GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Random Processes and Mathematical Statistics, PG_00048458		
Field of study	Automatic Control, Cybernetics and Robotics		
Date of commencement of studies	February 2024	Academic year of realisation of subject	2023/2024
Education level	second-cycle studies	Subject group	Optional subject group Subject group related to scientific research in the field of study
Mode of study	Full-time studies	Mode of delivery	at the university
Year of study	1	Language of instruction	Polish
Semester of study	1	ECTS credits	2.0
Learning profile	general academic profile	Assessment form	exam
Conducting unit	Department of Teleinformation Networks -> Faculty of Electronics, Telecommunications and Informatics		
Name and surname of lecturer (lecturers)	Subject supervisor	mgr inż. Sebastian Dziedziewicz	
	Teachers	mgr inż. Sebastian Dziedziewicz	

Lesson types and methods of instruction

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	15.0	15.0	0.0	0.0	0.0	30

E-learning hours included: 0.0

Learning activity and number of study hours

Learning activity	Participation in didactic classes included in study plan	Participation in consultation hours	Self-study	SUM
Number of study hours	30	4.0	16.0	50

Subject objectives

Knowledge of basic methods of random processes analysis and basics of mathematical statistics.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_W02] Knows and understands, to an increased extent, selected laws of physics and physical phenomena, as well as methods and theories explaining the complex relationships between them, constituting advanced general knowledge in the field of technical sciences related to the field of study	Student identifies, classifies and describes basic types of random processes, analyses their properties, calculates parameters and characteristics of random processes. Student describes principles of parameter estimation, properties of estimators, principles of hypotheses verification, calculates estimates and verifies statistical hypotheses.	[SW1] Assessment of factual knowledge
[K7_U03] can design, according to required specifications, and make a complex device, facility, system or carry out a process, specific to the field of study, using suitable methods, techniques, tools and materials, following engineering standards and norms, applying technologies specific to the field of study and experience gained in the professional engineering environment	Student identifies, classifies and describes basic types of random processes, analyses their properties, calculates parameters and characteristics of random processes. Student describes principles of parameter estimation, properties of estimators, principles of hypotheses verification, calculates estimates and verifies statistical hypotheses.	[SU1] Assessment of task fulfilment [SU4] Assessment of ability to use methods and tools

Subject contents	1. One-dimensional random variables- discrete, analog, mixed- common description with the aid of generalized probability density function, statistical moments, cumulants, characteristc function, generating function 2. Random vectors- real and complex, description methods, statistical moments- auto-correlation matrix and auto-covariance matrix and their properties; cross-correlation matrix and cross-covariance matrix and their properties 3. Linear transformations of random vectors and their properties 4. Diagonalization of auto-correlation matrix and diagonalization of auto-covariance matrix with the aid of unitary method; use of singular value decomposition of data matrix 5. Diagonalization of auto-correlation matrix and auto-covariance matrix with the aid of triangular method; use of QR decomposition of data matrix. 6. Definition and classification of random processes (RP); ensemble of realizations averaging method; cumulative probability distribution function, probability density function of RP. 7. Moments of RP, autocorrelation function, autocovariance function, cross-correlation and cross-covariance functions, RP stationarity in wide- and strict-sense; other stationarity definitions; RP ergodicity; time-averages. 8. RP examples- Bernoulli, binomial, random walking, discrete Wiener, Markov . Periodic RP, cycle-stationary RP. Gauss RP. 9. Markov chains (MC)- homogenity and stationarity of MC, classification of states; Kolmogorov-Chapman equation, random walking RP as MC. 10. Description of RP in frequency domain- power spectral density and its properties, physical interpretation. Sampling theorem for RP. White noise, band-pass white noise, discrete white noise. 11. Response of linear systems to RP inputs. 12. Moving average (MA) RP, autoregressive (AR) RP, autoregressive moving average (ARMA) RP. 13. Properties of MA, AR and ARMA RP- autocorrelation function, Youle-Walker equations. 14. Properties of MA, AR and ARMA RP- power density functions. 15. Methods of estimation, point and interval estimation, estimation of random variable parameters, maximum likelihood estimators, properties of estimators, Cramer-Rao bound. Verification of statistical hypotheses. 16. RP parameters estimation- mean value estimation, estimation of autocorrelation function and autocorrelation matrix. 17. Estimation of power density function of RP- correlogram, periodogramm, Blackmann-Tukey, Welch, Bartlett algorithms. 18. Estimation of power density function of RP using linear models AR, MA, ARMA.
Prerequisites and co-requisites	No requirements
Assessment methods and criteria	

Subject passing criteria	Passing threshold	Percentage of the final grade
Midterm colloquium	50.0%	100.0%

Recommended reading	Basic literature	A. Papoulis, Probability, Random Variables, and Stochastic Processes, McGraw-Hill, 1991 Hwei P. Hsu, Theory and Problems of Probability, Random Variables and Random Processes, McGraw-Hill, 1997
	Supplementary literature	Therrien, C. W. Discrete Random Signals and Statistical Signal Processing. Prentice-Hall, 1992.
	eResources addresses	Adresy na platformie eNauczanie:
Example issues/ example questions/ tasks being completed	For random process $\underline{X}(t)=\underline{A}\sin(\omega_0 t)+\underline{B}\cos(\omega_0 t)$, where $\underline{A}$ and $\underline{B}$ are independent random variables calculate mean value, auto-correlation function, auto-covariance function and answer the question: is this random process wide-sense stationary?	
Work placement	Not applicable	