MATHEMATICS

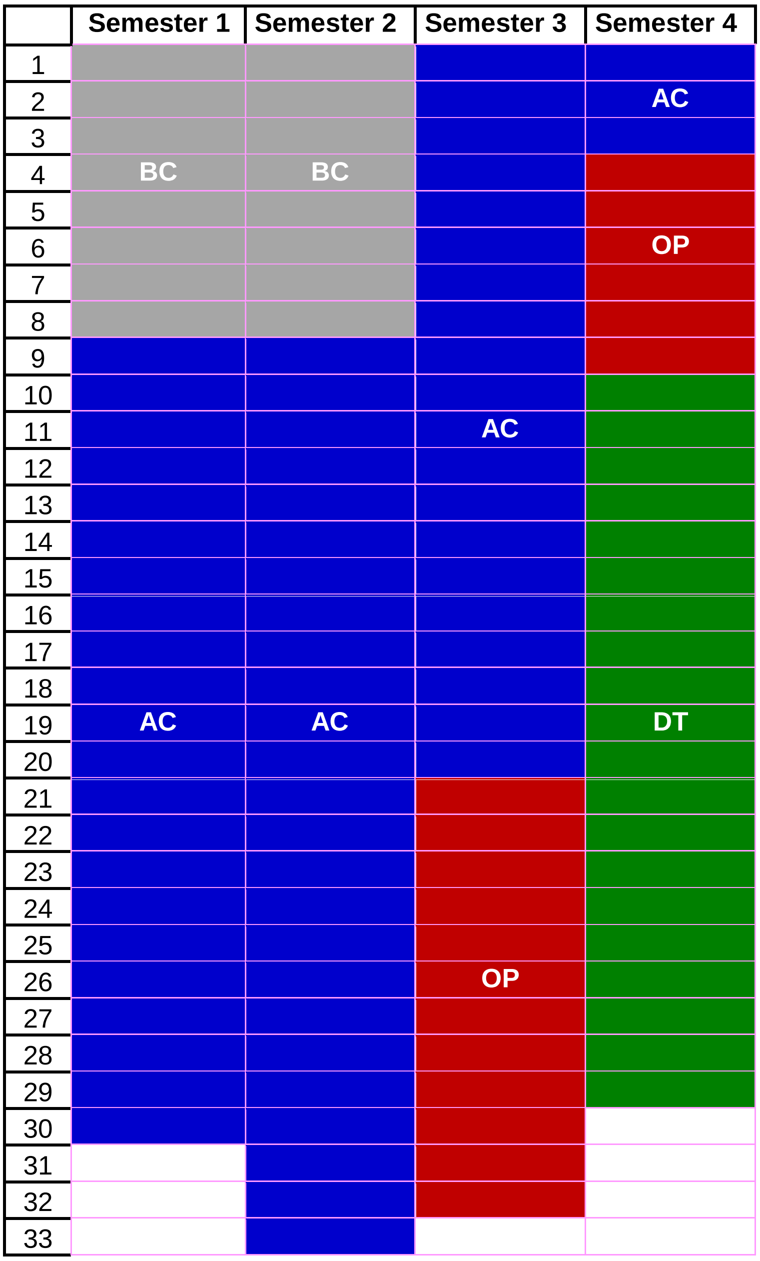
Mathematics for Industry and Commerce

II Level – MSc (4 semesters, 120 ECTS)

PROGRAM

4 SEMESTERS	*MSc*
Entry requirements: ***Diploma of the I level studies in: Mathematics, Economics/Finance, Management, Computer Science, Physics***	*Completed:* ***Diploma thesis,*** ***Final Exam***
Possible extension: ***Studies of the III level (PhD)***	*Graduate:* *Knowledge in mathematics and economics/finance. Experience in pricing financial and actuarial contracts. Prepared for solving problems in the financial/actuarial sector and gaining information from the literature and other sources. Organizational skills. Experience necessary for professional carrier at research units, industry and at universities and colleges; has gained substantial international experience. Well above standard skills in communication (English)*

Structure of the programme (credits)



BC – Basic Courses;
AC – Advanced Courses;
OP – Optional (Advanced) Courses;
DT – Diploma Thesis and Final Exam.

PLAN OF STUDIES

1st YEAR, SEMESTER 1

Obligatory courses:

No.	Code	Subject/Module	Contact hours/week					CHS	TSW	ECTS	Form of Assessment
			L	T	lab	p	s				
1	MAP001902	Real and complex analysis in mathematical modelling	2	2				60	240	8	E
2	MAP001903	Stochastic modelling	2	2				60	210	7	E
3	MAP001904	Statistics of time series	2		2			60	210	7	E
4	MAP001990	Computer simulations for random phenomena	2		2			60	120	4	T/CW
5	MAP001991	Discrete financial models	2		2			60	120	4	T
		TOTAL						**300**	**900**	**30**	

1st YEAR, SEMESTER 2

Obligatory courses:

No.	Code	Subject/Module	Contact hours/week					CHS	TSW	ECTS	Form of Assessment
			L	T	lab	p	s				
1	MAP001908	Functional analysis, topology and optimization	2		2			60	240	8	E
2	MAP001909	Statistical packages	2		2			60	180	6	T/CW
3	MAP001910	Differential equations	2		2			60	150	5	E
4	MAP001912	Stochastic models for futures contracts	2	2				60	180	6	E
5	MAP001992	Life insurance models	2	2				60	180	6	E
6	MAP001911	Diploma seminar I					2	30	60	2	CW
		TOTAL						**330**	**990**	**33**	

2nd YEAR, SEMESTER 3

Obligatory courses:

No.	Code	Subject/Module	Contact hours/week					CHS	TSW	ECTS	Form of Assessment
			L	T	lab	p	s				
1	MAP001993	Financial engineering and risk management	2		2			60	180	6	E
2	MAP001994	Insurance models for industry	2		2			60	180	6	E
3	MAP001995	Selected aspects of perturbation methods	2		2			60	180	6	T
4	MAFC1F	Optional course I	2		2			60	180	6	T
5	MAFC2F	Optional course II	2		2			60	180	6	T
6	MAP001915	Diploma seminar II					2	30	60	2	CW
		TOTAL						**330**	**960**	**32**	

2nd YEAR, SEMESTER 4

Obligatory courses:

No.	Code	Subject/Module	Contact hours/week					CHS	TSW	ECTS	Form of Assessment
			L	T	lab	p	s				
1	MAP1936	Diploma thesis							600	20	CW
2	MAFC3F	Optional course III	2		2			60	180	6	T
3	MAP001919	Diploma seminar III					2	30	90	3	CW
		TOTAL						**90**	**870**	**29**	

Optional courses

No.	Code	Subject/Module	Contact hours/week					CHS	TSW	ECTS	Form of Assessment
			L	T	lab	p	s				
1	MAP001922	Numerical methods in differential equations	2		2			60	180	6	T
2	MAP001996	Nonlinear methods	2		2			60	180	6	T
3	MAP001925	Computer simulations of stochastic processes 2	2		2			60	180	6	T
4	MAP001926	Estimation theory	2		2			60	180	6	T
5	MAP001997	Game theory and applications	2		2			60	180	6	T
6	MAP00xxxx	Introduction to Mathematical Image Processing	2		2			60	180	6	T

L	T	lab	p	s

L – Lecture T – Tutorials, **l** – laboratory, **p** – project, **s** – seminar,

CHS	TSW

CHS – Contact Hours (organized), **TSW** – Total Student Workload (h), **E** – Exam, T – Test, CW – Course Work

Description of the courses

1st Semester

CODE: MAP001902	REAL AND COMPLEX ANALYSIS IN MATHEMATICAL MODELLING				

Language: English — **Course: Basic**/Advanced
Year (I), semester (1) — **Level:** II — **Obligatory**/Optional
Prerequisites: None — **Teaching: Traditional**/Distance L.
Lecturer: Prof. Wojciech Okrasiński

	Lecture	Tutorials	Laboratory	Project	Seminar
Hours / sem. (h)	30	30			
Exam / Course work / T:	E				
ECTS	8				
Workload (h)	120	120			

Outcome: Group work; Mathematical modelling of real world problems using MATLAB; Seminar presentation.

Content: Selected topics of real and complex analysis; Differential and integral equations in mathematical modelling; Introduction to computational analysis in mathematical modelling.

Literature:

1. B. Barnes, G.R. Fulford, *Mathematical Modelling with Case Studies. A differential equation approach using Maple*.
2. K. Ericsson, D. Estep, P. Hansbo, C. Johnson, *Computational Differential Equations*.
3. J.D. Logan, *Applied Mathematics. A Contemporary Approach*.

CODE: MAP001903	STOCHASTIC MODELLING				

Language: English — **Course:** Basic/**Advanced**
Year (I), semester (1) — **Level:** II — **Obligatory**/Optional
Prerequisites: None — **Teaching: Traditional**/Distance L.
Lecturer: Prof. Aleksander Weron

	Lecture	Tutorials	Laboratory	Project	Seminar
Hours / sem. (h)	30	30			
Exam / Course work / T:	E				
ECTS	7				
Workload (h)	90	120			

Outcome: Individual work; Exercises; Case studies in stochastic modelling.

Content: Processes with independent increments; Poisson process; Wiener process; Geometric Brownian motion; Ornstein-Uhlenbeck process; Levy processes; Continuous time random walks; Martingales and semimartingales; Ito integral; Stochastic analysis; Stochastic differential equations; Feynman-Kac formula; Fokker-Planck equation.

Literature:

1. R. Cont, P. Tankov, *Financial Modelling with Jump Processes*.
2. I. Karatzas, S.E. Shreve, *Brownian Motion and Stochastic Calculus*.
3. K. Sobczyk, *Stochastic Differential Equations with Applications to Physics and Engineering*.

CODE: MAP001904	STATISTICS OF TIME SERIES

Language: English — **Course:** Basic/**Advanced**
Year (I), semester (1) — **Level:** II — **Obligatory**/Optional
Prerequisites: None — **Teaching: Traditional**/Distance L.
Lecturer: Dr. Agnieszka Wyłomańska

	Lecture	Tutorials	Laboratory	Project	Seminar
Hours / sem. (h)	30	30			
Exam / Course work / T:	E				
ECTS	7				
Workload (h)	90	120			

Outcome: Individual work; Case studies in data analysis using MATLAB.

Content: Descriptive statistics; Point and interval estimation; Correlation and covariance functions; Stationary time series models; Linearity, causality, invertible models; ARMA systems; FARIMA and SARIMA; ARCH and GARCH models.

Literature:

1. P.J. Brockwell, R.A. Davis, *Introduction to Time Series and Forecasting*.
2. D.S. Moore, G.P. McCabe, *Introduction to the Practice of Statistics*.
3. R.H. Schumway, D.S. Stoffer, *Time Series Analysis and Its Applications*.

CODE: MAP001990	COMPUTER SIMULATIONS FOR RANDOM PHENOMENA

Language: English — **Course:** Basic/**Advanced**
Year (I), semester (1) — **Level:** II — **Obligatory**/Optional
Prerequisites: None — **Teaching: Traditional**/Distance L.
Lecturer: Dr. Krzysztof Burnecki

	Lecture	Tutorials	Laboratory	Project	Seminar
Hours / sem. (h)	30		30		
Exam / Course work / T:	T		CW		
ECTS	4				
Workload (h)	60		60		

Outcome: Individual work; Case studies in fitting studied models to real-life data; Reports.

Content: Generating discrete and continuous random variables; Generating counting processes (homogeneous, non-homogeneous, mixed and doubly stochastic Poisson processes, and renewal process); Ito integral; Approximation of stochastic differential equations.

Literature:

1. P. Cizek, W. Haerdle, R. Weron, *Statistical Tools for Finance and Insurance*.
2. A. Janicki, A Weron, *Simulation and Chaotic Behavior of Stable Stochastic Processes*.
3. S. Ross, *Simulation*.

CODE: MAP001991	DISCRETE FINANCIAL MODELS

Language: English **Course:** Basic/**Advanced**
Year (I), semester (1) **Level:** II **Obligatory**/Optional
Prerequisites: None **Teaching: Traditional**/Distance L.
Lecturer: Dr. Rafał Weron

	Lecture	Tutorials	Laboratory	Project	Seminar
Hours / sem. (h)	30		30		
Exam / Course work / T:	T				
ECTS	4				
Workload (h)	60		60		

Outcome: Individual work; Seminar presentation; Case studies in pricing financial instruments.

Content: Investments, instruments, markets; Bond prices and yields; Efficient markets and the behavioral critique; Derivatives; Binomial trees and option pricing; Portfolio theory.

Literature:

1. Z. Bodie, A. Kane, A.J. Marcus, *Essentials of Investments*.
2. M. Capiński, T. Zastawniak, *Mathematics for Finance: An Introduction to Financial Engineering*.
3. J. Franke, W. Härdle, C. Hafner, *Introduction to Statistics of Financial Markets*.

CODE: MAP1908	FUNCTIONAL ANALYSIS, TOPOLOGY AND OPTIMIZATION				

Language: English — **Course: Basic**/Advanced
Year (I), semester (2) — **Level:** II — **Obligatory**/Optional
Prerequisites: None — **Teaching: Traditional**/Distance L.
Lecturer: Prof. Wojciech Okrasiński

	Lecture	Tutorials	Laboratory	Project	Seminar
Hours / sem. (h)	30		30		
Exam / Course work/T:	E				
ECTS	8				
Workload (h)	120		120		

Outcome: Individual work; Numerical treatment and modelling of inverse problems; Programming in MATLAB.

Content: Topological vector spaces; Operator theory; Real world problems modeled by integral equations; Functional analysis framework for inverse problems; Principal numerical methods for inverse problems.

Literature:

1. L. Debnath, P. Mikusiński, *Introduction to Hilbert Spaces with Applictions*.
2. Ch.W. Groetsch, *Inverse Problems in the Mathematical Science*.
3. E. Zeidler, *Applied Functional Analysis*

CODE: MAP1909	STATISTICAL PACKAGES				

Language: English — **Course:** Basic/**Advanced**
Year (I), semester (2) — **Level:** II — **Obligatory**/Optional
Prerequisites: None — **Teaching: Traditional**/Distance L.
Lecturer: Dr. Małgorzata Bogdan

	Lecture	Tutorials	Laboratory	Project	Seminar
Hours / sem. (h)	30		30		
Exam / Course work/T:	T		CW		
ECTS	6				
Workload (h)	90		90		

Outcome: Individual work; Statistical case studies; Reports.

Content: Data analysis with SAS; Descriptive statistics, Graphical representation of data; Statistical inference: confidence intervals, testing, checking model assumptions, Linear regression; Interpretation of results.

Literature:

1. R. Freund, R. Littell, *SAS System for Regression*.
2. M. H. Kutner, C. J. Nachstheim, J. Neter, W. Li, *Applied Linear Statistical Models.*
3. D. S. Moore, G.P. McCabe, *Introduction to the Practise of Statistics*

CODE: MAP1910	DIFFERENTIAL EQUATIONS				
Language: English				**Course:** Basic/**Advanced**	
Year (I), semester (2)	**Level:** II			**Obligatory**/Optional	
Prerequisites: None				**Teaching: Traditional/**Distance L.	
Lecturer: Dr. hab. Wojciech Mydlarczyk					
	Lecture	**Tutorials**	**Laboratory**	**Project**	**Seminar**
Hours / sem. (h)	30		30		
Exam / Course work/T:	E				
ECTS	5				
Workload (h)	60		90		

Outcome: Individual work; Analysis of case studies.

Content: Prime integrals; Heat conduction equation; Self-ignition of coal piles; Long time behaviour of the solutions to the parabolic problems; Weak solutions; Linear equations of the first order: domains of dependence, discretization using explicit, implicit and Crank-Nicolson schemes; Discretizations of the Burger's equation; Elliptic equations: uniqueness problems for Laplace's equation, Green's formula, the potential method for solving boundary problems for elliptic equations; Fredholm type integral equations of the second kind.

Literature:

1. D.K. Arrowsmith, C. M. Place, *Ordinary differential equations.*
2. L.C. Evans, *Partial differential equations.*
3. M.W. Hirsch, S. Smale, *Differential equations. Dynamical systems and linear algebra* .
4. R.M. Mattheij, S.W. Rienstra, J.H.M. ten Thije Boonkkamp, *Partial Differential Equations. Modeling, Analysis.*

CODE: MAP1911	DIPLOMA SEMINAR I				
Language: English				**Course:** Basic/**Advanced**	
Year (I), semester (2)	**Level:** II			**Obligatory**/Optional	
Prerequisites: None				**Teaching: Traditional/**Distance L.	
Lecturer: Prof. Aleksander Weron					
	Lecture	**Tutorials**	**Laboratory**	**Project**	**Seminar**
Hours / sem. (h)					30
Exam / Course work/T:					CW
ECTS					2
Workload (h)					60

Outcome: Individual work; Case studies using internet data bases; Seminar presentation.

Content: Normal diffusion; Anomalous diffusion; Fokker-Planck equation; Monte Carlo methods.

Literature:

1. Academic journals.
2. Recent working/research papers.

CODE: MAP1912	**STOCHASTIC MODELS OF FORWARD CONTRACTS**

Language: English | **Course:** Basic/**Advanced**
Year (I), semester (2) | **Level:** II | **Obligatory**/Optional
Prerequisites: Introduction to financial mathematics | **Teaching: Traditional**/Distance L.
Lecturer: Prof. Aleksander Weron, Dr. Rafał Weron

	Lecture	Tutorials	Laboratory	Project	Seminar
Hours / sem. (h)	30	30			
Exam / Course work / T:	E				
ECTS	6				
Workload (h)	90	90			

Outcome: Individual work; Case studies in modelling asset prices.

Content: Black-Scholes model: martingale approach, SDE approach; Sensitivity analysis; Term structure modelling; Short term interest rate models: Vasicek model, Cox-Ingersoll-Ross model; Heath-Jarrow-Morton model; Credit derivatives pricing.

Literature:

1. D. Brigio, F. Mercurio, *Interest Rate Models: Theory and Practice*.
2. P. Cizek, W. Härdle, R. Weron, *Statistical Tools for Finance and Insurance*.
3. J. Hull, *Options, Futures and Other Derivatives*.
4. M. Musiela, M. Rutkowski, *Martingale Methods in Financial Modelling*.

CODE: MAP1913	**LIFE INSURANCE MODELS**

Language: English | **Course:** Basic/**Advanced**
Year (I), semester (2) | **Level:** II | **Obligatory**/Optional
Prerequisites: None | **Teaching: Traditional**/Distance L.
Lecturer: Dr. Krzysztof Burnecki

	Lecture	Tutorials	Laboratory	Project	Seminar
Hours / sem. (h)	30	30			
Exam / Course work / T:	E				
ECTS	6				
Workload (h)	90	90			

Outcome: Individual work; Case studies in modelling future lifetime.

Content: Properties of life insurance; Distribution of future lifetime; Life tables; Net premiums; Life annuities; Net premium reserves.

Literature:

1. N.L. Bowers et al., *Actuarial Mathematics*.
2. H.U. Gerber, *Life insurance mathematics*.

3rd Semester

CODE: MAP001993 FINANCIAL ENGINEERING AND RISK MANAGEMENT

Language: English
Course: Basic/**Advanced**
Year (II), semester (3) **Level:** II
Obligatory/Optional
Prerequisites: Stochastic models of forward contracts
Teaching: Traditional/Distance L.
Lecturer: Prof. Aleksander Weron, Dr. Rafał Weron

	Lecture	Tutorials	Laboratory	Project	Seminar
Hours / sem. (h)	30	30			
Exam / Course work / T:	E				
ECTS	6				
Workload (h)	90	90			

Outcome: Group work; Seminar presentation; Case studies in financial engineering and risk management.

Content: Evolution of risk management products; Exotic instruments; Hybrid structures; Energy markets; Derivatives pricing; Market, credit and operational risk management; Integrated risk management.

Literature:

1. P. Cizek, W. Härdle, R. Weron, *Statistical Tools for Finance and Insurance*.
2. P. Jorion, *Value at Risk*.
3. M. Musiela, M. Rutkowski, *Martingale Methods in Financial Modelling*.
4. R. Weron, *Modeling and Forecasting Electricity Loads and Prices: A Statistical Approach*.

CODE: MAP001915 DIPLOMA SEMINAR II

Language: English
Course: Basic/**Advanced**
Year (II), semester (3) **Level:** II
Obligatory/Optional
Prerequisites: None
Teaching: Traditional/Distance L.
Lecturer(s): Dr. Krzysztof Burnecki, Dr. Rafał Weron

	Lecture	Tutorials	Laboratory	Project	Seminar
Hours / sem. (h)					30
Exam / Course work/T:					CW
ECTS					2
Workload (h)					60

Outcome: Individual work; Case studies in finance and insurance; Seminar presentation.

Content: Financial markets worldwide; Structured products; Energy markets; Catastrophic insurance market; Alternative risk transfer (ART).

Literature:

3. Academic journals.
4. Recent working/research papers.

CODE: MAP001994	INSURANCE MODELS FOR INDUSTRY				

Language: English — **Course:** Basic/**Advanced**
Year (II), semester (3) — **Level:** II — **Obligatory**/Optional
Prerequisites: None — **Teaching: Traditional**/Distance L.
Lecturer: Dr. Krzysztof Burnecki

	Lecture	**Tutorials**	**Laboratory**	**Project**	**Seminar**
Hours / sem. (h)	30	30			
Exam / Course work / T:	E				
ECTS	6				
Workload (h)	90	90			

Outcome: Individual work; Case studies in calculating ruin probability.

Content: Individual risk model; Collective risk model; Premium principles; Ruin probability; Reinsurance.

Literature:

1. N. L. Bowers et al., *Actuarial Mathematics*.
2. P. Cizek, W. Haerdle, R. Weron, *Statistical Tools for Finance and Insurance*.
3. E. Straub, *Non-Life Insurance Mathematics*.

CODE: MAP001995	SELECTED ASPECTS OF PERTURBATION METHODS				

Language: English — **Course:** Basic/**Advanced**
Year (II), semester (3) — **Level:** II — **Obligatory**/Optional
Prerequisites: Functional analysis, topology and optimization — **Teaching: Traditional**/Distance L.
Lecturer: Prof. Prof. Wojciech Okrasiński

	Lecture	**Tutorials**	**Laboratory**	**Project**	**Seminar**
Hours / sem. (h)	30		30		
Exam / Course work / T:	T				
ECTS	6				
Workload (h)	90		90		

Outcome: Individual work; Practical case studies

Content: Regular and singular perturbation methods; Asymptotic analysis, boundary layer approximations; Real-world case studies.

Literature:

1. E. J. Hinch, *Perturbation Methods*.
2. J. David Logan, *Applied Mathematics*.

CODE: MAP1919 **DIPLOMA SEMINAR III**

Language: English **Course:** Basic/**Advanced**
Year (II), semester (4) **Level:** II **Obligatory**/Optional
Prerequisites: None **Teaching: Traditional**/Distance L.
Lecturer: Prof. Wojciech Okrasiński, Prof. Aleksander Weron

	Lecture	Tutorials	Laboratory	Project	Seminar
Hours / sem. (h)					30
Exam / Course work/T:					CW
ECTS					3
Workload (h)					90

Outcome: Individual work; Seminar presentation.
Content: Presentation of thesis topics.

CODE: MAP1963 ANALYSIS OF CATEGORICAL DATA

Language: English **Course:** Basic/**Advanced**
Year (II), semester (3-4) **Level:** II Obligatory/**Optional**
Prerequisites: None **Teaching: Traditional**/Distance L.
Lecturer: Dr. Małgorzata Bogdan

	Lecture	Tutorials	Laboratory	Project	Seminar
Hours / sem. (h)	30		30		
Exam / Course work/T:	T		CW		
ECTS	6				
Workload (h)	90		90		

Outcome: Individual work; Case studies in statistics and analysis of categorical data.

Content: Classes of statistical problems; Multinomial distribution: parameter estimation, confidence intervals; Models for binomial and multinomial response data; Likelihood ratio test; Person tests and exact tests; Model selection.

Literature:

1. A. Agresti, *Categorical Data Analysis*.
2. R. Christensen, *Log-Linear Models*.
3. T.J. Santner, D.E. Duffy, *The Statistical Analysis of Discrete Data*.

CODE: MAP001922 NUMERICAL METHODS IN DIFFERENTIAL EQUATIONS

Language: English **Course:** Basic/**Advanced**
Year (II), semester (3-4) **Level:** II Obligatory/**Optional**
Prerequisites: None **Teaching: Traditional**/Distance L.
Lecturer: Dr. hab. Wojciech Mydlarczyk

	Lecture	Tutorials	Laboratory	Project	Seminar
Hours / sem. (h)	30		30		
Exam / Course work/T:	T		CW		
ECTS	6				
Workload (h)	90		90		

Outcome: Individual work; Case studies.

Content: One- and multistep approximation methods for ODE; Richardson extrapolation; Convergence of approximate methods; Elliptic PDEs; Dirichlet and Neumann boundary problems; Method of finite elements.

Literature:

1. G. Dahlquist, A. Björck, *Numerical Methods in Scientific Computing*.
2. B.P. Flannery, W.H. Press, S.A. Teukolsky, W.T. Vetterling, *Numerical Receipes in C*.

CODE: MAP001996 **NONLINEAR METHODS**

Language: English **Course:** Basic/**Advanced**

Year (II), semester (3-4) **Level:** II Obligatory/**Optional**

Prerequisites: None **Teaching: Traditional**/Distance L.

Lecturer: Prof. Wojciech Okrasiński

	Lecture	Tutorials	Laboratory	Project	Seminar
Hours / sem. (h)	30		30		
Exam / Course work/T:	T		CW		
ECTS	6				
Workload (h)	90		90		

Outcome: Individual work; Case studies.

Content: Introduction to nonlinear methods; Nonlinear optimization; Nonlinear methods in differential equations; Numerical methods in nonlinear phenomena.

Literature:

1. D. P. Bertsekas, *Nonlinear Programming*.
2. D.W. Jordan, P. Smith, *Nonlinear Ordinary Differential Equations*.
3. G. Nicolis, *Introduction to Nonlinear Science*.

CODE: MAP1925 **COMPUTER SIMULATIONS OF STOCHASTIC PROCESSES 2**

Language: English **Course:** Basic/**Advanced**

Year (II), semester (3-4) **Level:** II Obligatory/**Optional**

Prerequisites: None **Teaching: Traditional**/Distance L.

Lecturer: Dr. Krzysztof Burnecki

	Lecture	Tutorials	Laboratory	Project	Seminar
Hours / sem. (h)	30		30		
Exam / Course work / T:	T		CW		
ECTS	6				
Workload (h)	90		90		

Outcome: Individual work; Case studies in computer simulations; Reports.

Content: Generating stable random variables and vectors; Simulation of stable processes via series and integral representations; Stationary and self-similar processes; Generating processes with long-range dependence; Stable and long-memory models in physics and economics.

Literature:

1. P. Cizek, W. Haerdle, R. Weron, *Statistical Tools for Finance and Insurance*.
2. P. Doukhan, G. Oppenheim, M.S. Taqqu, *Theory and Applications of Long-Range Dependence*.
3. A. Janicki, A Weron, *Simulation and Chaotic Behavior of Stable Stochastic Processes*.

CODE: MAP1926	**ESTIMATION THEORY**				
Language: English				**Course:** Basic/**Advanced**	
Year (II), semester (3-4)	**Level:** II			Obligatory/**Optional**	
Prerequisites: None				**Teaching: Traditional/**Distance L.	
Lecturer: Dr. Małgorzata Bogdan					
	Lecture	**Tutorials**	**Laboratory**	**Project**	**Seminar**
Hours / sem. (h)	30		30		
Exam / Course work/T:	T		CW		
ECTS	6				
Workload (h)	90		90		

Outcome: Individual work; Case studies in statistics.

Content: Bootstrap method and its applications; Nonparametric methods of density and hazard function estimation; Linear regression; Nonlinear regression; Kaplan-Meier estimator.

Literature:

1. L. Devroye, *A Course in Density Estimation*.
2. B. Efron, R. Tibshirani, *Introduction to the Bootstrap*.
3. B. Silverman, *Density Estimation for Statistics and Data Analysis*.

MATERIAŁY DYDAKTYCZNE

Forma i treść do decyzji wydziałów. Powinien to być materiał w j.angielskim dla studentów np. konspekt wykładu, instrukcja laboratoryjna, prezentacja, materiały do ćwiczeń audytoryjnych itp. do jednego dowolnie wybranego kursu.