Universidad de Alcalá

TEACHING GUIDE

COMPUTER ARCHITECTURE AND ENGINEERING

Bachelor's Degree in Computing Engineering

Universidad de Alcalá

Academic Course 2019/2020

2nd Year – 2nd Term

Universidad de Alcalá

TEACHING GUIDE

Subject Name:	**Computer Architecture and Engineering**
Code:	**590005**
Degree:	**Computer Engineering**
Department and Area:	**Computer Engineering Dpt. (Automática)** **Arquitectura y Tecnología de Computadores**
Type:	**Obligatory of specific technology**
ECTS Credits:	**6**
Course and Term:	**2nd Year – 2nd Term**
Teaching Staff:	**Virginia Escuder Cabañas**
Tutoring hours:	**Refer to subject Webpage**
Language:	**Spanish/English**

1.b. COURSE SUMMARY

Computer Architecture and Engineering is a compulsory 6 ECTS course taught in the second year of the Degree in Computer Engineering. Its main objective is to provide a vision of the architectural aspects of computers that increase performance. It deals with parallelism and its implementation with emphasis on Pipelining and Superscalar execution It also analyses current trends in computer architecture.
To take this subject it is necessary to have successfully completed the previous course on Computer Structure and Organisation as it is a natural starting point of the current course and thus requires the skills and knowledge previously acquired on it.

2. SKILLS

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.

CG2 Ability to direct the activities under the projects in the field of information technology in accordance with the knowledge acquired as provided in paragraph 5 of resolution BOE-A-2009-12977.

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.

CG6 Ability to design and develop systems or centralized or distributed architectures integrating hardware, software and networks according to the knowledge acquired as provided in paragraph 5 of resolution BOE-A-2009-12977.

Specific skills:

CIC1 Ability to design and build digital systems, including computers, microprocessor-based systems and communications systems.

CIC3 Ability to analyze and evaluate computer architectures, including parallel and distributed platforms as well as develop and optimize software for them.

Learning Outcomes

RA1: Distinguish the essential characteristics of the architecture of processors that implement parallelism at different levels

RA2: Organize a simple channelized processing by providing a computer with the necessary structural elements and calculate its performance

RA3: Discriminate the different risks that occur in channel segmentation. Determine the situations in which there are "stoppages" loss cycles and what are the techniques applied to mitigate their effects. Obtain quantitative estimation of these improvements.

RA4: Know the different types of data and control dependencies that a program can present and know the static and dynamic techniques existing in compilers and processors for its treatment. Obtain quantitative estimation of these improvements.

RA5: Understand the basics of superscalar, vector and other parallel architectures

3. CONTENTS

1. Introduction to parallelism.
   - Need for parallel processing.
   - Computer performance.
   - Types of parallelism Classification.
2. Segmentation.
   - Concepts and requirements of Segmentation.
   - CISC / RISC instruction sets and their influence on segmentation
   - Structural requirements Harvard architecture
   - Estimation of benefits
3. Segmentation Hazards
   - Types of Hazards. Alternatives.
   - Detection of pipeline stalls and cycle losses
   - Static instruction planning.
   - Data dependencies
   - Unrolling of loops
   - Static and dynamic branch prediction techniques
4. Parallel architectures.
   - VLIW and Superscalar processors
   - Programming on parallel architecturers
   - Trends in parallel computing

Cronogram

Units (chapters shall be specified if necessary)	Number of lessons, credits or hours	**Units** (chapters shall be specified if necessary)
Introduction to paralellism	• Unit 1	• 4 h
Segmentation	• Unit 2	• 18 h
Segmentation Hazards	• Unit 3	• 26 h
Parallel Architectures	• Unit 4	• 12 h

4. LEARNING METHODOLOGY

The training activities comprise 6 ECTS credits. In the teaching-learning process of the contents, the following training activities will be used:

- Theoretical classes.
- Practical classes: problem solving.
- Practical classes: laboratory activities.
- Individual and / or group tutorials.

In addition, the following training activities, among others, may be used:

- Individual or group work: realization, exhibition and debate.
- Attendance at conferences, meetings or scientific discussions related to the subject.

So that the student can reach the indicated competences, the activities in this matter are distributed in the following way:

- 3 theoretical credits, based on lectures by the faculty and exposure and discussion of work by students.
- 3 practical credits, by solving problems and laboratory activities, in which the student will complete his training to reach the established competences.

In all cases, Information and Communication Technologies may be used to support training activities (search for information on the Internet, participation in forums and use of the materials available on teletraining platforms, etc.).

4.1. Credits distribution

Number of on-site hours:	Theory 28 hours + Lab/practical exercises 28 hours + 4 hours of assessment
Number of hours for individual student work:	90
Total hours:	150

4.2. Strategies, methods, materials and learning resources

Classes	• Theoretical classes • Resolution of practical cases • Partial tests • Presentations of the students • Questions and clarifications at the initiative of the students
Self work	• Study and individual work • Performing exercises • Participation in activities
Tutoring	The tutorials may be in groups or individuals. During the same, students will ask the teacher specific questions related to the subject.

The materials for the preparation of the face-to-face sessions and of the autonomous work, as well as the activities to be carried out, will be available on the webpage of the subject. The specific address of this page and all the information on the development of the subject, regulations, evaluation criteria, plagiarism policy, etc., will be detailed in the presentation class.

5. ASSESSMENT: Procedures and assessment and grading criteria

5.1. Procedures

The evaluation can be done continuously or through a final evaluation, there being two calls for enrollment in each case: ordinary and extraordinary.

- **Continuous evaluation**

The continuous evaluation assesses the development of the competences throughout the learning process of the subject through a series of training tests distributed throughout the course, which allow the student to approach the subject progressively.

Guarantees early feedback in the learning process of the student and allows teachers, coordinators and other elements of the Quality Assurance System to make a global follow-up, with the possibility of acting in case of certain indicators or situations.

- **Final evaluation**
  Should be explicitly requested by the student following School Procedures.

5.2. Evaluationa criteria

Evaluation Criteria must address the extent of acquisition of skills by the student. For this purpose, the following are defined:

CE1: Domain of the contents and concepts of the subject.

CE2: Correct and substantiated resolution of problems and proposed practices.

CE3: Application of the theoretical contents to practical situations

CE4: Interest and motivation in the follow-up of classes and participation in proposed activities

CE5: Honesty, originality and authorship

5.3. Instruments of evaluation

This section specifies the instruments that will be used for the student to demonstrate the results of their learning by applying the corresponding evaluation criteria.

PEPi Partial Evaluation Tests (written or oral) distributed throughout the course in which theoretical questions and problems to be solved by the student will be proposed.

PEF A final written test that will include all the subject and whose purpose is to determine the degree of global assimilation of the same and the acquisition of the specified competences

PAA Realization of the Practices and Activities that they pose out of class, Attendance to the sessions of class and to the laboratory.

5.4. Grading criteria

This section shows the relationship between learning outcomes, criteria and assessment and rating instruments.

The student must add at least 50% of the credit points in order to pass the course. As a general criterion, it will be considered not presented to a student who performs evaluation tests for a value of less than 60% of the total.

Ordinary Call, Continuous evaluation

Skills	Learning Outcomes	Evaluation Criteria	Evaluation Instruments	Weigth
CG1, CG2, CG4, CG6, CIC1, CIC3	RA1-R5	CE1-CE3, CE5	PEP1-3	40%
	RA1-RA5	CE1-CE3, CE5	PEF	40%
	RA1 – RA4	CE1, CE4,CE5	PAA	20%

Ordinary Call, Final Evaluation

Students not following continuous assessment, will take a Final Examination which will compute for 100% of the final grade for the course. The date and hour for this event will be published by the School.

Extraordinary Call

In the extraordinary call, students who have not passed the ordinary call or had not submitted to it will take a Final Examination which will compute for 100% of the final grade for the course. The date and hour for this event will be published by the School.

5. BIBLIOGRAPHY

Basic

- Computer Architecture: A Quantitative Approach, 5ª edition, John L. Hennessy, David A. Patterson, Morgan Kaufmann, 2012.
- Arquitectura de Computadores, Julio Ortega, Mancia Anguita, Alberto Prieto Thomson-Paraninfo, 2005.

Complementary

- Parallel Computer Architecture, David E. Culler, Jaswinder P. Singh, with Anoop Gupta, Morgan Kaufmann, 1998.
- Scalable Parallel Computing, Kai Hwang, Zhiwei Xu, WCB/McGraw-Hill, 1998.
- Aho/Sethi/Lan/Ullman "*Compilers*, *principles*, *techniques, and tools*", Ed. Pearson, 2nd Edition 2007