

Modelling and simulation - opis przedmiotu

Informacje ogólne	
Nazwa przedmiotu	Modelling and simulation
Kod przedmiotu	11.9-WE-AutP-ModSymul-Er
Wydział	Wydział Nauk Inżynieryjno-Technicznych
Kierunek	Automatyka i robotyka
Profil	ogólnoakademicki
Rodzaj studiów	Program Erasmus pierwszego stopnia
Semestr rozpoczęcia	semestr zimowy 2022/2023

Informacje o przedmiocie	
Semestr	2
Liczba punktów ECTS do zdobycia	6
Typ przedmiotu	obowiązkowy
Język nauczania	angielski
Sylabus opracował	<ul style="list-style-type: none">prof. dr hab. inż. Dariusz Uciński

Formy zajęć					
Forma zajęć	Liczba godzin w semestrze (stacjonarne)	Liczba godzin w tygodniu (stacjonarne)	Liczba godzin w semestrze (niestacjonarne)	Liczba godzin w tygodniu (niestacjonarne)	Forma zaliczenia
Wykład	30	2	-	-	Egzamin
Laboratorium	30	2	-	-	Zaliczenie na ocenę

Cel przedmiotu

- To provide students with methods, techniques and tools for modeling and simulation of continuous-time and discrete-time systems.
- To introduce students to mathematical models of typical electromechanical systems.
- To use Matlab / Octave / Scilab and Maple / Maxima for solving common engineering problems.

Wymagania wstępne

Mathematical Analysis, Linear Algebra with Analytic Geometry

Zakres tematyczny

Introduction to Maple V and Maxima. Elements of the language. Assignment. Basic types: sequences, sets, lists, tables, arrays and strings. Calling procedures. Using apostrophes. Internal data representation. Solving linear and nonlinear equations. Functions for linear algebra and mathematical analysis. Simplification of expressions: simplify, factor, expand, convert, normal, combine, map i assume. 2D and 3D graphics. Programming foundations. Applications in mathematical analysis, linear algebra, statistics and selected engineering problems.

Mathematical models of dynamic systems. Models, modelling and simulation. Classification of modelling methods. Goals and stages of modelling. Basic physical laws. Exemplary models of mechanical, electrical, economical and control systems.

Ordinary differential equations. Definitions, classification. Examples of geometric and physical problems leading to differential equations. Geometrical interpretation. Direction field. Integrals of ordinary differential equations. Existence and uniqueness of solutions. First-order equations in normal form. Equations with separated variables. Homogeneous equations. Linear equations. Bernoulli and Riccati equations. Complete differential equations. Trajectories. N-th order linear differential equations. General integrals of linear equations. Fundamental matrix and its properties. Second-order equations with variable coefficients. Systems of nonlinear ordinary differential equations.

Numerical methods of solving ordinary differential equations. One-step methods: Euler method, trapezoid method (Crank-Nicolson), Heun method. Explicit and implicit schemes. Multistep methods: Adams methods, backward difference methods. Predictor-corrector methods. Runge-Kutta methods. Adaptive step size selection. Systems of ordinary differential equations. Stiff problems.

Continuous linear dynamic systems. Descriptions: ordinary differential equations, transfer functions. Determining responses to any inputs. Matrix transfer functions. Examples of fundamental elements. State equations of linear systems.

Matlab-Simulink and Scilab-Xcos environments. Characteristics and applications. Operations on vectors and matrices. Logical expressions. Basic mathematical functions. 2D and 3D graphics. Animation. Low-level graphical functions. Iteration instructions. Scripts and functions. Elements of programming. Debugger. Code efficiency. Recursion. Vectorization of algorithms. Operating on strings. Nonstandard data structures: sparse matrices, structures, cell arrays, multidimensional arrays. Building graphical user interfaces. Operations on files. Calling MATLAB from C programs. Selected toolboxes. Building models of continuous and discrete processes. Simulink: blocks, S-functions.

Building mathematical models based on the principle of least action. Models of mechanical systems. Models of electrical systems. Models of electromechanical systems. Models of gases and liquids. Models of thermal systems. Models of chemical and biochemical processes. Model linearization. Implementation in MATLAB/Simulink.

Metody kształcenia

Lecture, laboratory exercises

Efekty uczenia się i metody weryfikacji osiągnięcia efektów uczenia się

Opis efektu	Symbole efektów	Metody weryfikacji	Forma zajęć
Can build and simulate a mathematical model of a simple engineering electro-mechanical system		<ul style="list-style-type: none">bieżąca kontrola na zajęciachwykonanie sprawozdań laboratoryjnychon-going assessment of teaching laboratory activities, writing laboratory reports	<ul style="list-style-type: none">Laboratorium
Can characterize the most important numerical methods of solving ordinary differential equations and implement them in a chosen programming language.		<ul style="list-style-type: none">bieżąca kontrola na zajęciachegzamin - ustny, opisowy, testowy i inneon-going assessment of teaching laboratory activities, test	<ul style="list-style-type: none">WykładLaboratorium
Can enumerate and characterize basic models of mathematical dynamic systems		<ul style="list-style-type: none">egzamin - ustny, opisowy, testowy i inneexam	<ul style="list-style-type: none">Wykład
Can identify and mathematically describe basic types of signals		<ul style="list-style-type: none">egzamin - ustny, opisowy, testowy i inneexam	<ul style="list-style-type: none">Wykład
Can skilfully use numerical and symbolic modern environments for modeling and visualization of results (Matlab/Octave/Simulink, Scilab/Xcos, Maple/Maxima).		<ul style="list-style-type: none">bieżąca kontrola na zajęciachwykonanie sprawozdań laboratoryjnychong-going assessment of teaching laboratory activities, writing laboratory reports	<ul style="list-style-type: none">Laboratorium
Can solve linear differential equations using basic analytical methods (method of separation of variables and variation of constant).		<ul style="list-style-type: none">bieżąca kontrola na zajęciachwykonanie sprawozdań laboratoryjnychon-going assessment of teaching laboratory activities, writing laboratory reports	<ul style="list-style-type: none">Laboratorium
Is aware of the importance of an adequate mathematical model in the system analysis and synthesis of control systems		<ul style="list-style-type: none">egzamin - ustny, opisowy, testowy i inneexam	<ul style="list-style-type: none">Wykład

Warunki zaliczenia

Lecture – the main condition to get a pass is a sufficient mark in a written or oral exam.

Laboratory – the passing condition is to obtain positive marks from all laboratory exercises to be planned during the semester.

Calculation of the final grade: lecture 50% + laboratory 50%

Literatura podstawowa

1. Christian Constanda (2017): Differential Equations: A Primer for Scientists and Engineers, Springer
2. Steven I. Gordon and Brian Guilfoos (2017): Introduction to Modeling and Simulation with MATLAB and Python, CRC Press
3. Carlos A. Smith and Scott W. Campbell (2016): A First Course in Differential Equations, Modeling, and Simulation 2nd Edition, CRC Press

Literatura uzupełniająca

Uwagi

