![Gdańsk University of Technology logo] **GDAŃSK UNIVERSITY OF TECHNOLOGY**

Subject card

Subject name and code	Information theory, PG_00031971
Field of study	Technical Physics

Date of commencement of studies	February 2024	Academic year of realisation of subject	2024/2025
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	2	Language of instruction	Polish
Semester of study	3	ECTS credits	4.0
Learning profile	general academic profile	Assessment form	assessment

Conducting unit	Department of Theoretical Physics and Quantum Information -> Faculty of Applied Physics and Mathematics

Name and surname of lecturer (lecturers)	Subject supervisor	prof. dr hab. Marek Czachor
	Teachers	

Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	0.0	0.0	0.0	30.0	60
	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	60	8.0	32.0	100

Subject objectives	Introduction to basic information theory with some modern applications.

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[K7_W03] Has general knowledge of current development paths and discoveries in the scope of physics and related fields of science and technology.	Student knows general foundations of the theory and its modern applications	[SW1] Assessment of factual knowledge
	[K7_W04] Has enhanced knowledge of mathematical, numerical and simulation methods applied in the description and modelling of physical phenomena.	Knows how to apply the theory to concrete computer science problems	[SW1] Assessment of factual knowledge
	[K7_U04] Can formulate and test hypotheses related to research problems.	Is capable of formulating an independent research problem	[SU3] Assessment of ability to use knowledge gained from the subject
	[K7_U09] Can popularize the achievements in physics and related fields of science.	Can present laymen-lectures	[SU3] Assessment of ability to use knowledge gained from the subject

Subject contents	Hartley information measure
	Amount of information according to Shannon
	Additivity of information
	Shannon entropy
	MaxEnt principle
	Method of Lagrange multipliers
	Ekstremum entropii przy kilku więzach
	Kolmogorov-Nagumo averages
	Derivation of Renyi entropy from KN averages
	Additivity of Renyi information
	Tsallis entropy
	Shannon entropy as a limit of Renyi entropy
	Zipf-Mandelbrot law
	MaxEnt principle for Renyi entropies
	Fractals
	Richardson's law
	Fractal dimension
	Joint entropy
	Conditional entropy
	Mutual information
	Mutual information vs. conditional entropy
	Relative entropy
	Concave and convex functions
	Jensen inequality
	Information inequality

	Log-sum inequality
	Non-negativity of mutual information
	Entropy vs. 2nd law of thermodynamics
	2nd law of thermodynamics for Markov chains
	Codes
	Alphabets
	Dictionaries
	Prefix code
	Kraft inequality
	Shannon theorem on discrete coding
	Shannon code
	Shannon-Fano code
	Arithmetic coding
	Huffman code
	Bernoulli law of large numbers
	Asymptotic equipartition principle for the Bernoulli process
	Theorem on capacity of a channel
Prerequisites and co-requisites	Elementary probability calculus.

Assessment methods and criteria			
	Subject passing criteria	Passing threshold	Percentage of the final grade
	Oral exam	60.0%	50.0%
	Seminar	60.0%	50.0%

Recommended reading		
	Basic literature	T. M. Cover, J. A. Thomas, Elements of information theory (Wiley, New York, 1991).
	Supplementary literature	A. Renyi, Selected papers of Alfred Renyi (Akadmiai Kiado, Budapest, 1976).
	eResources addresses	Adresy na platformie eNauczanie:

Example issues/ example questions/ tasks being completed	
	Properties of Shannon information
	Construct a Huffman code for a given set of events
	Prove Jensen inequality

Work placement	Not applicable