SYLLABUS

1. Data about the program of study

1.1	Institution	The Technical University of Cluj-Napoca
1.2	Faculty	Faculty of Electrical Engineering
1.3	Department	Electrotechnics and Measurements
1.4	Field of study	Electrical Engineering
1.5	Cycle of study	Bachelor of Science
1.6	Program of study/Qualification	Electrical Systems
1.7	Form of education	Full time
1.8	Subject code	55

2. Data about the subject

2.1	Subject name			Integrated energy conversion systems			
2.2	Course responsible/lecturer			Prof. dr. ing. Iulian Birou (birou@edr.utcluj.ro), S.l. dr. ing. Szabo Csaba (Csaba.Szabo@emd.utcluj.ro)			
2.3	Teachers in charge of seminars			S.l. dr. ing. Szabo Csaba (Csaba.Szabo@emd.utcluj.ro) Asist. drd. ing. Mihai Suciu (Mihai.Suciu@emd.utcluj.ro)			
2.4 Year of study	IV	2.5 Semester	2	2.6 Assessment			Ex
2.7 Subject category	Formative category						DS
	Optionality						DI

3. Estimated total time

3.1 Number of hours per week	4	of which	3.2 Course	2	3.3 Seminar		3.3 Laboratory	2	3.3 Project		
3.4 Total hours in the curriculum	56	of which	3.5 Course	28	3.6 Seminar		3.6 Laboratory	28	3.6 Project		

3.7 Individual study: 44	
(a) Manual, lecture material and notes, bibliography	32
(b) Supplementary study in the library, online and in the field	21
(c) Preparation for seminars/laboratory works, homework, reports, portfolios, essays	10
(d) Tutoring	3
(e) Exams and tests	3
(f) Other activities	

3.8 Total hours of individual study (summ (3.7(a)...3.7(f)))	69
3.9 Total hours per semester (3.4+3.8)	125
3.10 Number of credit points	5

4. Pre-requisites (where appropriate)

4.1	Curriculum	General knowledge on System Theory, Electrical Machines, Power Electronics, Electrical Drives
4.2	Competence	Specific competences related to System Theory, Electrical Machines, Power Electronics and Electrical Drives

5. Requirements (where appropriate)

5.1	For the course	
5.2	For the applications Seminar /Laboratory/Project	Mandatory presence

6. Specific competences

Professional competences	C6. Monitoring, control and diagnosis 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. C6.2. Implementarea algoritmilor de monitorizare și diagnosticare a unui sistem de acționare electrică, în scopul rezolvării unor situații problemă specifice. Implementation of monitoring and diagnosis algorithms 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 microprocessor 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. Discipline objectives (as results from the *key competences gained*)

7.1	General objective	Analysis and synthesis of controlled electrical drive systems based on field-oriented control (FOC) or Direct Torque Control (DTC) for AC machines (induction and synchronous).
7.2	Specific objectives	- Identification of specific components of an electrical drive system - Selection of the appropriate drive machine and power electronic converter for a specific application - Selection of the power electronic converter control procedure - Optimal control method identification based on application and the imposed performance standards. - Design of a reduced complexity control system for an industrial process

8. Contents

8.1. Lecture (syllabus)	Number of hours	Teaching methods	Notes
Constant V/Hz based scalar control of AC drives; voltage-drop compensation procedures	2		

Power electronic converters used in AC electrical drives: topologies and specific Pulse-Width Modulation procedures	2	Multimedia presentation, group projects, case studies	
The Space-Phasor Theory applied in AC drives as a unitary method of treatment for the three phase AC machines and power electronic converters and for the control system.	2		
The mathematic model of the asynchronous machine based on the Space phasor theory	2		
The Field-Orientation principle based on the analogy between the induction and the DC machine. Vector control strategies.	2		
Flux identification methods of the induction machine in vector control systems based on field orientation. Control of the electro-mechanical quantities in the active loop. Control of the electro-magnetic quantities in the reactive loop.	2		
Rotor-field oriented control structures of the induction machine fed by voltage or current controlled PWM-VSI (Pulse-Width Modulated Voltage-Source Inverter).	2		
The wound-excited synchronous machine: generalities, working principle, the mathematical model based on the space-phasor theory.	2		
The analogy of the wound-excited synchronous machine working with maximum power factor with the compensated DC machine. The field-orientation principle and vector control strategies of the synchronous machine.	2		
Stator-field oriented control of the wound-rotor synchronous machine	2		
The PM-synchronous machine: working principle and mathematical model.	2		
Vector control structures of the PM synchronous machine based on rotor-field orientation.	2		
Vector control structures of the PM synchronous machine based on stator-field orientation.	2		
The direct torque control of the AC machines	2		

Bibliography

1.Kelemen Árpád, Imecs Maria: Vector Control of AC Drives. Volume 1: Vector Control of Induction Machine Drives. OMIKK Publisher, Budapest, 1991, ISBN 9635931409 20.

2. Kelemen Árpád, Imecs Maria: Vector Control of AC Drives. Volume 2: Vector Control of Synchronous Machine Drives. Ecriture-Publisher, Budapest, Hungary, 1993, ISBN 9635931409

8.2. Seminar /Laboratory/Project	Number of hours	Teaching methods	Notes

Study of a working cycle driven by a V/Hz controlled cage-induction machine with. Design of a drive cycle driven by an induction machine fed by an industrial power electronic converter	4		
Study of a drive cycle realized by a vector controlled PMSM fed by an industrial power electronic converter Position control of a PMSM fed by an industrial converter: design of a full working cycle	4		
Rotor-field oriented control of the induction machine fed by a VSI. Sensorless vector control of the cage-induction machine.	4		
Torque-control based operation of the cage-induction machine fed by a PWM-VSI. Comparison of the speed control strategies for the cage-induction machine working in the low-speed region	4		
Analysis of the dynamic operation of a closed-loop speed-controlled DC-machine fed by a four-quadrant rectifier with excitation control. Analysis of the dynamic operation of a speed-controlled induction machine fed by a VSI.	4		
Design and implementation of a scalar control structure for an induction servomotor controlled by fixed-point DSP-based development system.	4		
Final evaluations, tests	4		

Bibliography

1.Kelemen Árpád, Imecs Maria: Vector Control of AC Drives. Volume 1: Vector Control of Induction Machine Drives. OMIKK Publisher, Budapest, 1991, ISBN 9635931409 20.
2. Kelemen Árpád, Imecs Maria: Vector Control of AC Drives. Volume 2: Vector Control of Synchronous Machine Drives. Ecriture-Publisher, Budapest, Hungary, 1993, ISBN 9635931409
3. *** Programming Guide, VLT® AutomationDrive FC 301/302
4. *** STÖBER ANTRIEBSTECHNIK *Servoumrichter Baureiche SDC Bedienungs und Inbetriebnahmeanleitung* CCS Nr. 440695, 1996.
5. *** Siemens Micromaster 440 – Operating instructions

4. Bridging course contents with the expectations of the representatives of the community, professional associations and employers in the field

5. Evaluation

Activity type	10.1 Assessment criteria	10.2 Assessment methods	10.3 Weight in the final grade
10.4 Course	Evaluation of the acquired knowledge during the course activities: theoretical and application-based exam	Written exam	65%
10.5 Seminar/ Laboratory/Project	Evaluation of the acquired competences based on: - Activity during lab - theoretical and practical tests - portfolio	- portfolio presentation - tests	35%
10.6 Minimum standard of performance			
Completion and presentation of laboratory activities, laboratory portfolio presentation. Final examination. Minimum final grade: 5			

Date of filling in:		Title Surname Name	Signature
September 2024	Lecturer	Prof. dr. ing. Iulian Birou S.l. dr. ing. Szabo Csaba	
	Teachers in charge of application	S.l. dr. ing. Szabo Csaba Asist. drd. ing. Mihai Suciu	

Date of approval in the department ....
September 2024

Head of Department:
Prof. Eng. MICU Dan Doru, PhD

Date of approval in the faculty ....
September 2024

Dean
Assoc. Prof.dr.Eng. Andrei CZIKER