Universitatea Naţională de Ştiinţă şi Tehnologie Politehnica Bucureşti
Facultatea de Electronică, Telecomunicaţii şi
Tehnologia Informaţiei

COURSE DESCRIPTION

1. Program identification information

1.1 Higher education institution	**National University of Science and Technology Politehnica Bucharest**
1.2 Faculty	**Electronics, Telecommunications and Information Technology**
1.3 Department	**Electronic Technology and Reliability**
1.4 Domain of studies	Electronic Engineering, Telecommunications and Information Technology
1.5 Cycle of studies	Masters
1.6 Programme of studies	Quality and Safety Engineering in Electronics and Telecommunications

2. Date despre disciplină

2.1 Course name (ro) (en)				Arhitecturi tolerante la defectări Fault tolerant architectures			
2.2 Course Lecturer				Prof. dr. ing. Angelica BACIVAROV			
2.3 Instructor for practical activities				Prof. dr. ing. Angelica BACIVAROV			
2.4 Year of studies	1	2.5 Semester	II	2.6. Evaluation type	E	2.7 Course regime	Ob
2.8 Course type		S	2.9 Course code	2		2.10 Tipul de notare	Nota

3. Total estimated time (hours per semester for academic activities)

3.1 Number of hours per week	4	Out of which: 3.2 course	2.00	3.3 seminary/laboratory	2
3.4 Total hours in the curricula	56.00	Out of which: 3.5 course	28	3.6 seminary/laboratory	28
Distribution of time:					hours
Study according to the manual, course support, bibliography and hand notes Supplemental documentation (library, electronic access resources, in the field, etc) Preparation for practical activities, homework, essays, portfolios, etc.					92
Tutoring					0
Examinations					2
Other activities (if any):					0

3.7 Total hours of individual study	94.00
3.8 Total hours per semester	150
3.9 Number of ECTS credit points	6

4. Prerequisites (if applicable) (where applicable)

4.1 Curriculum	Not applicable.

4.2 Results of learning	Accumulation of basic knowledge in the fields of quality / reliability / maintainability and mathematical statistics.

5. Necessary conditions for the optimal development of teaching activities (where applicable)

5.1 Course	The course will take place in a room equipped with a video projector and computer
5.2 Seminary/ Laboratory/Project	The applications will take place in a room equipped with computers, the necessary software, Internet access. Attendance at laboratory sessions is mandatory (according to POLITEHNICA Bucharest regulations).

6. General objective *(Reffering to the teachers' intentions for students and to what the students will be thought during the course. It offers an idea on the position of course in the scientific domain, as well as the role it has for the study programme. The course topics, the justification of including the course in the currcula of the study programme, etc. will be described in a general manner)*

The general objective of the discipline "Fault tolerant architectures" consists in the analysis of the architecture of modern IT systems with high reliability performance, essential in systems of high functional responsibility - aerospace, communications, for process control, medical and banking IT systems. The course mainly develops the techniques of protection of the system against failures and presents techniques for developing systems - hardware and software - of high reliability.

The laboratory will highlight the basic methods used to implement fault tolerance and evaluate the performance of these structures. Concrete applications will be presented with student participation in the development of both the software and hardware components.

7. Competences *(Proven capacity to use knowledge, aptitudes and personal, social and/or methodological abilities in work or study situations and for personal and proffesional growth. They refflect the empolyers requirements.)*

Specific Competences	Demonstrate basic / advanced knowledge of fault tolerant system architectures Correlate fault tolerance knowledge Apply the knowledge related to the construction of fault-tolerant systems in practice Apply standardized methods and tools, specific to the field, to carry out the evaluation and diagnosis process of a situation, depending on the identified/reported problems; identify solutions. Argue and analyze coherently and correctly the context of application of the basic knowledge of the field, using key concepts of the discipline and the specific methodology. Use scientific vocabulary specific to the field, in order to communicate effectively, in writing and orally.

Transversal (General) Competences	Work in a team and communicate effectively, coordinating efforts with others to solve problem situations of medium complexity. Autonomy and critical thinking: the ability to think in scientific terms, search and analyze data independently, and draw and present conclusions / identify solutions. Ability to analyze and synthesize: presents the acquired knowledge in a synthetic way, as a result of a process of systematic analysis. Respect the principles of academic ethics: correctly cite the bibliographic sources used in the documentation activity. Put elements of emotional intelligence into practice in the appropriate social-emotional management of real-life/academic/professional situations, demonstrating self-control and objectivity in decision-making or stressful situations.

8. Learning outcomes *(Synthetic descriptions for what a student will be capable of doing or showing at the completion of a course. The learning outcomes reflect the student's acomplishments and to a lesser extent the teachers' intentions. The learning outcomes inform the students of what is expected from them with respect to performance and to obtain the desired grades and ECTS points. They are defined in concise terms, using verbs similar to the examples below and indicate what will be required for evaluation. The learning outcomes will be formulated so that the correlation with the competences defined in section 7 is highlighted.)*

Knowledge	*The result of knowledge aquisition through learning. The knowledge represents the totality of facts, priciples, theories and practices for a given work or study field. They can be theoretical and/or factual.* • Listing the most important stages that marked the development of the field of fault tolerant architectures. • Defining specific notions of fault tolerance and redundancy. • Describing/classifying notions/processes/phenomena/structures. • Highlighting consequences and relationships.
Skills	*The capacity to apply the knowledge and use the know-how for completing tasks and solving problems. The skills are described as being cognitive (requiring the use of logical, intuitive and creative thinking) or practical (implying manual dexterity and the use of methods, materials, tools and intrumentation).* • Selecting and grouping relevant information in a given context. • Reasonably using specific principles in order to ensure the fault tolerance of systems. • Working productively in a team. • Elaborating a scientific text. • Experimentally verifying identified solutions. • Solving practical applications. • Adequately interpreting causal relationships. • Analyzing and comparing specific features and functionalities of fault tolerant systems. • Identifying solutions and developing solution/project plans. • Formulating conclusions to the experiments carried out. • Arguing the identified solutions/solutions.

Responsability and autonomy	*The student's capacity to autonomously and responsably apply their knowledge and skills.* • Selecting appropriate bibliographic sources and analyzing them. • Respecting the principles of academic ethics, correctly citing the bibliographic sources used. • Demonstrating responsiveness to new learning contexts. • Demonstrating collaboration with other colleagues and teaching staff in carrying out teaching activities. • Demonstrating autonomy in organizing the learning situation/context or the problem situation to be solved. • Demonstrating social responsibility through active involvement in student social life/involvement in academic community events. • Promoting/contributing through new solutions related to the specialized field to improve the quality of social life. • Realizing the value of their contribution in the field of engineering to the identification of viable/sustainable solutions to solve problems in social and economic life (social responsibility). • Applying principles of professional ethics/deontology in the analysis of the technological impact of the proposed solutions in the specialized field on the environment. • Analyzing and capitalizing on business/entrepreneurial development opportunities in the specialized field.

9. Teaching techniques *(Student centric techniques will be considered. The means for students to participate in defining their own study path, the identification of eventual fallbacks and the remedial measures that will be adopted in those cases will be described.)*

Starting from the analysis of students' learning characteristics and their specific needs, the teaching process will explore both expository (lecture, exposition) and conversational-interactive teaching methods, based on discovery learning models facilitated by direct and indirect exploration of reality (experiment, demonstration, modelling), but also on action-based methods, such as exercise, practical activities and problem solving.

In the teaching activity, lectures will be used, based on PowerPoint presentations or different videos that will be made available to the students. Each course will start with a recap of the chapters already covered, with an emphasis on the concepts covered in the last course.

Presentations use images and diagrams so that the information presented is easy to understand and assimilate.

This discipline covers information and practical activities designed to support students in their learning efforts and the development of optimal collaborative and communicative relationships in a climate conducive to discovery learning.

The practice of active listening and assertive communication skills, as well as feedback construction mechanisms, will be considered as ways of regulating behavior in various situations and adapting the pedagogical approach to the students' learning needs.

Teamwork skills will be practiced to solve different learning tasks.

10. Contents

COURSE		
Chapter	**Content**	**No. hours**

1	Introduction The concept of fault tolerance. Modeling the concept of fault tolerance. Structural description of systems for implementing fault tolerance and performance modeling.	1
2	Basic strategies used in designing fault-tolerant architecture. Fault masking algorithms and system reconfiguration when faults occur.	1
3	Redundant structures for implementing fault tolerance at the hardware level. Implementation schemes. Performance evaluation.	2
4	Redundant static protective structures of individual and global type resulting from multiplication. Majority Logic Redundant Structure.	2
5	Quad logic static protective redundant structure. Redundant static protective structure with wiring logic. Redundant structure by coding.	2
6	Dynamic protective redundant structure. Hybrid redundant structure.	2
7	Redundant structures for the interconnections of a system. Synchronization problems in digital systems with redundant structure.	2
8	Criteria for comparing redundant structures. Reliability improvement indices.	2
9	Designing a redundant structure at the optimal level.	2
10	Evaluation of reliability performance for redundant structures when partial restorations are made.	2
11	Multiplication fault tolerant architectures. Case studies. Architecture of a RAID system (Redundant Array of Independent Disks).	2
12	Fault-tolerant single-processor and multiprocessor architectures.	2
13	Case studies on commercial fault tolerant architectures: JPL STAR, TANDEM, FTMP, Sequoia, BIN.	2
14	Reconfiguration techniques in the presence of defects for processors and memories.	1
15	Reconfiguration model in multiprocessor systems.	1
16	Linear and tree structures for VLSI processor arrays. Reconfiguration techniques.	1
17	Error-tolerant software structures. The recovery block. Systems using message logging and checkpoints. n-version programming.	1
	Total:	28

Bibliography:

[1] https://www.euroqual.pub.ro/cursuri/.
[2] V. Cătuneanu, Angelica Bacivarov, Structuri electronice de înaltă fiabilitate. Toleranţa la defectări, Editura Militară, Bucureşti, 1999.
[3] V. Cătuneanu, I. C. Bacivarov, Fiabilitatea sistemelor de telecomunicaţii, Editura Militară, Bucureşti, 1995.
[4] T. Anderson, P. Lee, Fault Tolerance. Principles and Practices, Prentice Hall, 1999.
[5] I. Koren, C. Mani Krishna, Fault Tolerant Systems, Elsevier, 2007.
[6] Moodle course support - https://curs.upb.ro.

LABORATORY

Crt. no.	Content	No. hours
1	Designing a ROM memory with crossed parity codes	4
2	Reliability analysis of structures with static redundancy of the majority logic type	4
3	Fan-in, fan-out and synchronization problems when implementing static redundant structures at integrated circuit level	4
4	Evaluation of static/dynamic redundant hardware structures with self-testing features	4
5	Linear and tree structures for VLSI processor arrays	4
6	Predictive evaluation of the performance of reliability, availability, credibility of fault-tolerant systems	4
7	Evaluation of static/dynamic redundant software structures with self-testing features	4
	Total:	28

Bibliography:

[1] https://www.euroqual.pub.ro/cursuri/.
[2] V. Cătuneanu, Angelica Bacivarov, Structuri electronice de înaltă fiabilitate. Toleranţa la defectări, Editura Militară, Bucureşti, 1999.
[3] Moodle course support - https://curs.upb.ro.

11. Evaluation

Activity type	11.1 Evaluation criteria	11.2 Evaluation methods	11.3 Percentage of final grade
11.4 Course	Knowing how to apply the theory to specific problems	- homework	20%
	Knowledge of fundamental theoretical notions	- verification test - final exam (written)	40%
11.5 Seminary/laboratory/project	Evaluation of laboratory activity	- final laboratory colloquium	40%
11.6 Passing conditions			
• Fulfilling the obligations characteristic of laboratory activity: submitting and presenting laboratory reports. • Obtaining 50% of the score related to the activity during the semester. In order to pass the discipline, the student must obtain at least 50% of the total score, in compliance with all the requirements specified in the POLITEHNICA Bucharest / ETTI Regulations.			

12. Corroborate the content of the course with the expectations of representatives of employers and representative professional associations in the field of the program, as well as with the current state of knowledge in the scientific field approached and practices in higher education institutions in the European Higher Education Area (EHEA)

• Through the activities carried out, students develop skills to offer solutions to problems and to propose ideas to improve the state of the art in the field of fault-tolerant architectures

• Knowledge / aspects / phenomena described by specialized literature / own research published / presented in journals and scientific conferences were taken into account in the development of the content of the discipline

• Through the practical activities in the FTA laboratory, the development of the student's skills to manage practical situations that he may face in real life is considered in order to increase his contribution to the improvement of the socio-economic environment.

Date	Course lecturer	Instructor(s) for practical activities
23.09.2025	Prof. dr. ing. Angelica BACIVAROV	Prof. dr. ing. Angelica BACIVAROV

Date of department approval	Head of department
	Conf. dr. ing. Marian VLĂDESCU

Date of approval in the Faculty Council	Dean
	Prof. dr. ing. Radu Mihnea UDREA