**Universitatea Naţională de Ştiinţă şi Tehnologie Politehnica Bucureşti**
**Facultatea de Electronică, Telecomunicaţii şi**
**Tehnologia Informaţiei**

# COURSE DESCRIPTION

## 1. Program identification information

| | |
|---|---|
| 1.1 Higher education institution | **National University of Science and Technology Politehnica Bucharest** |
| 1.2 Faculty | **Electronics, Telecommunications and Information Technology** |
| 1.3 Department | **Applied Electronics and Information Engineering** |
| 1.4 Domain of studies | Electronic Engineering, Telecommunications and Information Technology |
| 1.5 Cycle of studies | Bachelor/Undergraduate |
| 1.6 Programme of studies | Applied Electronics |

## 2. Date despre disciplină

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2.1 Course name (ro)<br>(en) | | | | Prelucrarea digitală a semnalelor<br>Digital Signal Processing | | | |
| 2.2 Course Lecturer | | | | Conf. Dr. Cristina Oprea, Conf. dr. ing. Laura Dogariu | | | |
| 2.3 Instructor for practical activities | | | | Conf. Dr. Cristina Oprea, Conf. dr. ing. Laura Dogariu | | | |
| 2.4 Year of studies | 3 | 2.5 Semester | II | 2.6. Evaluation type | E | 2.7 Course regime | Ob |
| 2.8 Course type | | D | 2.9 Course code | 04.D.06.O.510 | | 2.10 Tipul de notare | Nota |

## 3. Total estimated time (hours per semester for academic activities)

| | | | | | |
|---|---|---|---|---|---|
| 3.1 Number of hours per week | 5 | Out of which: 3.2 course | 2.00 | 3.3 seminary/laboratory | 3 |
| 3.4 Total hours in the curricula | 70.00 | Out of which: 3.5 course | 28 | 3.6 seminary/laboratory | 42 |
| Distribution of time: | | | | | hours |
| Study according to the manual, course support, bibliography and hand notes<br>Supplemental documentation (library, electronic access resources, in the field, etc)<br>Preparation for practical activities, homework, essays, portfolios, etc. | | | | | 10 |
| Tutoring | | | | | 0 |
| Examinations | | | | | 6 |
| Other activities (if any): | | | | | 0 |

| | |
|---|---|
| 3.7 Total hours of individual study | 30.00 |
| 3.8 Total hours per semester | 100 |
| 3.9 Number of ECTS credit points | 4 |

## 4. Prerequisites (if applicable) (where applicable)

| | |
|---|---|
| 4.1 Curriculum | Special Mathematics, Signals and Systems, Circuit Analysis and Synthesis, Project – Signals and Programming |
| 4.2 Results of learning | Common knowledge regarding mathematics, signals and programming. |

**5. Necessary conditions for the optimal development of teaching activities** (where applicable)

| | |
|---|---|
| 5.1 Course | The course takes place in a hall owning a videoprojector and a computer. |
| 5.2 Seminary/ Laboratory/Project | The seminar/laboratory/project activities are held in an suitable space having computers, videoprojector and adequate furniture. |

**6. General objective** *(Reffering to the teachers' intentions for students and to what the students will be thought during the course. It offers an idea on the position of course in the scientific domain, as well as the role it has for the study programme. The course topics, the justification of including the course in the currcula of the study programme, etc. will be described in a general manner)*

The current subject is studied in the domain of „Electronics engineering, Telecommunications and Information Technology", specialty „Applied Electronics (English)" (ELAen). The aim is to familiarize students with the main approaches, techniques and theories applied in the field of digital signal processing.

- Presentation of basic analysis and synthesis methods and implementation of the usual structures in digital signal processing.
- Creation of abilities to apply general knowledge concerning techniques of digital signal processing in various practical applications.
- Presentation of specific algorithms.
- Utilization of digital signal processing in diverse technical fields.
- Abilities of analysis, design and testing for specific functional blocks.
- Utilization of MATLAB programming environment for simulation of the algorithms and digital signal processing schemes.

**7. Competences** *(Proven capacity to use knowledge, aptitudes and personal, social and/or methodological abilities in work or study situations and for personal and proffesional growth. They refflect the empolyers requirements.)*

| | |
|---|---|
| **Specific Competences** | Application, in typical situations, of basic methods of signal acquisition and processing.<br>Signals characterization in time and frequency domains; The usage of simulation environments to analyze and process digital signals; Using specific methods and tools for signals analysis;<br>Application of standard and domain specific methods and tools to assess and evaluate a situation, considering the confirmed issues, and identify solutions.<br>Explanation and interpretation of the main requirements and techniques used typically in the field, using key concepts of the discipline and specific methods.<br>Building scripts in an object-oriented language, starting from specifying the requirements and up to execution, debugging and results interpretation;<br>Oral and written communication in a foreign language (English) – prove the mastery of the vocabulary in that field. |

| | |
|---|---|
| **Transversal (General) Competences** | Team work and efficient communication skills, to coordinate efforts with others to solve typical problems of medium complexity.<br>Autonomy and critical thinking – the ability to think in scientific terms, to search and analyse data independently, confirm and present solutions and conclusions.<br>Analysis and synthesis skills – can present in a concise manner the acquired knowledge.<br>Respect the academic ethic principles – cite and copyright rules.<br>Practice of emotional intelligence to solve various situations of academic / professional nature, proving selfcontained and taking objective decisions in stressful situations.<br>Adaptation to new technologies, professional and personal development, by continuous formation by using books, articles, specialized software and electronic resources in English. |

**8. Learning outcomes** *(Synthetic descriptions for what a student will be capable of doing or showing at the completion of a course. The learning outcomes reflect the student's acomplishments and to a lesser extent the teachers' intentions. The learning outcomes inform the students of what is expected from them with respect to performance and to obtain the desired grades and ECTS points. They are defined in concise terms, using verbs similar to the examples below and indicate what will be required for evaluation. The learning outcomes will be formulated so that the correlation with the competences defined in section 7 is highlighted.)*

| | |
|---|---|
| **Knowledge** | *The result of knowledge aquisition through learning. The knowledge represents the totality of facts, priciples, theories and practices for a given work or study field. They can be theoretical and/or factual.*<br>Enumerate main methods and tools used in digital signal processing.<br>Define basic notions in the field of digital signal processing.<br>Present main modern techniques used in signal analysis, signal processing, filtering and filter design.<br>Developp the ability to extend the knowledge acquired in course for applications of discrete signal processing.<br>Identify main issues related to digital signal processing and filter design.<br>Acquire basic technical skills to determine the best solutions in practical signal processing situations. |
| **Skills** | *The capacity to apply the knowledge and use the know-how for completing tasks and solving problems. The skills are described as being cognitive (requiring the use of logical, intuitive and creative thinking) or practical (implying manual dexterity and the use of methods, materials, tools and intrumentation).*<br>Select and group relevant data in a certain context.<br>Usage based on arguments of specific principles.<br>Able of productive team work.<br>Write a scientific text.<br>Verify in practice the identified solutions.<br>Solve practical applications.<br>Find suitable interpretations for causality relations.<br>Analyze and compare methods to be used in solving a specific problem.<br>Identify solutions and establish solving plans.<br>Designate conclusions for the experiments realized.<br>Scientifically argue the identified solutions |

| | |
|---|---|
| **Responsability and autonomy** | *The student's capacity to autonomously and responsably apply their knowledge and skills.*<br>Select and analyze suitable references<br>Respect principles of ethic in academia by citing the sources used.<br>Prove beeing receptive to new learning contexts.<br>Colaborate with coleagues in teaching activities.<br>Selfcontained and autonomous in organizing the learning process<br>Social responsible and actively involved in student activities<br>Understand the value of its own work in identifying solutions. |

**9. Teaching techniques** *(Student centric techniques will be considered. The means for students to participate in defining their own study path, the identification of eventual fallbacks and the remedial measures that will be adopted in those cases will be described.)*

The teaching process relies on displaying the information using a video projector (covering the communication and argumentation functions); the oral communication methods are the enunciation and the interpretation methods. Course materials include lecture notes and course presentations. Students use Matlab programming environment to simulate, test and assess independently the signal processing methods and the algorithms for filter design. The teaching materials in laboratory are the laboratory platforms.

**10. Contents**

| **COURSE** | | |
|---|---|---|
| **Chapter** | **Content** | **No. hours** |
| 1 | Digital signals and systems – review of basic concepts | 2 |
| 2 | Finite impulse response (FIR) digital filters.<br>Specific features. Linear phase FIR filters. Design by windowing method. Design by frequency domain sampling method. Design methods based on error minimization in the frequency domain | 6 |
| 3 | Infinite impulse response (IIR) digital filters.<br>Specific features of the IIR filters. Indirect design methods of the digital IIR filters: design of the analogical prototype, transformation methods of the analogical prototype in a digital filter, frequency transformations. | 5 |
| 4 | Digital filters structures.<br>Direct, transposed and lattice form realizations for FIR filters. Direct, cascade, parallel, lattice form realizations for IIR filter. Shur-Cohn criterion. | 5 |
| 5 | Multirate systems.<br>Decimation. Interpolation. Sampling rate conversion by rational factors. Equivalences in multirate circuits. Efficient realizations of the decimation and interpolation filters. Applications of the multirate systems: filter banks, sigma-delta A-D converters, transmultiplexers, subband coding | 6 |
| 6 | Fast algorithms for convolution and Discrete Fourier Transform.<br>Linear and cyclic convolutions: representations, segmentation procedures, fast algorithms. Discrete Fourier Transform-general features. Decimation-in-time Radix-2 FFT algorithm and decimation-in-frequency Radix-2 FFT algorithm. Mixed-radix algorithms, prime factor algorithm | 4 |
| | **Total:** | 28 |

**Bibliography:**
1. Oprea C. C., ”Prelucrarea digitală a semnalelor”, suport de curs electronic, https://curs.upb.ro/2021/course/view.php?id=9091
2. C.C. Oprea, L.M. Dogariu, I. Pirnog, "Digital Signal Processing. Theory and Applications", Editura Politehnica Press, ISBN 978-606-515-937-2, 2020.
3. S. Ciochină, R.M. Udrea, “Digital signal processing techniques for telecommunications”, Editura Printech, ISBN 978-606-23-0677-9, 2016.
4. C. Paleologu, M. Udrea, A. Enescu, Prelucrarea numerică a semnalelor, Îndrumar de laborator, Editura „Electronica 2000”, 2004.
5. J. Proakis, ”Digital signal processing”, Pearson, ISBN 9781292025735, 2013.
6. V. K. Ingle, J. G. Proakis, ”Digital signal processing using Matlab: A problem solving companion. 4th Edition”, Cengage Learning, 2016.

**LABORATORY**

| Crt. no. | Content | No. hours |
|---|---|---|
| 1 | Introduction. Discrete-time signals. Spectral representation. | 4 |
| 2 | Discrete systems - general properties | 4 |
| 3 | Finite impulse response digital filters | 4 |
| 4 | Infinite impulse response digital filters | 4 |
| 5 | Digital filters structures | 4 |
| 6 | Multirate systems | 4 |
| 7 | Laboratory assessment | 4 |
| | **Total:** | 28 |

**SEMINARY**

| Crt. no. | Content | No. hours |
|---|---|---|
| 1 | Discrete time signals – specific transformations | 2 |
| 2 | FIR filters design | 4 |
| 3 | IIR filters design | 2 |
| 4 | Digital filters structures | 2 |
| 5 | Multirate systems | 4 |
| | **Total:** | 14 |

**Bibliography:**

1. Oprea C. C., ”Prelucrarea digitală a semnalelor”, suport de curs electronic, https://curs.upb.ro/2021/course/view.php?id=9091
2. C.C. Oprea, L.M. Dogariu, I. Pirnog, "Digital Signal Processing. Theory and Applications", Editura Politehnica Press, ISBN 978-606-515-937-2, 2020.
3. S. Ciochină, R.M. Udrea, “Digital signal processing techniques for telecommunications”, Editura Printech, ISBN 978-606-23-0677-9, 2016.
4. C. Paleologu, M. Udrea, A. Enescu, Prelucrarea numerică a semnalelor, Îndrumar de laborator, Editura „Electronica 2000”, 2004.
5. J. Proakis, ”Digital signal processing”, Pearson, ISBN 9781292025735, 2013.
6. V. K. Ingle, J. G. Proakis, ”Digital signal processing using Matlab: A problem solving companion. 4th Edition”, Cengage Learning, 2016.

**11. Evaluation**

| Activity type | 11.1 Evaluation criteria | 11.2 Evaluation methods | 11.3 Percentage of final grade |
|---|---|---|---|
| 11.4 Course | Criteria 1 | Midterm exam | 25% |
| | Criteria 2 | Final exam | 25% |
| 11.5 Seminary/laboratory/project | Criteria for laboratory | Laboratory tests in Matlab | 30% |
| | Criteria for seminar | Test | 20% |
| 11.6 Passing conditions | | | |
| application of the adequate algorithms to solve a real simple problem of digital signal processing and the implementation of the afferent structures;<br>evaluation of the functionality for a simple solution of a digital systems design and analysis problem.<br>Acquire 50% of total number of points | | | |

**12. Corroborate the content of the course with the expectations of representatives of employers and representative professional associations in the field of the program, as well as with the current state of knowledge in the scientific field approached and practices in higher education institutions in the European Higher Education Area (EHEA)**

Accumulated competences allow the understanding of the new communication technologies and the afferent equipments. This discipline offers fundamental knowledge in the broad field of signal processing, that will be continued in the next year and in the numerous sections of master, by other courses, in specific fields, as image processing, multimedia signal processing, medical electronics applications.
This provides graduates with the appropriate skills and training requirements according to current qualifications, and a modern, high quality and competitive scientific and technical training, enabling them acquiring a working place after the graduation. The course fits therefore perfectly to the Bucharest Polytechnic University policy, considering both its content and structure, and the skills and international openness it offers to students.

| Date | Course lecturer | Instructor(s) for practical activities |
|---|---|---|
| 21.09.2026 | Conf. Dr. Cristina Oprea | Conf. Dr. Cristina Oprea |
| | | Conf. dr. ing. Laura Dogariu |

Date of department approval

Head of department

Conf. dr. ing. Bogdan Florea

**Universitatea Naţională de Ştiinţă şi Tehnologie Politehnica Bucureşti**

**Facultatea de Electronică, Telecomunicaţii şi**

**Tehnologia Informaţiei**

| Date of approval in the Faculty Council | Dean |
| --- | --- |
| 22.09.2026 | Prof. Dr. Mihnea Udrea |

