SYLLABUS

1. Program Information

1.1 Higher education institution	Technical University of Cluj-Napoca
1.2 Faculty	Faculty of Automation and Computer Science
1.3 Department	Department of Automation
1.4 Field of study	Automation, Applied Informatics and Intelligent Systems
1.5 Cycle of studies	Bachelor
1.6 Study Programme/Qualification	TBD
1.7 Form of education	IF – full-time education
1.8 Course code	36.00

2. Course information

2.1 Course title	**Electrical machines and Drives**					
2.2 Course lecturer	*Prof.dr.ing. Horia Hedesiu - Horia.Hedesiu@emd.utcluj.ro*					
2.3 Seminar / Laboratory / Project Lecturer	*Ing. Ciprian Iakab (Emerson)*					
2.4 Year of study	3	2.5 Semester	1	2.6 Type of assessment		E
2.7 Course status	Formative category *(DF, DS, DC)*					DS
	Optionality *(DOB, DOP, DFac)*					DOB

3.Total estimated time

3.1 Number of hours per week	4	of which:	HEI	Lecture	2	Seminar	0	Laboratory	0	Project	0
			CO		0		0		2		0
3.2 Number of hours per semester	56	of which:	HEI	Lecture	28	Seminar	0	Laboratory	0	Project	
			CO		0		0		28		0

3.3 Distribution of time allocation (hours per semester) for:	HEI	CO
(a) Study based on textbook, course support, bibliography, and notes	14	14
(b) Additional documentation in library, specialized electronic platforms, and fieldwork	5	14
(c) Preparation of seminars/laboratories, assignments, papers, portfolios and essays	0	14
(d) Tutoring	0	5
(e) Examinations	3	0
(f) Other activities:	0	0
3.4 Total individual study hours (sum (3.3(a)... 3.3(f)))	22	47
3.5 Total hours per semester (3.2+3.4)	50	75
3.6 Number of credits per semester	2	3

(HEI = Higher Education Institution, CO = Company)

4. Prerequisites (where applicable)

4.1 Curriculum Prerequisites	Technical physics, electrical circuit theory, mathematical description of circuits
4.2 Competency Prerequisites	Knowledge of basic physical phenomena related to electricity

5. Conditions (where applicable)

5.1. Course Organization Conditions	Lecture room equipped with projector, whiteboard, and internet connection; access to simulation software (MATLAB/Simulink or equivalent).
5.2. Seminar / Laboratory / Project organization conditions	Access to laboratory platforms including: — Test benches for electrical machines (DC, induction, synchronous, PMSM); — Variable frequency drives (VFDs) and DC drive modules; — Power electronics converters and measurement equipment

	(oscilloscopes, multimeters, current probes); — Simulation tools for modeling drives (MATLAB/Simulink, LabVIEW).

6. Specific Competencies Acquired

Professional Competencies	• PC02 Analyse test data • PC08 Design automation components • PC10 Develop electronic test procedures • PC20 Record test data • PC25 Use technical drawing software • PC28 Use testing equipment • PC31 Use remote control equipment
Transversal Competencie s	• TC01 Apply knowledge of science, technology and engineering • TC02 Think analitically

7. Learning outcomes

Knowledge:	The student will: • Understand the operating principles, equivalent models, and characteristics of DC, induction, synchronous, and permanent magnet machines. • Describe the architecture of electric drive systems, including power converters, control strategies, and industrial applications. • Explain modern control techniques (scalar control, vector control, field-oriented control) and their applicability to different machine types. • Identify typical faults, diagnostic methods, and reliability considerations for electrical machines and drives.
Skills:	The student will be able to: • Model and simulate electrical machines and drive systems using specialized software. • Configure and operate drive systems on laboratory hardware, including power converters and measurement equipment. • Perform tests on different electrical machines, collect data, and analyze performance indicators. • Apply fault-detection procedures and evaluate drive system behavior under fault scenarios.
Responsibility and autonomy:	The student will: • Demonstrate responsible operation of electrical equipment and compliance with safety protocols. • Work independently on laboratory tasks, including experimental setup, measurement, and interpretation. • Prepare structured reports, justify technical decisions, and present results clearly. • Collaborate effectively in small teams during laboratory and project activities.

8. Course Objectives

8.1 General objective of the course	Understand and master the electric drives equipped with different types of electrical machines
8.2 Specific objectives	Ability to understand the functionalities of different electrical machines, how power electronics are attached to those and

	several control methods, particularized function of the characteristics of the drive itself.

9. Contents

9.1 Lectures	No. of hours	Teaching methods	Obs.
1 Electrical Drive Systems Architecture and Applications	2	Power Point presentations and computations	
2 Modeling and Simulation of Electrical Machines	2		
3 Advanced DC Machines and Drives	2		
4 Induction Machines and Vector Control	2		
5 Synchronous Machines and Drives	2		
6 Permanent Magnet Machines and Drives	2		
7 Special Electrical Machines	2		
8 Multiphase Machines and Drives	2		
9 Power Electronics for Electrical Drives	2		
10 Fault Diagnosis and Reliability of Electrical Drives	2		
11 Fault Tolerant Electrical Machines and Drives	2		
12 Drives for Renewable Energy Systems	2		
13 Electric and Hybrid Vehicle Drives	2		
14 Multilevel models development for Analysis of Electrical Machines	2		

Bibliography:

1. Boldea, I., Nasar, S.A., Electric machine dynamics, 1986. 3/4
2. El-Hawary, M.E. Principles of electric machines with power electronic applications, 2002.
3. Gottlieb I.M., Electric motors & control techniques, 1994.
4. GONEN, Turan, Electrical machines with MATLAB, CRC Press (272), 2012
5. Viorel, I.A., Henneberger, G., Variable reluctance electrical machines, 2001.
6. GERLING, Dieter, Electrical machines : mathematical fundamentals of machine topologies, Springer (1025), 2015
7. Claudia Marţiş, Horia Hedeşiu, Sisteme electromecanice, Mediamira, 2007

9.2 Seminar / laboratory / project	Hours HEI	Hours CO	Teaching methods	Obs.
1. Introduction, Safety, and DC Machine Testing Familiarization with drive test benches, safety procedures, DC motor modeling, open- and closed-loop control, and experimental identification of parameters.	2		Collaborative work, Template-based design, Implementation Visual modeling, Scenario setup, Execution and debug, Oral presentation and defense	
2. Induction Machine Modeling and Scalar Control (V/f) Simulation and practical characterization of induction machines; implementing and evaluating V/f control strategies on inverter-fed drives.	2			
3. **Field-Oriented Control (FOC) of Induction Machines** Modeling, setup, tuning, and testing of vector control; measuring dynamic response and performance indicators.	2			
4. **Synchronous and Permanent Magnet Machines** Modeling and operating synchronous machines; PMSM control implementation, inverter-based drives, and efficiency assessment.	2			
5. **Special Electrical Machines and Drive Configurations** Stepper and switched reluctance machine operation; analysis of control methods and characteristic behaviors.	2			
6. **Power Electronics for Drives & Fault Diagnosis** Characterization of converters (rectifiers, choppers,	2			

inverters), measurement procedures, simulation of typical electrical machine faults, and diagnostic techniques.				
7. **Applications: Renewable Energy & Electric Vehicle Drives** Drive systems for wind/solar generator emulation; EV traction drive simulation and experimental evaluation; final project presentation and defense.	2			

Bibliography:

1. Boldea, I., Nasar, S.A., Electric machine dynamics, 1986. 3/4
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3. Gottlieb I.M., Electric motors & control techniques, 1994.
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10. Correlation of course content with the expectations of the epistemic community representatives, professional associations, and major employers in the field related to the program

The course is aligned with the requirements of professional associations and industry leaders in electrical drives, automation, and energy conversion. Its content reflects the competencies expected by industrial employers such as Siemens, Emerson, ABB, Continental, and automotive companies transitioning to electric mobility. The emphasis on modeling, power electronics, and advanced control aligns with modern industrial practice, while laboratory exposure ensures graduates are prepared to work with real hardware, fault-diagnosis procedures, and renewable-energy drive systems.

11. Evaluation

Activity Type	**Evaluation criteria**	**Evaluation methods**	**Weight in final grade**
11.1 Lecture	Conceptual understanding and design formulation	Written exam	50%
11.2 Seminar/ Laboratory/Project	Practical circuit analysis, implementation, reporting	Continuous in-lab evaluation + final report	50%
11.3 Minimum Performance Standard			
• Final exam >=5 • Lab grade>=5 mandatory to be able to take the final exam **50% Final exam + 50% Lab Grade > 5**			

Date of completion:	Lecturers		Signature
	Course	*Prof.dr.ing. Horia Hedesiu*	

Date of approval by the Department of Automation Council 24.11.2025	Director of the Department of Automation Prof.dr.ing. Honoriu VĂLEAN
Date of approval by the Faculty of Automation and Computer Science Council 28.11.2025	Dean Prof.dr.ing. Vlad MUREȘAN