# Politehnica University of Bucharest

# Faculty of Electronics, Telecommunications and Information Technology

**COURSE DESCRIPTION**

**1. Program identification information**

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| 1.1 Higher education institution | Polytechnic University of Bucharest |
| 1.2 Faculty | Faculty of Electronics, Telecommunications and Information Technology |
| 1.3 Department | Department of Applied Electronics and Information Engineering |
| 1.4 Domain of studies | Computers and Information Technology |
| 1.5 Cycle of studies | Undergraduate |
| 1.6 Program of studies/Qualification | Information Engineering |

**2. Course identification information**

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| 2.1 Name of the course | Signal Processors (SP) |
| 2.2 Lecturer | S.L. Dr. Ing. Nita Iulian |
| 2.3 Instructor for practical activities | Dr. Ing. Sacaleanu Dragos |
| 2.4 Year of studies | IV | 2.5 Semester | I  | 2.6 Evaluation type | verification | 2.7 Course choice type | mandatory |

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

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| 3.1 Number of hours per week, out of which | 3 | 3.2 course | 2 | 3.3 practical activities | 1 |
| 3.4 Total hours in the curricula, out of which | 42 | 3.5 course | 28 | 3.6 practical activities | 14 |
| Distribution of time | hours |
| Study according to the manual, course support, bibliography and hand notes | 25 |
| Supplemental documentation (library, electronic access resources, in the field, etc) | 3 |
| Preparation for practical activities, homeworks, essays, portfolios, etc. | 5 |
| Tutoring | 0 |
| Examinations | 3 |
| Other activities | 0 |
| 3.7 Total hours of individual study | 36 |  |  |
| 3.9 Total hours per semester | 78 |  |  |
| 3. 10 Number of ECTS credit points | 3 |  |  |

**4. Prerequisites (if applicable)**

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| 4.1 curricular | • Microprocessor Architecture• Microcontrollers• Digital Signal Processing |
| 4.2 competence-based | General knowledge of digital signal processing, processor architectures, assembly language programming, embedded C and / or graphical programming in Labview |

**5. Requisites (if applicable)**

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| 5.1 for running the course | According to the rules undergraduate studies in UPB |
| 5.2 for running of the applications | Mandatory presence at laboratories (under regulation undergraduate studies in UPB). |

**6. Specific competences**

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| Professional competences | C2. The design of hardware, software and communicationsC3. Solving problems using the tools of computer science and engineeringC4. Using programming technologies and environments |
| Transversalcompetences | CT3 Demonstration of initiative and action for updating professional knowledge, economic and organizational culture |

**7. Course objectives (as implied by the grid of specific competences)**

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| 7.1 General objective of the course | Discipline familiarizes students with the basic concepts of hardware and software architecture signal processor. Such is the notion of design and use of programmable microelectronic systems made ​​with general purpose microprocessors, microcontrollers, digital signal processors, programmable circuits FPGA, ASIC circuits and use these computing architectures for implementing signal processing algorithms. |
| 4.2 Specific objectives | Studying Micro Speedy33 (National Instruments) based on digital signal processor floating point TMS320VC33 (TI) and visual application development environment LabView. Specific applications will be developed using hardware and software kits (interfaces I / O, peripherals, memory, buses) to implement signal processing algorithms (convolution, correlation, digital filtering, calculation TFD). Students will be involved both in the realization of the hardware and software. |

**8. Content**

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| 8.1 Lectures | Teaching techniques | Remarks |
| Introduction . Hardware and software features of digital signal processors . Comparisons with other microprocessors. Classification. Variants . | Teaching is based on oral exposure (covering communication function and demonstration) used oral communication methods are expository method and problem-method. Course materials are lecture notes and presentations, exercise book proposed (theoretical and practical solving using computer). | 2 |
| Fixed-point number representation in floating point. Structural and functional features . | 2 |
| Memory architecture . Types of memory. Functional features . Cache . Memory management . The concept of virtual memory. | 2 |
| Addressing data. Addressing modes . Features of addressing modes used signal processors . | 2 |
| Instruction Set . Types of instructions . Instructions specific for signal processors . Examples . | 2 |
| Control mechanisms of operation: instruction execution loops , execution interrupts , stack operation , execution jumps. | 2 |
| Test 1 | 2 |
| Introduction to DSP multicore or multiprocessor systems on chip. Architecture, performance criteria. Hardware design methodology Software.Exemple. | 4 |
| Pipelined architectures . Superscalar processors . VLIW processors . SIMD processors . In -order processors . Out -of -Order Processors . Communication between the processing elements. | 2 |
| Organization memory multiprocessor systems . Methods of accessing memory . Models of consistent data. Models of coherent cache .Designing software applications on multiprocessor systems . Forms of parallelism . Parallelization techniques . Mapping . | 2 |
| Implementation models based on BSP , API and MoC . Kahn Process Networks . Real Time Operating Systems with support for multiprocessing . | 2 |
| Test 2 | 2 |
| Bibliography:1. V. Lazarescu, Procesoare de semnal – Note de curs (2009, 2010)
2. Wayne Wolf, Ahmed Amine Jerraya, and Grant Martin, Multiprocessor System-on-Chip (MPSoC) Technology, IEEE transactions on computer-aided design of integrated circuits and systems, vol. 27, no. 10, october 2008
3. V. Lazarescu, A. Dumitras, C. Radoi, Arhitectura microprocesoarelor, UPB, 1994
4. V. Lazarescu, Prelucrarea digitala a semnalelor, Ed. Amco Press, Bucuresti, 1994
5. Sen M. Kuo, Woon-Seng S. Gan, Digital Signal Processors: Architectures, Implementations, and Applications, Ed. Prentice-Hall, 2004
6. Phil Lapsley, Jeff Bier, Amit Shoham, DSP Processor Fundamentals. Architectures and Features, Ed. IEEE Press, NY, 1996
7. Digital Signal Processing Applications with the TMS320 Family, Texas Instruments, 1990, (<http://www.ti.com>)
8. Embedded Microcontrollers and Processors - vol. I si II, Intel, 1993, (<http://www.intel.com>)
 |
| 8.2 Practical applications | Teaching techniques | Remarks |
| Lab 1. Introduction. Description for Speedy33 development kit and Labview development environment. | Teaching is based on using the projector (covering communication function and demonstration) Oral communication method used is problem-method. Students simulate, implement, test and evaluate independently the same problems using the computer software environment and development kit based on signal processor, from Texas Instruments. Educational materials are laboratory platforms, available on laboratory site. | 2 |
| Lab 2. Generating audio filters, adaptive filters. | 2 |
| Lab 3. Audio Equalizer. | 2 |
| Lab 4. Modulator AM. Audio effects: Echo and Reverb. | 2 |
| Lab 5. Image processing. | 2 |
| Lab 6. Dual Tone Multi Frequency (DTMF) system | 2 |
| Final Laboratory Examination | 2 |
| Bibliography:[www.nspg.pub.ro](http://www.nspg.pub.ro)  |

**9. Bridging the course content with the expectations of the epistemic community representatives, professional associations and employers representatives for the domain of the program**

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| Digital signal processors are available in most embedded systems. Continuous increased performance and new development of hardware and software design methods have led to a progressive professional requirements and knowledge needed to address this area.The course syllabus answer these existing requirements development and evolution, the European economy has subscribed services in the Computer and Information Technology ( CTI ). In the context of current technological advancement devices, fields concerned are virtually endless, from applications " consumer " technologies ( digital cameras, mobile terminals "smart -phone " ) , healthcare (products and technologies for the analysis and medical imaging) , the military (products and technology of " remote sensing " satellite imaging ) , the security ( surveillance and biometric systems ) , industrial Automation ( product inspection systems ) , robotics (systems human-machine interface ) and others.By the content of the course, students are trained in interdisciplinary application knowledge, methods and tools specific to computer science and engineering, conducting experiments and interpreting the results. Students are trained to use simulation environment (LabView ), dedicated systems for signal analysis (Speedy333 ) and design of basic functional blocks to implement digital signal processing algorithms(audio and images) .Through long-term partnerships that EIA Department has with leading manufacturers in this field (Microchip and ATMEL), graduates of this course are guided in their career and professional evolution by providing specific skills correlated directly with the market needs. |

**10. Evaluation**

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| Type of activity | 10.1 Evaluation criteria | 10.2 Evaluation methods | 10.3 Weight in the final mark |
| 10.4 Lectures | -knowledge of fundamental theoretical concepts;- Knowledge of the application of theory to specific problems;- Differential analysis techniques and theoretical methods. | Two multiple choice test, written examination, equal weights during the semester, supported data set at the beginning of the course, the topics cover the whole field, providing a synthesis of comparative theoretical material covering and explaining the exercises and problems of application patterns. (2 x 30%)Evaluation of each student attending classes at the lectures, homework and interactivity. (10%) | 70% |
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| 10.5 Practical applications | -Knowledge of Speedy33 National Instruments development kit, based on the TMS320 signal processor.- Knowledge of visual design environment for applications - LabView- Demonstrate the operation of a digital signal processor algorithm | Laboratory Final Examination is a practical component. Practical component is assessed by verifying the student’s solution (implementation, testing, operation) of one practical problems. |  |
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| 10.6 Minimal performance standard |
| A project integrating computer componentsEffective realization of an application using the tools of computer scienceCompletion of projects on areas of knowledgeAchieving a work of synthesis within a topical area, using sources both in Romanian and in a foreign language |

Date Lecturer Instructor for practical activities

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Date of department approval Director of Department,

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