UNIVERSIDAD DE CASTILLA - LA MANCHA
GUÍA DOCENTE

Course: COMPUTER ORGANIZATION

Type: CORE COURSE

Degree: 406 - UNDERGRADUATE DEGREE IN COMPUTER SCIENCE AND ENGINEERING (AB)

Center: 604 - SCHOOL OF COMPUTER SCIENCE AND ENGINEERING (AB)

Year: 2

Main language: Spanish

Use of additional languages:

Web site:

Code: 42311

ECTS credits: 6

Academic year: 2023-24

Group(s): 10 11 12

Duration: First semester

Second language: English

English Friendly: N

Bilingual: Y

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2. Pre-Requisites

It is convenient the student has previously passed the courses related with the Computer Engineering field included in the previous year of the degree. Specifically, these courses are "Tecnología de Computadores" and "Estructura de Computadores". Both courses provide the basic knowledge about technology and configuration of a computer-based system, which is essential to go further into these aspects during the second year of the degree.

3. Justification in the curriculum, relation to other subjects and to the profession

What is a computer? How does a computer work? How is it designed? How is it programmed? There are many questions whose answers can be found on the field of Computer Engineering (CE). CE is a field of knowledge with unique characteristics, resulting from the combination of purely technological aspects, as well as problems on organization, structure and optimization, and finally the implementation of the controlling software and its integration with other systems. Hence, in order to provide the required instruction in CE, a set of courses have been included in the Degree on Computer Science that fulfill the formative needs of new graduates.

In the first year of the degree the courses "Tecnología de Computadores" and "Estructura de Computadores" introduce the basic components of computers to the students . These components will be used as essential elements of the designs addressed by the courses of the next years. Thus, in these two courses the "bricks" to build more complex structures, in further courses of the area, are studied.

During the second year, the students have to study the course "Computer Organization, where the different alternatives to build a datapath in multicycle systems (with or without pipelining) are studied, as well as the memory system of a computer, focusing mainly on the cache and virtual memory hierarchy. These are fundamental aspects in a computer; indeed their configuration has a significant impact on computers performance.

During the third year of the degree the students study the course "Arquitectura de Computadores". This course continues directly from the knowledge acquired in the previous subject. Specifically, in this course the concepts of pipelining, introduced in the previous course, are expanded. For instance, new techniques to take advantage of the instruction level parallelism are introduced. Moreover, new architectures with the same purposes are introduced, such as superscalar processors. Finally, a broad vision of current processors is given.

With this background the student reaches the fourth year of the degree, to study the course "Computadores Avanzados". In this course the parallel computing systems based on multiple computing nodes, such as multicomputers or multiprocessors, are introduced to the students. The aspects of their structure that differentiate from the systems with only one processing node are analyzed. As an example, special attention is devoted to the networks interconnecting the multiple nodes.

Note that the course of the second year is mandatory for those students whose intention is to work designing computing systems because

understanding and controlling the basic concepts covered by this course is crucial to design even the simplest systems.

However, this course is also fundamental even for those students whose intention is not to work on the design of systems, in order to break the image of the computer as a black box that magically executes the programs. Indeed, without a deep insight into the processes carried out under the surface, the future graduate will not be able to develop or understand the mechanisms of optimization that allow, for instance, to analyze and understand the performance problems of a system. All these skills are an added value, and in fact are increasingly appreciated in almost whichever professional activity related to this area.

4. Degree competences achieved in this course

Course competences

Code	Description
BA05	Knowledge about the structure, organization, functioning, and inter connexions of digital programmes, with their application in engineering problems.
CO01	Ability to design, develop, select, and assess, applications and digital systems, guaranteeing their reliability, security, and quality, according to ethical principles and the current and common laws.
CO09	Ability to know, understand, and assess the structure and architecture of computers, and their basic components.
INS01	Analysis, synthesis, and assessment skills.
INS05	Argumentative skills to logically justify and explain decisions and opinions.
PER02	Ability to work in multidisciplinary teams.

5. Objectives or Learning Outcomes

Course learning outcomes

Description

Understanding of the principles of computer architecture.

Identification of types of data storage, understanding of their role in the hierarchic system in a computer memory, and their influence on effective latency.

Knowledge of the structure of a CPU, identification of its functioning units, and explanation of their role in the execution of instructions.

Knowledge and understanding of virtual memory management techniques, and their integration within the memory hierarchy of the computer.

Knowledge and identification of parallelism at instruction level throughout pipelining and problems linked to it.

Knowledge of assessment techniques for computer performance.

Additional outcomes

Knowledge about how a pipelined processor works. Hazards and exceptions

6. Units / Contents

Unit 1: Designing the datapath processor
- **Unit 1.1** Introduction
- **Unit 1.2** Executing an instruction
- **Unit 1.3** A first design of a processor
- **Unit 1.4** Building the datapath
- **Unit 1.5** The datapath with the control signals
- **Unit 1.6** Conclusions

Unit 2: Pipelining the datapath processor
- **Unit 2.1** Introduction
- **Unit 2.2** Datapath pipelining
- **Unit 2.3** Control of the datapath
- **Unit 2.4** Hazards of the pipelining
- **Unit 2.5** Exceptions treatment
- **Unit 2.6** Floating point instructions pipelining
- **Unit 2.7** Conclusions

Unit 3: Cache memory
- **Unit 3.1** Introduction
- **Unit 3.2** Cache basics
- **Unit 3.3** Cache design schemes
- **Unit 3.4** Improving cache performance
- **Unit 3.5** Conclusions

Unit 4: Virtual memory
- **Unit 4.1** Introduction
- **Unit 4.2** Virtual memory basics
- **Unit 4.3** Types of virtual-memory management
- **Unit 4.4** Fast translation of addresses
- **Unit 4.5** Accessing cache in virtual-memory systems
- **Unit 4.6** Conclusions

7. Activities, Units/Modules and Methodology

Training Activity	Methodology	Related Competences (only degrees before RD 822/2021)	ECTS	Hours	As	Com	Description
Class Attendance (theory) [ON-	Lectures	BA05 CO09	1.24	31	N	-	Large-group classes mix the talk of the professors with short activities to reinforce the topics explained, mainly by solving exercises. If

Activity	Method	Codes	Credits	Hours	As	Com	Description
[ON-SITE]							required by the sanitary situation, the classes may be given exclusively online.
Class Attendance (practical) [ON-SITE]	Combination of methods	BA05 CO01 CO09 INS01 INS05 PER02	0.52	13	N		Small-group classes consist in practices where simulators are used to model and evaluate both pipelined processors and memory hierarchies. If required by the sanitary situation, the practices may be given exclusively online.
Study and Exam Preparation [OFF-SITE]	Combination of methods	BA05 CO09 INS01	3.68	92	N	-	Students must study the subjects addressed in both theory and practices, and also prepare the different exams.
Laboratory practice or sessions [ON-SITE]	Assessment tests	BA05 CO09 INS05	0.06	1.5	Y	N	Practices questionnaires. If required by the sanitary situation, the practices questionnaires may be taken online.
Progress test [ON-SITE]	Assessment tests	BA05 CO09	0.06	1.5	Y	N	Theory tests for each unit. If required by the sanitary situation, the theory tests may be taken online.
Final test [ON-SITE]	Assessment tests	BA05 CO09 INS05	0.12	3	Y	Y	Final exams of the course regarding theory tests, exercises and practices. If required by the sanitary situation, the exams may be taken online.
Formative Assessment [ON-SITE]	Problem solving and exercises	BA05 CO09 INS05	0.32	8	Y	N	
Total:			**6**	**150**			
Total credits of in-class work: 2.32							**Total class time hours: 58**
Total credits of out of class work: 3.68							**Total hours of out of class work: 92**

As: Assessable training activity

Com: Training activity of compulsory overcoming (It will be essential to overcome both continuous and non-continuous assessment).

8. Evaluation criteria and Grading System

Evaluation System	Continuous assessment	Non-continuous evaluation*	Description
Theoretical exam	20.00%	25.00%	Theory tests with questions from the units of the course (ESC code in the Degree Report). The use of any device, mechanism or trick intended to allow the students copying or being copied will lead to an automatic fail of the test Trying to access remotely to any test, questionnaire, or exam, intended to be done presentially (without a previous agreement with the professor) will lead to the corresponding punishment.
Laboratory sessions	35.00%	35.00%	Questionnaires related to the practices. (Codes INF (5%) and LAB (30%) of the Degree Report). The use of any device, mechanism or trick intended to allow the students copying or being copied will lead to an automatic fail of the questionnaire. Trying to access remotely to any test, questionnaire, or exam, intended to be done presentially (without a previous agreement with the professor) will lead to the corresponding punishment.
Final test	35.00%	40.00%	Exercises related to the course topics (ESC code in the Degree Report). The use of any device, mechanism or trick intended to allow the students copying or being copied will lead to an automatic fail of the exam. Trying to access remotely to any test, questionnaire, or exam, intended to be done presentially (without a previous agreement with the professor) will lead to the corresponding punishment.
Assessment of active participation	10.00%	0.00%	
Total:	**100.00%**	**100.00%**	

According to art. 4 of the UCLM Student Evaluation Regulations, it must be provided to students who cannot regularly attend face-to-face training activities the passing of the subject, having the right (art. 12.2) to be globally graded, in 2 annual calls per subject , an ordinary and an extraordinary one (evaluating 100% of the competences).

Evaluation criteria for the final exam:

Continuous assessment:

In the ordinary convocation, there will be an exercises exam with a percentage weight of 35% over the final total mark of the subject. In addition, those students whose weighted average mark in the progress tests (i.e., the theory tests) taken during the course were lower than 4.00, must take in the ordinary convocation a theory test whose structure will be similar to the progress tests, and will have the same percentage weight (20%) in the final total mark of the

subject. Those students willing to improve their weighted average mark in the theory tests taken during the course can also take the theory test of the ordinary convocation; in theses cases, the mark of the theory part will be the one obtained in the theory test of the ordinary convocation. Similarly, those students whose weighted average mark in the practices questionnaires taken during the course were lower than 4.00, must take in the ordinary convocation a questionnaire of practices that will consist of questions from all the practices questionnaires, and will have the same percentage weight (35%) in the final total mark of the subject. Those students willing to improve their weighted average mark in the practices questionnaires taken during the course can also take the practices questionnaire of the ordinary convocation; in theses cases, the mark of the practices part will be the one obtained in the practices questionnaire of the ordinary convocation. A 10% of the final total mark of the subject corresponds to the mark obtained from the active participation in the activities developed during both the classes and laboratory sessions, consisting in exercises and theory questionnaires. A minimal mark in this active participation is not necessary to pass the course. The final mark of the ordinary convocation will be the average of the marks of the different parts of the subject (practices, theory tests, exercises, and active participation) weighted by the percentages indicated above, but it is necessary to have a minimal mark of 4.00 in the parts of theory, practices, and exercises to validate this weighted average; if the mark of theory, or practices, or exercises, were lower than 4.00, the final mark of the ordinary convocation would be a mark not higher than 4.00, even though the weighted average of the marks of theory, practices, exercises, and active participation were higher than 4.00. It is not valid to have passed any part of the subject in previous academic years, i.e., no mark of any part of the subject is saved for or from other academic years. In the case of students of the English group, all the tests, questionnaires, and exams will be done in English.

Any student may change to the non-continuous evaluation modality if he/she has not participated in evaluable activities that together account for more than 50% of the total evaluation of the subject. If a student has reached 50% of evaluable activities, he/she will be considered in continuous evaluation without the possibility of changing the evaluation mode.

By default, the student will be evaluated by continuous evaluation. If you wish to change to non-continuous evaluation, you must indicate it to the professors before the end of the academic period of the semester, using the following link: https://www.esiiab.uclm.es/alumnos/evaluacion.php.

Non-continuous evaluation:

In the ordinary convocation, there will be an exercises exam with a percentage weight of 40% over the final total mark of the subject. In addition, in the ordinary convocation there will be a theory test whose structure will be similar to the progress tests, with a percentage weight of 25% in the final total mark of the subject. In addition, in the ordinary convocation there will be a questionnaire of practices that will consist of questions from all the practices questionnaires, and will have the same percentage weight (35%) in the final total mark of the subject. The final mark of the ordinary convocation will be the average of the marks of theory, practices, and exercises, weighted by the percentages indicated above, but it is necessary to have a minimal mark of 4.00 in each one of these parts to validate this weighted average; if the mark of any of these parts were lower than 4.00, the final mark of the ordinary convocation would be a mark not higher than 4.00, even though the weighted average of the marks of the theory, practices, and exercises parts were higher than 4.00. It is not valid to have passed any part of the subject in previous academic years, i.e., no mark of any part of the subject is saved for or from other academic years. In the case of students of the English group, all the tests, questionnaires, and exams will be done in English.

Any student may change to the non-continuous evaluation modality if he/she has not participated in evaluable activities that together account for more than 50% of the total evaluation of the subject. If a student has reached 50% of evaluable activities, he/she will be considered in continuous evaluation without the possibility of changing the evaluation mode.

By default, the student will be evaluated by continuous evaluation. If you wish to change to non-continuous evaluation, you must indicate it to the professors before the end of the academic period of the semester, using the following link: https://www.esiiab.uclm.es/alumnos/evaluacion.php.

Specifications for the resit/retake exam:

Those students with a mark lower than 5.00 either in the theory test part or the exercises part in the ordinary convocation must take both parts in the retake (i.e., extraordinary) convocation, even if they had a mark higher than 5.00 in one particular part among these two parts, or even it they had a mark higher than 5.00 in the theory test part as progress tests during the course; these parts of the retake convocation will have percentage weights in the final total mark of the subject respectively of 25% the theory test part and 40% the exercises part. Those students with a mark lower than 5.00 in the practices part (either by the average of practices questionnaires taken during the course, or in the practices questionnaire of the ordinary convocation) must take a practices questionnaire in the extraordinary convocation, that will consist of questions from all the practices questionnaires, and will have the same percentage weight (35%) in the final total mark of the subject as in the ordinary convocation. The final mark of the retake (extraordinary) convocation will be the average of the marks of theory, practices, and exercises, weighted by the percentages indicated above, but it is necessary to have a minimal mark of 4.00 in in each one of these parts to validate this weighted average; if the mark of any of these parts were lower than 4.00, the final mark of the retake convocation would be a mark not higher than 4.00, even though the weighted average of the marks of the theory, practices, and exercises parts were higher than 4.00. It is not valid to have passed any part of the subject in previous academic years, i.e., no mark of any part of the subject is saved for or from other academic years. In the case of students of the English group, all the tests, questionnaires, and exams will be done in English.

Specifications for the second resit / retake exam:

In this convocation there will be a theory test part with a percentage weight of 25% over the final total mark of the subject, an exercises part with a percentage weight of 40% over the final total mark of the subject, and a practices part with a percentage weight of 35% over the final total mark of the subject. The final mark of this convocation will be the average of the marks of of theory, practices, and exercises, weighted by the percentages indicated above, but it is necessary to have a minimal mark of 4.00 in each one of these parts to validate this weighted average; if the mark of any of these parts were lower than 4.00, the final mark of this convocation would be a mark not higher than 4.00, even though the weighted average of the marks of the theory, practices, and exercises parts were higher than 4.00. It is not valid to have passed any part of the subject in previous convocations, i.e., no mark of any part is recovered from previous convocations. In the case of students of the English group, all the tests, questionnaires, and exams will be done in English.

9. Assignments, course calendar and important dates	
Not related to the syllabus/contents	
Hours	**hours**
Final test [PRESENCIAL][Assessment tests]	3

General comments about the planning: This course schedule is APPROXIMATE. It could vary throughout the academic course due to teaching needs, bank holidays, etc. A weekly schedule will be properly detailed and updated on the online platform (Virtual Campus). Note that all the lectures, practice sessions, exams and related activities performed in the bilingual groups will be entirely taught and assessed in English. Classes will be scheduled in 3 sessions of one hour and a half per week.

Unit 1 (de 4): Designing the datapath processor	
Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	2
Class Attendance (practical) [PRESENCIAL][Combination of methods]	1.5
Study and Exam Preparation [AUTÓNOMA][Combination of methods]	7.44
Laboratory practice or sessions [PRESENCIAL][Assessment tests]	.16
Progress test [PRESENCIAL][Assessment tests]	.2
Formative Assessment [PRESENCIAL][Problem solving and exercises]	2

Unit 2 (de 4): Pipelining the datapath processor	
Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	12
Class Attendance (practical) [PRESENCIAL][Combination of methods]	4.5
Study and Exam Preparation [AUTÓNOMA][Combination of methods]	36.93
Laboratory practice or sessions [PRESENCIAL][Assessment tests]	.67
Progress test [PRESENCIAL][Assessment tests]	.3
Formative Assessment [PRESENCIAL][Problem solving and exercises]	2
Unit 3 (de 4): Cache memory	
Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	10
Class Attendance (practical) [PRESENCIAL][Combination of methods]	4.5
Study and Exam Preparation [AUTÓNOMA][Combination of methods]	26.1
Laboratory practice or sessions [PRESENCIAL][Assessment tests]	.5
Progress test [PRESENCIAL][Assessment tests]	.4
Formative Assessment [PRESENCIAL][Problem solving and exercises]	2
Unit 4 (de 4): Virtual memory	
Activities	**Hours**
Class Attendance (theory) [PRESENCIAL][Lectures]	7
Class Attendance (practical) [PRESENCIAL][Combination of methods]	2.5
Study and Exam Preparation [AUTÓNOMA][Combination of methods]	21.53
Laboratory practice or sessions [PRESENCIAL][Assessment tests]	.17
Progress test [PRESENCIAL][Assessment tests]	.6
Formative Assessment [PRESENCIAL][Problem solving and exercises]	2
Global activity	
Activities	**hours**
Formative Assessment [PRESENCIAL][Problem solving and exercises]	8
Class Attendance (practical) [PRESENCIAL][Combination of methods]	13
Study and Exam Preparation [AUTÓNOMA][Combination of methods]	92
Laboratory practice or sessions [PRESENCIAL][Assessment tests]	1.5
Progress test [PRESENCIAL][Assessment tests]	1.5
Final test [PRESENCIAL][Assessment tests]	3
Class Attendance (theory) [PRESENCIAL][Lectures]	31
Total horas:	150

10. Bibliography and Sources

Author(s)	Title/Link	Publishing house	Citv	ISBN	Year	Description
David A. Patterson, John L. Hennessy	Computer Organization and Design The Hardware/Software Interface, 5th Edition	Morgan Kaufman Publishers		978-0-12-407726-3	2014	
	http://store.elsevier.com/Computer-Organization-and-Design/David-Patterson/isbn-9780124077263/					
Patterson, David A.; Hennessy, John L.	Estructura y diseño de computadores: la interfaz hardware/software	Reverté		9788429126204	2011	
	http://www.diazdesantos.es/libros/patterson-david-a-estructura-y-diseno-de-computadores-la-interfaz-hardware-software-L0001104300965.html					