SYLLABUS

Name: ***Digital Modeling (InfAAu>SM2DM19)***
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:

EGZ

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 laboratory exercises is acquiring skills in the use of various methods and software tools for describing dynamic systems, performing optimization task, simulating continuous systems and discrete event ones using R, Matlab-Sinulink, OMNeT++, SimEvents, CSL#.

Description:

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

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

Lectures:

Definition of modeling goal as a task of parametric optimization problem. Algorithm of solving parametric optimization problems. Methods of minimum finding with keeping travel direction track. Gradient methods. Methods of obtaining gradient components. Method of penalty function for solving problem of optimization with constraints. Solving parametric optimization problem using model built in Matlab, Matlab-Simulink, R.
Models of discrete event systems. Elements of discrete event systems. Description and evaluation of discrete event systems. Models based on activity selection concept. Model based on event planning concept. Model based on process interaction concept. Evaluation of simulation results. Description of Computer Simulation Language (CSL). Elements of CSL++ library. OMNeT++ description and scope of applying. Example of process interaction concept based on applying SimEvents package.
Random numbers generating. Generating random numbers with uniform distribution. Verifying of generators: distributions' compliance and independence tests. Arithmetical properties of pseudorandom generators. Constructing generators of pseudorandom numbers described by any probability distribution. Method of cumulative distribution function inversion. Method of distribution superposition. Method of elimination. Examples of constructing pseudorandom generators for selected probability distribution.

Laboratories:
During laboratory students solve typical modeling problem using different simulation software tools. Each laboratory exercise takes 4 hour units.
1) R environment – responses and phase portraits of dynamical systems.
2) Matlab-Simulink environment.
3) Matlab-Simulink environment – parametric optimization task.
4) CSL++ library – models of discrete event system using activity selection concept.
5) SimEvents package – models of discrete event system using process interaction concept.
6) OMNeT++ environment – models of discrete event system using event planning concept.

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:
Examination

In the 2nd semester a student must pass must have positive final marks of laboratory exercises. A student must pass the final exam (scope: the 1st and 2nd sem.)

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	