GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

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| Subject name and code | Advanced Processing of Telecommunications Signals, PG_00048355 | | |
| Field of study | Electronics and Telecommunications | | |
| Date of commencement of studies | February 2023 | Academic year of realisation of subject | 2023/2024 |
| Education level | second-cycle studies | Subject group | Optional subject group<br>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 | 2 | 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 | dr hab. inż. Marek Blok | |
| | Teachers | dr hab. inż. Marek Blok | |

**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 | 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**

Familiarize students with selected advanced digital signal processing techniques encountered in digital telecommunications.

**Learning outcomes**

| Course outcome | Subject outcome | Method of verification |
|---|---|---|
| [K7_W01] Knows and understands, to an increased extent, mathematics to the extent necessary to formulate and solve complex issues related to the field of study. | Determines the signal parameters based on the eyediagram. Draws and describes diagrams of a quadrature modulator with interpolation and a quadrature demodulator with decimation and determines changes in signals and their spectra at subsequent processing stages. Determines a specification of the interpolation and decimation filter. | [SW1] Assessment of factual knowledge<br>[SW3] Assessment of knowledge contained in written work and projects |
| [K7_W03] Knows and understands, to an increased extent, the construction and operating principles of components and systems related to the field of study, including theories, methods and complex relationships between them and selected specific issues - appropriate for the curriculum. | Describes the modulation and channel access techniques used in digital telecommunications. Explains the operation of basic multirate algorithms. Describes the classical sampling rate conversion algorithms. Draws and describes the schemes of polyphase interpolator and decimator. Explains the principle of the interpolated FIR filter. Describes the basic techniques of spread spectrum. Describes selected techniques of all-optical signal processing used in OTN networks. | [SW1] Assessment of factual knowledge |

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| Subject contents | 1. Classification of contemporary telecommunications signals – speech and data transmission. Channel capacity.<br>2. Modulation techniques used in data transmission: ITU-T standards – from telephone modem to OTN.<br>3. Multiple access techniques for data transmission channel.<br>4. Modulation techniques in digital transmission.<br>5. Introduction to multirate signal processing. Fundamental building blocks of multirate algorithms and their properties.<br>6. Equivalent structures in multirate processing. Transposition rules for multirate structures.<br>7. Classic sample rate conversion algorithm and its polyphase implementations.<br>8. Aliasing in polyphase structures. Computational complexity of polyphase structures.<br>9. Digital signal processing for VoIP.<br>10. Multirate ADC and DAC converters. Principles and operation of vocoder. Subband coding. Estimation of speech parameters.<br>11. Digital filters in data transmission – theory and design. Hilbert transformer and complex Hilbert filter. Shaping and receiving filters.<br>12. Quadrature mirror filters.<br>13. Cascade and multistage filter structures. I-FIR filters. Multistage CIC filters.<br>14. Multistage sample rate conversion.<br>15. Modulation based on quadrature modulator with interpolation (QMI). Demodulation based on quadrature demodulator with decimation (QDD).<br>16. Multichannel QDD and QMI.<br>17. Digital implementation of resonators and narrowband filters.<br>18. Carrier and symbol timing recovery in digital receiver.<br>19. Delaying digital signals.<br>20. Variable fractional delay filters and their application in symbol synchronizations.<br>21. FFT as multirate DFT implementation. Arbitrary length FFT. Fast convolution.<br>22. Analysis and synthesis filter banks - implementation based on DFT.<br>23. Multicarrier modulations: FMT, DMT and OFDM.<br>24. Multicarrier transmission in multipath environment.<br>25. Spectrum spreading in data transmission - FHSS, DSSS.<br>26. UWB technology. UWB signal. UWB receiver.<br>27. Propagation of data transmission signals: distortions and countermeasures.<br>28. Channel parameters estimation and equalization.<br>29. Review of optical signal processing methods.<br>30/ Selected techniques for all digital optical signal processing used in OTN networks. |
| Prerequisites and co-requisites | |
| Assessment methods and criteria | |

| Subject passing criteria | Passing threshold | Percentage of the final grade |
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| Activity | 0.0% | 10.0% |
| Written exam | 50.0% | 90.0% |

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| Recommended reading | Basic literature | 1. Fredric J. Harris: Multirate Signal Processing for Communication Systems, Prentice Hall, 2004<br>2. John G. Proakis, Dimitris K. Manolakis: Digital Signal Processing, Prentice Hall, 2006<br>3. Andrea Goldsmith: Wireless Communications, Stanford University, California, 2005 |
| | Supplementary literature | 1. P. P. Vaidyanathan: Multirate Systems And Filter Banks, Prentice Hall, 1992<br>2. Ronald E. Crochiere, Lawrence R. Rabiner: Multirate Digital Signal Processing, Prentice Hall, 1983<br>3. M. Ibnkahla Ed., Signal Processing for Mobile Communications Handbook, CRC Press, 2004 |
| | eResources addresses | Adresy na platformie eNauczanie:<br>Zaawansowane przetwarzanie sygnałów telekomunikacji cyfrowej - Wykład 2023/2024 - Moodle ID: 28821<br>https://enauczanie.pg.edu.pl/moodle/course/view.php?id=28821 |
| Example issues/ example questions/ tasks being completed | | |
| Work placement | Not applicable | |