**Nazwa przedmiotu:**

Wybrane zagadnienia matematyki i algorytmiki

**Koordynator przedmiotu:**

prof. dr hab. inż. Aleksander Brzeziński

**Status przedmiotu:**

Obowiązkowy

**Poziom kształcenia:**

Studia II stopnia

**Program:**

Geodesy and Cartography

**Grupa przedmiotów:**

Obowiązkowe

**Kod przedmiotu:**

1060-GK000-MSA-1002

**Semestr nominalny:**

1 / rok ak. 2023/2024

**Liczba punktów ECTS:**

4

**Liczba godzin pracy studenta związanych z osiągnięciem efektów uczenia się:**

1. Number of contact hours: 48, including:
a) presence during lectures 15h
a) presence during classes 30 h
b) participation in consultations: 3 h
2. Student's own work - 32 hours, including:
a) consolidation of the theory: 10 h
b) execution of projects: 17 h
c) independent literature studies: 5 h
TOTAL 80 h - 4 p. ECTS

**Liczba punktów ECTS na zajęciach wymagających bezpośredniego udziału nauczycieli akademickich:**

1. Number of contact hours: 48, including:
a) presence during lectures 15h
a) presence during classes 30 h
b) participation in consultations: 3 h
TOTAL 48 h - 2.4 p. ECTS

**Język prowadzenia zajęć:**

angielski

**Liczba punktów ECTS, którą student uzyskuje w ramach zajęć o charakterze praktycznym:**

a) presence during classes 15 h
b) making of home projects: 17 h
TOTAL 32 h - 1.6 p. ECTS

**Formy zajęć i ich wymiar w semestrze:**

|  |  |
| --- | --- |
| Wykład: | 15h |
| Ćwiczenia: | 30h |
| Laboratorium: | 0h |
| Projekt: | 0h |
| Lekcje komputerowe: | 0h |

**Wymagania wstępne:**

Basic knowledge and skills in mathematics, physics, geodesy and programming languages.

**Limit liczby studentów:**

-

**Cel przedmiotu:**

To give students theoretical and practical knowledge on the selected methods of random signals analysis. The course will present mathematical background and describe algorithms of empirical data analysis, both in the time and frequency domain.

**Treści kształcenia:**

The course will begin with description of the random signals. Special attention will be paid to the properties of stationarity and ergodicity. Then, the basic characteristics of the signals will be introduced: mean value and variance, probability density, autocorrelation and power spectral density (PSD) functions, then the joint characteristics: joint probability density, cross correlation and the cross power spectral density (CPSD). The data analysis algorithms will include the classical methods, based on the digital Fourier transform, and the parametric methods focusing on the autoregressive (AR) modeling of time series. In case of AR models, the maximum entropy method (MEM) will be adopted as a basic tool for analysis of empirical data. The last part of the course will be devoted to the application of the linear Kalman filter the time domain analysis of discrete data. It will begin with definition of the linear dynamical system using the state-space formulation, then the filtering equations will be derived. The project part of the course will include application of the computer programs for analysis of empirical data. The computer programs will be those available in standard packages (Numerical Recipes, …), provided by the lecturer (MEM package), and the own program codes developed by the students.

**Metody oceny:**

The final assessment of knowledge and skills consists of a grade from exercises with a weight of 0.55 and the exam grade with a weight of 0.45, the lecturer has the right to correct it by a half of grade. Passing the lecture is carried out by the written exam covering theoretical-problem nature issues (pass requires obtaining minimum 60% of points). To pass the project it is required to obtain more than 60% of points from all assessments/reports and attendance at classes. An additional element of the assessment of the exercises is the substantive activity of the student. An unjustified absence from more than 2 projects means failing the project.

**Egzamin:**

tak

**Literatura:**

Bendat J. S., and A. G. Piersol (2010). Random Data Analysis and Measurement Procedures, Fourth Edition, John Wiley & Sons, Inc., Hoboken, New Jersey.
Beutler G. (2005). Methods of Celestial Mechanics, 2 volumes with CD-ROM, Springer Verlag, Berlin, Heidelberg, New York.
Box G. E. P. and G. M. Jenkins (1983). Analiza szeregów czasowych, PWN, Warszawa.
Brown G. R., and P. Y. C. Hwang (2012). Introduction to Random Signals and Applied Kalman Filtering with MATLAB exercises, 4th ed., John Wiley & Sons, Inc.
Gelb A., (ed.) (2001). Applied Optimal Estimation, Sixteenth printing, The M.I.T. Press, Cambridge, Mass.
Marple S. L., Jr. (1987). Digital Spectral Analysis with Applications, Prentice-Hall, Englewood, Cliffs., New Jersey.
Press W. H., S. A. Teukolsky, W. T. Vetterling and B. P. Flannery (1992). Numerical Recipes in Fortran, The Art of Scientific Computing, Second Edition, Cambridge University Press.
Publikacje prowadzącego wykład w zakresie tematyki wykładu:
Brzeziński A., 1992, Polar motion excitation by variations of the effective angular momentum function: considerations concerning deconvolution problem, manuscripta geodaetica, 17, pp. 3–20.
Brzeziński A., 1994, Algorithms for estimating maximum entropy coefficients of the complex-valued time series, Allgemeine Vermessungs–Nachrichten, No. 3, pp. 101–112.
Brzeziński A., 1995, On the interpretation of maximum entropy power spectrum and cross-power spectrum in earth rotation investigations, manuscripta geodaetica, Vol. 20, pp. 248–264..

**Witryna www przedmiotu:**

**Uwagi:**

## Efekty przedmiotowe

### Profil ogólnoakademicki - wiedza

**Efekt W\_1:**

Student knows methods of description of statistical data.

Weryfikacja:

Passing the exam.

**Powiązane efekty kierunkowe:**

**Powiązane efekty obszarowe:**

**Efekt W\_2:**

Student has knowledge about classification of random signals.

Weryfikacja:

Passing the exam.

**Powiązane efekty kierunkowe:**

**Powiązane efekty obszarowe:**

**Efekt W\_3:**

Student has knowledge about classic (Fourier) and parametric methods of random signals analysis.

Weryfikacja:

Passing the exam.

**Powiązane efekty kierunkowe:**

**Powiązane efekty obszarowe:**

### Profil ogólnoakademicki - umiejętności

**Efekt U\_1:**

Student is able to make statistical description of data using descriptive statistics.

Weryfikacja:

Passing the exam.

**Powiązane efekty kierunkowe:**

**Powiązane efekty obszarowe:**

**Efekt U\_2:**

Student is able to apply the algorithm of Fourier transform for analysis of random signals.

Weryfikacja:

Passing the exam.

**Powiązane efekty kierunkowe:**

**Powiązane efekty obszarowe:**

**Efekt U\_3:**

Student is able to apply the autoregressive (AR) model for analysis of empirical data.

Weryfikacja:

Passing the exam.

**Powiązane efekty kierunkowe:**

**Powiązane efekty obszarowe:**