Universidad de Alcalá

# TEACHING GUIDE

# Fundamentals of Computer Technology

## Bachelor's Degree on:
## Computer Science
## Computer Engineering

## Universidad de Alcalá

**Academic year 2019/2020**

**1st year – 1st semester**

# TEACHING GUIDE

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| Subject name: | Fundamentals of Computer Technology |
| Code: | 780002 |
| Degrees: | Bachelor's Degree on Computer Science<br>Bachelor's Degree on Computer Engineering |
| Department and area: | Computer Engineering Department. Computer Architecture and Technology area |
| Type: | Basic |
| ECTS credits: | 6 |
| Course and term: | 1st year, 1st semester |
| Teaching staff: | Álvaro Perales Eceiza |
| Language: | Spanish/English |

## 1. COURSE SUMMARY

The subject Fundamentals of Computer Technology is a six credits course taught in the first year of the Grades on Computer Science, Computer Engineering and Information Systems.

The fundamental goal of the course is to understand the basic level operation of a computer. For this purpose, the processing of binary data (bits) at different levels of abstraction is studied, from logic gates to basic electronic devices, with an introduction to the functional units at architectural level.

Therefore, it implies an essential learning for students regardless of their professional profile, and its contents have a close relationship with many other subjects in the curriculum.

Finally, it is important to note that the technology used in manufacturing today's computers is subject to continuous development and involves intensive research throughout the world, particularly by large companies that build microprocessors. This course also gives an overview of possible future technologies (optical computing, quantum computing, etc.)

## 2. COMPETENCES

## General skills:

CG1 Ability to conceive, write, organize, plan, develop and sign projects in the field of computer engineering whose purpose, according to the knowledge acquired as provided in paragraph 5 of resolution BOE-A-2009-12977 the design, development or exploitation of systems, services and applications.

CG4 Ability to define, evaluate and select hardware and software platforms for the development and implementation of systems, services and applications, according to the knowledge acquired as provided in paragraph 5 of resolution BOE-A-2009-12977.

CG8 Knowledge of basic materials and technologies that enable learning and development of new methods and technologies, as well as to equip them with great versatility to adapt to new situations.

CG9 Ability to solve problems with initiative, decision making, autonomy and creativity. Ability to communicate and transmit knowledge and skills of the profession of Technical Engineer.

CG10Knowledge to perform measurements, calculations, assessments, appraisals, surveys, studies, reports, scheduling and similar work computer, according to the knowledge acquired as provided in paragraph 5 of resolution BOE-A-2009 -12,977.

## Specific skills:

CIB2 Understanding and mastery of basic concepts of fields and waves and electromagnetism, theory of electrical circuits, electronic circuits, physical principles of semiconductors and logic families, electronic and photonic devices and their application for solving problems of engineering.

CI9 Ability to know, understand and evaluate the structure and architecture of computers as well as the basic components that make them up.

## Learning Outcomes:

For Bachelor's Degree on **Computer Engineering**

RA1.- Explain in systems terms the fundamental characteristics and components of computer and telecommunication hardware and system software, and explain how these components interact.

RA2.- Provide an introduction to peripheral devices and their characteristics

RA3.- Understand the concepts of hardware architectures.

RA4.- To work with binary numbers, other systems of representation and their arithmetic. To perform logic functions with networks of logic gates and to simplify associated circuits.

RA5.- To analyze and design combinational logic networks. To analyze the behavior of synchronous and asynchronous machines.

RA6.- To apply the principles of design of digital systems.

RA7.- Identify some of the components of a computer. Explain von Neumann architecture organization and its main functional units. Explain the execution cycle of an instruction. Write small programs in assembly language.

For Bachelor's Degree on **Computer Science**

RA1.- To know the physical foundations of a computer system.

RA2.- To know the underlying mathematical elements in the dynamics of a computer system.

RA3.- To work with binary numbers, other systems of representation and their arithmetic. To perform logic functions with networks of logic gates and to simplify associated circuits.

RA4.- To analyze and design co mbinational logic networks. To analyze the behavior of synchronous and asynchronous machines.

RA5.- To apply digital system design principles.

## 3. CONTENTS

| Content blocks | Hours and credits |
|---|---|
| **1. Introduction**<br>• Levels of abstraction in the study of computers and relation with other subjects in the curriculum.<br>• Historical evolution of computers.<br>• Von Neumann Architecture and instruction execution.<br>• Programming languages.<br>• Performance. | • 3 theory hours<br>• 2 laboratory hours |
| **2. Bases and Numbering Systems**<br>• Pure binary, sign magnitude, 1's complement and 2's complement.<br>• Hexadecimal<br>• Arithmetics in different numbering systems. | • 5 theory hours<br>• 2 laboratory hours |

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| **3. Combinational Systems**<br>• Introduction to Digital Systems.<br>• Logical operations and logic gates.<br>• Logic functions, truth tables and simplification: Karnaugh maps.<br>• Analysis and synthesis of combinational circuits.<br>• Basic Combinational Circuits: adders, decoders, multiplexers. | • 8 theory hours<br>• 10 laboratory hours |
| **4. Sequential Systems**<br>• Latches and flip-flop. Definition and types<br>• Registers.<br>• Counters.<br>• Sequential systems design. | • 8 theory hours<br>• 10 laboratory hours |
| **5. Memory System**<br>• Memory system hierarchy<br>• Memory operation. Address, control and data buses.<br>• Types and memory technologies. | • 4 theory hours<br>• 4 laboratory hours |

## Schedule

It will be detailed in the subject website at the beginning of each course.

## 4. TEACHING LEARNING METHODOLOGIES.-FORMATIVE ACTIVITIES

Formative activities are developed in one subject with 6 ECTS credits. In the teaching-learning process, the following training activities will be used:

- Theoretical classes.
- Practical classes: problem solving.
- Practical classes: laboratory.
- Tutorials: individual and/or group.

The following training activities may be used as well:

- Individual or group assignments: realization, presentation and discussion
- Attendance to conferences, meetings and scientific discussions related to the subject.

To achieve the specified competencies, activities are distributed as follows:

- 3 theoretical credits based on lectures in which students will acquire all the required knowledge about the skills.
- 3 practical credits (of which, one third may be acquired in person and two thirds by the individual student work), by solving problems and laboratory activities in which students will complete their training to achieve the skills.

## 4.1. Credit Distribution

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|---|---|
| Number of attendance hours: | 28 hours in large group<br>28 hours in small group (problem solving and lab)<br>4 hours' exam<br>(Total 60 hours) |
| Number of hours of student's independent work: | 90 hours including assimilation of theoretical concepts, problem solving, assignment, lab preparation and tutorship |
| Total | 150 hours |

## 4.2. Methodological strategies, teaching materials and resources

The teaching strategy is based on a model of reflective learning of concepts and their application to solve exercises.

In large groups the lecture will be combined with problem solving by the teacher and by the students, with exercises and both individual and group activities.

For small groups and lab work, a participatory and active student strategy Is proposed to promote teamwork and peer learning, enriching the theory concepts and helping to verify their evolution in the teaching-learning process.

In the lab. the students will perform practices to gain skills in assembling combinational, sequential and memory systems. For that purpose, they will use specific equipment as power sources and multimeters.

Information Communication Technologies may be used to support training activities (Internet and e-mail forums, e-learning platforms, etc.)

## 5. EVALUATION: Procedures, evaluation criteria and qualification

Preferably students will be offered a system of continuous evaluation. For this purpose, the following procedures, evaluation criteria, evaluation tools and qualification criteria are established.

**Evaluation procedure.**
The annual evaluation process consists of two sessions: an ordinary call and an extraordinary call.

**1. ORDINARY CALL**

The ordinary call consists either of continuous evaluation or final evaluation.

To qualify for the final evaluation, the student must write to the Center Director in the first two weeks of the course, explaining the reasons by which he or she cannot attend to continuous evaluation. The Director must assess the circumstances cited by the student

and make a reasoned decision. After 15 days without receiving written response, the student application will be considered as estimated.

**Continuous Evaluation**
It will consist of completion and delivery of learning and assessment activities distributed throughout the semester

The theory grade will be set based on the performance in three exams during the course, each of which will represent a third of the final grade for theory.

The lab grade will be set based on the completion, submission and defense of the proposed practices. The realization in the lab of such practices is compulsory and therefore there is no final lab exam. The only way to pass the lab (and therefore the subject) is finishing properly the practices on schedule in the lab.

Students who undergo continuous evaluation and failed will not be qualified for the final evaluation of the ordinary examination.

**Final Evaluation**
Students who obtain permission from the Director of the Centre to qualify for the final evaluation will be evaluated by a single theory exam consisting of theoretical questions and exercises similar to those carried out during the course and will account for the total theory grade.

Following article 6.4 of the Learning Assessment Regulations, It is essential to overcome mandatory practices carried out during the course to pass the course. Therefore, the students who choose the final evaluation should contact the coordinators of the subject during the first two weeks of the course to set evaluating sessions during the first quarter.

## 2. EXTRAORDINARY CALL

Those students who have not passed the ordinary evaluation (either continuous or final) may attend to an extraordinary exam.

The extraordinary call will consist of two parts: theory and laboratory and such as the ordinary call, the theory will represent 60% of the grade for the course and the laboratory will represent 40% of the grade.

Students who have not passed one of the parts in the ordinary call (either theory or laboratory), can attend only that part in the extraordinary call.

Following article 6.4 of the Learning Assessment Regulations, it is essential to overcome mandatory practices carried out during the course to pass the course. Therefore, the students who have not passed the practical part of the subject should contact the coordinators of the subject during the first two weeks of the second quarter to set evaluating sessions.

**Evaluation Criteria**

The assessment of the acquisition of competencies will consider the following criteria:

CE1: Mastering of contents and basic concepts.

CE2: Application of contents in solving problems and lab practices.

CE3: Interest and motivation in the tasks and practices.

The evaluation of skills acquired in the labs will consider the following criteria:

CE4: To know how the different functional units of a computer interact with each other

CE5: To know how to use the basic lab instrumentation (multimeter, power supply, etc.) and correctly make the connections among the various components and integrated circuits.

**Evaluation tools**

1. Lab practices (PL): Design and realization of various combinational and sequential circuits.
2. Assignment (TA): The teacher may propose the realization of an assignment on a topic related to the subject and/or participation in various activities carried out inside and/or outside the classroom.
3. Evaluation tests (PE): Consisting of analyzing and solving exercises and theoretical and practical problems.
4. The final evaluation call, both ordinary and extraordinary, will be a Final Exam (PEF) consisting on solving practical and theoretical problems.
5. In the extraordinary call there will be a Final Lab Exam (PEFLAB) that could consist in theoretical and practical exercises, and in designing and implementing combinational/sequential systems and explaining them

**Qualification criteria**

The final grade for the course will consist of:

- 60% of the theory grade
- 40% of the laboratory grade

**Ordinary call, continuous evaluation**

The relationship between competencies, learning outcomes, and evaluation criteria and tools is the following:

| Competence | Learning Outcome | Evaluation criteria | Evaluation tool | Weight in grades |
|---|---|---|---|---|
| CG1, CG4, CG8, CG9, G5.10, CI9, CIB2 | Para GIC: RA1-RA7 Para GII: RA1-RA5 | CE1, CE2, CE3 | PE1/TA | 20% |
| | | | PE2 | 20% |
| | | | PE3 | 20% |
| | | CE4-CE5 | PL | 40% |

**Ordinary call, Final Evaluation**

| Competence | Learning | Evaluation | Evaluation tool | Weight in |
|---|---|---|---|---|

| | Outcome | criteria | | grades |
|---|---|---|---|---|
| CG1, CG4, CG8, CG9, G5.10, CI9, CIB2 | Para GIC: RA1-RA7 Para GII: RA1-RA5 | CE1-CE3 | PEF | 60% |
| | | CE4, CE5 | PEFLAB | 40% |

**Extraordinary call, Final Evaluation**

| Competence | Learning Outcome | Evaluation criteria | Evaluation tool | Weight in grades |
|---|---|---|---|---|
| CG1, CG4, CG8, CG9, G5.10, CI9, CIB2 | Para GIC: RA1-RA7 Para GII: RA1-RA5 | CE1-CE3 | PEF | 60% |
| | | CE4, CE5 | PEFLAB | 40% |

In order to pass the course in any of the evaluation procedures is an essential requirement to pass both theoretical part and laboratory part.

## 6. BIBLIOGRAPHY

### Basic bibliography


- Digital Fundamentals, 10th edition 2008
  Thomas Floyd. Prentice-Hall.


### Supplementary Bibliography


- Logic and Computer Design Fundamentals.
  M. Morris Mano, C. R. Kime, Pearson/Prentice-Hall 2004
- Digital Design.
  M. Morris Mano, Pearson/Prentice-Hall 2003