GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Digital Filters, PG_00048075		
Field of study	Electronics and Telecommunications		
Date of commencement of studies	October 2020	Academic year of realisation of subject	2022/2023
Education level	first-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	3	Language of instruction	Polish
Semester of study	5	ECTS credits	1.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Department of Microelectronic Systems -> Faculty of Electronics, Telecommunications and Informatics		
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Maciej Kokot	
	Teachers	dr inż. Maciej Kokot	

Lesson types and methods of instruction

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	15.0	0.0	0.0	0.0	0.0	15

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	15	1.0	9.0	25

Subject objectives

Learning methods of description and rules of designing digital filters IIR and FIR, calculation of DFT and FFT, and applications of digital filters in various fields.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K6_U04] can apply knowledge of programming methods and techniques as well as select and apply appropriate programming methods and tools in computer software development or programming devices or controllers using microprocessors or programmable elements or systems specific to the field of study	Student explains the basic methods of digital filter design. Student explains selected algorithms for designing and optimizing digital filters. Student analyzes various methods of filter design using tools (Matlab).	[SU2] Assessment of ability to analyse information
[K6_W31] Knows the definitions of measurement error and uncertainty, measurement methods, including digital methods of time, frequency and phase measurements, transducer properties and knows digital signal processing systems.	Student names the requirements for digital filters, identifies basic blocks and structures. Student describes the applications of digital filters in various fields.	[SW1] Assessment of factual knowledge

<table>
<tr><td>Subject contents</td><td>1. Introduction. Main topics. Gradiuation criteria. 2. Specification of desired properties of digital filters. Basic features, algorithms and fields of application of digital filtering. 3. Basic network structures for IIR systems. 4. Basic network structures for FIR systems. 5. Matrix, signal flow graph and state variable description. Generation of various structures with the same system function. 6. Analysis of the effects of finite register length. 7. Limit cycle oscillations. 8. Quantization error and additive noise models for fix- and floating-point realization and for fast Fourier transform algorithms. 9. Digital filter design techniques for IIR systems. Impulse invariance and bilinear transformation methods. Digital Butterworth, Chebyszev and elliptic filters. 10. Randomized Yule-Walker method. 11. Modeling of given characteristics of FIR filters in time domain. 12. Computer-aided design including minimalization of the Lp norm. 13. Design of FIR filters with linear phase using windows. 14. Computer-aided design of FIR filters using frequency sampling method. 15. Mean root square optimization and Chebyszev approximations methods (Remez algorithm). 16. Generalized Butterworth’s method. 17. Selective and special filters: Hilbert filter, differential filter, interpolator and decimator filters. 18. The computation of the discrete Fourier transformwith fast algorithms for real, complex and two-dimensional signals. 19. Filter design and modern spectrum analysis by AR, MA and ARMA modeling. 20. Basis of adaptive filtering. Wiener filter, gradient adaptive filters. 21. Compression of speech. Estimation of digital filter coefficients (vocal-tract parameters). Lattice structures – properties and design. 22. Filtering of images. Median filters, computer tomography. 23. Computer-aided design tools. Utilizing the Signal Processing Toolbox of Matlab.</td></tr>
<tr><td>Prerequisites and co-requisites</td><td>No requirements</td></tr>
<tr><td>Assessment methods and criteria</td><td>
<table>
<tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr>
<tr><td>Written exam</td><td>50.0%</td><td>100.0%</td></tr>
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<tr><td>Recommended reading</td><td>
<table>
<tr><td>Basic literature</td><td>1. Alan V. Oppenheim, Ronald W. Schafer, Digital Signal Processing, Prentice-Hall, Inc.,Englewood Cliffs, New Jersey 1975. 2. Tomasz P. Zieliński, Cyfrowe przetwarzanie sygnałów. Od teorii do zastosowań. WKiŁ. Warszawa 2005. 3. Dag Stranneby, Digital Signal Processing. BTC. Warszawa 2004.</td></tr>
<tr><td>Supplementary literature</td><td>1. Steven W. Smith, Digital Signal Processing: A Practical Guide for Engineers and Scientists Published by arrangement with Elsevier, 2003.</td></tr>
<tr><td>eResources addresses</td><td>Adresy na platformie eNauczanie:
Filtry Cyfrowe Wykład 2022-23 zima - Moodle ID: 27702
https://enauczanie.pg.edu.pl/moodle/course/view.php?id=27702</td></tr>
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<tr><td>Example issues/ example questions/ tasks being completed</td><td>Specification of the desired properties of a IIR digital filter are given (i.e. tolerances of the magnitude of the frequency response in the passband and the stopband, and the border frequency). Calculate filter rank, distribution of poles in s domain, and write down transmitance function by applying the impulse invariance designing technique and/or the bilinear transformation method.</td></tr>
<tr><td>Work placement</td><td>Not applicable</td></tr>
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