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	35.20

2. Data about the subject

2.1 Subject name	***Knowledge-based Systems***				
2.2 Course responsible/lecturer	Conf.dr.ing. Rusu-Both Roxana – roxana.both@aut.utcluj.ro				
2.3 Teachers in charge of applications	Conf.dr.ing. Rusu-Both Roxana – roxana.both@aut.utcluj.ro				
2.4 Year of study	3	2.5 Semester	1	2.6 Assessment *(E/C/V)*	E
2.7 Type of subject	*DF – fundamental, DD – in the field, DS – specialty, DC – complementary*				DS
	DI – compulsory, DO – elective, Dfac – optional				D0

3. Estimated total time

3.1 Number of hours per week	4	of which:	Course	2	Seminar	0	Laboratory	1	Project	1
3.2 Number of hours per semester	125	of which:	course	28	Seminar	0	Laboratory	14	Project	14
3.3 Individual study										
(a) Manual, lecture material and notes, bibliography										28
(b) Supplementary study in the library, online and in the field										10
(c) Preparation for seminars/laboratory works, homework, reports, portfolios, essays										28
(d) Tutoring										
(e) Exams and tests										3
(f) Other activities:										

3.4 Total hours of individual study (sum of (3.3(a)…3.3(f)))	69
3.5 Total hours per semester (3.2+3.4)	125
3.6 Number of credit points	5

4. Pre-requisites (where appropriate)

4.1 Curriculum	• Basics in Special mathematics in engineering • Basics in Measurements and transducers • Basics is process modeling
4.2 Competence	Basic knowledge of data analysis and statistical concepts. Basic knowledge of process modeling.

5. Requirements (where appropriate)

5.1. For the course	• Interactive lectures using **multimedia technology (laptop, projector, blackboard)** • Emphasis on **practical examples and case studies** from industrial contexts • Attendance at lectures is **not mandatory**, but is encouraged and recorded and rewarded
5.2. For the applications	• Labs and projects will be conducted in collaboration with company partners, offering real industrial data and case studies • Students will work with Python, MATLAB and other relevant tools for data analysis and modeling • Attendance at labs and project activities is mandatory • Preliminary preparation of laboratories is recommended

6. Specific competences

6.1 Professional competences	C2 Operation with fundamental concepts from computer science, information and communication technology. C2.2 Reasoned use of concepts from informatics and computer technology in solving well-defined problems in systems engineering and in applications that require the use of hardware and software in industrial systems or in computer systems. C3 Use of automation fundamentals, modeling, simulation, process identification and analysis methods, computer-aided design techniques. C3.1 Identification of the fundamental concepts of systems theory, automatic control engineering, basic principles of modeling and simulation, as well as process analysis methods, in order to explain the basic problems in the field. C3.2 Explaining and interpreting the automation problems of some types of processes by applying the fundamentals of automation, methods of modeling, identification, simulation and analysis of processes, as well as computer-aided design techniques. C3.3 Solving some types of management problems by: using modeling methods and principles, developing simulation scenarios, applying identification and analysis methods of some processes (including technological processes) and systems.
6.2 Cross competences	

7. Course objectives

7.1 General objective	To provide students with **practical and theoretical knowledge** in processing industrial data and implementing predictive models for automation and optimization.
7.2 Specific objectives	• To introduce students to data-driven workflows in industrial environments • To develop skills in data acquisition, cleaning, transformation, and visualization • To introduce basic and advanced predictive modeling approaches (machine learning, deep learning) relevant to industrial systems • To provide hands-on experience in evaluating and validating models • To enable students to analyze and interpret industrial data using modern software tools

8. Contents

8.1 Lecture	No.hours	Teaching methods	Notes
Introduction to data driven systems. Application domains and examples.	2	Teaching using laptop, projector and blackboard; Systematic exposure; Interactive course, debate; Case Study.	On-site
Data understanding 1: Data aquisition, exploration (statistics), and visualization techiques	2		
Data understanding 2: Data quality analysis, time-frequency analysis	2		
Data pre-processing 1: Data filtering (denoising) and dimensionality reduction techniques	2		
Data pre-processing 2: Date detrending and handling missing data and outliers	2		
Data pre-processing 3: Feature extraction, feature selection	2		
Modeling: Introduction to predictive modeling techniques	2		
Modeling: time-series segmentation and semantic labeling	2		
Modeling: prediction models I: regression	2		
Modeling: prediction models II: classification	2		
Modeling: anomaly detection methods	2		
Modeling: models for multivariate time series	2		
Evaluation and validation: methods and metrics	2		

Evaluation and validation: model validation framework	2		

Bibliography

1. A.V. Oppenheim and A.S. Willsky, with S.H. Nawab, Signals and Systems, Prentice-Hall, Second Edition, 1997. (Biblioteca UTCN - 3 exemplare);
2. E.S. Gopi. Algorithm Collections for Digital Signal Processing Applications Using Matlab, Springer, 2007, ISBN 978- 1-4020-6410-4 (Biblioteca UTCN - 1 exemplar);
3. D.S.G. POLLOCK, A Handbook of Time-Series Analysis, Signal Processing and Dynamics, Academic Press, 1999,
4. Bisgaard, S., & Kulahci, M, Time series analysis and forecasting by example, John Wiley & Sons., 2011
5. Christopher M.Bishop, Pattern Recognition And Machine Learning, Springer, 2006
6. John D. Kelleher, Brian Mac Namee, Aoife D'Arcy, Fundamentals of Machine Learning for Predictive Data Analytics: Algorithms, Worked Examples, and Case Studies, MIT Press, 2015
7. Roxana Rusu-Both et all. Knowledge-based systems, Laboratory notes, available in electronic format

8.2 Aplications (laboratory)	No.hours	Teaching methods	Notes
Data aquisition - experimental	2	Presentation of examples. Practical application. Case Study. Discussions.	Mandatory attendance
Data understanding: descriptive statistics, visual analytics, correlation analysis, data quality check	2		
Data pre-processing: filtering, principal component analysis	2		
Predictive modeling I : regression	2		
Predictive modeling II: classification	2		
Anomaly detection	2		
Activity recognition	2		

Bibliography

1. A.V. Oppenheim and A.S. Willsky, with S.H. Nawab, Signals and Systems, Prentice-Hall, Second Edition, 1997. (Biblioteca UTCN - 3 exemplare);
2. E.S. Gopi. Algorithm Collections for Digital Signal Processing Applications Using Matlab, Springer, 2007, ISBN 978- 1-4020-6410-4 (Biblioteca UTCN - 1 exemplar);
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8.3 Aplications (project)	No.hours	Teaching methods	Notes
Topic assignment: Experimental Setup and data aquisition	2	Presentation of examples. Practical application. Case Study. Discussions.	Mandatory attendance
Data analysis: vizualization, quality analysis	2		
Data preprocessing: denoising, detrending, etc.	2		
Data modeling	2		
Data modeling	2		
Model evaluation	2		
Final Presentation/ Final Report	2		

Bibliography

1. A.V. Oppenheim and A.S. Willsky, with S.H. Nawab, Signals and Systems, Prentice-Hall, Second Edition, 1997. (Biblioteca UTCN - 3 exemplare);
2. E.S. Gopi. Algorithm Collections for Digital Signal Processing Applications Using Matlab, Springer, 2007, ISBN 978- 1-4020-6410-4 (Biblioteca UTCN - 1 exemplar);
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9. Bridging course contents with the expectations of the representatives of the community, professional associations and employers in the field

The content of this course is **designed to align with the current and future needs of the industrial automation sector**, ensuring that students are prepared to tackle **real-world challenges** in industrial systems by emphasizing **practical data analysis, predictive maintenance, and system optimization techniques**. It ensures that students acquire competencies in **handling real-world industrial data** and **developing predictive solutions**, highly valued by employers and recognized in engineering education standards (ARACIS).
The content of the discipline, together with the acquired skills and abilities, was discussed with other universities and important companies from Romania. It also ensures the adoption of ethical standards appropriate to engineering practice.

10. Evaluation

Activity type	Assessment criteria	Assessment methods	Weight in the final grade
Course	Understanding of theoretical concepts, clarity in explanations, and ability to apply theory in practice	Written exam	50%
Seminar			
Laboratory	Practical execution of data preprocessing, modeling, and evaluation tasks; troubleshooting and interpretation	Continuous in-lab evaluation + Practical assessment	25%
Project	Ability to design and complete a data-driven project, clarity of presentation, and soundness of analysis	Oral presentation + report	25%

Minimum standard of performance:

- Final exam >=5
- Lab grade >=5, mandatory to be able to take the final exam
- Project grade >=5, mandatory to be able to take the final exam

50% Final exam + 25% Lab Grade + 25% Project grade > 5

Date of filling in:		**Title Firstname NAME**	**Signature**
27.01.2025	Course	Assoc. Prof. eng. Roxana BOTH, PhD	
	Applications	Assoc. Prof. eng. Roxana BOTH, PhD	

Date of approval by the Department Board Automation
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Head of Departament
Prof.dr.ing. Honoriu VĂLEAN

Date of approval by the Faculty Council Automation and Computer Science
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Dean
Prof.dr.ing. Vlad Mureșan