Universitatea Națională de Știință și Tehnologie Politehnica București
Facultatea de Electronică, Telecomunicații și
Tehnologia Informației

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	**Telecommunications**
1.4 Domain of studies	Electronic Engineering, Telecommunications and Information Technology
1.5 Cycle of studies	Masters
1.6 Programme of studies	Electric Vehicle Propulsion and Control

2. Date despre disciplină

2.1 Course name (ro) (en)				Sisteme neliniare de control automat Nonlinear Control Systems			
2.2 Course Lecturer				Prof. Dr. CIPRIAN LUPU			
2.3 Instructor for practical activities				Prof. Dr. CIPRIAN LUPU			
2.4 Year of studies	1	2.5 Semester	II	2.6. Evaluation type	V	2.7 Course regime	Ob
2.8 Course type		DA	2.9 Course code	UPB.04.M1.O.24-10		2.10 Tipul de notare	Nota

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

3.1 Number of hours per week	2	Out of which: 3.2 course	1.00	3.3 seminary/laboratory	1
3.4 Total hours in the curricula	28.00	Out of which: 3.5 course	14	3.6 seminary/laboratory	14
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.					41
Tutoring					2
Examinations					4
Other activities (if any):					0

3.7 Total hours of individual study	47.00
3.8 Total hours per semester	75
3.9 Number of ECTS credit points	3

4. Prerequisites (if applicable) (where applicable)

4.1 Curriculum ·	Completion and promotion of the following courses: Control Systems Project: Embedded Systems

4.2 Results of learning	Accumulation of the following knowledge: Advanced automatic control systems and structures, real-time system programming, real-time hardware architectures

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 video projector and computer.
5.2 Seminary/ Laboratory/Project	Laboratory equipped with a video projector, computers equipped with hardware equipment and IDE software specialized for the development of real-time control applications (microcontrollers, PLC, data acquisition systems).

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)*

This discipline is studied within the field of Electronics, Telecommunications and Information Technology / Master program Electrical Vehicle Propulsion and Control (EPIC) and aims to familiarize students with specific elements regarding the implementation of hardware and software as well as the operation of control systems for non-linear SISO processes and MIMO in the general field of engineering (and in particular of electric vehicle type systems).

Emphasis is placed on the acquisition of advanced control and supervision structures in the fields of automatic control, systems with real-time operation, involving the designing, implementation and use of control systems for complex processes (non-linear and/or multivariable). These processes are also found in electric vehicles.

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	Understanding and using fundamental concepts to develop control architectures for non-linear processes Correlate knowledge Apply the knowledge in practice Apply standardized field-specific methods and tools to identify problems and optimal solutions Correctly analyzes the context of application of basic knowledge of the field, using key concepts of the discipline and specific methodology. Oral and written communication in a foreign language (English): demonstrates understanding of subject-related vocabulary in a foreign language.
Transversal (General) Competences	The ability to make decisions in order to solve current problems that arise in process control The ability to constantly inform and document for personal and professional development by reading specialized literature The ability to analyze and synthesize information Autonomy and critical thinking Flexibility in the use of new systems and technologies within a team where members together achieve a well-defined goal while assuming different roles or tasks Adherence to the principles of academic ethics The ability to work in stressful situations and optimal time management.

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.* **Lists** the most important purchase and control structures usable in the case of automotive processes. **Defines** domain-specific notions. **Describes** and substantiates control structures for non-linear processes. **Highlights** the tracked performances. **Presents** real-time implementation solutions.
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).* · Reasonably **uses** specific principles in order to control non-linear processes. · **Work** productively in a team. **Develop** a scientific solution. Experimentally **verifies** identified solutions. · **Solve** practical applications. · Adequately **interpret** causal relationships. · **Analyze and compare** the obtained performances. · **Identifies** solutions and develops design methods. · **Formulates** conclusions to the experiments carried out. **Argue** the identified solutions/solutions.
Responsability and autonomy	*The student's capacity to autonomously and responsably apply their knowledge and skills.* · **Select** appropriate bibliographic sources and analyze them. · **Respect** the principles of academic ethics, correctly citing the bibliographic sources used. · **Demonstrates responsiveness** to new learning contexts. · **Demonstrates collaboration with other colleagues** and teaching staff in carrying out teaching activities **Demonstrates autonomy** in organizing the learning situation/context or the problem situation to be solved **Promotes/contributes** through new solutions related to the specialized field to improve the quality of social life. **Realizes the value of his contribution** in the field of engineering to the identification of viable/sustainable solutions to solve problems in social and economic life (social responsibility). · **Apply principles of professional ethics/deontology** in the analysis of the technological impact of the proposed solutions in the specialized field on the environment. · **Analyzes and capitalizes on business/entrepreneurial development opportunities** in the specialized field. **Demonstrates real-life situation management skills** (collaborative vs. conflict time management).

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.)*

Both the course and the applications are presented on a video projector (covering the communication and demonstration function), but the demonstrations and some schemes are practically done on equipment, components and installations. Students may take notes during the course, but are encouraged to study the bibliography provided as well. Course support and bibliography are made available to students on the UPB Moodle Platform https://curs.upb.ro/. The seminar support can be obtained from the lab.

Students are provided with documentation on the faculty's online course portal (Moodle), as well as documentation that they can study in the classroom.

For the periods of online classes and applications, they will be held through the Microsoft Teams platform, in the channel dedicated to the NCS discipline.

The modification of the way of conducting the course will be done according to the decisions of the UNSTPB Senate.
Students are trained in research and documentation activity by completing assigned tasks in teams that they will present to their colleagues and course and application holders.

10. Contents

COURSE		
Chapter	**Content**	**No. hours**
1	C1. Introduction Classic control structures	1
2	C2-3. The study of the nonlinearities of processes and phenomena Nonlinear types encountered in continuous processes. Nonlinear types encountered in mechanical and electrical processes. Nonlinearities due to hardware and software implementations.	2
3	C4. Real-time hardware and software architectures for managing existing processes in the area of mobile electrical systems Software structures. Hardware structures	1
4	C5-7. Multimodel systems Multimodel structures. Problems specific to multimodel structures. Optimal determination of the number of models / algorithms. Solutions for selecting the best model / algorithm. Solutions for switching algorithms. Stability of multimodel systems.	2
5	C8. Internal model systems Internal model structures. Problems specific to internal model structures. Construction of the internal model. Design of the control algorithm.	1
6	C9-10. Adaptive systems Adaptive structures. Problems specific to adaptive structures. Closed loop identification. Stability.	2

7	C11-12. Multivariable process control solutions Disconnection and coupling of control loops.	2
8	C13-14. Solutions for implementation	2
	Total:	14

Bibliography:

Course:04-ELECTRONICA-M-A1-S2: Sisteme neliniare de control automat (Seria EPIC - 2022) (upb.ro)
04-NCS-A1-S2-2023 | General | Microsoft Teams
Handbook of Real-Time and Embedded Systems, editat de Insup Lee,Joseph Y-T. Leung,Sang H. Son,
AUTOSAR - A standard in the course of time, EUROFORUM Automotive Software Development, September 6th 2016, Munich
Lupu C., Udrea A., Popescu D., Petrescu C., Ticlea Al., Dimon C., Irimia B., - Practically solutions for nonlinear processes control / Solutii practice de conducere a proceselor neliniare, Editura PolitehnicaPress, 2010, 310 pag., ISBN 978-606-515-105-5

LABORATORY

Crt. no.	Content	No. hours
1	Classic control structures. Closed loop. Cascade. Hardware-software control architectures.	1
2	Nonlinearities of processes and phenomena	3
3	Multimodel systems.	2
4	Internal model systems.	2
5	Adaptive systems	2
6	Multivariable processes control.	2
7	Integration of complex systems	2
8	Recovery (limited) of some laboratories	1
	Total:	14

Bibliography:

Course:04-ELECTRONICA-M-A1-S2: Sisteme neliniare de control automat (Seria EPIC - 2022) (upb.ro)
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Manuals, tutoriale (hardware si software

Rockwell Automation. Control Logix 5000. RSView.

National Instruments. Data acquisition.

Omron

Horner

11. Evaluation

Activity type	11.1 Evaluation criteria	11.2 Evaluation methods	11.3 Percentage of final grade
11.4 Course	Knowledge of the fundamental theoretical notions regarding control systems of non-linear processes.	Written exam in the exam/verification session. The subjects cover the entire subject taught.	50%
11.5 Seminary/laboratory/project	Completion of individual / laboratory subgroup applications	Oral evaluation (presentation) of laboratory applications	30%
	Final Project - Completion of the homework and its oral presentation	Oral evaluation	20%
11.6 Passing conditions			
• Obtaining 50% of the total score. • Obtaining 50% of the score related to the activity during the semester.			

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 for improving the existing situation in the Automotive field by expanding some notions and concepts associated with the field of Automation. The course has similar content to equivalent courses held in European universities.

Date	Course lecturer	Instructor(s) for practical activities
18.10.2024	Prof. Dr. CIPRIAN LUPU	Prof. Dr. CIPRIAN LUPU

Date of department approval	Head of department
27.10.2024	Conf. Dr. Serban Georgica Obreja

Date of approval in the Faculty Council — Dean

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25.10.2024

Prof. Dr. Mihnea Udrea