Syllabus
Field of study* : Financial Engineering

Module name			
Probability theory and stochastic processes			
Module name in english			
Probability theory and stochastic processes			
Module code			**Method of evaluation**
WIGEFES.21A.12345.18			Exam
Field of study		**Track**	**Year / semester**
Financial Engineering		General academic	1 / 1
Specialisation		**Language of instruction**	**Module**
All		English	Obligatory
Number of hours		**Number of ECTS points**	**Block**
Lectures: 30	Classes: 30	6	A
Level of qualification	**Mode of studies**	**Education field**	
Second-cycle programme	Full-time	Social Sciences	
Author	Karolina Sobczak		
Teachers	Karolina Sobczak		

Subject's educational aims

C1	Presentation of fundamental concepts in probability theory and stochastic processes theory
C2	Presentation of basic applications of these theories in economic sciences

Subject's learning outcomes

Code	Outcomes in terms of	Learning outcomes within the field
Knowledge		
W1	Knows basic probability distributions and fundamental stochastic processes	K2_W01, K2_W04
W2	Knows and understands main concepts in probability theory and stochastic processes theory	K2_W01, K2_W04
W3	Defines properties of given probability distributions	K2_W01, K2_W04
Skills		
U1	Calculates basic characteristics of probability distributions	K2_U02
U2	Exploits formulas to calculate values of functions of random variables	K2_U02
U3	Exploits definitions and theorems to prove given properties of stochastic processes	K2_U02
U4	N/A : Stosuje oprogramowanie MATLAB do obliczania wartości: funkcji masy prawdopodobieństwa, funkcji gęstości prawdopdobieństwa, funkcji zmiennych losowych	K2_U02

U5	N/A : Posługuje się oprogramowaniem MATLAB w celu wizualizacji wyników obliczeń oraz w celu interpretacji wyników	K2_U01, K2_U02
Social competences		
K1	Is open-minded to knowledge broading and responsible for his/her educational progress	K2_K01, K2_K04
K2	Takes care of good learning environment and good conditions for educational progress of other students	K2_K01, K2_K03

Study content

No.	Study content	Subject's educational aims	Subject's learning outcomes
1.	Events as sets, probability measure and its properties, probability space	C1	W2, K1, K2
2.	Conditional probability, total probability, Bayes' theorem, independece of events (pairwise, general), conditional independence	C1	W2, K1, K2
3.	Random variables, distribution function, discrete probability distribution and its examples, indicator function, tails of distribution, law of averages	C1	W1, W2, U5, K1, K2
4.	Discrete and continuous random variables, probability mass function, density function	C1	W1, W2, W3, U4, K1, K2
5.	Random vectors, joint distribution function and its properties, marginal distribution functions, joint mass function, joint density function, Monte Carlo simulations	C1	W2, U5, K1, K2
6.	Examples of discrete distributions (binomial, Bernoulli, hypergeometric, Poisson), independence of random variables	C1	W1, W2, W3, K1, K2
7.	Expected value of discrete random variable, expected value of discrete random variable's function, properties of expected value	C1	W2, U1, U2, K1, K2
8.	Moments and central moments of random variable, variance of random variable, standard deviation, properties of variance, unocorrelated random variables	C1	W2, U1, U2, K1, K2
9.	Examples of expected value and variance for discrete variables (in ditributions: Bernoulli, binomial, trinomial, multinomial, Poisson, hypergeometric, geometric, negative binomial)	C2	W1, W3, U1, U2, U4, K1, K2
10.	Expected value of continuous random variable, expected value of continuous random variable's function, examples of expected value and variance for continuous variables (in distributions: uniform, exponential, normal, standard normal, gamma, chi-squared, Cauchy, beta, Weilbull)	C2	W1, W3, U2, U4, U5, K1, K2
11.	Dependence of random variables, covariance and correlation coefficient, conditional probability: distribution function, mass function, density function, conditional expected value	C1	W2, K1, K2
12.	Stochastic processes, discrete and continuous time, realization of process, examples of stochastic processes (simple random walk, random walk, discrete white noise, Poisson, Wiener, Galton-Watson)	C1	W1, W2, U3, U5, K1, K2
13.	Simple random walk ans its applications in economic sciences, properties of simple random walk (spatial homogentity, temporal homogeneity, Markov property), reflection principle	C2	W1, W2, U3, U5, K1, K2
14.	Markov processes, examples of Markov processes, transition matrix, Chapman-Kolmogorov formula	C1	W1, W2, U3, K1, K2
15.	Classification of states, classification of chains, stationary distributions and the limit theorem, continuous-time Markov chains	C1	W1, W2, U3, K1, K2

Bibliography

Obligatory

1. Grimmett G. R, Stirzaker D. R., 2004, Probability and Random Processes 3rd Edition, Oxford University Press
2. Grimmett G. R, Stirzaker D. R., 2009, One Thousand Exercises in Probability 1st Edition, Oxford University Press

Recommended

1. Parzen E., 2015, Stochastic Processes, Dover Books Publications
2. Gikhman I.I., Skorokhod A.V., 2004, The Theory of Stochastic Processes I, Springer
3. Stoyanov J.M., 2013, Counterexamples in Probability, Third Edition, Dover Publications
4. Billingsley P., 2012, Probability and Measure, Anniversary Edition, Jon Wiley & Sons, New York

Entry requirements	Znajomość podstawowych pojęć matematycznych, Dobra znajomość języka angielskiego
Teaching methods	Lecture with multimedia presentation, Case study, Exercises, Laboratories
Method of evaluation	Written exam, Written exam with open questions, Final quiz, Final test, Class participation, Individual project, Group project / Group work, Research

Settlement of ECTS points

Forms of student work	Average number of hours for student work*
Preparation for test	20
Participation in classes	30
Consultations with teacher	7
Participation in the exam	2
Preparation for classes	20
Participation in lectures	30
Preparation for exam	25
Data collection	10
Literature research	7

Student work in total	Number of hours 151	ECTS points 6
Contact hours (with the teacher)	Number of hours 69	ECTS points 2.5
Practical-class work	Number of hours 30	ECTS points 1

* one hour of classes = 45 minutes

Methods of evaluating the learning outcomes

Learning-outcome code	Methods of evaluation							
	Written exam	Written exam with open questions	Final quiz	Final test	Class participation	Individual project	Group project / Group work	Research
W1	x	x	x	x	x	x	x	x
W2	x	x	x	x		x	x	

W3	x	x	x	x		x	x	x
U1	x	x	x	x	x			x
U2	x	x	x	x	x	x	x	x
U3	x	x	x	x	x			
U4					x	x	x	x
U5					x	x	x	x
K1	x	x	x	x	x	x	x	x
K2	x	x	x	x	x	x	x	

Effects

Code	Content
K2_K01	can critically and correctly assess his/her knowledge and skills and plan systematic improvement through permanent self-education. He/She understands the need for development through reading the professional literature, he/she is able to select and study, even very advanced positions. He\She can choose courses and training to improve his/her competence
K2_K03	has a full understanding of the importance of intellectual honesty; he\she is aware of ethical issues in the context of the reliability of the research (plagiarism or self-plagiarism)
K2_K04	is able to plan his/her career and effectively implement the next stages that require increasing knowledge and skills
K2_U01	is able to perform in-depth analysis of complex socio-economic phenomena, based on that he/she can build models and interpret the results
K2_U02	is able to choose, build and use quantitative tools of varying sophistication to the forecasting and simulation of socio-economic phenomena. He/she can critically select the methods of analysis
K2_W01	understands the social sciences and their relationship to science and humanities
K2_W04	has in-depth knowledge of quantitative tools that can be used in the modeling, analysis and optimization in the economy. He/she knows the capabilities and limitations of these tools. He/she understands economic processes well enough to choose or design the appropriate advanced model