SYLLABUS

1. Information regarding the programme

1.1 Higher education institution	**Babeş-Bolyai University**
1.2 Faculty	**Faculty of Mathematics and Computer Science**
1.3 Department	**Department of Mathematics**
1.4 Field of study	**Mathematics**
1.5 Study cycle	**Master**
1.6 Study programme / Qualification	**Advanced Mathematics**

2. Information regarding the discipline

2.1 Name of the discipline	**Stochastic Models**						
2.2 Course coordinator	**Assoc.Prof.PhD. Hannelore Lisei**						
2.3 Seminar coordinator	**Assoc.Prof.PhD. Hannelore Lisei**						
2.4. Year of study	2	2.5 Semester	4	2.6. Type of evaluation	E	2.7 Type of discipline	Optional

3. Total estimated time (hours/semester of didactic activities)

3.1 Hours per week	3	Of which: 3.2 course	2	3.3 seminar/laboratory	1
3.4 Total hours in the curriculum	36	Of which: 3.5 course	24	3.6 seminar/laboratory	12

Time allotment:	hours
Learning using manual, course support, bibliography, course notes	60
Additional documentation (in libraries, on electronic platforms, field documentation)	50
Preparation for seminars/labs, homework, papers, portfolios and essays	40
Tutorship	19
Evaluations	20
Other activities:	0

3.7 Total individual study hours	189
3.8 Total hours per semester	225
3.9 Number of ECTS credits	9

4. Prerequisites (if necessary)

4.1. curriculum	• Mathematical Analysis, Probability Theory
4.2. competencies	• Computing integrals; average programming and simulation skills

5. Conditions (if necessary)

5.1. for the course	• Laptop, beamer

5.2. for the seminar /lab activities	• Laboratory with computers

6. Specific competencies acquired

Professional competencies	Identifying the models and adequate methods for solving problems Ability to understand and manipulate advanced concepts, results and theories in the fields of mathematics.
Transversal competencies	Ability to use acquired and complementary knowledge in preparing a PhD in Mathematics, Applied Mathematics, or other fields which use mathematical methods.

7. Objectives of the discipline (outcome of the acquired competencies)

7.1 General objective of the discipline	The course aims deepening the basic notions of Stochastics, followed by their applicative side and their practical interpretation.
7.2 Specific objective of the discipline	• Monte Carlo methods • Stochastic processes and their applications • Brownian motion and applications • Markov chains

8. Content

8.1 Course	Teaching methods	Remarks
1. Review of the basic notions of Probability Theory, conditional probabilities; discrete and continuous random variables	Lecture, description, explanation	
2. Stochastic processes; examples	Exposure, description, explanation, examples	
3. Random walks (on the line, in the plane, in the space)	Exposure, description, explanation, examples	
4. Discrete time Markov chains	Exposure, description, explanation, proof	
5. Multivariate normal distribution	Exposure, description, explanation, examples	
6. Continuous time Markov chains	Exposure, description, explanation, proof	
7. Stationary processes	Exposure, description, explanation, proof, examples	
8. Gaussian processes	Exposure, description, explanation, proof	
9. The Brownian motion (I)	Exposure, description, explanation, proof	

10. The Brownian motion (II)	Exposure, description, explanation, proof	
11. Linear and quadratic variation of the Brownian motion	Exposure, description, explanation, proof	
12. The Poisson process	Exposure, description, explanation, proof	

Bibliography

Blaga, P., Radulescu, M., Calculul probabilitatilor, Universitatea "Babes-Bolyai" Cluj-Napoca, 1987.

Ciucu G., Tudor C., Probabilitati şi Procese Stocastice. Vol.I, Vol.II., Edit. Acad. 1978, 1979.

Karatzas I., Shreve S.E., Brownian Motion and Stochastic Calculus, Springer Verlag, New York, 2005.

Lisei, H., Probability Theory, Casa Cărţii de Ştiinţă, Cluj-Napoca, 2004.

Lisei, H., Grecksch, W., Iancu, M., Probability: Theory, Examples, Problems, Simulations. World Scientific Publishing, Singapore, 2020.

Lisei, H., Micula, S., Soos, A., Probability Theory trough Problems and Applications, Cluj University Press, Cluj-Napoca, 2006.

Morariu, C. O., Probabilităţi şi statistică aplicată, Editura Universităţii "Transilvania", Braşov, 2010.

Ross, S.M., Simulation, Academic Press, 2013.

8.2 Seminar / laboratory	Teaching methods	Remarks
S1. Generation of random numbers	Presentation, discussion	The seminar is structured as 2 hours classes every second week
S2. Random walks (on the line, in the plane, in the space)	Presentation, individual work	
S3. Markov chains (discrete time)	Presentation, individual work	
S4. Markov chains (continuous time)	Discussion, group-based work, modelling	
S5. Brownian motion	Discussion, group-based work, modelling	
S6. Poisson process	Discussion, group-based work, modelling, simulation	

Bibliography

P. Blaga, Statistică prin Matlab, Presa Univ. Clujeană, 2002.

Gorunescu, F., Modelare stochastică şi simulare, Editura Albastră, 2001.

Karatzas I., Shreve S.E., Brownian Motion and Stochastic Calculus, Springer Verlag, New York, 2005.

Lisei, H., Probability Theory, Casa Cărţii de Ştiinţă, Cluj-Napoca, 2004.

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9. Corroborating the content of the discipline with the expectations of the epistemic community, professional associations and representative employers within the field of the program

The content of this discipline is in accordance with the curricula of the most important universities in Romania and abroad, where advanced mathematics and its applications play an essential role.

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Share in the grade (%)
10.4 Course	Knowledge of main concepts presented in the course	Written exam	60%
10.5 Seminar/lab activities	To be able to solve specific problems	-Practical examination -presentation -continuous observations	40%
10.6 Minimum performance standards			
At least grade 5 (from a scale of 1 to 10) at the written exam. The student should be able to perform specific reasoning, to use stochastic methods, to give examples of Markov chains, to list properties of the Brownian motion.			

Date	Signature of course coordinator	Signature of seminar coordinator
20.04.2021	Assoc.Prof.PhD. Hannelore Inge Lisei	Assoc.Prof.PhD Hannelore Inge Lisei

Date of approval	Signature of the head of department
28.04.2021	Prof. Dr. Octavian Agratini