Syllabus

1. Data about the program of study

1.1 Institution	Technical University of Cluj-Napoca
1.2 Faculty	Automation and Computer Science
1.3 Departament	Automation
1.4 Field of study	Systems Engineering
1.5 Cycle of study	Bachelor of Science
1.6 Program of study/Qualification	Automation and Applied Informatics (English)
1.7 Form of education	Full time
1.8 Codul disciplinei	21.00

2. Data about the subject

2.1 Subject name	***Process Modelling***				
2.2 Course responsible/lecturer	Prof. dr. eng. Daniel Moga – daniel.moga@aut.utcluj.ro				
2.3 Teachers in charge of applications	Prof. dr. eng. Daniel Moga – daniel.moga@aut.utcluj.ro				
2.4 Year of study	2	2.5 Semester	1	2.6 Assessment *(E/C/V)*	C
2.7 Type of subject	*DF – fundamental, DD – in the field, DS – specialty, DC – complementary*				DD
	DI – compulsory, DO – elective, Dfac – optional				DI

3. Estimated total time

3.1 Number of hours per week	4	of which:	Course	2	Seminar	0	Laboratory	2	Project	0
3.2 Number of hours per semester	56	of which:	Course	28	Seminar	0	Laboratory	28	Project	0
3.3 Individual study										
(a) Manual, lecture material and notes, bibliography										14
(b) Supplementary study in the library, online and in the field										10
(c) Preparation for seminars/laboratory works, homework, reports, portfolios, essays										17
(d) Tutoring										0
(e) Exams and tests										3
(f) Other activities:										0

3.4 Total hours of individual study (sum of (3.3(a)…3.3(f)))	44
3.5 Total hours per semester (3.2+3.4)	100
3.6 Number of credit points	4

4. Pre-requisites (where appropriate)

4.1 Curriculum	Linear algebra, Special Mathematics in engineering, Physics, Chemistry, Electrotechnics, Basis of electronic circuits, Numerical calculus
4.2 Competence	Mathematics (linear algebra and mathematical analysis), Physics, Fundamental electronic circuits, Elementary numerical methods

5. Requirements (where appropriate)

5.1. For the course	Blackboard, projector, computer / Internet access to online platforms
5.2. For the applications	Computers, specific software

6. Specific competences

6.1 Professional competences	C1 Operating with basic concepts of mathematics, physics, measurement science, mechanical engineering, chemical engineering, electrical engineering in systems engineering. C1.2 Explaining the problems to be solved and the argumentation of the solutions in system engineering using the techniques, concepts, and methods of mathematics, physics, technical graphics, electrical engineering and electronics. C1.5 Development of projects in the field of systems engineering by selecting and applying mathematical and other scientific methods specific to the field

6.2 Cross competences	

7. Course objectives

7.1 General objective	Acquiring knowledge related to model building (system modelling / data modelling) and dynamic models simulation
7.2 Specific objectives	• Acquiring knowledge related to analysis, modeling and simulation of dynamic systems • Acquiring the skills for building equivalent electrical models. • Learning of elementary numerical modeling techniques.

8. Contents

8.1 Lecture	No.hours	Teaching methods	Notes
Fundamentals of process modeling	4	Presentations, discussions	
Mathematical representation of physical systems (physical variables, state, transformations)	4		
System modeling using generalized variables and energy handling analysis (electrical components)	2		
System modeling using generalized variables and energy handling analysis (mechanical components)	2		
System modeling using generalized variables and energy handling analysis (hydraulic components)	2		
Formulating the analogies between different energy domains	4		
Building of equivalent electrical models for thermal processes	2		
Modeling of energy conversion: electromagnetic radiation / electric current and electromechanical actuators	4		
Bond graph representation for constructing mathematical models	2		
Mathematical representations for processes modeled by differential equations	2		

Bibliography
1. P. E. Wellstead. Introduction to physical system modelling, 2000. Electronic Edition. Publisher: Control Systems Principles (www.control-systems-principles.co.uk),
Online: http://www.control-systems-principles.co.uk/ebooks/Introduction-to-Physical-System-Modelling.pdf
2. Dean C. Karnopp, Donald L. Margolis, Ronald C. Rosenberg. System Dynamics: Modeling, Simulation, and Control of Mechatronic Systems, 5th Edition, 2012. ISBN: 978-0-470-88908-4.
3. Devendra K. Chaturvedi. Modeling and Simulation of Systems Using MATLAB and Simulink CRC Press, 2010
4. S . Graham Kelly. Advanced Engineering Mathematics with Modeling Applications, CRC Press 2008
5. D. Basmadjian. The art of modeling in science and engineering, CRC Press 1999
6. P. Dobra – Teoria Sistemelor, Realizări de stare, Mediamira, 2002

8.2 Applications (seminar/laboratory/project)	No.hours	Teaching methods	Notes
Introduction in Matlab	2	Exercises, Simulation in Matlab	
Introduction in Simulink	2		
Symbolic calculus in Matlab	2		
Numerical integration. Non-zero initial conditions	2		
Elementary techniques for data approximation models. Piece-wise linear models	2		
Least squares methods	4		
Modeling a car suspension	2		
Modeling electromechanical converters	2		
Hydraulic networks	4		
Simulation of thermal models	2		
Monte Carlo methods	4		

Bibliography
1. J. Kiusalaas, Numerical Methods in Engineering with MATLAB. Cambridge University Press, 2005.
2. E. Holzbecher, Environmental Modeling: Using Matlab. Springer, 2007.

9. Bridging course contents with the expectations of the representatives of the community, professional associations and employers in the field

Laboratory work targeted on interest areas of the active local/regional companies

10. Evaluation

Activity type	Assessment criteria	Assessment methods	Weight in the final grade
Course	Knowledge of process modelling methods	(E) Written exam	60%
Seminar			
Laboratory	Ability to build equivalent models and simulate mathematical models in MATLAB	(L) Creation and simulation of models using Matlab	40%
Project			
Minimum standard of performance: E ≥ 5; final grade ≥ 5			

Date of filling in:		**Title Firstname NAME**	**Signature**
30.06.2022	Course	Prof.dr.eng. Daniel MOGA	
	Applications	Prof.dr.eng. Daniel MOGA	

Date of approval by the Automation Department Board _____	Head of Automation Department Prof.dr.ing. Honoriu VĂLEAN
Date of approval by the Automation and Computer Science Faculty Council _____	Dean Prof.dr.ing. Liviu Cristian MICLEA