

Course Unit	Computer Architecture	Field of study	Computer Engineering
Bachelor in	Informatics Engineering	School	School of Technology and Management
Academic Year	2023/2024	Year of study	1
Type	Semestral	Semester	2
Level	1-1	ECTS credits	6.0
Code	9119-706-1201-00-23		
Workload (hours)	162	Contact hours	T 30 TP - PL 30 TC - S - E - OT - O -

T - Lectures; TP - Lectures and problem-solving; PL - Problem-solving, project or laboratory; TC - Fieldwork; S - Seminar; E - Placement; OT - Tutorial; O - Other

Name(s) of lecturer(s) José Carlos Rufino Amaro, ARNALDO ANTÓNIO PINTO PEREIRA, Gilberto Sousa Ferraz

### Learning outcomes and competences

At the end of the course unit the learner is expected to be able to:

1. understand the role of each computing system component
2. know the operating mechanism of a processor and its interaction with the other system components
3. understand the effect produced by high-level programming languages code fragments at the level of computing systems hardware
4. predict the impact that a specific hardware upgrade would produce in the entire system performance
5. size and evaluate computing systems

### Prerequisites

Before the course unit the learner is expected to be able to:

1. know the role of digital logic in the context of computing systems
2. understand the operation and the goal of small programmes written in C language

### Course contents

Introduction to computer architecture and organization. Data representation. MARIE simplified architecture. Instruction set architectures. Memory. Input/Output and storage systems. Performance measurement and optimization. Alternative architectures.

### Course contents (extended version)

1. Introduction to computer architecture and organization
  - SI and IEC units of measurement
  - main components of a computer
  - standards organizations
  - historical evolution
  - the computer level hierarchy
  - the von Neumann model
2. Data representation
  - positional numbering systems
  - conversion between different number bases
  - signed integer representation
  - floating-point representation
  - character codes
  - error detection and correction
3. Study of a simulated architecture
  - basic components of a CPU
  - basic organization of the Main Memory
  - MARIE CPU structure and organization
  - MARIE instruction set architecture
  - MARIE instruction processing
  - MARIE assembly programs
  - MARIE instructions decoding
4. Instruction set architectures
  - instruction formats
  - instruction types
  - addressing
  - instruction-level pipelining
  - CISC vs RISC
5. Memory
  - types of memory
  - the memory hierarchy
  - main memory
  - cache memory
  - virtual memory
6. Input/Output and storage systems
  - buses
  - I/O subsystem
  - I/O architectures
  - storage technologies
  - RAID schemes
7. Performance measurement and optimization
  - mathematical metrics
  - benchmarking
  - CPU performance optimization
  - Amdahl's law
8. Alternative architectures
  - Flynn's taxonomy
  - parallel systems
  - other systems

### Recommended reading

1. "The essentials of computer organization and architecture, 5th Ed. "; Linda Null, Julia Lobur; Jones and Bartlett Publishers; 2018
2. "Princípios Básicos de Arquitetura e Organização de Computadores, 2ª Edição"; Linda Null, Julia Lobur; Bookman; 2010
3. "Arquitetura de Computadores, 5ª Edição"; José Delgado, Carlos Ribeiro; FCA; 2014

**Recommended reading**

4. "Computer Organization and Design: The Hardware/Software Interface, 5th Revised Ed. "; D. A. Patterson, J. L. Hennessy; Morgan Kaufman; 2013
5. "Computer Architecture: A Quantitative Approach, 6th Ed. "; J. L. Hennessy, D. A. Patterson; Morgan Kaufman; 2017

**Teaching and learning methods**

The subject is taught by interleaving the exposition of theoretical concepts with the resolution of exercises. All documentation (slides, exercises, solutions) is provided through the IPB e-learning platform.

**Assessment methods**

1. Alternative 1 - (Regular, Student Worker) (Final)
  - Intermediate Written Test - 40% (first intermediate test (part P1))
  - Intermediate Written Test - 40% (second intermediate test (part P2))
  - Final Written Exam - 20% (first oficial exam (part P3))
2. Alternative 2 - (Regular, Student Worker) (Supplementary)
  - Final Written Exam - 100% (second oficial exam (structured in parts P1, P2 and P3; allows evaluation of any part combination))
3. Alternative 3 - (Regular, Student Worker) (Special)
  - Final Written Exam - 100% (exam with the same structure of the 2nd oficial exam and reuse of the previous grades of the 3 parts)

**Language of instruction**

1. Portuguese
2. English

**Electronic validation**

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23-02-2024	14-03-2024	16-03-2024	17-04-2024