**Nazwa przedmiotu:**

Differential Equations

**Koordynator przedmiotu:**

Piotr Figurny, M.Sc.

**Status przedmiotu:**

Obowiązkowy

**Poziom kształcenia:**

Studia I stopnia

**Program:**

Electric and Hybrid Vehicles Engineering

**Grupa przedmiotów:**

Matematyka

**Kod przedmiotu:**

115

**Semestr nominalny:**

2 / rok ak. 2022/2023

**Liczba punktów ECTS:**

5

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

1) Number of contact hours- 66, including:
a) lecture - 30 h.;
b) practicals – 30 h
c) consultations - 4 h
d) exam -– 2 h
2) Student’s individual work 60 hours, including:
a) 30 h – student’s current preparation for practicals and lectures, literature study,
b) 20 h – student’s current preparation for tests,
c) 10 h - student’s current preparation for exam
3) TOTAL – sum of individual work and contact hours- 126 h.

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

2,6 ECTS points – number of contact hours - 66, including:
a) lecture - 30 h.;
b) practicals – 30 h
c) consultations - 4 h
d) exam -– 2 h

**Język prowadzenia zajęć:**

angielski

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

Brak

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

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

**Wymagania wstępne:**

Knowledge of the differential and integral calculus of one variable function (within the scope of Analysis I program).

**Limit liczby studentów:**

Brak

**Cel przedmiotu:**

Knowledge of selected branches of ordinary differential equations, the theory of numerical, functional and Fourier series, and differential geometry necessary to study major subjects.

**Treści kształcenia:**

Lecture
1. Ordinary differential equations
Basic definitions. Classification of differential equations. General and specific solutions. Cauchy's problem for ordinary differential equations. Theorems of Peano and Picard. First order differential equations:
- differential equations with separated variables,
- differential equations that can be reduced to equations with separated variables,  linear differential equations,
- Bernoulli's differential equation.
Differential equations of the line family. Orthogonal lines.
Second order differential equations:
- differential equations applied to first order equations,
- linear differential equations,
- heterogeneous linear differential equations with constant coefficients, the method of constant constitution and the method of predictions.
Linear differential equations of order n with fixed coefficients.
Systems of differential equations.
2. Numeric series
Definition of the sum of the series. Necessary condition of convergence. Criteria for the convergence of series: comparative, d'Alembert, Cauchy, integral, Leibniz.
3. Strings and function series
The point convergence and uniform convergence of the series, Weierstrass's theorem on the convergence of a series of functions.
Power series, Cauchy-Hadamard theorem, developing functions in the ranks of Taylor and Maclaurin.
4. Fourier series
Definition of trigonometric series and Fourier series, Euler-Fourier patterns, Dirichlet conditions.
5. Elements of differential geometry
Flat curves:
- definition of a flat curve, parametric form, explicit and entangled equation of the curve, regular curve, regular curve, arc and curve orientation,  tangent and normal vector, tangent equation,
- curvature, curvature circle,
- curve involute and involute curve,
- a boundary of a single-parameter family of flat curves.
Curves in space:
- curvature and torsion of the spatial curve,
- Frenet's triad.
Practicals
1. Ordinary differential equations
First order differential equations:
- identification of equation types,
- setting general solutions,
- solving Cauchy's problem,
Determination of differential equations of the family of lines and equations of orthogonal lines.
Second order differential equations:
- solving of import equations to first order equations,
- solving linear homogeneous differential equations,
- solving non-homogenous linear differential equations with constant coefficients using constant method and prediction method. Solving linear differential equations of order n with constant coefficients.
Solving systems of differential equations.
2. Numerical series - testing the convergence of series.
3. Strings and function series - determining the convergence intervals of power series, developing functions in the Taylor and Maclaurin series.
4. Fourier series - determination of Fourier series.
5. Elements of differential geometry
Flat curves:
- determination of curve equations,
- construction of the tangent and normal vector, determination of the tangent equation,
- determination of curvature and curvature circle,
- determination of the evolute, involute and envelope of a single-parameter family of flat curves.
Curves in space:
- determination of curvature and turbulence of the spatial curve,
- determining the normal plane, strictly tangent and rectifying
and Frenet's triad.

**Metody oceny:**

Lecture: Exam, Credit is granted based on sum of points obtained from practicals and an exam.
Practicals: Tests and work during classes.

**Egzamin:**

tak

**Literatura:**

1. Gewert M., Skoczylas Z., Równania różniczkowe zwyczajne. Teoria, przykłady, zadania Oficyna Wydawnicza GiS, 2011.
2. Nawrocki J., Matematyka 30 wykładów z ćwiczeniami, Oficyna Wydawnicza Politechniki Warszawskiej, Wyd. 2, 2007.
3. Krysicki W., Włodarski L., Analiza matematyczna w zadaniach cz.2, PWN, 2006.
4. Otto E. (red.), Matematyka dla wydziałów budowlanych i mechanicznych, tom II, PWN, 1980.
5. Leitner R., Zarys matematyki wyższej dla studentów. Cz. II. Rachunek całkowy, równania różniczkowe, funkcje zespolone, przekształcenie Laplace'a, WNT, 2001.
6. Matwiejew M., Zadania z równań różniczkowych zwyczajnych, PWN, 1974

**Witryna www przedmiotu:**

Brak

**Uwagi:**

Brak

## Efekty przedmiotowe

### Profil ogólnoakademicki - wiedza

**Efekt 1150-00000-ISA-0115\_W1:**

The student demonstrates knowledge of classification of ordinary differential equations and techniques of solving selected types of equations.

Weryfikacja:

Obtaining the required by the regulations to pass the subject the number of points for activity in the class, colloquium 1 and the exam.

**Powiązane efekty kierunkowe:** K\_W01

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

**Efekt 1150-00000-ISA-0115\_W2:**

The student has a basic knowledge of the theory of numeric and functional series.

Weryfikacja:

Obtaining the required by the regulations to pass the subject the number of points for activity in the class, colloquium 2 and the exam.

**Powiązane efekty kierunkowe:** K\_W02

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

**Efekt 1150-00000-ISA-0115\_W3:**

Student ma uporządkowaną wiedzę w zakresie podstaw geometrii różniczkowej.

Weryfikacja:

Obtaining the required by the regulations to pass the subject the number of points for activity in the class, colloquium 2 and the exam.

**Powiązane efekty kierunkowe:** K\_W03

**Powiązane efekty obszarowe:** T1A\_W01, T1A\_W02

### Profil ogólnoakademicki - umiejętności

**Efekt 1150-00000-ISA-0115\_U1:**

Student is able to identify the type of differential equation and apply the appropriate method to solve it.

Weryfikacja:

Obtaining the required by the regulations to pass the subject the number of points for activity in the class, colloquium 1 and the exam.

**Powiązane efekty kierunkowe:** K\_U01

**Powiązane efekty obszarowe:** T1A\_U01

**Efekt 1150-00000-ISA-0115\_U2:**

The student is able to apply appropriate criteria to study the convergence of numerical series, develop functions in the Taylor and Maclaurin series and determine the Fourier series.
The student is able to use methods of mathematical analysis to study the properties of curves, determine curvature, torsion and elements of Frenet triad.

Weryfikacja:

Obtaining the required by the regulations to pass the subject the number of points for activity in the class, colloquium 2 and the exam.

**Powiązane efekty kierunkowe:** K\_U01

**Powiązane efekty obszarowe:** T1A\_U01