SYLLABUS

1. Data about the program of study

1.1 Institution	The Technical University of Cluj-Napoca
1.2 Faculty	Faculty of Automation and Computer Science
1.3 Department	Automation
1.4 Field of study	System's Engineering
1.5 Cycle of study	Master
1.6 Program of study / Qualification	CYBER PHYSICAL SYSTEMS
1.7 Form of education	Full time

2. Data about the subject

2.1 Subject name	***Dependability of Cyber-Physical Systems***			Subject code	**13.00**
2.2 Course responsible / lecturer	Prof.dr.eng. Liviu Miclea, Liviu.Miclea@aut.utcluj.ro				
2.3 Teachers in charge of seminars / Laboratory / project	Lect.dr. Cosmina Corcheş, Cosmina.Corches@aut.utcluj.ro				
2.4 Year of study	2	2.5 Semester	1	2.6 Type of assessment (E - exam, C - colloquium, V – verification)	E
2.7 Subject category	Formative category: DA – advanced, DS – speciality, DC – complementary				DA
	Optionality: DI – imposed, DO – optional (alternative), DF – optional (free choice)				DI

3. Estimated total time

3.1 Number of hours per week	3	of which:	Course	2	Seminars	0	Laboratory	1	Project	0
3.2 Number of hours per semester	42	of which:	Course	28	Seminars	0	Laboratory	14	Project	0
3.3 Individual study:										
(a) Manual, lecture material and notes, bibliography										15
(b) Supplementary study in the library, online and in the field										14
(c) Preparation for seminars/laboratory works, homework, reports, portfolios, essays										23
(d) Tutoring										3
(e) Exams and tests										3
(f) Other activities:										0

3.4 Total hours of individual study (suma (3.3(a)…3.3(f)))	58
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	N/A
4.2 Competence	Mathematics (algebra, logic, graph theory) and statistics. Knowledge of reliability. Knowledge of programming engineering.

5. Requirements (where appropriate)

5.1. For the course	-
5.2. For the applications	-

6. Specific competence

6.1 Professional competences	• Interacts professionally in research and professional environments; • Analyzes test data; • Conducts interdisciplinary research; • Manage interoperable and reusable data that is accessible and easy to find; • Thinks abstractly; • Performs data analysis; • Tests hardware; • Speaks several foreign languages; • Records test data; • Analyzes software specifications; • Develops software prototypes; • Uses software libraries
6.2 Cross competences	• Show initiative; • Think analytically; • Apply scientific, technological, and engineering knowledge; • Work in teams.

7. Expected Learning Outcomes

Knowledge	The student will know: • advanced concepts, principles, and methodologies in systems engineering, automation, and cyber-physical systems; • techniques, methods, and technologies for the analysis, design, implementation, and optimization of applications based on programmable equipment and embedded systems; • principles of design, operation, and evaluation for complex control systems, industrial networks, and related hardware and software components; • standards, best practices, and regulations for quality, safety, security, and ethical conduct in professional and research activities; • advanced applications of AI, machine learning, and AR/VR technologies in industrial contexts, including their integration into control systems, automation, and human-machine interaction.
Skills	The student will be able to: • design, develop, simulate, and implement hardware, software, and control applications for industrial and cyber-physical systems; • create prototypes, test systems, and optimize performance through experimental evaluation and comparative analysis; • analyze technical data, evaluate alternatives, and apply problem-solving strategies to complex engineering challenges; • use modeling, simulation, AI, machine learning, and AR/VR tools to develop intelligent, autonomous, and automated solutions; • integrate multidisciplinary knowledge to design, optimize, implement, and evaluate innovative solutions for complex control systems and industrial networks.
Responsibilities and autonomy	• The student will be responsible for carrying out professional or research projects in compliance with quality, safety, and security standard; • The student will be responsible for ensuring ethical conduct, academic integrity, and proper management of research and experimental data; • The student will be responsible for promoting collaboration, teamwork, knowledge transfer, and innovation within professional and research environments.

8. Discipline objective (as results from the *key competences gained*)

8.1 General objective	The main techniques for assessing the dependability of cyber-physical systems. Basic models used in assessing the dependability of cyber-physical systems. Activities, management, automation of dependability assessment and related aspects, team organization, assessment process, role and responsibilities of employees, process automation tools.

8.2 Specific objectives	Knowledge of some methodologies for calculating the dependability of cyber-physical systems. Acquiring effective methods of developing procedures for assessing the dependability of cyber-physical systems. The use of environments for the creation and development of tests. The ability to coordinate the operational and efficient assessment process of the dependability of cyber-physical systems.

9. Contents

9.1 Lectures	Hours	Teaching methods	Notes
1. Dependable systems and incidents	4	Didactic exposition, didactic conversation, questioning	
2. Dependability - Basic Concepts and Taxonomy	4		
3. Fault-Tolerance and Modelling	4		
4. Certification – Processes and Standards	4		
5. Failure Modes and Models	4		
6. Hardware aspects of dependable CPS	4		
7. Software aspects of dependable CPS	4		

Bibliography:
1. Pedro H. J. Nardelli, “Cyber-physical Systems : Theory, Methodology, and Applications”, ISBN 1119785162, ISBN-13 9781119785163, Wiley, 2022
2. Harris Maria, Handbook of Dependability Engineering, ISBN 9781639872770, Ed. Murphy & Moore Pub, 2022
3. W. Goble, “Control Systems Safety Evaluation and Reliability, 3rd Edition”, ISBN 978-1-934394-80-9, ISA, 2010
4. Edward A. Lee, “Cyber Physical Systems: Design Challenges”, 11th IEEE Symposium on Object Oriented Real-Time Distributed Computing (ISORC), ISBN 978-0-7695-3132-8/08, DOI 10.1109/ISORC.2008.25, 2008
5. Jing Lin, Sahra Sedigh, and Ann Miller, “Towards Integrated Simulation of Cyber-Physical Systems: A Case Study on Intelligent Water Distribution”, 2009 Eighth IEEE International Conference on Dependable, Autonomic and Secure Computing, ISBN 978-0-7695-3929-4/09,
DOI 10.1109/DASC.2009.140
6. Peng Zhou, Decheng Zuo, Kun Mean Hou, Zhan Zhang, Jian Dong, Jianjin Li
and Haiying Zhou, “A Comprehensive Technological Survey on the Dependable Self-Management CPS: From Self-Adaptive Architecture to Self-Management Strategies”, Sensors 2019, 19, 1033; doi:10.3390/s19051033
7. Algirdas Avizienis, Jean-Claude Laprie, Brian Randell, and Carl Landwehr, “Basic Concepts and Taxonomy of Dependable and Secure Computing”, IEEE Transactions on Dependable and Secure Computing, Vol. 1, No. 1, January-March 2004, ISSN 1545-5971/04
8. Jin Jiang, “Fault-tolerant Control Systems”, ACTA AUTOMATICA SINICA, Vol. 31, No. 1, January 2005

9.2 Applications - Seminars/Laboratory/Project	Hours	Teaching methods	Notes
1. Basic concepts and terminology	2	Case studies, methods for evaluating the dependability of Cyber-Physical Systems, and interactive discussions	
2. Reliability Block Diagram (RBD)	2		
3. Modeling and Evaluation Stochastic Petri Nets (SPN) Modeling and Evaluation	2		
4. Continuous-Time Markov Chains (CTMC) Modeling and Evaluation	2		
5. Discrete-Time Markov Chains (DTMC) Modeling and Evaluation	2		
6. Fault Trees (FT) Modeling and Evaluation	2		
7. Complex applications	2		

Bibliography
1. Mercury Tool Manual, v4.8, 2020, MoDCS Research Group, http://www.modcs.org
2. H. Pham, “System reliability concepts,” in System Software Reliability.,Springer, 2006
3. R. Matos Junior, A. Guimaraes, K. Camboim, P. Maciel, and K. Trivedi, “Sensitivity analysis of availability of redundancy in computer networks,” in CTRQ 2011, The Fourth International Conference on Communication Theory, Reliability, and Quality of Service. IARIA, Apr 2011, pp. 115–121. [Online]. Disponibil: http://www.thinkmind.org/index.php?view=article&articleid=ctrq_2011_6_10_10047
4. G. Callou, P. Maciel, D. Tutsch, and J. Araujo, “Models for dependability and sustainability analysis of data center cooling architectures,” in Dependable Systems and Networks (DSN), 2012 IEEE International Conference on, Jun 2012, pp. 1 –6.
5. A. V. Ratzer, L.Wells, H.M. Lassen,M. Laursen, J. F. Qvortrup,M. S. Stissing,M.Westergaard, S. Christensen, and K. Jensen, “Cpn tools for editing, simulating, and analysing coloured petri nets,” in Applications and Theory of Petri Nets 2003. Springer, 2003, pp. 450–462.

**It will be specified, as the case may be: the theme of the seminars, the laboratory work, the theme and the stages of the project.*

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

The laboratory topics are inspired by the applications of some companies from Cluj-Napoca, such as Bosch, Siemens, Arobs, Emerson, etc.
The themes of the project correspond to some applications of our companies in the country.

10. Evaluation

Activity type	Assessment criteria	Assessment methods	Weight in the final grade
Course	Knowledge of theoretical and practical aspects and ability to solve problems	Exam based on lecture and laboratory questions (CL)	100% (10% of office)
Seminar			
Laboratory	Problem-solving skills. Presence. Interactivity.	Checks during the semester	A/R
Project			
Minimum standard of performance: CL>=5; N=1+0.9*CL.			

Date of filling in: 05.07.2026	**Responsible**	**Title First name Last name**	**Signature**
	Course	Prof.dr.ing. Liviu Miclea	
	Applications	Lect.dr. Cosmina Corcheș	

Date of approval in the department of Automation _____	Head of department, Prof.dr.eng. Honoriu VĂLEAN
Date of approval in the Faculty of Automation and Computer Science Council _____	Dean, Prof.dr.eng. Vlad MUREȘAN