# SYLLABUS

## 1. Information about the program

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| **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

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|---|---|---|---|---|---|---|---|
| **2.1a** Name of discipline/The educational classe[4] | Automotive Systems Modelling and Design /DS | | | | | | |
| **2.1b** Name of discipline in Romanian | Modelarea și proiectarea sistemelor din industria automotive | | | | | | |
| **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 | 2 | **2.6** Type of evaluation | V | **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)

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| **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, Tustin Transform, Analog to Digital Converters |

## 5. **Conditions** (where applicable)

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| **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

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| 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.<br>• C13. The student/graduate demonstrates advanced knowledge of power electronics principles, conversion circuits, and their applications in industrial and energy systems.<br>• C14. The student/graduate explains methods and techniques for modeling power electronic systems, including the analysis of components and their interactions.<br>• C15. The student/graduate is familiar with testing procedures and standards applicable to power electronic systems, as well as engineering solutions for performance optimization.<br>• 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.<br>• A20. The student/graduate designs within the field of power electronics, developing circuits and constructive solutions that meet functional and safety requirements.<br>• A21. The student/graduate tests power electronic systems, applying verification and performance validation procedures.<br>• A22. The student/graduate models power electronic systems, using simulation tools and mathematical methods for optimization.<br>• 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.<br>• RA3. The student/graduate ensures quality and professional ethics in the design and testing of electronic systems, in compliance with international and national regulations.<br>• RA14. The student/graduate assumes responsibility for the quality of design and testing of power electronic systems, ensuring compliance with technical and safety standards.<br>• RA15. The student/graduate demonstrates autonomy in modeling and implementing innovative solutions for power circuits.<br>• 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)

- Make the students familiar to accelerated steady state calculation for periodic stiff systems
- Understanding and deepening modern control methods that ensure a quality response time: “one cycle” control and ripple-based control
- Ability to design digital controls for nonlinear and time-varying systems

8. **Content**

| **8.1** Course | Number of hours | Of which online | Teaching methods |
|---|---|---|---|

| | | | |
|---|---|---|---|
| 1. One cycle control in switching converters | 2 | | The course content is explained by deriving the main equations on the whiteboard or tablet, and presenting more complex schemes and simulations that accompany the theoretical considerations using multimedia means |
| 2. Accelerated steady-state calculation for stiff systems using the vector Newton-Raphson method | 2 | | |
| 3. Ripple-based control technique principles. Constant on time control | 2 | | |
| 4. Ripple-based control with constant off time.l | 2 | | |
| 5. Constant frequency ripple-based peak voltage control | 2 | 2 | |
| 6. Constant frequency valley voltage control | 2 | 2 | |
| 7. Digital control of switched-mode power converters. Discrete-time systems | 2 | 2 | |
| 8. The A/D conversion and the digital pulse-width modulator (DPWM). Continuous to discrete time mapping. Prewarping | 2 | 2 | |
| 9. Discrete regulators. Discrete time compensation design | 2 | 2 | |
| 10. Digital controller implementation. The cascade architecture | 2 | 2 | |
| 11. The parallel controller architecture | 2 | 2 | |
| 12. Quantization effects | 2 | | |
| 13. Stability in nonideal discrete systems | 2 | | |
| 14. Digital systems simulation | 2 | | |

Bibliography[10]


1. R. W. Erickson, D. Maksimovic, Fundamentals of Power Electronics, 3rd Edition, Springer, 2001,
2. Luca Corradini, Dragan Maksimovic, Paolo Mattavelli, Regan Zane, Digital Control of High-Frequency Switched-Mode Power Converters, Wiley, 2015
3. IEEE Transactions on Industrial Electronics and IEEE Transactions on Power Electronics colection
4. The MathWorks Inc., MATLAB 2025
5. Plexim, PLECS, User Manual
6. Simulation Research, Caspoc, User manual


| **8.2** Applied activities[11] | Number of hours | Of which online | Teaching methods |
|---|---|---|---|
| Laboratory work | | | Practical work preceded by PLECS and Caspoc simulations. |
| 1. One cycle controlled buck converter | 2 | | |
| 2. Accelerated steady-state calculation of a stiff system using the vector Newton-Raphson method. Case study: the Ćuk converter | 2 | 2 | |
| 3. Integrated circuits for ripple-based control | 2 | | |
| 4. Constant on time ripple-based controlled buck converter | 2 | | |
| 5. Constant off time ripple-based controlled buck converter | 2 | 2 | |
| 6. Constant frequency peak voltage controlled buck converter | 2 | | |
| 7. Constant frequency valley voltage controlled buck converter | 2 | 2 | |
| 8. Buck converter controller using a digital compensator – simulation case study | 2 | | |
| 9. Digital cascade controller implementation | 2 | | |
| 10. Digital parallel controller implementation | 2 | 2 | |
| 11. Fully digital controlled buck converter | 2 | | |
| 12. Individual laboratory work – digital controlled boost converter using FPGA – part 1. Continous transfer functions measurements with the AP300 frequency response analyzer | 2 | 2 | |
| 13. Individual laboratory work – digital controlled boost converter using FPGA – part 2 | 2 | 2 | |

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|---|---|---|---|
| 14. Individual laboratory work – digital controlled boost converter using FPGA – part 3. Report defence | 2 | 2 | |
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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 examination | 67% |
| **9.5** Applied activities | **S:** | | |
| | **L:** Mastering the use of "one-cycle" control techniques and ripple-based control with its four versions. Ability to calculate the accelerated steady state of a rigid system. Ability to design and implement a high-performance digital controller for a 2nd order dc-dc converter. | Supervision of practical activities and checking of reports | 33% |
| | **P:** | | |
| | **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] | | | |
| • Verification is performed through the requirements regarding minimal answers (50%) to the exam (both theory and problems, distinct), and on the laboratory tests and reports | | | |

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