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	Electrical Machines and Drives
1.4	Field of study	Electrical Engineering
1.5	Cycle of study	Bachelor of Science
1.6	Program of study/ Qualification	Electrical System Cluj-Napoca in English language
1.7	Form of education	Full time
1.8	Subject code	50.00

2. Data about the subject

2.1	Subject name			Electric Traction		
2.2	Course responsible/ lecturer			Assoc. Prof. Dr. Ing. Ștefan Breban Stefan.Breban@emd.utcluj.ro		
2.3	Teachers in charge of Seminars/ Laboratory/ Project			Assoc. Prof. Dr. Ing. Ștefan Breban, Stefan.Breban@emd.utcluj.ro S.L. Dr. Ing. Sorin COSMAN, Sorin.Cosman@emd.utcluj.ro		
2.4 Year of study	IV	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	20
(b) Supplementary study in the library, online and in the field	10
(c) Preparation for seminars/laboratory works, homework, reports, portfolios, essays	24
(d) Tutoring	-
(e) Exams and tests	2.5
(f) Other activities	1.5

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	Basic knowledge in: rigid solid mechanics, theory of electrical circuits, electrical installations, transformers and electrical

		machines, electrical drives, power electronics, theory of systems and automatic control, electromagnetic compatibility
4.2	Competences	-

5. Requirements (where appropriate)

5.1	For the course	-
5.2	For the applications	-

6. **Specific competences**

Professional competences	- specific phenomena, theoretical models and calculation methods, as well as practical solutions, of current electric traction systems for urban, suburban and interurban transport; - to know the fundamental aspects related to the design, operation and operation of fixed (power supply) and mobile (vehicles) electric traction installations. - design and operation of component equipment of fixed (power supply) and mobile (actual vehicles) urban, suburban and interurban electric traction installations; - efficient use of electricity in the sustainable development of environmentally friendly public transport; - analyze and evaluate the overall performance of complex technical systems such as modern electric traction systems. - operate and maintain equipment of energy supply installations and urban, suburban and interurban electric traction vehicles; - simulation and management of the overall operation of an urban/suburban/interurban electric traction system
Cross competences	Identifying responsibilities and effectively applying the division of labor in a multidisciplinary urban/suburban/interurban transport engineering team.

7. **Discipline objectives (based on specific competencies acquired)**

7.1	General objective	Development of skills in the field of design and operation of fixed and mobile urban, suburban and interurban electric traction installations.
7.2	Specific objectives	Assimilation of knowledge regarding the specific phenomena, calculation and practical solutions of modern electric traction systems for urban, suburban and interurban transport; Obtaining the skills of operation, performance evaluation and efficient use of the component equipment of the power supply installations and electric traction vehicles for urban, suburban and interurban transport.

8. Contents

8.1. Course (Lectures)		Number of hours	Teaching methods	Additional remarks
1	General problems regarding electric traction. The development of electric traction in Romania. Recent evolution of electric	2	Interactive	

	traction		lectures using PowerPoint course materials	
2	Fixed power supply installations in urban and suburban electric traction (d.c.). Urban and suburban electric traction (DC) substations. Contact Line and Return Circuit in Urban and Suburban Electric Traction (DC)	2		
3	Fixed power supply installations in interurban railway electric traction (single-phase AC). Balancing of the single-phase electric traction load. Single-phase AC electric traction substations. Contact line and return circuit in single-phase AC electric traction.	2		
4	The Basics of Electric Motor Vehicle (EV) Dynamics	2		
5,6	VEM transmission systems equipped with rotary motors. EV support and guidance systems equipped with linear motors	4		
7,8	VEM equipped with DC traction machines and static direct voltage drives (choppers) or variable transformers. Traction mode. Electric braking mode. The Romanian electric locomotive	4		
9	VEM equipped with asynchronous traction machines and PWM inverter. Traction mode. Electric braking mode	2		
10	VEM equipped with synchronous traction machines and PWM inverter. Traction mode. Electric braking mode	2		
11	Fuel cells used to power electric vehicles	2		
12	Electrochemical batteries used to power electric vehicles	2		
13	Electric Vehicle Battery Management Systems	2		
14	Recap	2		

Bibliography

1. A. STEIMEL, 'Electric Traction – Motive Power and Energy Supply', Oldenburg Industrieverlag, Munich, 2008.
2. J.-M. ALLENBACH et al., 'Traction électrique', 2nd edition, Presses Polytechniques et Universitaires Romandes, Lausanne, 2008.
3. I. HUSAIN, 'Electric and Hybrid Vehicles: Design Fundamentals', CRC Press, 2021.

8.2. Applications (Seminar/Laboratory/Project)		Number of hours	Teaching methods	Additional remarks
1	Safety in laboratory. Modeling in Malab/Simulink of the dynamics of a vehicle's movement.	2	Laboratory testing, case studies, solving problems, technical visits	
2	Power supply of DC and AC electric traction vehicles. Case studies. Exercises. Modeling in Matlab/Simulink .	4		
3	Vehicles dynamics exercises.	1		
4	The electrical power circuit of a VEMC equipped with DC traction machine and variable transformer. Study on laboratory model.	1		
5	The electrical power circuit of an electric vehicle equipped with a three-phase asynchronous traction machine and PWM voltage inverter. Study on laboratory model.	1		
6	The electrical power circuit of an electric vehicle equipped with a three-phase synchronous traction machine and PWM voltage inverter. Study on laboratory model.	1		
7	Modeling an electrochemical battery and its management system.	2		
9	Laboratory evaluation.	2		
10	Technical visits to: Centre Recovery Station, Cluj-Napoca Tram Depot, Cluj-Napoca Trolleybus and Electric Bus Section, C.F. Cluj Depot - optional.			

Bibliography

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

The competencies acquired will be necessary for those employed as operation and maintenance engineers of road and rail, urban and interurban electric transport systems.

10. Assessment

Activity Type	10.1 Assessment criteria	10.2 Assessment methods	10.3 Weight of the final grade [%]
10.4 Course	Solving theoretical or applied topics from the course and applications.	Exam with 4-6 theoretical or applied topics from the course and applications. - duration 2.5 hours	100 %
10.5 Laboratory	Answering questions and modeling of an electrical system in Matlab/Simulink.	Questions on practical and phenomenological topics from the laboratory experiments. Evaluation of the model built in Matlab/Simulink.	100 %
10.6 Minimum standard of performance The score equivalent to the minimum grade 5/10 must be obtained for both assessments.			

Date of completion: 01.09.2024	**Holders**	**Title First Name LAST NAME**	**Signature**
	Course	Assoc. Prof. Dr. Ing. Ștefan Breban	
	Laboratory	Assoc. Prof. Dr. Ing. Ștefan Breban	
		S.L. Dr. Ing. Sorin Cosman	

Date of approval in the Department Council .....

September 2024

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

Date of approval in the Faculty Council .....

September 2024

Dean
Assoc. Prof. Dr. Andrei Cziker