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 Engineering
1.5	Cycle of study	Master of Science
1.6	Program of study/Qualification	CYBER PHYSICAL SYSTEMS
1.7	Form of education	Full time
1.8	Subject code	13.00

2. Data about the subject

2.1	Subject name			Dependability of Cyber-Physical Systems			
2.2	Subject area			System Engineering			
2.2	Course responsible/lecturer			Prof.dr.eng. Liviu Miclea, Liviu.Miclea@aut.utcluj.ro			
2.3	Teachers in charge of seminars			S.l.dr. Cosmina Corcheș, Cosmina.Corches@aut.utcluj.ro			
2.4 Year of study	2	2.5 Semester	1	2.6 Assessment		E	
2.7 Subject category	Formative category					DA	
	Optionality					DI	

3. Estimated total time

3.1 Number of hours per week	3	of which	3.2 Course	2	3.3 Seminar	0	3.3 Laboratory	1	3.3 Project	0
3.4 Total hours in the curriculum	42	of which	3.5 Course	28	3.6 Seminar	0	3.6 Laboratory	14	3.6 Project	0

3.7 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

3.8 Total hours of individual study (summ (3.7(a)…3.7(f)))	58
3.9 Total hours per semester (3.4+3.8)	100
3.10 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 (seminar / laboratory / project)	Attendance at the laboratory is mandatory.

6. Specific competences

Professional competences	C4. Contextual integration and integrity of complex control systems and industrial networks. C5. The creative combination of multidisciplinary knowledge in the field of systems engineering, computers and information technology in order to research, design, optimize, implement and test original theories, algorithms and methods specific to complex control systems and industrial networks.
Cross competences	N/A

7. Discipline objectives (as results from the *key competences gained*)

7.1	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.
7.2	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.

8. Contents

8.1. Lecture (syllabus)	Number of hours	Teaching methods	Notes
1. Dependable systems and incidents	4	Didactic exposition,	
2. Dependability - Basic Concepts and Taxonomy	4		

3. Fault-Tolerance and Modelling	4	didactic conversation, questioning	
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

8.2. Laboratory	Number of 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].
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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.

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	10.1 Assessment criteria	10.2 Assessment methods	10.3 Weight in the final grade
10.4 Course	Knowledge of theoretical and practical aspects and ability to solve problems	Exam based on lecture and laboratory questions (CL)	100% (10% of office)
10.6 Minimum standard of performance CL>=5; N=1+0.9*CL.			

Date of filling in:		**Title Surname Name**	**Signature**
03.06.2024	Lecturer	Prof.dr.ing. Liviu Miclea	
	Teachers in charge of application	S.l.dr. Cosmina Corcheș	

Date of approval in the Department of Automation _____	Head of department Prof.dr.ing. Honoriu Vălean
Date of approval in the Faculty of Automation and Computer Science _____	Dean Prof.dr.ing. Mihaela Dinsoreanu