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	**Applied Electronics and Information Engineering**
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 de control automat Control Systems			
2.2 Course Lecturer				Prof. dr. ing. Dan Alexandru Stoichescu			
2.3 Instructor for practical activities				Conf. dr. ing. Bogdan Cristian Florea			
2.4 Year of studies	1	2.5 Semester	I	2.6. Evaluation type	E	2.7 Course regime	Ob
2.8 Course type		S	2.9 Course code	3		2.10 Tipul de notare	Nota

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

3.1 Number of hours per week	3	Out of which: 3.2 course	2.00	3.3 seminary/laboratory	1
3.4 Total hours in the curricula	42.00	Out of which: 3.5 course	28	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.					28
Tutoring					0
Examinations					5
Other activities (if any):					0

3.7 Total hours of individual study	33.00
3.8 Total hours per semester	75
3.9 Number of ECTS credit points	3

4. Prerequisites (if applicable) (where applicable)

4.1 Curriculum	Mathematical Analysis 1 and 2; Special Mathematics; Physics 1 and 2; Electrotechnics 1 and 2; Electronic Devices; Basic Electronic Circuits; Analogic Integrated Circuits

4.2 Results of learning	Laplace transform. Z-transform.Using the fundamental elements of electronic devices, circuits, systems, instruments and technology

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

5.1 Course	The course is conducted in a classrom with video projector and computer
5.2 Seminary/ Laboratory/Project	The laboratory activity is carried out in a laboratory room with laboratory platforms required by the program and the necessary measuring devices.

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 course belongs to the domain Electronic Engineering, Telecommunications and Information Technology ; its purpose is to familiarize the students with the basic notions and theory of the domain, used for solving relevant practical applications.
The course approaches the following specific notions, concepts and principles: linear continuous control systems (LCCS) and digital control systems (DCS) transfer functions, state variables, LCCS and DCS stability and performance, LCCS and DCS design. In this way, the students acquire an overview of the methodological benchmarks and procedural milestones of the domain

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	The students: prove that they have basic knowledges in the field of control systems, correlate knowledges, apply the acquired knowledge in practice, apply standardized methods and tools specific to the field to carry out the evaluation process of a situation and identify solutions
Transversal (General) Competences	The students: are able to work in a team, coordinating their efforts with others to solve problems of medium complexity, are able to think in scientific terms, to look for and analyze data independently and to find solutions, are able to present the acquired knowledge in a synthetic way, as a result of a systematic analysis, implement elements of emotional intelligence in managing some situations in their professional life, demonstrate 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.* define and classify notions and processes in the field of automatic control; highlight consequences and reletionships in the field of automatic control; apply, in typical situations, the basic methods of electrical signal processing; understand and are able to use the fundamental concepts of the automatic control.
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).* select and group relevant information within a given complex; use specific principles in a reasoned manner in order to solve specialized problems; work productively in a team; prepare scientific texts of medium complexity; experimentally verify theoretically obtained solutions; solve practical applications; adequately interpret causal relationships; draw conclusions from the experiments carried out.
Responsability and autonomy	*The student's capacity to autonomously and responsably apply their knowledge and skills.* demonstrate responsiveness to new learning contexts; collaborate with other colleagues and teaching staff in carrying out teaching activities; demonstrate autonomy in organizing a learning context; show social responsibility through active involvement in student social life; demonstrate real-life situation management skills (time-management, collaboration versus conflict); have the ability to communicate and collaborate with specialists in fields different of electonics in order to provide electronic solutions to their technical problems; have the ability to communicate with higher hierarchical structures and the subordinate team; have the ability to function as leaders of teams that may be composed of people with different specializations and qualification levels; have the ability to make decisions in order to solve current or unpredictable problems that arise in the process of operation of electronic equipment; have the ability to communicate and present a technical content in english.

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.)*

In the teaching process, expository teaching methods will be used (lecture, exposition) as well as conversational-interactive (experiment, demonstration, modeling) but also action-based methods (exercise, practical activities and problem solving).
In the teaching activity, lectures will be used, based on Power Point presentations that will be made available to students. Each course will begin with a recap of the chapters already covered, with an emphasis on the concepts covered in the last course.
The presentations will use images and diagrams so that the information presented is easy to understand and assimilate. An optional climate for discovery learning will be provided.
Teamwork skills will be practiced to solve different learning tasks.
The video projector will be used, but the blackboard too when students ask unexpected questions.

10. Contents

COURSE		
Chapter	**Content**	**No. hours**
1	Introduction. Definitions; Open-Loop and Closed-Loop Control Systems; Classification of Control Systems.	1
2	Input-Output Model of the Continuous Linear Control Systems. 2.1 Analysis of Physical Systems using Differential Equations; 2.2 Physical System Analysis using Transfer Functions H(s): Definition of H(s), Transfer Functions of Electrical Networks, Mechanical, Electromecanical, Thermal and Fluid Systems, Equivalent Transfer Functions, Contoller Transfer Functions, Multivariable Control Systems, Step Response of Control Systems; 2.3 Frequency Analysis of Control Systems.	4
3	State-Space Model of Control Systems. 3.1 Generals 3.2 Electrical, Mechanical and Electromechanical Systems State-Space Model; 3.3 Determining the State-Space Model Equations starting from Transfer Functions; 3.4 Determining Transfer Functions starting from State-Space Model; 3.5 Determination of the Control System Response using the State-Space Model.	4
4	Control System Performance. 4.1 Linear Continuous Control Systems (LCCS) Stability; 4.2 LCCS Performance Measures.	3
5	LCCS Control Design. 5.1 Generals; 5.2 The Pole-Zero Design Method; 5.3 Using PID Controllers for LCCS Control Design.	4
6	Digital Control Systems (DCS) characteristics. 6.1 Generals; 6.2 DCS Analysis with Difference (Recurrent) Equations.	1
7	DCS Analysis using Z-Transfer Functions. 7.1 Z-Transform; 7.2 Z-Transfer Functions.	2
8	State-Space Model of DCS. 8.1 DCS State-Space Model Determination using the “Command” Block Diagram; 8.2 DCS State-Space Model Determination using the “Observer “ Block Diagram; 8.3 DCS State-Space Model Determination using Graphs; 8.4 Z-Transfer Function Determination starting from the State-Space Model of the DCS.	2
9	DCS Performance. 9.1 Output Sequence y(k) Determination; 9.2 DCS Stability; 9.3 DCS Steady State and Transitory Performance..	4

10	DCS Design 10.1 Methods of DCS Design; 10.2 Digital Controllers by Continuous System Design; 10.3 Direct Design of Digital Controllers.	3
	Total:	28

Bibliography:
Dan Alexandru Stoichescu: Control Systems – course in electronic format on Moodle;
Van de Vegte J – Feedback Control Systems, Prentice Hall, Inc, Englewood Cliffs, New Jersey, 1994;
Stoichescu D.A., Vasile D. – Sisteme automate-Culegere de Probleme, Universitatea Politehnica din București, 1998 ;
Ksouri M, Borne P. – La commande par calculateur, Ed. Technip, Paris, 1999 ;
Stoichescu D.A,, Florea B.C., Constantinescu Rodica Claudia – Sisteme automate numerice, Ed. Printech, București, 2022 .

LABORATORY

Crt. no.	Content	No. hours
1	Temperaure Control	2
2	Light Control	2
3	Liquid Level Control	2
4	Liquid Flow Control	2
5	Liquid Pressure Control	2
6	Electric Motor Shaft Position and Speed Control	2
7	Final Practical Examination	2
	Total:	14

Bibliography:
Dan Alexandru Stoichescu: Control Systems – course in electronic format on Moodle;
Van de Vegte J – Feedback Control Systems, Prentice Hall, Inc, Englewood Cliffs, New Jersey, 1994;
Stoichescu D.A., Vasile D. – Sisteme automate-Culegere de Probleme, Universitatea Politehnica din București, 1998 ;
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11. Evaluation

Activity type	11.1 Evaluation criteria	11.2 Evaluation methods	11.3 Percentage of final grade

11.4 Course	Knowledge of LCCS analysis and synthesis	An evaluation test; the test consists in course elements: theory and applications ; 3-4 short tests consisting in applications	30%
	Knowledge of DCS analysis and synthesis	Final examination which consists in course elements: theory and applications ; 3-4 short tests consisting in applications during the semester	30%
11.5 Seminary/laboratory/project	knowledge of the theory concerning the experiments performed in the laboratory; familiarization with experimental modules structure and understanding their operation; ability to perform laboratory experiments	Oral examination during the laboratory activity during the semester and short questions during the semester final examination; hands-on final examination	20%
	The ability to solve control systems problems in the seminary	Examination during the seminary during the semester	20%
11.6 Passing conditions			
50% of the total score. 50% of the laboratory score.			

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)

The early aim of the control systems, realized mostly with electronic circuits, has been the improvement of the industrial equipment work, but they are used now in very different fields: the same procedures and, sometimes, the same circuits are encountered in motor command and blood pressure monitoring. In medicine, telecommunications, transport, robotics, radar the automatic control is omnipresent and no practical application in these fields can be achieved without the knowledge of the control basic notions and principles.
The discipline curriculum fits very well to this demand: in the first part of the course, the ground notions are rigorously defined and explained; a lot of examples are given for a total understanding of the analysis methods of the physical systems belonging to the control loops and of the control systems in totality; the control systems performances are defined and the basic design methods are developed; .
The course and laboratory activities are conceived in a way to make the students able to solve medium complexity problems in the field of the automatic control.

Date	Course lecturer	Instructor(s) for practical activities
25.09.2024	Prof. dr. ing. Dan Alexandru Stoichescu	Conf. dr. ing. Bogdan Cristian Florea

Date of department approval	Head of department
	Conf. dr. ing. Bogdan Cristian Florea

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