**Nazwa przedmiotu:**

Theory of Machines and Automatic Control

**Koordynator przedmiotu:**

Sebastian Korczak, PhD Eng.

**Status przedmiotu:**

Obowiązkowy

**Poziom kształcenia:**

Studia I stopnia

**Program:**

Electric and Hybrid Vehicles Engineering

**Grupa przedmiotów:**

Obowiązkowe

**Kod przedmiotu:**

1150-00000-ISA-0204

**Semestr nominalny:**

3 / rok ak. 2022/2023

**Liczba punktów ECTS:**

4

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

Direct hours – 50 hrs, including:
a) lectures – 30 hrs,
b) project classes – 15 hrs,
c) consulting hours – 3 hrs,
d) exam – 2 hrs.
Own work – 65 hrs, including:
a) 15 hrs – preparation for the lecture and project classes, literature study,
b) 30 hrs – preparation of projects,
b) 8 hrs – preparation for tests,
c) 12 hrs – preparation for the exam.
Total – 115 hrs.

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

2.0 ECTS points – direct hours – 50 hrs, including:
a) lectures – 30 hrs,
b) project classes – 15 hrs,
c) consulting hours – 3 hrs,
d) exam – 2 hrs.

**Język prowadzenia zajęć:**

angielski

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

2.4 ECTS points – 60 hrs, including:
a) 15 hrs – project classes,
b) 15 hrs – preparation for the lecture and project classes, literature study,
c) 30 hrs – preparation of projects.

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

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

**Wymagania wstępne:**

Algebra - complex numbers, polynomials.
Analysis - ordinary differential equations.
Basics of trigonometry, geometry and vector calculus.
Theoretical mechanics I - moments of inertia, kinematics of a particle.

**Limit liczby studentów:**

-

**Cel przedmiotu:**

After completion of the course student should have acquired:
- basic knowledge of planar mechanisms, machine dynamics and control theory,
- ability to describe kinematic and dynamic properties of planar mechanisms and simple machines,
- ability to prepare time and frequency characteristics of simple elements and control systems,
- ability to use stability criteria.

**Treści kształcenia:**

\*\* Lecture contents \*\*
1. Classification of kinematic pairs. Structural formula. Overconstraints. Four-bar chain. Examples.
2. Planar mechanisms and their classification. Methods of determining velocities and accelerations in planar mechanisms.
3. Velocity and acceleration schemes in mechanisms, incl. Coriolis acceleration. Four-bar linkage. Grashof’s conditions.
4. Analytical methods for determining velocities and accelerations in plane mechanisms.
5. Cam mechanisms. Methods for determining velocities and accelerations.
6. Synthesis of cam mechanisms. Kinematics of Cardan mechanism.
7. Dynamics of plane mechanisms. Method of reduced mass. Inertia forces.
8. Analytic-graphical method for determining forces in plane mechanisms.
9. Machine dynamics. Reduction of masses and forces. Machine equation of motion. Non‑uniformity of machine motion. Flywheel.
10. Basic notions of automatic control. Principles of operational calculus.
11. Types of system inputs. Input time- and frequency characteristics.
12. Characteristics of basic automatic control elements in the time- and frequency domains. Inertialess elements. Inertial elements of the 1-st and 2-nd order. Integral, derivative and time delay elements.
13. Block diagram algebra.
14. Types of controllers. Proportional-plus-itegral-plus-differential controller. Stability of linear automatic control systems.
15. Hurwitz and Nyquist criteria of stability. Module and phase stocks. System correction.
16. State-space representation.
\*\*Project class contents – overview\*\*
1. Kinematic analysis of a given mechanism.
2. Dynamic analysis of a given machine – inertia end forces reduction, solution of a machine equation of motion and flywheel calculation.
3. Project of a control system for a simple mechanical system with stability analysis.

**Metody oceny:**

Exam: written examination on skills and knowledge after completing and successful attestation of project classes. During the course students perform three individual projects according to class schedule. To pass the class all projects must be accepted by teacher and total number of 51% points must be achieved.

**Egzamin:**

tak

**Literatura:**

R. S. Khurmi, J. K. Gupta, Theory of Machines, chapters 5-10.
Jacqueline Wilkie, Michael Johnson, Reza Katebi, Control engineering - An introductory course.
Jan Willem Polderman, Jan C. Willems, Introduction to the Mathematical Theory of Systems and Control, chapters 7-8.
T. Kołacin, Podstawy teorii maszyn i automatyki, Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa, 2005.

**Witryna www przedmiotu:**

https://usosweb.usos.pw.edu.pl/kontroler.php?\_action=katalog2/przedmioty/pokazPrzedmiot&prz\_kod=1150-00000-ISA-0204

**Uwagi:**

Presence at the lecture – not obligatory. Presence at the project class – obligatory.

## Efekty przedmiotowe

### Profil ogólnoakademicki - wiedza

**Efekt 1150-MT000-ISA-0204\_W1:**

Has the basic knowledge on application of laws and principles of Mechanics to describe motion of mechanisms and machines and analyze the dynamics of their elements and whole systems including stability in case of automatic control.

Weryfikacja:

Individual projects and exam.

**Powiązane efekty kierunkowe:** K\_W01, K\_W02, K\_W13

**Powiązane efekty obszarowe:** T1A\_W01, T1A\_W07, T1A\_W03, T1A\_W04, T1A\_W03

### Profil ogólnoakademicki - umiejętności

**Efekt 1150-MT000-ISA-0204\_U1:**

Is skilled to apply analytical and graphical methods to determine kinematic and dynamic parameters of mechanisms and machines, incl. automatic control systems and their elements.

Weryfikacja:

Individual projects and exam.

**Powiązane efekty kierunkowe:** K\_U01, K\_U02, K\_U10

**Powiązane efekty obszarowe:** T1A\_U01, T1A\_U02, T1A\_U07, T1A\_U08, T1A\_U09