**Nazwa przedmiotu:**

Dynamic Measurement of Mechanical Quantities

**Koordynator przedmiotu:**

Prof. Jacek Dziurdź, PhD, DSc

**Status przedmiotu:**

Obowiązkowy

**Poziom kształcenia:**

Studia I stopnia

**Program:**

Mechatronics of Vehicles and Construction Machinery

**Grupa przedmiotów:**

Obowiązkowe

**Kod przedmiotu:**

1150-MT000-ISA-0216

**Semestr nominalny:**

4 / rok ak. 2020/2021

**Liczba punktów ECTS:**

2

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

1) Number of contact hours – 33 h, including:
a) lecture – 30 h.;
b) consultations – 1 h.;
c) exam – 2 h;
2) Student’s individual work – 25 hours, including:
a) 5 h – current preparation for a lecture,
b) 10 h – literature study,
c) 10 h – preparation for exam.
3) TOTAL – 58 h.

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

1.3 ECTS points – number of contact hours – 33 h, including:
a) lecture – 30 h;
b) consultations– 1 h;
c) Exam – 2 h.

**Język prowadzenia zajęć:**

angielski

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

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

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

**Wymagania wstępne:**

Basic knowledge from the subjects: Analysis I and II, Mechanics, especially: sets, functions, function derivatives, indefinite integrals, non-composite numbers and trigonometry.

**Limit liczby studentów:**

According to University Regulations

**Cel przedmiotu:**

Gaining knowledge in methods and techniques of measuring dynamic values occurring in machine construction and basic knowledge in methods and techniques of analysis and processing signals. Learning about methods of signal analysis in the scope necessary to understand application subjects (e.g. machine diagnostics, vibrations and noise reduction etc.). Obtaining skills to select useful information on an observed dynamic system to perform a given task (diagnostics, norm evaluation, model identification etc.) and based on this to select the proper methods of signal processing.

**Treści kształcenia:**

1. Basic terms: definition of measurement, definition of dynamic variable measurement; mathematical record of basic definitions; notion of metrics, norm, measure, metric space; examples of metrics.
2. Measuring system: registration as information transmission, measurement path as information processing, change in information carrier; measurement transducers: of acceleration, speed, dISAlacement, acoustic pressure, temperature, deformation etc.
3. General characteristics of measurement path, linear postulate; description of measurement path from a transducer to analyzing system; drawing conclusions based on intermediate measurements; scaling of a measurement path; functional scales, relative logarithmic scale (dB).
4. Randomization of obtained information; elements of basic definitions of randomization processed and their properties – a generic example.
5. Classification of observed signals; determined - random signals, intermittent - non-intermittent signals, stationary - non-stationary etc. Randomization of measurement as an element accompanying each measurement activity, notion of an estimate.
6. Basic characteristics of random signals in the scope of time: average value, mean square value, effective value, functions of own and reciprocal correlation, standard deviation.
7. Basic characteristics of random signals in the scope of amplitude: distribution of density of amplitude probability, distribuant.
8. Models of determined signals: intermittent signals (harmonic and poli-harmonic), non-intermittent signals, quasi intermittent signals, transition signal (non specified).
9. Introduction to frequency analysis: Fourier series (trigonometric and expotential forms), Fourier Transform: straight and reverse.
10. Fourier Transform of random signal, power spectral density, dependence between power spectral density and correlation function, Parseval theorem.
11. ‘Gating’ and signal filtration, Borel theorem
12. Signal filtration: filter characteristics (impulse response), description of characteristics in a linear scale of values (amplification factor), description of characteristics in a relative scale and constant relative width of band (in decibels), attenuating signals in rejection band of filters;
13. Division of filters due to operation band, band filters with a constant band width and constant relative band width, using band filters; frequency characteristics of randomized signals: ‘white’ noise and ‘pink’ noise.
14. Digital processing of real signals; problem of finite registration time, signal sampling, Shannon theorem on sampling, aliasing, mistakes in spectral analysis due to sampling, quantization of signal amplitudes.
15. Discreet (DFT) and fast (FFT) Fourier Transfor, examples of analysis.
16. Measurements and analysis of input-output relations, coherent analysis, system transmittance, amplification factor;
17. Coherence functions: the influence of input signal noise interference on values of established system transmittances, influence of output signal noise interference on values of established system transmittances.

**Metody oceny:**

Written exam

**Egzamin:**

tak

**Literatura:**

Textbooks and lectures on Mathematics relating to:
 sets, functions, function derivatives, indefinite integrals (Analysis 1),
 composite numbers (Algebra)
 trigonometry.
1. Textbooks and lectures on Mechanics and Vibrations Theory.
2. Julius S. Bendat, Allan G. Piersol, Metody analizy i pomiaru sygnałów losowych, Państwowe Wydawnictwo Naukowe, Warszawa 1976.
3. Richard G. Lyons, Wprowadzenie do cyfrowego przetwarzania sygnałów, Wydawnictwa Komunikacji i Łączności, Warszawa 2012.
4. Edward Ozimek, Podstawy teoretyczne analizy widmowej sygnałów, Państwowe Wydawnictwo Naukowe, Warszawa 1985.
5. Robert Randall, Frequency Analysis, Bruel & Kjaer, Copenhagen 1987.
6. Jerzy Szabatin, Podstawy teorii sygnałów, Wydawnictwo: WKŁ, Warszawa 2007.
7. Tomasz P.Zieliński, Cyfrowe przetwarzanie sygnałów. Od teorii do zastosowań, Wydawnictwa Komunikacji i Łączności, Warszawa 2013.
And similar books from similar domains.

**Witryna www przedmiotu:**

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**Uwagi:**

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## Charakterystyki przedmiotowe

### Profil ogólnoakademicki - wiedza

**Charakterystyka 1150-MT000-ISA-0216\_W1:**

Knows methods and techniques of measuring dynamic quantities occurring in machine construction (dISAlacements, velocities, accelerations, strains etc.)

Weryfikacja:

Exam

**Powiązane charakterystyki kierunkowe:** K\_W02, K\_W15

**Powiązane charakterystyki obszarowe:**

**Charakterystyka 1150-MT000-ISA-0216\_W2:**

Knows basic methods and techniques of signal analysis and processing.

Weryfikacja:

Exam

**Powiązane charakterystyki kierunkowe:** K\_W15

**Powiązane charakterystyki obszarowe:**

**Charakterystyka 1150-MT000-ISA-0216\_W3:**

Knows methods of signal analysis within the scope necessary to understand application subjects (e.g. Machine Diagnostics, Noise and Vibrations Reduction etc.)

Weryfikacja:

Exam

**Powiązane charakterystyki kierunkowe:** K\_W09, K\_W15, K\_W20

**Powiązane charakterystyki obszarowe:**

### Profil ogólnoakademicki - umiejętności

**Charakterystyka 1150-MT000-ISA-0216\_U1:**

Can select useful information on an observed dynamic system to perform a given task (diagnostics, norm evaluation, model identification etc.) and based on this select proper methods of signal processing.

Weryfikacja:

Exam

**Powiązane charakterystyki kierunkowe:** K\_U01, K\_U06, K\_U08, K\_U11, K\_U16

**Powiązane charakterystyki obszarowe:**

### Profil ogólnoakademicki - kompetencje społeczne

**Charakterystyka 1150-MT000-ISA-0216\_K1:**

Can establish and study influence of machine and devices on human surroundings and natural environment.

Weryfikacja:

Exam

**Powiązane charakterystyki kierunkowe:** K\_K02, K\_K05

**Powiązane charakterystyki obszarowe:**