Politehnica University of Bucharest
Faculty of Electronics, Telecommunications and Information Technology

# COURSE DESCRIPTION
# COMPUTER ARCHITECTURE

**1. Program identification information**

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| 1.1 Higher education institution | Politehnica University of Bucharest |
| 1.2 Faculty | Electronics, Telecommunications and Information Technology |
| 1.3 Department | Applied Electronics and Information Technology |
| 1.4 Domain of studies | Electronic Engineering, Telecommunications and Informational Technologies |
| 1.5 Cycle of studies | License (engineering) |
| 1.6 Program of studies/Qualification | Applied Electronics |

**2. Course identification information**

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| 2.1 Name of the course | | | | Computer Architecture | | | |
| 2.2 Lecturer | | | | Assoc. Prof. Radu Rădescu | | | |
| 2.3 Instructor for practical activities | | | | Assoc. Prof. Radu Rădescu | | | |
| 2.4 Year of studies | IV | 2.5 Semester | I | 2.6 Evaluation type | Exam | 2.7 Course choice type | Compulsory |

**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 | 2 |
| 3.4 Total hours in the curricula, out of which | 56 | 3.5 course | 28 | 3.6 practical activities | 28 |

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| Distribution of time | hours |
| Study according to the manual, course support, bibliography and hand notes | 18 |
| Supplemental documentation (library, electronic access resources, in the field, etc) | 14 |
| Preparation for practical activities, homework, essays, portfolios, etc. | 7 |
| Tutoring | 0 |
| Examinations | 3 |
| Other activities | 0 |

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| 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<br>Digital Integrated Circuits |

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| | Boolean Algebra |
| 4.2 competence-based | The main purpose of this subject is to develop the student abilities to apply the general knowledge of computer architecture in specific projects. The skill to evaluate a certain type of computer based on performance criteria and to establish the functioning conditions for a computer system in a given situation. Acquiring the necessary skills for computer systems analysis and design (principles, structure, and functioning) in order to satisfy specific requirements. |

**5. Requisites (if applicable)**

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| 5.1 for running the course | Projector, screen |
| 5.2 for running of the applications | Mandatory attending the laboratory classes (according to the license graduation regulation of the PUB) |

**6. Specific competences**

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| Professional competences | Description of the operation of a computer system, the principles of architecture of microcontrollers and general purpose microprocessors, the general principles of structured programming (C3.1); definition of concepts, principles and methods used in the fields of computer programming, high-level languages and specific CAD techniques for achieving electronic modules, microcontrollers, computer systems architecture, programmable electronics, graphics, hardware reconfigurable architectures (C4.1); the principles and methods underlying the manufacture, tuning, testing and servicing of appliances and equipment in the fields of aaplied electronics (C6.1); the use of general-purpose programming languages and application-specific microcontrollers and microprocessors; explanation of the operation of control systems (C3.2); explaining and interpreting the specific hardware and software structures requirements in the fields of computer programming, high-level languages and specific CAD techniques for achieving electronic modules, microcontrollers, computer systems architecture, programmable electronics, graphics, hardware reconfigurable architectures (C4.2); solving practical problems that include elements of specific data structures and algorithms, programming and use of microprocessors or microcontrollers (C3.3); using the appropriate performance criteria for the evaluation, including simulation, hardware and software dedicated systems, services or activities that use microcontrollers or computers of low to medium complexity (C4.4), achieving projects involving hardware (processors) and software (programming) (C3.5). |
| Transversal competences | Methodical analysis of the problems encountered in the professional activity, identifying items for which there are dedicated solutions, thus ensuring professional tasks (CT1); adaptation to new technologies, professional and personal development through training using printed documentation sources, specialized software and electronic resources in Romanian and, at least, in a foreign language (CT3). |

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

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| 7.1 General objective of the course | Several widely used typical computer architecture presentations. Study of the computer structure: central processing unit, memory, input-output devices, peripherals connection. Presentation of computer components and interaction between them at the physical level (processor, IRQ, buses), at the micro-programmed level (horizontal, vertical, mixed, nano-programming), and at the operating system level (virtual memory management). Analysis, design, exploiting, examples, and applications. |
| 4.2 Specific objectives | The detailed study of components at the physical level, micro-programmed level, and operating system level. Computer system configuration by establishing the main functioning parameters. Computer components design and dimension. Applying algorithms for managing the computer functioning at all its levels. |

**8. Content**

| 8.1 Lectures | Teaching techniques | Remarks |
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| Computer multilevel structure, brief history of machine evolution, serial and parallel computer structure, computers classification and architecture examples. The fifth generation of computing machines. The paradigm shift in system architectures: invisible and low-power computers: miniaturized, flexible, extensible, programmable systems. Hardware and software codesign. | The teaching method is based on projector use (with communication and demonstration function); oral communication models: frontal exposition and problems. Lectures support: notes and course presentation, exercises, problems, simulations and applications (theoretical and computer-based). Electronic support: course site, Easy-Learning and Moodle platforms. | 6 hours |
| Computer structure: CPU, memory, I/O devices, peripherals connection to the system. Input-output interfaces: serial, parallel and wireless. Parallel computer architectures and multiprocessors types, parallelism levels for computing systems. Examples of processors and chips in central processing units for embedded systems and systems-on-a-chip. Intel, AMD, Sun, AVR, ARM family architectures. Examples and case studies. | | 6 hours |
| Physical level: microprocessors, IRQ, buses, bus arbitration, types, families and examples of buses. Communication protocols currently used and their implementations. Performance evaluation, architectural analysis and design principles. Examples and case studies. | | 6 hours |
| Micro-programming level: examples of architectures in horizontal, vertical and hybrid format, micro-instructions, micro-commands, nano-programming. Examples and case studies. | | 4 hours |
| Operating system level: paging, page replacement policy, segmentation, segment replacement algorithms, memory management solutions. Examples and case studies. | | 4 hours |
| Computer applications in specific domains | | 2 hours |

Bibliography:


1. Radu Rădescu, *Arhitectura sistemelor de calcul* (Computer Architecture), Politehnica Press, Bucharest, 2009.
2. Radu Rădescu, *Arhitectura sistemelor de calcul – lucrări practice* (Computer Architecture – Practical Works), 3rd Edition, Politehnica Press, Bucharest, 2009.
3. Andrew Tanenbaum, Todd Austin – *Structured Computer Organization, 6th edition*, Pearson Education Inc., Prentice Hall, 2013.
4. Andrew Tanenbaum, *Organizarea structurată a calculatoarelor*, ediţia a IV-a, Editura Byblos, Bucureşti, 2004.


| 8.2 Practical applications | Teaching techniques | Remarks |
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| Benchmark methods for microprocessors.<br>Benchmark methods for buses. | Laboratory works are based on an original computer application system, integrated in the Easy-Learning e-learning online platform. Oral communication model: problems. The students independently simulate, implement, test and evaluate the same applications based on the continuous use of computer and software media. The laboratory documentation is available on the printed version of practical works guide and on the Easy-Learning e-learning online platform. | 2 hours |
| Hardware & software mechanisms of parallel processing.<br>Multithreading and CPU performance evaluation. | | 2 hours |
| RAM memory: SRAM vs. DRAM.<br>Cache memory. | | 2 hours |
| I/O transactions management.<br>Study of serial transmission. | | 2 hours |
| Synchronous and asynchronous buses.<br>Bus arbitration mechanisms. | | 2 hours |
| Horizontal and vertical micro-programming, nano-programming, virtual memory management: pagination and segmentation. | | 2 hours |
| Laboratory assessment | | 2 hours |

Bibliography:


1. Radu Rădescu, *Arhitectura sistemelor de calcul*, ediţia a IV-a, Editura Politehnica Press, Bucureşti, 2009.
2. Radu Rădescu, *Arhitectura sistemelor de calcul – lucrări practice*, ediţia a III-a, Editura Politehnica Press, Bucureşti, 2009.


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

The present course tries to set the limits of computer structure and functioning, emphasizing principles, design, operating and relational aspects involving the modern computer components. It draws the landmarks of a fundamental domain in computer engineering and sets the connection between software&hardware and technology, being addressed to future specialists and designers. The course syllabus directly answers the present requirements of developing and evolution, assumed by the European economy of Applied Electronics services in the domain of Electronic Engineering and Telecommunications. Taking into account the current progress of electronic devices, the aimed activity domains are very numerous, practical applications having a particularly diversity.

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| This way, the graduating student are provided with adequate skills for the needs in present specializations and with modern, high-quality and competitive scientific and technical background, that can allow them a quick integration after graduation. This course in very well integrated in the PUB policy, with regard to the structure and content, as well as to the skills and labor market offered to the students. |

**10. Evaluation**

| Type of activity | 10.1 Evaluation criteria | 10.2 Evaluation methods | 10.3 Weight in the final mark |
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| 10.4 Lectures | - assimilation of basic theoretical concepts;<br>- assimilation of application of theory into specific application areas;<br>- assimilation of analysis, evaluation and design methods for computer components | Final exam, four equally-weighted written tests at the end of fundamental chapters and a homework due at the term end; subjects cover the complete syllabus, supposing a synthesis of compared theoretical aspects and exercises-based applications and analysis, evaluation and design assignments. | 70% |
| 10.5 Practical applications | - assimilation of computer analysis, performance evaluation and design methods, in every involved aspect;<br>- assimilation of technology and algorithm types used in computer design and functioning;<br>- assimilation of operating modes for practical schemes and of connections between blocks at different levels: technological, physical, micro-programmed and operating systems. | Final laboratory test, involving theoretical and practical components. The theoretical component is evaluated by means of questions and exercises, and the practical component is evaluated by means of solving a practical application (analysis, design, implementation, functioning and testing). | 30% |
| 10.6 Minimal performance standard | | | |
| - modeling simple or medium-complexity real problems, involving the overall analysis of computer systems and selecting the necessary design methodology in order to solve requested specifications;<br>- design, evaluation and operational testing of a specialized hardware and software solution for a requested architectural problem and determining the performances of the resulting system. | | | |

Date,
19.10.2015

Lecturer,
Assoc. Prof. Radu Rădescu

Instructor for practical activities,
Assoc. Prof. Radu Rădescu

Date of department approval,
19.10.2015

Director of Department,
Prof. Sever Pașca