cases of the student's specialization. The questions of the final exam comprise the compulsory courses of the Applied Mathematics MSc Program. The list of exam questions consists of two parts: questions from the core material, and questions pertaining to the student's specialization. Students draw a random question from the entire list, and after a certain preparation period, give an account on it. After this, the committee chooses a small item from one of the other type of questions, and after a preparation period the student gives an account on this as well. The committee gives a single mark for the student's answers in the final exam.

Physical Education: MSc students have to attend two classes of Physical Education per week for at least one semester. Students can sit the final exam only after attending the compulsory number of these PE classes.

Rating of the certificate: Students get a rating of their degree certificate according to the average of the following marks:

- weighted average of exam marks during the whole period of studies,
- the average of the marks of the thesis and of the defense,
- the exam mark obtained for the exam questions in the final exam.

In the following tables the semester number assigned to each course is only a recommendation. These courses may be attended a year earlier or later, but the prerequisites of each course have to be always taken into account. In some cases, in the 'prerequisites' column the code of the practical course is indicated with the abbreviation (p) of 'parallel'. In this case, the practical course must be attended parallelly with the lecture, and students can sit an exam only after successfully absolving the practical course.

Applied mathematics MSc

Basics

Students having a BSc degree in Mathematics are granted exemption from these subjects. Students having degree in other subjects have to put in a credit-acceptance form. The Institue of Mathematics will decide what basic subjects the students will have to learn.

Code	Subject	Credit	Hours/week		Examination	Prerequisites	Semester
			Theory	Practice			
TTMME0101	Introduction to modern algebra	3	2		E	TTMMG0101(p)	1
TTMMG0101	Introduction to modern algebra	2		2	P		1
TTMME0202	Operation research	3	2		E	TTMMG0202(p)	1
TTMMG0202	Operation research	2		2	P		1
TTMME0301	Selected topics in geometry	3	2		E	TTMMG0301(p)	1
TTMMG0301	Selected topics in geometry	2		2	P		1
TTMME0401	Probability theory	3	2		E	TTMMG0401(p)	1
TTMMG0401	Probability theory	2		2	P		1

Advanced prof module

Code	Subject	Credit	Hours/week		Examination	Prerequisites	Semester
			Theory	Practice			
	Basic information	0		1	S		1
TTMME0104	Grapy theory and applications	3	2		E	TTMMG0104(p)	1
TTMMG0104	Graph theory and applications	2		2	P		1
TTMME0106	Algorithms in mathematics	3	2		E	TTMME0104	2

						TTMMG0106(p)	
TTMMG0106	Algorithms in mathematics	2		2	P	TTMME0104	2
TTMME0205	Convex optimization	3	2		E	TTMMG0205(p)	1
TTMMG0205	Convex optimization	2		2	P		1
TTMME0107	Discrete optimization	3	2		E	TTMMG0107(p)	2
TTMMG0107	Discrete optimization	2		2	P		2
TTMME0207	Applications of ordinary differential equations	3	2		E	TTMMG0207(p)	3
TTMMG0207	Applications of ordinary differential equations	2		2	P		3
TTMME0204	Partial differential equations	3	2		E	TTMMG0204(p)	4
TTMMG0204	Partial differential equations	2		2	P		4
TTMME0402	Stochastic processes	3	2		E	TTMMG0402(p)	2
TTMMG0402	Stochastic processes	2		2	P		2
TMME0403	Multivariate analysis	3	2		E	TTMMG0403(p)	3
TTMMG0403	Multivariate analysis	2		2	P		3
TTMME0404	Option pricing	3	2		E	TTMMG0404(p)	1
TTMMG0404	Option pricing	2		2	P		1
TTMME0405	Financial mathematics I.	3	2		E	TTMMG0405(p)	2
TTMMG0405	Financial mathematics I.	2		2	P		2
TTMME0901	Introduction to finance	5	2	2	E		1
TTMME0902	Microeconomics	5	2	2	E		2
TTMME0904	Econometrics	4	2	1	E	TTMME0403(p)	3
TTMME0905	Financial accounting	5	2	2	E		4
TTMME0208	Game theory	3	2		E	TTMMG0208(p)	4
TTMMG0208	Game theory	2		2	E		4

Elective courses

The required credits points of elective subjects depend on how many subjects are accepted from the Basics. (The student has to learn subjects from elective courses for the same amount of credit points that is accepted from the Basics.)

Code	Subject	Credit	Hours/week		Examination	Prerequisites	Semester
			Theory	Practice			
TTMME0903	Macroeconomics	5	2	2	E	TTMME0902	3
TTMME0407	Insurance mathematics	3	2		E		2/4
TTMME0406	Financial mathematics II.	3	2		E	TTMME0405	3
TTMME0303	Finite geometries and coding theory	3	2		E	TTMMG0303(p)	2/4
TTMMG0303	Finite geometries and coding theory	2		2	P		2/4
TTMME0206	Fourier series	4	2	1	E		1

Thesis, free optional courses

Code	Subject	Credit	Hours/week		Examination	Prerequisites	Semester
			Theory	Practice			
TTMMG0701	Thesis 1.	10			P		3
TTMMG0702	Thesis 2.	10			P	TTMMG0701	4
	Free optional courses	6					1

E - Exam
P - Practical
S - Signature

Subjects

Basics

TTMME0101, TTMMG0101
Introduction to modern algebra
2+2 classes/week, 3+2 credit, E+P
Lecturer: Dr. Horváth Gábor
Prerequisities: none

Sylow's theorems. Semidirect product. Maximal subgroups of p-groups are normal of index p. Characteristic subgroup, commutator. Solvable groups and their basic properties. Alternating group is simple if acting on at least 5 points. Free groups, generators, relations, Dyck's theorem. Necessary and sufficient condition for a ring to be a unique factorization domain, ascending and descending chain conditions. Field of fractions. Artinian and Noetherian rings, Hilbert's basis theorem. Algebras, minimal polynomial over algebras, Frobenius's theorem. Splitting field, existence, uniquencess, algebraic closure existence, uniqueness. Normal extensions, extensions of perfect fields are simple. Galois theory. Fundamental theorem of algebra. Compass and ruler constructions. Theorem of Abel and Ruffini, Casus Irreducibilis is unavoidable for degree three polynomials.
Compulsory/Recommended Readings:
John B. Fraleigh: A first course in abstract algebra, Addison-Wesley Publishing Company, 1989.
Derek J. S. Robinson: A course in the theory of groups, Sringer-Verlag, 1980.

TTMME0202, TTMMG0202
Operation research
2+2 classes/week, 3+2 credit, E+P
Lecturer: Dr. Mészáros Fruzsina
Prerequisities: none

Problems reducible to linear programming tasks. Extreme points of convex polyhedra, simplex algorithm and its geometry, sensitivity analysis. Duality. Transportation and assignment model, network models. Special linear programming models.
Compulsory/Recommended Readings:
Ronert Vanderbei: Linear Programming, Foundations and Extensions, Kluwer Academic Publishers, 1998.
Dinitris Bertsimas, John Tsitsiklis: Introduction to Linear Optimization, Athena Scientific Series in Optimization and Neural Computation, 1997.

TTMME0301, TTMMG0301
Selected topics in geometry
2+2 classes/week, 3+2 credit, E+P
Lecturer: Dr. Kozma László
Prerequisities: none

Differentiable curves. Curvature, torsion. The fundamental theorem of curves. Surfaces in the Euclidean space. Fundamental form of surfaces. Normal curvature, principal curvatures, principal directions. Variational problem of arc-length. Geodesics. Geodesic curvature. Minimizing property of geodesics. Axioms of affine and projective planes. Projective completion of an affine plane. Duality. Vector space model of porjective planes, homogenous coordinates. Perspectivities (central projections) and projectivities. Cross ratio of four points or lines, Pappus-Steiner theorem. Desargues's theorem and Pappus's theorem. Complete quadrilateral, complete quadrangle, harmonic sets of points and lines. Collineations, fundamental theorem of projective geometry. The parallel postulate, the development of hyperbolic geometry. The Cayley-Klein model of hyperbolic geometry, Poincaré disk model and upper half-plane model. Description of congruences. Spherical geometry: measuring distance on the sphere, spherical triangles. Elliptic metric.
Compulsory/Recommended Readings:
Wolfgang Kühnel: Differential Geometry: Curves – Surgaces – Manifolds, AMS, 2006.
H. S. M. Coxeter: Projective Geometry, Springer, 1974.
Patrick J. Ryan: Euclidean and non-Euclidean geometry: an analytical approach, Cambridge, 1986.

TTMME0401, TTMMG0401
Probability theory
2+2 classes/week, 3+2 credit, E+P
Lecturer: Dr. Fazekas István

Prerequisities: none

Probability, random variables, probability distributions. Asymptotic theorems of probability theory.

Compulsory/Recommended Readings:
A. N. Shiryayev: Probability, Springer-Verlag, Berlin, 1984.

Advanced prof module

TTMME0104, TTMMG0104
Graph theory and applications
2+2 classes/week, 3+2 credit, E+P
Lecturer: Dr. Nyul Gábor
Prerequisities: none

Multiply connected graphs: Menger's theorems, edge-disjoint spanning trees. Graph colourings: chromatic number, greedy vertex colouring, Brooks' theorem, Mycielski construction, perfect graphs, chromatic polynomial, chromatic index, Vizing-theorem. Independence and covering: Gallai's theorems, Kőnig's theorem, Hall's theorem, perfect mathchings in bipartite and in arbitrary graphs, augmenting path method. Extremal graph theory: Mantel's theorem, Turán's theorem. Friendship theorem, strongly regular graphs. Planar graphs, crossing number. Directed paths and cycles in directed graphs, tournaments.
Compulsory/Recommended Readings:
J. A. Bondy, U. S. R. Murty: Graph Theory, Springer, 2008.

TTMME0106, TTMMG0106
Algorithms in mathematics
2+2 classes/week, 3+2 credit, E+P
Lecturer: Dr. Bérczes Attila
Prerequisities: TTMME0104

Representing graphs, breadth-first search and depth-first search, finding minimal spanning trees: Kruskal's, Prim's and Boruvka's algorithms. The Bellman-Ford-algorithm. Dijkstra's algorihtm. Structure of shortest paths: Floyd-Warshall-algorithm. Transitive closure of directed graphs, Johnson's algorithm on sparse graphs. Representing polynomials: discrete and fast Fourier-transformation. Number theoretical algorithms: Euclidean algorithm, operations with residue classes, Chinese remainder theorem. Computing powers. Prime tests, factorizing integers. Random prime tests, Agrawal–Kayal–Saxena prime test. Pollard's rho-algorithm.
Compulsory/Recommended Readings:
Herbert S. Wilf: Algorithms and Complexity, electronic edition, 1994.

TTMME0205, TTMMG0205
Convex optimization
2+2 classes/week, 3+2 credit, E+P
Lecturer: Dr. Bessenyei Mihály
Prerequisities: none

Hull operations and their representations. The Stone–Kakutani separation theorem. Algebraic interior and algebraic closure. The intersection of the algebraic closure of complementary convex sets; separation of convex sets by linear functions. The Dubovickij–Miljutin theorem and its consequences. The Bernstein–Doetsch theorem for linear functions; the topological form of the separation theorems. Convex and sublinear functions; the maximum theorem and its consequences. Subgradient and directional derivative of convex functions. Rules of calculus. The Bernstein–Doetsch theorem for convex functions. Distance function, tangent cone, normal cone. The minimum of convex conditional extremum problems; primal and dual conditions. The convex Fermat principle. Penalty function. The Karush–Kuhn–Tucker theorem and its consequence. Slater condition and Slater theorem.
Compulsory/Recommended Readings:
T. R. Rockafellar: Convex Analysis, Princeton University Press, Princenton, N. J., 1970.
J. M. Borwein and A. S. Lewis: Convex Analysis and Nonlinear Optimization, CMS Books in Mathematics, Springer, New York, 2006.

TTMME0107, TTMMG0107
Discrete optimization
2+2 classes/week, 3+2 credit, E+P

Lecturer: Dr. Nyul Gábor
Prerequisities: none

Theoretical background of discrete optimization problems. Totally unimodular matrices, integer linear programming, Hoffman-Kruskal theorem. Assignment problem, quadratic assignment problem, set covering problem, Chinese postman problem, travelling salesman problem, Steiner-tree problem, bin packing problem. Max flow−min cut problem, Ford-Fulkerson theorem, Edmonds-Karp theorem. Greedy algorithm for downward closed family of sets, matroids.
Compulsory/Recommended Readings:
Bernhard Korte, Jens Vygen: Combinatorial Optimization, Springer-Verlag, 2006.
Dieter Jungnickel: Graphs, Networks and Algorithms, Springer-Verlag, 2008.
Vijay V. Vazirani: Approximation Algorithms, Springer-Verlag, 2001.

TTMME0207, TTMMG0207
Applications of ordinary differential equations
2+2 classes/week, 3+2 credit, E+P
Lecturer: Dr. Novák-Gselmann Eszter
Prerequisities: none

Autonomous systems of differential equations and their phase spaces. Stability of differencial equations, the theorems of Lyapunov, the direct method of Lyapunov. Boundary value problems and eigenvalue problems. Green function. Existence and uniqueness theorems. Maximum and minimum principles. Nonlinear boundary value problems. Sturm-Liouville eigenvalue problems. Rotationally symmetric elliptic problems. Diffeomorphisms and their symmetries. The application of the one-parameter symmetry group to integration of equations. Calculus of variations, the Euler–Lagrange differential equations, the invariance of the Euler–Lagrange differential equations, the canonical form of the Euler–Lagrange differential equations, the first integrals of the Euler–Lagrange differential equations. The Noether theorem. The principle of stationary action.
Compulsory/Recommended Readings:
B. Dacorogna, Introduction to the Calculus of Cariations, 2nd ed., London: Imperial College Press, 2008.
A. D. Ioffe, V. M. Tihomirov, Theory of Extremal Problems, Studies in Mathematics and its Applications, 6. North-Holland Publishing Co., Amsterdam-New York, 1979.
W. Walter, Gewöhnliche Differentialgleichungen - Eine Einfürung, 7. Auflage, Springer, 2000.

TTMME0204, TTMMG0204
Partial differential equations
2+2 classes/week, 3+2 credit, E+P
Lecturer: Dr. Fazekas Borbála
Prerequisities: none

Examples in physics. First order equations: homogeneous linear equations, quasilinear equations and Cauchy problems for general equations. Higher order equations, the Cauchy–Kovalevskaya theorem. One, two and three dimensional wave equation. Inhomogeneous wave equation. Poisson equation, Green functions, harmonic functions, maximum principle. Initial value problem for the Laplace and Poisson equations. The heat conduction equation. Sobolev spaces, weak solutions.
Compulsory/Recommended Readings:
V. I. Arnold: Lectures on Partial Differential Equations, Springer, Berlin, 2004.

TTMME0402, TTMMG0402
Stochastic processes
2+2 classes/week, 3+2 credit, E+P
Lecturer: Dr. Barczy Mátyás
Prerequisities: none

General notion of conditional expected value, discrete and continuous time Markov chains, discrete time martingals, Wiener processes, stochastic integration with the Wiener process (Itô integral), Itô's formula, stochastic differential equations, diffusion processes.
Compulsory/Recommended Readings:
I. Karatzas, S. E. Shreve: Brownian Motion and Stochastic Calculus, Springer-Verlag, 1991.
N. Shiryayev: Probability, 2nd edition, Springer-Verlag, 1995.
S. M. Ross: Introduction to Probability Models, 10th edition, Academic Press, 2009.

TTMME0403, TTMMG0403

Multivariate analysis
2+2 classes/week, 3+2 credit, E+P
Lecturer: Dr. Baran Sándor
Prerequisities: none

Multivariate sample and its properties, principal component analysis, factor analysis, canonical correlation analyis, methods of statistical classification, cluster analysis, multidimensional scaling.
Compulsory/Recommended Readings:
A. J. Izenman: Modern Multivariate Statistical Techniques. Regression, Classification and Manifold Learning, Springer, 2008.
N. H. Timm: Applied Multivariate Analysis, Springer, 2002.
B. Everitt, T. Hothorn: An Introduction to Applied Multivariate Analysis with R, Springer, 2011.
K. V. Mardia, J. T. Kent, J. M. Bibby: Multivariate Analysis, Academic Press, 1982.

TTMME0404, TTMMG0404
Option pricing
2+2 classes/week, 3+2 credit, E+P
Lecturer: Dr. Gáll József
Prerequisities: none

The students get to know about the fundamental derivatives and their roles, the fundamentals of the mechanism of derivatives markets, the principles of pricing derivatives, the principle of arbitrage-freeness and how to apply it, some classical models and problems and methods related to their fitting and applications.
Compulsory/Recommended Readings:
Hull, J. C.: Options, Futures and Other Derivatives, 10th edition, Pearson, 2018.
Musiela, M. and Rutkowsky, M.: Martingale Methods in Financial Modelling, 2nd edition, Springer, 2005.

TTMME0405, TTMMG0405
Financial mathematics I.
2+2 classes/week, 3+2 credit, E+P
Lecturer: Dr. Barczy Mátyás
Prerequisities: none

Discrete time models of shares markets and options pricing, risk measures, coherent measures, Value at Risk, Expected Shortfall, operational risk and its models based on composite distributions. Markowitz-type mean-variance portfolio analysis, CAPM.
Compulsory/Recommended Readings:
Harry H. Panjer: Operational Risk: Modeling Analytics, Wiley, 2006.
Musiela, M. and Rutkowski, M.: Martingale Methods in Financial Modeling, Springer-Verlag, Berlin, Heidelberg, 2005.

TTMME0901
Introduction to finance
2+2 classes/week, 5+0 credit, E
Lecturer: Dr. Gáll József
Prerequisities: none

Basic notions of finances and financial markets, time value of money, methods of calculating present value, other fundamental financial statements, financial statement frauds based on financial and market data, bonds and shares and basic methods of the pricing, internal rate of return, elementary questions on investment.
Compulsory/Recommended Readings:
Brealey, R. and Myers, S.: Principles of Corporate Finace, Concize Edition, McGraw Hill Higher Education, 2010.

TTMME0902
Microeconomics
2+2 classes/week, 5+0 credit, E
Lecturer: Dr. Kapás Judit
Prerequisities: none

Fundamental principles of microeconomics. Methodology of microeconomical analysis: modelling, comparative statics, optimization, marginal analysis. Central problems of microeconomics. The mechanism of market: analysis of demand and supply. Interventions of government into the market: price control, taxation. Modelling of consumer decision. Preference ordering, utility theory, types of preference. Budget set. Optimization of consumption, individual demand. Applications of demand theory, elasticities. Production theory. The microeconomical concept of corporational perception, the corporation as decision maker. Entrepeneur, owner, manager. Profit maximization as main goal. Terms. Short and long term production function. Factor demand, marginal product and increment. Competitive industry: commodity prices over short and long term. Well-being of society: consumer and producer surplus. Monopolist behaviour: profit maximization of pure monopoly, analysis of effects on well-being.
Compulsory/Recommended Readings:
Besanko, David – Breautigam, Ronald R. : Microeconomics (International Student version)
Third Edition. John Wiley and Sons, Inc., New York, 2008.
Besanko, David – Breautigam, Ronald R. : Microeconomics. Study Guide
Third Edition. John Wiley and Sons, Inc., New York, 2008.

TTMME0904
Econometrics
2+1 classes/week, 4+0 credit, E
Lecturer: Dr. Balogh Tamás László
Prerequisities: TTMME0403 (p)

Topics of econometrics, fields of interest. Introduction to the R. Single and mutlivariate regression models: the OLS estimate, goodness-of-fitting, indices, hypothesis testing. Autocorrelation, multicollinearity. Dummy and truncated variables. Simultaneous econometrics models. Error of variables. Analysis of panel data. Basic notions in time series analysis. Case studies.
Compulsory/Recommended Readings:
G. S. Maddala, Kajal Lahiri: Introduction to Econometrics 4th Edition, Wiley, 2009.
Achim Zeileis and Christian Kleiber: Applied Econometrics with R, Springer, 2008.
Ramu Ramanathan: Introductory econometrics with applications, South-Western/Thomson Learning, 2002.

TTMME0905
Financial accounting
2+2 classes/week, 5+0 credit, E
Lecturer: Dr. Tóth Kornél
Prerequisities: none

Notion of public accountancy. Steps in the accounting process. Accounting system, practice of public accountancy. International Financial Reporting Standards (IFRS). The content of financial statements and their presentation.
Compulsory/Recommended Readings:
David Alexander and Christopher Nobes: Financial Accounting: An International Introduction
5th Edition. Prentice Hall, London, 2013.

TTMME0208, TTMMG0208
Game theory
2+2 classes/week, 3+2 credit, E+P
Lecturer: Dr. Boros Zoltán
Prerequisities: none

The normal form of non-cooperative games. The notion and existence of Nash equilibrium. The best response mapping. Fixed point theorems in game theory. Analysis of finite games, strictly dominated strategies, bimatrix representation of finite two-person games. Application of the game theoretic approach to simple market models (duopolium, oligopolium). Mixed extension of finite games. Two-person zero-sum games, matrix games. Games in extensive form. Combinatorial games, Grundy's games, Grundy numbering. Cooperative games, the value of

the coalition. Nash's model of bargaining.
Compulsory/Recommended Readings:
J. H. Conway: On Numbers and Games, Academic Press, 1976.
Martin J. Osborne: An Introduction to Game Theory, Oxford University Press, 2003.

Elective courses

TTMME0903
Macroeconomics
2+2 classes/week, 5+0 credit, E
Lecturer: Dr. Czeglédi Pál
Prerequisities: TTMME0902

Central problems in macroeconomics. Principles of measuring aggregates: economic cycle and the GDP, nominal and real GDP, applications of GDP, the GDP-deflator and the consumer price index, measuring unemployment. Economy in the long run: equilibrium of the goods market, equilibrium of the factor market and the distribution of income, theories of natural unemployment. Importance of money and inflation: the functions of money and the money supply, quantity theory of money, money demand, costs of inflation. Short run models of economy: the keynesian cross, the IS-LM model, models of aggregate supply and aggregate demand. Relation between short term and long term deductions: the expectations-augmented Philips curve and the Friedman and Modigliani-type theory of consumption functions.
Compulsory/Recommended Readings:
Mankiw, Gregory: Macroeconomics
Sixth Edition. Worth Publisher, New York, 2007.
Kaufman, Roger T.: Student Guide and Workbook for Use with Macroeconomics
Kaufman, Roger T.: Student Guide and Workbook for Use with Macroeconomics. Worth Publisher, New York, 2007., 2007

TTMME0407
Insurance mathematics
2+0 classes/week, 3+0 credit, E
Lecturer: Dr. Barczy Mátyás
Prerequisities: none

Notion of insurance, classification of insurances, classical non-life insurance models, methods for determining total loss, related regression and statistical questions. Pricing. Life and reinsurances, annuity calculation, priceing of life insurances.
Compulsory/Recommended Readings:
Straub, Erwin: Non-life Insurance Mathematics, Springer-Verlag, 1980.
Mikosch, Thomas: Non-life Insurance Mathematics, Springer, Berlin, Heidelberg, New York, 2006.

TTMME0406
Financial mathematics II.
2+0 classes/week, 3+0 credit, E
Lecturer: Dr. Gáll József
Prerequisities: TTMME0405

Utility theory, expected utility, axioms and criticism in related literature. Risk aversion and its measuring, optimal portfolios. Contionuous time shares and interest-rate models, analysis of arbitrage-freeness, pricing of shares, bonds and interest-rate derivatives.
Compulsory/Recommended Readings:
Musiela, M. and Rutkowski, M.: Martingale Methods in Financial Modeling, Springer-Verlag, Berlin, Heidelberg, 2005.
Björk, T.: Arbitrage Theory in Continuous Time, Oxford University Press, Oxford/New York, 1998.
Brigo, D. and Mercurio, F.: Interest Rate Models - Theory and Practice: With Smile, Inflation and Credit, Springer, Berlin, Heidelberg New York, 2006.

TTMME0303, TTMMG0303
Finite geometries and coding theory
2+2 classes/week, 3+2 credit, E+P
Lecturer: Dr. Szilasi Zoltán
Prerequisities: none

Finite incidence structures: projective and affine planes, Galois geometry. Combinatorial properties of finite projective planes. Arcs and ovals. Finite projective planes and algebraic structures. Finite projective and affine planes over a field. Examples of combinatorial point sets on finite projective plane. Further incidence structures: block design and Steiner-system. Applications of finite geometry in coding theory.
Compulsory/Recommended Readings:
A. Beutelspacher: Projective Geometry – From Foundations to Applications, Cambridge, 1998.
J. W. P. Hirschfeld: Projective Geometries Over Finite Fields, Oxford, 1998.
D. R. Hughes, F. C. Piper: Projective Planes, Springer, 1973.
S. E. Payne: Topics in Finite Geometry, 2007.

TTMME0206
Fourier series
2+1 classes/week, 4+0 credit, E
Lecturer: Dr. Gát György
Prerequisities: none

The interpolation theorems of Marcinkiewicz, classical and complex trigonometric systems, the theorems of Weierstrass, the density of trigonometric polynomials, the Riemann-Lebesgue lemma, Dirichlet kernels, Fejér kernels, norm convergence of Fejér means, the Calderon-Zygmund decomposition, Hilbert operator, Fejér-Lebesgue theorem, the Dini and the Lipschitz criteria for convergence, the norm convergence of Fourier partial sum operators, Fourier series with respect to Walsh systems.
Compulsory/Recommended Readings:
N. K. Bary: A Treatise on Trigonometric Series, Elsevier, 2014.
A. Zygmund, Trigonometric Series Vol I., Cambridge University Press, 2002.