SYLLABUS

1. Data about the program of study

1.1	Institution	Technical University of Cluj-Napoca
1.2	Faculty	Faculty of Electrical Engineering
1.3	Department	Power Systems and Management
1.4	Field of study	Energy Engineering
1.5	Cycle of study	Master of Science
1.6	Program of study/ Qualification	Modern Power Systems - Cluj-Napoca in English language
1.7	Form of education	Full time

2. Data about the subject

2.1	Subject name			Systems Engineering	Course code	13.00	
2.2	Course responsible/ lecturer			Prof.dr.ing. Iulian BIROU – Iulian.Birou@emd.utcluj.ro			
2.3	Teachers in charge of Seminars/ Laboratory/ Project			Prof.dr.ing. Iulian BIROU – Iulian.Birou@emd.utcluj.ro			
2.4 Year of study	V	2.5 Semester	1	2.6 Type of assessment *(E – exam, C – colloquium, V – verification)*	E		
2.7 Subject category	*DF – fundamental, DD – in the field, DS – specialty, DC – complementary*				DS		
	DI – compulsory, DO – elective, Dfac – optional				DI		

3. Estimated total time

3.1 Number of hours per week:	3	of which	3.2 Course	2	3.3 Seminar		3.3 Laboratory	1	3.3 Project		
3.2 Total hours per semester	42	of which	3.5 Course	28	3.6 Seminar		3.6 Laboratory	14	3.6 Project		

3.7 Individual study:	
(a) Manual, lecture material and notes, bibliography	22
(b) Supplementary study in the library, online and in the field	9
(c) Preparation for seminars/laboratory works, homework, reports, portfolios, essays	22
(d) Tutoring	2
(e) Exams and tests	3
(f) Other activities	

3.8 Total hours of individual study *[sum (3.7(a) to 3.7(f))]*	58
3.9 Total hours per semester *[sum of 3.4 and 3.8]*	100
3.10 Number of credit points	4

4. Prerequisites (where applicable)

4.1	Curriculum	General knowledge of Systems Theory – recommended, Electric Machines – recommended, Electric Drives – recommended, Computing Systems – recommended
4.2	Competences	General knowledge of Systems Theory – recommended, Electric Machines – recommended, Electric Drives – recommended, Computing Systems – recommended

5. Requirements (where appropriate)

5.1	For the course	
5.2	For the applications	Mandatory presence

6. Specific competences

Professional competences	C6. Design and control of electrical drive systems C6.1. Identification of fundamental aspects specific related to system theory and automated control, and of the investigation methods of an electrical drive system. C6.3. Application of control principles and specific procedures used for optimization of working parameters of a control system, for evaluation of the working limits of an electrical drive system. C6.4. Development of digital control based electrical drives fed by power electronic converters controlled by dedicated microprocessors or DSP based systems. C6.5. Development of a control system of reduced complexity of an industrial process using specific techniques and procedures.
Cross competences	CT1 Identification of the main objectives, available resources, completion conditions, work steps, work times, terms and related risks. CT3 Efficient use of documentation and communication resources and assisted professional training (on-line database, specific software and hardware solutions.

7. Expected learning outcomes

Knowledge	The student/graduate correlates the advanced knowledge of the field with the objectives of sustainability, resilience and energy efficiency.
Skills	The student/graduate integrates technical, operational and economic data for the evaluation of alternatives for the development of the system.
Responsibility and autonomy	The student/graduate manages complex and unpredictable work or study situations that require strategic decisions. The student/graduate autonomously substantiates professional solutions and assumes their technical and organizational implications.

8. Discipline objectives (based on specific competencies acquired)

7.1	General objective	Control an integrated energy conversion system, to use computer systems for controlling processes
7.2	Specific objectives	After completing the course, students will be able to: – to calculate and interpret parameters of electro-mechanical systems – to choose an electro-mechanical conversion system with optimal efficiency – to link in a unitary system an electrical machine with an electronic converter, with an electrical/mechanical transducer and with the mechanical process

		– to choose the optimal strategy for regulating the given process, to design an efficient regulator for the electro-mechanical system – to use the calculation system related to the process

9. Contents

9.1. Course (Lectures)		Number of hours	Teaching methods	Additional remarks
1	Introduction to high-performance electro-mechanical conversion systems for energy generation, with the definition in context of the notions of: - high energy efficiency - motion control - Mechatronics system	2	1.Phenomenological presentation of the taught systems 2. Using the overhead projector and the digital projector for the presentation of complex schemes and structures 3. Resorting to an interactive communication to some components of the course 4. Stimulating the creative thinking process through interpellations 5. Reference to complementary bibliography	
2	Presentation of an integrated electro-mechanical conversion system, consisting of the elements of strong currents (force: electronic power converter, electric machine, mechanical process) and the circuit of weak currents (information: transducers, regulation system, control techniques, real-time calculation system);	2		
3	Description of electrical machines in the form of equations of state; Description of alternating current machines in the form of simplified (linearized) transfer function; Operation in motor and generator modes.	2		
4	Using electronic power converters to increase energy efficiency and performance of an energy coverage system	2		
5	Power quality of electrical energy. Use of active filters to improve the power factor and eliminate harmonics	2		
6	Types of transducers used in electromechanical conversion systems. Calculation and identification of control quantities	2		
7	High-performance control methods used in the control of electro-mechanical conversion systems: - description of the process in the form of equations of state - description of the electrical machines in the form of a simplified transfer function (linearized) - the use of classic control methods (PID and sliding-mode) for motion control;	2		
8	Adaptive and robust control of energy conversion systems;	2		
9	Intelligent control of energy conversion systems. Controllers based on fuzzy logic	2		
10	Neural networks in flexible systems; genetic algorithms in the process of learning, optimization and control; Notions of artificial intelligence	2		
11	Electric drive system in generator mode at variable speeds. Their use in wind generators, micro-hydropower plants, biomass-based generators.	2		

12	Use of computing systems in control of energy conversion systems	2		
13	Electricity storage system	2		
14	Design notions of integrated electrical systems	2		

Bibliography

1. I. Birou, Metode performante de control in actionari electrice de curent alternativ. Casa Cartii de Stiinta, 1999.
2. I. Birou: Sisteme de calcul in timp real pentru comanda actionarilor electrice. Ed. Mediamira, Cluj-Napoca, 2000.
3. Mueller, Andreas; Birou, M.T. Iulian, et al (2011): Recent Advances in Robust Control.
4. Notite de curs si material de predare in format electronic

9.2. Applications - Seminar /Laboratory/Project		Number of hours	Teaching methods	Additional remarks
1	Identifying the parameters of an energy conversion system	2	1. Reference to complementary bibliography 2. Stimulating the creative thinking process through interpellations	
2	Determination of losses in an energy conversion system; Energy balance	2		
3	Equations of state of a multivariable system; Modeling PID and predictive regulators	2		
4	Modeling adaptive control systems	2		
5	Robust controllers	2		
6	Intelligent control; Elements of fuzzy math; Applications with neural networks	2		
7	Regenerative power generation systems	2		

Bibliography

I.Birou: Aplicatii ale sistemelor de control performant al generarii energiei. Material de prezentare in format electronic

10. Alignment of course content with expectations of the epistemic community, professional associations, and representative employers in the field

The content of the discipline can be found in the curricula of most of the specializations in the fields of Energy Engineering, as well as in the curricula of some specializations in related fields of study

11. Assessment

Activity type	10.1 Assessment criteria	10.2 Assessment methods	10.3 Weight in the final grade (%)
10.4 Course	Examination of the knowledge acquired in the course	- oral and/or written examination	0.35
10.5 Laboratory	Assessment of competences by submitting a scientific report	- presentation of reports in the team (9 hours)	0.65
10.5 Project			
10.6 Minimum standard of performance: Preparation and presentation of the scientific report; Obtaining the grade min. 5			

Date of completion	Lecturers	Title/ Surname/ Name:	Signature
September 2025	Course	Prof.dr.ing. Iulian BIROU	Prof. dr. ing. Iulian BIROU
	Applications Seminar/ Laboratory/ Project		
		Prof.dr.ing. Iulian BIROU	Prof. dr. ing. Iulian BIROU

Endorsement of the Director of the department coordinating the course, only if this differs from the department organizing the study program.	**Head of Department Power Engineering and Management** Assoc. Prof. Eng. Horia G. BELEIU, PhD

Date of approval in the council of the Department of Power Engineering and Management September 2025	**Head of Department Power Engineering and Management** Assoc. Prof. Eng. Horia G. BELEIU, PhD
Date of approval in the Faculty of Electrical Engineering Council September 2025	**Dean:** Assoc. Prof. Eng. Andrei C. CZIKER, PhD