SYLLABUS

1. Information about the program

1.1 Higher education institution	Universitatea Politehnica Timișoara
1.2 Faculty[1] / Department[2]	Electronics, Telecommunications and Information Technologies
1.3 Field of study (name/code[3])	Electronics, Telecommunications and Information Technologies/20.20.10
1.4 Study cycle	Master
1.5 Study program (name/code/qualification)	Automotive Electronic Systems 20.20.10/239.25

2. Information about discipline

2.1a Name of discipline/The educational classe[4]	Advances in Power Electronics Design/DS						
2.1b Name of discipline in Romanian	Tehnici avansate de proiectare în electronica de putere						
2.2 Coordinator (holder) of course activities	Prof. dr. ing. Dan Lascu						
2.3 Coordinator (holder) of applied activities[5]	Prof. dr. ing. Dan Lascu						
2.4 Year of study[6]	1	**2.5** Semester	1	**2.6** Type of evaluation	E	**2.7** Regime of discipline[7]	DOB

3. **Total estimated time** (direct activities (fully assisted), partially assisted activities and unassisted activities[8])

3.1 Number of hours fully assisted/week	4 ,of which:	course	2	seminar/laboratory/project	2		
3.1* Total number of hours fully assisted/sem.	56 ,of which:	course	28	seminar/laboratory/project	28		
3.2 Number of on-line hours fully assisted/sem	28 ,of which:	course	14	seminar/laboratory/project	14		
3.3 Number of hours partially assisted/week	,of which:	project, research		training		hours designing M.A. dissertation	
3.3* Number of hours partially assisted/ semester	,of which:	project of research		training		hours designing M.A. dissertation	
3.4 Number of hours of unassisted activities/ week	4.93 ,of which:	Additional documentation in the library, on specialized electronic platforms, and on the field	1				
		Study using a manual, course materials, bibliography and lecture notes	2				
		Preparation of seminars/ laboratories, homework, assignments, portfolios, and essays	1.93				
3.4* Total number of hours of unasssited asctivities/ semester	69 ,of which:	Additional documentation in the library, on specialized electronic platforms, and on the field	14				
		Study using a manual, course materials, bibliography and lecture notes	28				
		Preparation of seminars/ laboratories, homework, assignments, portfolios, and essays	27				
3.5 Total hrs./week[9]	8.93						
3.5* Total hrs./semester	125						
3.6 No. of credits	5						

4. **Prerequisites** (where applicable)

4.1 Curriculum	• Power Electronics, Power Supplies, Systems Modelling and Simulation, Signals and Systems, Fundamentals of Data Acquisition Systems
4.2 Learning outcomes	• Continuous Time State Space Models, Numerical Integration methods, Linear Circuit Analysis

5. **Conditions** (where applicable)

5.1 of the course	• Room with at least 35 seats with access to computers or at least to the Internet, with pre-installed Caspoc, PLECS and Matlab programs, projector, whiteboard
5.2 to conduct practical activities	• Room with at least 16 seats, 8 computers available and Internet access, with pre-installed Caspoc, PLECS and Matlab programs, projector, blackboard. Triple DC

	voltage sources, electronic loads, oscilloscopes, digital multimeters, components and breadboards, all grouped in at least 4 work points

6. **Learning outcomes** acquired through this discipline

Knowledge	• C1. The student/graduate demonstrates advanced knowledge of the categories of electronics, the principles of electricity and engineering, and the physics and mathematics required for the design and analysis of complex electronic systems. C13. The student/graduate demonstrates advanced knowledge of power electronics principles, conversion circuits, and their applications in industrial and energy systems. • C13. The student/graduate demonstrates advanced knowledge of power electronics principles, conversion circuits, and their applications in industrial and energy systems. • C14. The student/graduate explains methods and techniques for modeling power electronic systems, including the analysis of components and their interactions. • C15. The student/graduate is familiar with testing procedures and standards applicable to power electronic systems, as well as engineering solutions for performance optimization. • C3. The student/graduate is familiar with regulations and legislation concerning environmental protection and the environmental risks associated with engineering processes, as well as requirements for battery management systems and sustainable technologies.
Skills	• A2. The student/graduate conducts scientific research in electronics, developing innovative methods and solutions for circuits, semiconductors, and advanced technological applications. • A20. The student/graduate designs within the field of power electronics, developing circuits and constructive solutions that meet functional and safety requirements. • A21. The student/graduate tests power electronic systems, applying verification and performance validation procedures. • A22. The student/graduate models power electronic systems, using simulation tools and mathematical methods for optimization. • A24. The student/graduate prepares prototypes for production, developing experimental models and associated technical documentation.
Responsibility and autonomy	• RA2. The student/graduate demonstrates autonomy in leading scientific research and making complex engineering decisions, coordinating multidisciplinary technical teams. • RA3. The student/graduate ensures quality and professional ethics in the design and testing of electronic systems, in compliance with international and national regulations. • RA14. The student/graduate assumes responsibility for the quality of design and testing of power electronic systems, ensuring compliance with technical and safety standards. • RA15. The student/graduate demonstrates autonomy in modeling and implementing innovative solutions for power circuits. • RA4. The student/graduate promotes innovation and lifelong learning, integrating scientific and technological progress into research and development activities.

7. **Objectives of the discipline** (based on the grid of learning outcomes acquired)

- Mastering the synthesis of resonant converter topologies, their static and small-signal analysis using the FHA method and the EDF method. Computer-aided analysis and design
- The dual active bridge (DAB) topology. Phase shift control, triangular modulation and trapezoidal modulation. Analysis and CAD design of a DAB using the above-mentioned control techniques.

8. **Content**

8.1 Course	Number of hours	Of which online	Teaching methods

1. Switching losses in hard-switching converters	2		The course content is explained by deriving the main equations on the whiteboard, and presenting more complex schemes and simulations that accompany the theoretical considerations using multimedia means
2. Resonant converter and resonant inveters block architectures. Compatibility between the supply type and resonant tank. Compatibility between the resonant tank and output low-pass filter	2		
3.The emulated resistance corresponding to the four architectures	2		
4.The series resonant converter (SRC)	2		
5. Resonant converters analysis using the extended describing function (EDF)	2	2	
6. The state-space models of a SRC using EDF	2	2	
7. Soft-switching and hard-switching in voltage supplied single-phase bridge. Snubber circuits	2	2	
8. The extraelement theorem (EET). The reciprocity relationship	2	2	
9. The elliptical output characteristic theorem. The input impedance absolute value monotonicity theorem.	2	2	
10. The ZCS-ZVS border theorem	2	2	
11. The dual active bridge (DAB): topology, general waveforms	2	2	
12. DAB employing phase-shift modulation	2		
13. DAB employing triangular modulation			
14. DAB employing trapezoidal modulation			

Bibliography[10]

1. R. W. Erickson, D. Maksimovic, Fundamentals of Power Electronics, 3rd Edition, Springer, 2001,
2. D. Lascu, Tehnici şi circuite de corecţie activă a factorului de putere, Editura de Vest, 2004
3. Marian K. Kazimierczuk, Dariusz Czarkowski Resonant Power Converters, 2nd Edition", Wiley, 2011
4. S. Ang, A. Oliva, Power Switching Converters, 2nd edition, CRC Press, 2005
5. The MathWorks Inc., MATLAB 2025
6. Plexim, PLECS, User Manual
7. Simulation Research, Caspoc, User manual

8.2 Applied activities[11]	Number of hours	Of which online	Teaching methods
Project 1.Resonant converter analysis starting from the third order resonant tank provided - converter architecture - FHA analysis - control characteristic - EDF analysis, including small-signal model derivation - open circuit and short circuit characteristics - resonant inverter operation - converter design and validation by simulation 2. DAB employing phsa-shift/triangular/trapezoidal modulation: analysis, design and simulation	28	14	Project consisting of: - synthesis, - analysis - design - steady state simulation in PLECS and Caspoc - transfer functions derivation and PLECS verification followed by verification with the AP300 frequency response analyzer Practical implementation, in order to compare the results with the theoretical considerations

	Bibliography[12] 1. Ioana Monica Pop-Călimanu, Aurel Cireșan, Dan Lascu, DC-DC Converters – Analysis, Design, Experiments, Editura Politehnica, 2024, ISBN 978-606-35-0604-8 2. Raymond Ridley, Power Supply Design, Volume 1: Control, Ridley Engineering, 2011 3. Ridley Engineering - AP300 frequency response analyzer, user manual 4. Christiaan Nagy, The Missing Link in Educating Power Electronics for Electrical Engineers: The Universal Two Leg, Bachelor Thesis, Spring 2023, THUAS, The Netherlands 5. The MathWorks Inc., MATLAB 2025 6. Plexim, PLECS, User Manual 7. Simulation Research, Caspoc, user manual

9. Evaluation

Type of activity	**9.1** Evaluation criteria[13]	**9.2** Evaluation methods	**9.3** Share of the final grade
9.4 Course	The ability to demonstrate acquired knowledge by answering to 11 short theoretical topics and to solve 2-3 problems from the subject taught in the course	Written exam	67%
9.5 Applied activities	**S:**		
	L:		
	P: Ability to synthesize a resonant topology, analyze it with FHA and EDF, predict the main waveforms, perform the design and implementation of a low-power prototype Similar for a phase shift controlled DAB.	Review of the project report, presentation of the project by the team, highlighting the practical operation, then followed by a questions and answers session	33%
	Pr:		
	Tc-R[14]:		
9.6 Minimum performance standard (minimum amount of knowledge necessary to pass the discipline and the way in which this knowledge is verified[15]			
• Basic knowledge on resonant dc-dc converters, ability to analyze a given structure with the FHA or EDF methods • Ability to design a DAB with a control type at student choice: phase shift control, triangular or trapezoidal modulation • Verification is performed through the requirements regarding minimal answers (50%) to the exam (both theory and problems, distinct), and to the realization and presentation of the project			

Date of completion 24.09.2025	**Course coordinator** **(signature)**	**Coordinator of applied activities** **(signature)**
Head of Department **(signature)**	**Date of approval in the Faculty Council** [16] 7.10.2025	**Dean** **(signature)**