

Curriculum Reform in Computing at the University of Alicante

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Abstract

Computing is a broad discipline that crosses the boundaries between mathematics, science, and engineering. New computing disciplines emerge over time and knowledge changes rapidly in computing. Therefore, several reports that define and update guidelines for computing curricula have appeared over the past four decades. Computing Curricula 2005 from the ACM, the AIS, and the IEEE-CS provides an overview of the different kinds of undergraduate degree programs in computing that are currently available.

Based on Computing Curricula 2005, new undergraduate degree programs on computing are being elaborated during the last few years in Spain. These undergraduate degree programs cover the following areas: Computer engineering (CE), Computer science (CS), Information systems (IS), Information technology (IT), and Software engineering (SE).

The University of Alicante is finishing the bachelor program on computing. This program has a length of four years, 60 ECTS (European Credit Transfer System) per year, and 1 ECTS is equivalent to 25 hours of lecture, laboratory, tutorials, and so on. In total, this program has duration of 6.000 hours during 4 years.

Besides, the University of Alicante is also finishing the master program. This program has a length of 1 year, 60 ECTS per year.

1. Introduction

Computing is a broad discipline that crosses the boundaries between mathematics, science, and engineering. New computing disciplines emerge over time and knowledge changes rapidly in computing. Computing consists of several fields. These computing fields are related but also quite different from each other.

In the United States, several reports that define and update guidelines for computing curricula have appeared over the past four decades. Recent efforts have targeted international participation, reflecting the need for the leading professional organizations to become truly global in scope and responsibility.

Computing Curricula 2005 (CC2005) [1] provides an overview of the different kinds of undergraduate degree programs in computing that are currently available. CC2005 summarizes the content of the various discipline-specific reports and its goal is to provide

perspective for those in academia who need to understand what the major computing disciplines are and how the respective undergraduate degree programs compare and complement each other.

Based on CC2005, new undergraduate degree programs on computing are being elaborated during the last few years in Spain. The aim of these reforms is to adapt to the European Higher Education Area (EHEA) [2], also known as the *Bologna process*.

Specifically at the University of Alicante, the new undergraduate degree programs on computing cover the following areas: Computer engineering (CE), Computer science (CS), Information systems (IS), Information technology (IT), and Software engineering (SE).

The University of Alicante is finishing the bachelor program on computing. This program has a length of four years, 60 ECTS (European Credit Transfer System) per year, and 1 ECTS is equivalent to 25 hours of lecture, laboratory, tutorials, and so on. In total, this program has duration of 6.000 hours during 4 years.

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2. Computing Curricula 2005

Computing Curricula 2005 (CC2005) is a cooperative project of the Association for Computing Machinery (ACM), the Association for Information Systems (AIS), and the Computer Society (IEEE-CS). CC2005 is oriented to higher education in the United States and Canada.

Computing Curricula Series 2005 consists of two main documents:

- *CC2005 Overview Report*: Its goal is to provide perspective for those in academia who need to understand what the major computing disciplines are and how the respective undergraduate degree programs compare and complement each other.
- *The Guide to Undergraduate Programs in Computing*: This guide offers guidance to a broader audience, including prospective students, their parents and guidance counselors, and others who have reason to care about the choices that await students who move from high school to college

The diagram in Figure 1 represents the content of Computing Curricula Series. Each of the first five sub-blocks represents a curriculum report for one of the existing computing disciplines. The sixth sub-block is a placeholder for future reports on additional computing disciplines as necessitated by the emergence of new computing disciplines.

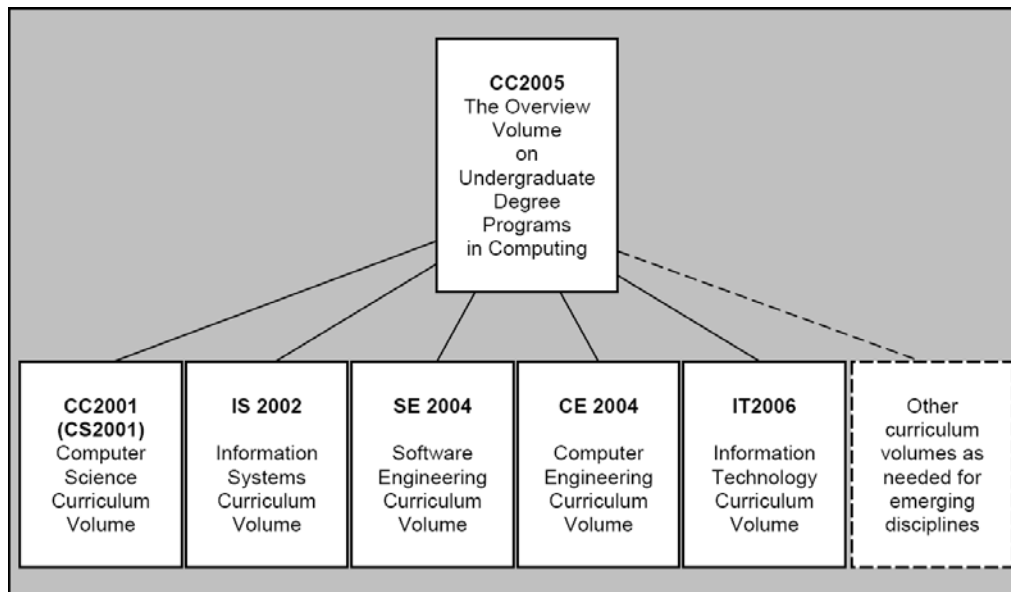


Figure 1

Nowadays, the five discipline-specific volumes that exist are:

- **Computer engineering (CE):**
 - The design and construction of computers and computer-based systems
 - It involves the study of hardware, software, communications, and the interaction among them
 - Its curriculum focuses on the theories, principles, and practices of traditional electrical engineering and mathematics and applies them to the problems of designing computers and computer-based devices
- **Computer science (CS):**
 - Theoretical and algorithmic foundations
 - Robotics
 - Computer vision
 - Intelligent systems
 - Bioinformatics
- **Information systems (IS):**
 - Its curriculum focuses on integrating information technology solutions and business processes to meet the information needs of businesses and other enterprises, enabling them to achieve their objectives in an effective, efficient way
 - It includes two main degree programs:

- Computer Information Systems: strong technology focus
 - Management Information Systems: emphasize the organizational and behavioral aspects of IS
- **Information technology (IT):**
- The professional on IT assumes responsibility for selecting hardware and software products appropriate for an organization, integrating those products with organizational needs and infrastructure, and installing, customizing, and maintaining those applications for the organization's computer users
- **Software engineering (SE):**
- A foundation in programming fundamentals and basic CS theory
 - Problem modeling and analysis
 - Software design
 - Software verification and validation
 - Software quality
 - Software process
 - Software management

3. Bachelor on Computing at the University of Alicante

At the University of Alicante, computing studies are arranged into a degree program of four years, with two semesters per academic year.

One academic year corresponds to 60 ECTS-credits (European Credit Transfer and Accumulation System) [3] that are equivalent to 1500 hours of study per academic year. Therefore, one ECTS-credit is equal to 25 hours of study.

In total, Bachelor on Computing at the University of Alicante corresponds to 240 ECTS-credits or 6.000 hours of study.

The degree program is structured in the following modules:

- Fundamentals: 60 ECTS
- Common of computing: 108 ECTS
- Specific (Computer Engineering, Computer Science, Information Systems, Information Technology, and Software Engineering): 48 ECTS
- Professional training or English: 12 ECTS

- Final project: 12 ECTS

All the subjects of the modules correspond to 6 ECTS-credits. In the following, the subjects of Fundamentals and Common of computing are shown. The official name of the subject in Spanish is written between brackets.

Fundamentals is composed of 10 subjects structured into three semesters:

- First semester:
 - Mathematics 1 (*Matemáticas 1*)
 - Physics Fundamentals of Computing (*Fundamentos Físicos de la Informática*)
 - Programming 1 (*Programación 1*)
 - Fundamentals of Computers (*Fundamentos de los Computadores*)
 - Information Systems and Technologies (*Sistemas y Tecnologías de Información*)
- Second semester:
 - Mathematics 2 (*Matemáticas 2*)
 - Discrete Mathematics (*Matemática Discreta*)
 - Programming 2 (*Programación 2*)
 - Fundamentals of Databases (*Fundamentos de las Bases de Datos*)
- Third semester:
 - Statistics (*Estadística*)

Common of computing is composed of 18 subjects:

- Computer Structures (*Estructura de los Computadores*)
- Computer Architecture (*Arquitectura de los Computadores*)
- Computer Engineering (*Ingeniería de los Computadores*)
- Programming and Data Structures (*Programación y Estructuras de Datos*)
- Programming 3 (*Programación 3*)
- Design of Databases (*Diseño de Bases de Datos*)
- Operating Systems (*Sistemas Operativos*)

- Computer Networks (*Redes de Computadores*)
- Administration of Operating Systems and Computer Networks (*Administración de Sistemas Operativos y de Redes de Computadores*)
- Languages and Programming Paradigms (*Lenguajes y Paradigmas de Programación*)
- Analysis and Design of Algorithms (*Análisis y Diseño de Algoritmos*)
- Advanced Tools for Application Development (*Herramientas Avanzadas para el Desarrollo de Aplicaciones*)
- Distributed Systems (*Sistemas Distribuidos*)
- Analysis and Specification of Software Systems (*Análisis y Especificación de Sistemas Software*)
- Intelligent Systems (*Sistemas Inteligentes*)
- Design of Software Systems (*Diseño de Sistemas Software*)
- Planning and Validation of Software Systems (*Planificación y Pruebas de Sistemas Software*)
- Software Projects Management (*Gestión de Proyectos Informáticos*)

In the following, the subjects of the five specific modules are shown. The official name of the subject in Spanish is written between brackets.

3.1 Computer Engineering

- Real-time Systems (*Sistemas de Tiempo Real*)
- Concurrent Programming (*Programación Concurrente*)
- Computer and Network Maintenance Engineering (*Ingeniería de Mantenimiento de Computadores y Redes*)
- Home Automation and Intelligent Environments (*Domótica y Entornos Inteligentes*)
- Embedded Systems (*Sistemas Embebidos*)
- Industrial Systems (*Sistemas Industriales*)
- Software Development for Parallel Architectures (*Desarrollo de Software en Arquitecturas Paralelas*)
- Automation and Robotics (*Automatización y Robótica*)

3.2 Computer Science

- Computability (*Teoría de la Computación*)
- Artificial Vision and Robotics (*Visión Artificial y Robótica*)
- Automatic Reasoning (*Razonamiento Automático*)
- Interactive Graphic Systems (*Sistemas Gráficos Interactivos*)
- Programming Challenges (*Desafíos de Programación*)
- Language Processing (*Procesamiento de Lenguajes*)
- Use of Information (*Explotación de la Información*)
- Architecture and Technology of Robots (*Tecnología y Arquitectura Robótica*)

3.3 Information Systems

- Data Processing for Information Systems (*Tratamiento de Datos para Sistemas de Información*)
- Technology Scenarios in Organizations (*Escenarios Tecnológicos en las Organizaciones*)
- Information Management (*Gestión de la Información*)
- Requirements Engineering (*Ingeniería de Requisitos*)
- Business Intelligence and Process Management (*Inteligencia de Negocio y Gestión de Procesos*)
- Integration of Applications and Business Processes (*Integración de Aplicaciones y Procesos Empresariales*)
- Electronic Business Management (*Administración de Negocio Electrónico*)
- Business Management (*Administración de Empresas*)

3.4 Information Technology

- Security Strategies (*Estrategias de Seguridad*)
- Management and Government of Information Technologies (*Gestión y Gobierno de las Tecnologías de la Información*)

- Application Development in Internet (*Desarrollo de Aplicaciones en Internet*)
- Content and Users Web Management Systems (*Sistemas de Gestión de Contenidos y de Usuarios en la Web*)
- Management and Implementation of Computer Networks (*Gestión e Implantación de Redes de Computadores*)
- Administration and Implementation of Internet Services (*Administración e Implantación de Servicios en Internet*)
- Databases Administration and Management (*Administración y Gestión de Bases de Datos*)
- Network Interconnection (*Interconexión de Redes*)

3.5 Software Engineering

- Agile Methods of Software Development (*Metodologías Ágiles de Desarrollo de Software*)
- Security in Software Design (*Seguridad en el Diseño de Software*)
- Distributed Applications in Internet (*Aplicaciones Distribuidas en Internet*)
- Advanced Techniques of Software Specification (*Técnicas Avanzadas de Especificación Software*)
- Software Quality Assurance (*Gestión de Calidad Software*)
- Collaborative Development of Applications (*Desarrollo Colaborativo de Aplicaciones*)
- Web Engineering (*Ingeniería Web*)
- Methods and Technologies of System Integration (*Metodologías y Tecnologías de Integración de Sistemas*)

4. References

[1] Computing Curricula 2005 - The Overview Report. ACM and the IEEE Computer Society, 2005.

[2] European Higher Education Area. Wikipedia. Internet:
http://en.wikipedia.org/wiki/European_Higher_Education_Area

[3] European Credit Transfer and Accumulation System. Wikipedia. Internet:
http://en.wikipedia.org/wiki/European_Credit_Transfer_and_Accumulation_System