SYLLABUS

Name: ***Digital Modeling (InfAAu>SM1DM19)***
Name in Polish:
Name in English: ***Digital Modeling***

Information on course:

Course offered by department: Faculty of Automatic Control, Electronics and Computer Science
Course for department: Silesian University of Technology

Default type of course examination report:

ZAL

Language:

English

Course homepage:

https://platforma2.polsl.pl/rau2/course/view.php?id=949

Short description:

The aim of the lecture is to provide students with basic knowledge in the field of modeling dynamical systems, algorithms used in models of continuous systems and discrete events systems, formalization of modeling purpose and automation of experiments.

The purpose of the classes is to acquire skills in the use of various means of describing dynamic systems, determining state equations, assessing stability of models, using program resources to create digital models and processing and analyzing outcomes of experiments.

Description:

ECTS: 3
Total workload: 90 (45 contact hours / 45 student's own work hours)
Lectures: 30h
Classes: 15h

Student's own work: preparation for classes, preparation for tests

Lectures:

Models, modeling and simulation. Classification of modeling methods. Goals and stages of modeling. Dynamical system models. Methods of description of linear dynamical systems: differential equations, transfer functions, matrix transfer functions. Examples of description of basic elements. Holistic and structural methods. Block diagrams and transformation rules. State equations of a linear system. Discrete linear dynamical systems. Examples of discrete systems. Discrete transforms. Transfer function of discrete systems. State equations of a discrete system. Nonlinear continuous systems. Linearization. Phase plane method. Equilibrium point. Nonlinear discrete systems. Properties of dynamical systems. Stability concept. Conditions of linear continuous systems. Hurwitz stability criterion. Conditions of linear discrete systems. Applying Hurwitz criterion. Stability of nonlinear systems. Lapunov theorem.

Model of continuous systems. Element of model. Example of model building using general algorithmic language. Matlab-Simulink – description and scope of applying. Workspace, matrix operations, graphics, scripts and function M-files. Examples of building of continuous system model and conducting of simulation. Numerical integration methods for obtaining approximate solution of differentia equations. Single-step and multi-step methods. Changes of order and step of integration method. Local truncation error. Convergence and stability of integration method. Sample model in Simulink.

Classes:

Responses of continuous dynamical systems. Solving of linear state equations system. Properties of transition matrix. Transforms of step function. Z transform. Solving linear differential equations with constant coefficients. Applying Z transform. Finding state equations for dynamical system. Obtaining initial conditions for state variables. R environment – descriptions and basic structures: vectors, lists, matrix, tables, data frames, function object and instructions. Solving initial condition problem using deSolve package. Simulink package: using operational blocks for building models. Simulink-based models used in Matlab. Assessment of stability of linear continuous system. Assessment of stability of integration method used for numerical solving of differential equations.

Bibliography:

1) Skowronek M.: Modelowanie cyfrowe - metody i narzędzia. Wyd. III uzupełnione, Wyd. Pol. Śl., Gliwice, 2020.
2) Skowronek M.– red.: Modelowanie cyfrowe – zadania. Wyd. II zmienione. Wyd. Pol. Śl., Gliwice, 2016.
3) Augustyn D.R.: Metody rozwiązywania równań różnicowych oparte na analogii do równań różniczkowych. MINUT Matematyka i Informatyka na Uczelniach Technicznych. ISSN 2719-3063 2020, s. 163 - 170
4) Tyszer J.: Symulacja cyfrowa. WNT, Warszawa, 1990.
5) Osowski S.: Modelowanie i symulacja układów i procesów dynamicznych. Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa, 2007.
6) Sradomski W.: MATLAB. Praktyczny podręcznik modelowania. Helion, Gliwice, 2015.
7) Biecek P.: Przewodnik po pakiecie R. Wyd. 4, Oficyna Wydawnicza GIS, 2017.
8) Soetaert K., Cash J., Mazzia F.: Solving Differential Equations in R. Springer, 2012.
9) Fishman G. S.: Discrete-Event Simulation: Modeling, Programming and Analysis. Springer-Verlag, New York, 2001.
10) OMNeT++ 5.4. User Manual. http://www.omnetpp.org/doc/manual/usman.html.
11) Matlab R2020b – Programming. The MathWorks Inc., 2020.
12) Simulink R2020b – Using Simulink. The MathWorks Inc., 2020.
13) Matlab R2020b – SimEvents. The MathWorks Inc., 2020.
14) Atkinson K.E.: An Introduction to Numerical Analysis, Wiley., 1988.
15) Butcher J.C.: Numerical Methods for Ordinary Differential Equations, Wiley., 2016.
16) Chapra, S.C. Canale R.P.: Numerical Methods for Engineers, McGraw-Hill., 2015.
17) Hairer E., Nørsett S.P., Wanner G.: Solving Ordinary Differential Equations I Nonstiff Problems, Springer., 1993.
18) Iserles A.: A First Course in the Numerical Analysis of Differential Equations, Cambridge University Press., 2008.

Additional:
• H. Josiński, A. Świtoński, K. Jędrasiak, A. Polański, K. Wojciechowski: Matlab Based Interactive Simulation Program for 2D Multisegment Mechanical Systems. Proceedings of the International Conference on Computer Vision and Graphics ICCVG 2010, LNCS 6374, Springer, pp. 131-138.
• Ł. Wyciślik, P. Wiejak: Implementacja biblioteki modelowania układów zdarzeń dyskretnych opartej na języku CSL, z wykorzystaniem platformy. NET. Studia Informatica, vol. 31 nr 2B (112), Gliwice 2013.
• D.R. Augustyn, Ł. Warchał: Cloud Service Solving N-Body Problem Based on Windows Azure Platform. Communications in Computer and Information Science, Computer Networks, vol. 79, Springer-Verlag 2010, pp. 84-95.
• D.R. Augustyn, Sz. Kunc: Efektywność programów symulacji ciągłych układów dynamicznych, wyko-rzystujących moduł Parallel Extensions to .NET Framework, uruchamianych na komputerach z procesorami wielordzeniowymi. Studia Informatica, vol. 31 nr 3(91), Gliwice 2010, s. 53-76.
• D.R. Augustyn, Sz. Kunc: Moduł translacji języka MATLAB na C#, wspomagający tworzenie programów symulacji ciągłych układów dynamicznych, działających w środowisku uruchomieniowym .NET. Studia Informatica, vol. 31 nr 3(91), Gliwice 2010, s. 77-94.
• D.R. Augustyn: Wydajność mechanizmów modułu Parallel Computing Toolbox systemu MATLAB w zrówno-leglonej realizacji symulacji ruchu ciał w polu grawitacyjnym. Studia Informatica, vol. 31 nr 4A(92), Gliwice 2010, s. 33-74.
• D.R. Augustyn: CSL# - .NET Computer Simulation Language - środowisko do budowy modeli i symulacji układów zdarzeń dyskretnych. Sieci komputerowe. Nowe technologie, WKŁ 2007, s. 291-304.
• D.R. Augustyn, Ł. Wyciślik: Technologia Web Services i .NET w rozproszonej realizacji zadania optymalizacji parametrycznej w modelowaniu ciągłych układów dynamicznych. Współczesne problemy sieci komputerowych. Zastosowanie i bezpieczeństwo, WKŁ 2004, s. 251-255.
• D.R. Augustyn, Ł. Wyciślik: Zastosowanie technologii rozproszonego przetwarzania DCOM firmy Microsoft Corp. w zrównoleglonej realizacji zadania optymalizacji parametrycznej. Studia Informatica, vol. 24 nr 3(55), Gliwice 2003, s. 283-291.

Learning outcomes:

The student has a structured knowledge of differential equations and mathematical statistics. The student can describe and solve continuous systems using differential equations and L-C transforms.
The student has knowledge of creating digital models of continuous systems, discrete systems, and discrete-event systems (K2A_W01).
The student can independently complete tasks within laboratory exercises (K2A_U06). The student can independently conduct simulation experiments, interpret obtained results, and draw conclusions (K2A_U07).
The student can evaluate the effectiveness/optimality of proposed simulation models (K2A_U09).
The student can select appropriate simulation software tools for modeling purposes (K2A_U13).

Assessment methods and assessment criteria:

Method of knowledge verification:
Kolokwium (classes)

In the 1st semester a student must pass two tests and must have positive both final marks.

The syllabus is valid from the 1st semester / academic year 2025/2026-Z, and its content is not subject to change during the semester.

Course credits in various terms:

Informatics, full-time master degree studies 3 sem. (InfAAu-SM3)

Type of credits	Number	First term	Last term
European Credit Transfer System (ECTS)	3	2020/2021-Z	