ANEXA 1

MODELING AND SIMULATION
ANALYTIC SYLLABUS

Academic Year 2024-2025

Year of study III / Semester Ii

1. Information on academic programme

1.1. University	**„1 Decembrie 1918" University of Alba Iulia**
1.2. Faculty	**Faculty of Computer Science and Engineering**
1.3. Department	**Computer Science, Mathematics and Electronics Department**
1.4. Field of Study	**Computer Science**
1.5. Cycle of Study	**Undergraduate**
1.6. Academic programme / Qualification COR/ESCO	**Computer Science/ ESCO: 2511/ Systems Analyst, 2512/ Software developers; Analyst-251201, Computer System Programmer -251204, Computer System Engineer – 251203.**

2. **Information of Course Matter**

2.1. Course	*Modeling and simulation*			2.2. Code		CSE 310	
2.3. Course Leader			Full Prof. PhD. Habil., Nicoleta Breaz				
2.4. Seminar Tutor			Asist. PhD. Daniela Nagy - Onița				
2.5. Academic Year	**III**	2.6. Semester	**II**	2.2. Type of Evaluation (E – final exam/ CE - colloquy examination / CA -continuous assessment)	**E**	2.8. Type of course (**C**– Compulsory, **Op** – optional, **F -** Facultative)	**C**

3. Course Structure (Weekly number of hours)

3.1. Weekly number of hours	**4**	3.2. course	***2***	3.3. seminar, laboratory	***2***
3.4. Total number of hours in the curriculum	*48*	3.5. course	***24***	3.6. seminar, laboratory	***24***

Allocation of time:	Hours
a.Individual study of readers	**20**
b.Documentation (library)	**20**
c.Home assignments, Essays, Portfolios	**40**
d.Tutorials	**7**
e.Assessment (examinations)	**10**
f.Other academic activities (study visit, projects etc.)	**5**

3.7 Total number of hours for individual study	102
3.8. Total number of hours for academic activities	48
3.9 Total number of hours per semester	150
3.10 Number of ECTS	6

4. Prerequisites (*where applicable*)

4.1. curriculum-based	***There are no compulsory prerequisites but the following courses are useful:*** ***1. Probability and mathematical statistics*** ***2. Mathematical software***
4.2. competence-based	C4. ***The use of the theoretical basis of computer science and of formal models (mathematical concepts)***

5. Requisites (*where applicable*)

5.1. course-related	***The course is hosted in a room equipped with video projector and computers having installed Matlab/Octave. The tutorials are at the students' disposal (in the library). The course materials will be uploaded also on Microsoft Teams (if it is available).*** ***Note: The students are strongly encouraged to attend the course, in order to gain knowledge for practical applications.***
5.2. seminar/laboratory-based	***The laboratory is hosted in a room equipped with video projector and computers having installed Matlab/Octave. The tutorial is at the students' disposal (in the library).*** ***Note: The attendance of the laboratory classes is compulsory, a student who doesn't attend all classes being not allowed at the exam. The missed classes can be recovered by a student, during other classes, before the final examination, by completing a portfolio with all homewoks related to missed subjects.***

6. Specific competences to be aquired (chosen by the course leader from the programme general competences grid)

Professional competences	The course is focused on the development of skills required to solve complex modeling problems; the graduate will be able to translate a real problem in mathematical language and then to solve that mathematical problem based on mathematical concepts implemented in a software product. Aiming the development of these specific competences, the course assures the knowledge on modeling techniques which contributes to the general professional competences given by the study program, regarding ***The use of the theoretical basis of computer science and of formal models (*C4**).*** These can be clearly described by the level descriptors related to: C4.1 The definition of base concepts and principles of computer science and mathematics as well as of the mathematical theories and models. C4.2 The interpretation of mathematical and computer science (formal) models. C4.3 The identification of appropriate models and methods for solving real-life problems. C4.4 The use of simulation in the study of the behavior of developed models and evaluation of results. C4.5 The embedding of formal models in specific applications in various domains.
Transversal competences	-

7. Course objectives (as per the programme specific competences grid)

7.1 General objectives of the course	The general aim related to this course consists in getting knowledge which helps the students to use the mathematical concepts together with a specific software to model phenomenon from various fields as medicine, physics, chemistry, economy, sociology, etc.., the students acquiring not only the knowledge of basics mathematical modeling aided by software products but also, they become open minded regarding the interdisciplinary matter and hence they get competencies in the ***use of the theoretical basis of computer science and of formal models in solving specific problems from various fields.***
7.2 Specific objectives of the course	It is aiming the development of some specific competences to model phenomenon with computer's help, based on mathematical modeling concepts, modeling and simulation processes and practical studies, such that the student is in the end capable ***to define base concepts and principles of computer science and mathematics as well as of the mathematical theories and models, to give the interpretation of mathematical and computer science (formal) models, to identify the appropriate models and methods for solving real-life problems, to use the simulation in the study of the behavior of developed models and evaluation of results and to embed the formal models in specific applications in various domains.***

8. Course contents

8.1 Course (learning units)	**Teaching methods**	**Remarks**
I. Elements of mathematical modeling (1 hour) 1. Introduction 2. Process of mathematical modeling 3. Types of models. Regression models 4. Simulation of the values of a stochastic variable 5. Examples of mathematical models	***Lecture, discussion***	Minimal lectures: 2 (see the list)
II. Regression models. Generalities. Examples in Matlab/Octave (1 hour**)** 1. General concepts of correlation and regression 2. Simple versus multiple regression 3. Examples	***Lecture, discussion, exemplification***	Minimal lectures: 2 (see the list)
III. Simple linear regression model (8 hours)	***Lecture, discussion, exemplification in***	Minimal lectures:

1. Correlogram analysis 2. Coefficient of linear correlation 3. Definition of the linear simple model 4. Estimation of the parameters 5. Prediction 6. Inferences 7. Matlab/Octave functions. Examples and applications	***Matlab/Octave***	2 (see the list)
IV. Multiple linear regression model (5 hours) 1. Definition of the multiple linear regression model 2. Predictors selection 3. Estimation of the parameters 4. Goodness of fit 5. Matlab/Octave functions. Examples and applications	***Lecture, discussion, exemplification in Matlab/Octave***	Minimal lectures: 2 (see the list)
V. Non linear models. Examples in Matlab/Octave (5 hours) 1. Non linear models. Linearisable models 2. Comparative analysis of the regression models 3. Polynomial model 4. Exponential model 5. Hyperbolic model 6. Matlab/Octave functions. Examples and applications	***Lecture, discussion, exemplification in Matlab/Octave***	Minimal lectures: 2 (see the list)
VI. Comparative analysis of the regression models – applications (4 hours) 1. Regression models in Matlab/Octave	***Lecture, discussion, exemplification in Matlab/Octave***	Minimal lectures: 2 (see the list)

References

1. **E.A. Bender,** *An introduction to mathematical modeling techniques***,** Dover, New York, 2000
2. **N.Breaz,** *Mathematical modeling and simulation*, Univ. "1 Decembrie 1918" din Alba Iulia, 2024 (electronic version)
3. **D. J. Higham, N. J. Higham,** *MATLAB Guide*, 2nd edition, SIAM, 2005
4. **S. Lee**, M. Buzby, Mathematical Modeling and Simulation with Matlab, Publisher: University of Alaska Southeast, 2021
5. **M. P. McLaughlin,** *A tutorial on Mathematical Modeling* **(**www.causascientia.org/math_stat/Tutorial.pdf**),** 1999
6. **C. Moler** – *Numerical Computing in MATLAB*, SIAM, 2005
7. **A. Stahel**, Octave at BFH-TI Biel, Lecture notes, 2015 (*staff.ti.bfh.ch/sha1/Labs/PWF/Documentation/OctaveAtBFH.pdf*)
8. **K. Velten**, Mathematical Modeling and Simulation, Introduction for scientists and engineers, Wiley-VCH, 2008
9. ***–** *Documentation for MathWorks Products*- http://www.mathworks.com/
10. *** - Documentation for Octave GNU Octave https://octave.org

8.2 Seminars-laboratories	**Teaching methods**	
1. Basics concepts in Matlab/Octave (6 hours) - the use of commands dedicated to graphics - the use of mathematical/statistical functions - how to write a program - how to generate random numbers	***Coordination and evaluation of computer-based works***	Minimal lectures: 2 (see the list)
3. Applications in Matlab/Octave for simple linear regression model (4 hours) -simple linear model (correlation coefficient, correlogram, parameters, inference, goodness of fit and prediction)	***Coordination and evaluation of computer based works***	Minimal lectures: 2 (see the list)
5. Applications in Matlab/Octave for multiple regression model (4 hours) - determination of the parameters, inferences - selection of the predictors	***Coordination and evaluation of computer based works***	Minimal lectures: 2 (see the list)
7. Applications in Matlab/Octave for polynomial model (4 hours) - Matlab/Octave functions for polynomial fitting - graphical user interface for polynomial fitting	***Coordination and evaluation of computer based works***	Minimal lectures: 2 (see the list)
9 . Applications in Matlab/Octave for other non linear models (exponential, hyperbolic) (4 hours) - how to use Excel function for linear models in the exponential and hyperbolic regression - graphical user interface for various models	***Coordination and evaluation of computer based works***	Minimal lectures: 2 (see the list)
10. Applications in Matlab/Octave for the selection of the best model for a given data set (2 hours) - the selection of the data set - comparative analysis of various models	***Coordination and evaluation of computer based works***	Minimal lectures: 2 (see the list)

References

1. E.A. Bender, *An introduction to mathematical modeling techniques*, Dover, New York, 2000
2. N.Breaz, *Mathematical modeling and simulation*, Univ. "1 Decembrie 1918" din Alba Iulia, 2024 (electronic version)
3. Hans-Joachim Bungartz, Stefan Zimmer, Martin Buchholz, Dirk Pfluger, Modeling and Simulation, Springer-Verlag Berlin and Heidelberg GmbH & Co. KG, 2016
4. S.I. Gordon, B. Guilfoos, Introduction to Modeling and Simulation with Matlab and Python, Crc Pr Inc, 2017
5. D. J. Higham, N. J. Higham, *MATLAB Guide*, 2nd edition, SIAM, 2005
6. S. Lee, M. Buzby, Mathematical Modeling and Simulation with Matlab, Publisher: University of Alaska Southeast, 2021
7. M. P. McLaughlin, *A tutorial on Mathematical Modeling* (www.causascientia.org/math_stat/Tutorial.pdf), 1999
8. Cleve Moler – *Numerical Computing in MATLAB*, SIAM, 2005
9. ***– *Documentation for MathWorks Products, R2009a*- http://www.mathworks.com/
10. *** - Documentation for Octave GNU Octave https://octave.org

9. Corroboration of course contents with the expectations of the epistemic community's significant representatives, professional associations and employers in the field of the academic programme

The skill's development regarding the understanding and modeling of phenomenon from various fields, the knowledge of mathematical concepts and the capacity to project and use of specific software contribute to the formation of a complete specialist, capable to take part at interdisciplinary research teams or at the software projecting teams, the course answering in this way to the necessity of the graduate to be adapted at various fields from the labor market, where specialists in computer science are needed.

10. Assessment

Activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of final grade
10.4 Course	-checking the modelling concepts *- correct use of mathematical tools requested by modeling problem* - correct understanding and interpretation of the results	***Continuous assessment:*** *- testing based on the theoretical concepts of the modeling in the applicative framework -25%* **Final evaluation:** – a final project of modeling based on real or simulated data in Matlab/Octave, evaluation based on a set of questions related to modeling concepts in the particular framework of the project -25%	50%
10.5 Seminar/laboratory	*- the students have to solve correctly modeling problems from their practical works required during classes;* *- correct use of mathematical software requested by modeling problems in the final project* *- following of modeling steps in the final project*	***Continuous assessment:*** *During the classes, the assessment of practical skills in modeling will be done, by evaluating the portfolio containing all required practical works. - 25%* **Final evaluation:** – a final project of modeling based on real or simulated data in Matlab/Octave, evaluation of the correctness of the project -25%	50%
10.6 Minimum performance standard:			
Correct solving of some mathematical problems having a medium level of complexity, namely, the elaboration of a project containing models based on real or simulated data, using Matlab/Octave (minimum performance standard to get the ECTS: modeling a set of data with a linear simple model). **Note:** ***Please see also the alignment 5 (Requisites), related to compulsory attendance of the practical classes. Also, a student who doesn't attend the Final examination, can not get a final mark even if he/she has a mark for continuous assessment. The assessment scale is from 1 to 10, and 5 is minimum to pass the exam.***			

Data completării Semnătura titularului de curs Semnătura titularului de seminar

Data avizării în departament Semnătura directorului de departament