Teaching Guide				
Identifying Data				2019/20
Subject (*)	High Performance Architecture		Code	614473101
Study programme	Mestrado Universitario en Computación de Altas Prestacións / High Performance Computing (Mod. Presencial)			
Descriptors				
Cycle	Period	Year	Type	Credits
Official Master's Degree	1st four-month period	First	Obligatory	6
Language	English			
Teaching method	Face-to-face			
Prerequisites				
Department	Departamento profesorado másterEnxeñaría de Computadores			
Coordinador	Doallo Biempica, Ramon	E-mail	ramon.doallo@udc.es	
Lecturers	Blanco Heras, Dora Doallo Biempica, Ramon Fernández Rivera, Francisco Touriño Dominguez, Juan Vázquez Álvarez, Álvaro	E-mail	 ramon.doallo@udc.es juan.tourino@udc.es	
Web	aula.cesga.es			
General description	In this course, the students complete their knowledge about HPC architectures, to this end, we consider modern parallel architectures both from the functional point of view to their design. Thi knowledge will facilitate the student to design correct and efficient parallel algorithms based on the architectural characteristics of the target systems. Courses related with the programming will benefited from this one.			

Study programme competences / results	
Code	Study programme competences / results
A1	CE1 - Define, evaluate and select the most appropriate architecture and software to solve a problem
A2	CE2 - Analyze and improve the performance of a given architecture or software
A3	CE3 - Know the high performance computing basic concepts
A4	CE4 - Deepen in the knowledge of different programming tools and programming languages in the field of the high performance computing
A8	CE8 - Be able to apply the acquired knowledge, capabilities and aptitudes to the profesional environment, planning, managing and evaluating project in the high performance computing field
B1	CB6 - Possess and understand the knowledge that give a baseline or opportunity to be original in the development and/or application of ideas, often in a research environment
B2	CB7 - The students have to know how to apply the acquired knowledge and their capacity to solve problems in new or hardly explored environment inside wider contexts (or multidiscipinary) related to its area of development
B3	CB8 - The students have to be able to integrate knowledge and face the complexity to make judgments from information, despite being partial and limited, includes reflexions about the social and ethical responsabilities linked to the application of their judgements and knowledge
B4	CB9 - The students have to be able to communicate their conclusions, their knowledge and the reasons that hold them to specialized and non specialized audience in a clear and unambiguous manner
B5	CB10 - The students have to possess learning skills that allows them to continue to study in a mainly self-driven or autonomous manner
B6	CG1 - Be able to search and select useful information to solve complex problems, using the bibliographic sources of the field
B7	CG2 - Elaborate adqueately and originally written essays or motivated reasonings, write planings, work projects, scientific papers and formulate reasonable hypothesis
B9	CG4 - Be able to plan and do research, development and innovation tasks in high performance computing related environments
B10	CG5 - Be able to work in teams, specially multidisciplinary, and do a proper time and people management and decision taking
C1	CT1 - Use the basic technologies of the information and computing technology field required for the professional development and the long-life learning

Learning outcomes			
Learning outcomes	Study programme competences / results		
The student will know the different types of parallel architectures and their classification.	AJ1 AJ3	BJ1 BJ5	CJ1
The student will study the basics about organization and design of a parallel architecture, both at microarchitecture level and multiprocessor systems level.	AJ2 AJ8	BJ2 BJ4 BJ6	
The student will know the design principles an main componentes of a multiprocessor system.	AJ2 AJ3 AJ8	BJ1 BJ3 BJ7 BJ9 BJ10	CJ1
The student will learn to analyse parallel architecture performance.	AJ2 AJ4 AJ8	BJ4 BJ7 BJ9	CJ1

Contents	
Topic	Sub-topic
Chapter 1. Parallel computers	- Historic introduction - Levels of parallelism: form microarchitecture to supercomputers - Classification
Chapter 2. Design of multiprocessors, multicores and manycores	- Introduction - Architecture of multiprocessors, multicores and manycores - Memory architecture
Chapter 3. Cache Coherence	- Protocols - Snooping (UMA systems) - Protocols based on directories (CC-NUMA systems)
Tema 4. Sincronización e consistencia de memoria en multiprocesadores	- Primitivas de sincronización - Soporte hardware para sincronización - Implementaciones software de sincronización - Modelos de consistencia de memoria - Comparación entre os modelos de consistencia
Chapter 5. Interconexion networks	- Types of networks - Main components - Performance - Design
Chapter 6. Distributed systems: clusters	- Introduction - Cluster architecture - Nodes - Interconnection networks - Software - Tools - Applications - Load balance
Chapter 7. Introduction to performance analysis.	- Motivation - Basic concepts - Characterization of performance issues - Architecture features related to performance

Planning				
Methodologies / tests	Competencies / Results	Teaching hours (in-person & virtual)	Student?s personal work hours	Total hours
Guest lecture / keynote speech	A1 A3 B1 B5	22	0	22
Laboratory practice	A2 A4 B2 B6 B10 C1	24	24	48
Supervised projects	A8 B3 B4 B7 B9	0	72	72
Mixed objective/subjective test	B4 B7	2	0	2
Personalized attention		6	0	6
(*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.				

Methodologies	
Methodologies	Description
Guest lecture / keynote speech	The lecturer presents contents of the subject, and asks questions to the student in order to improve learning. There can also be discussions about specific topics.
Laboratory practice	Practices and exercices are done in laboratory to support contents explained at keynote speech.
Supervised projects	Students will develop individually or joined to other students specific projects/works. It could be possible to present to the rest to the students these works.
Mixed objective/subjective test	Some questions about practice and supervised projects can be done by lecturer.

Personalized attention	
Methodologies	Description
Laboratory practice Supervised projects	Laboratory practice: Lecturer and student analyse the practices done by the student. Supervised projects: Students receive lecturer guidance about their assigned supervised projects, and the acomplishment of the scheduled goals are verified periodically.

Assessment			
Methodologies	Competencies / Results	Description	**Qualification**
Laboratory practice	A2 A4 B2 B6 B10 C1	Valórase o correcto funcionamento, a estructuración do código, e aa comprensión dos conceptos traballados. Tamén valórase a participación activa do estudante durante as sesións de prácticas.	39
Supervised projects	A8 B3 B4 B7 B9	No caso de desenvolvemento de código, valoranse os mesmos aspectos que nas prácticas. No caso de traballos escritos, valorase a capacidade de comprensión e síntesis sobre o tema proposto, e a calidade da presentación.	59
Mixed objective/subjective test	B4 B7	Tanto no caso das prácticas como dos traballos tutelados o profesor pode facer preguntas concretas aos estudantes que poden complementar a avaliación.	2

Assessment comments

Evaluation is done in a continuous way based on the supervised projects delivered by the students (60%), and practices and active participation of the students (40%)

The student can be requested to identify themselves by an official identification document in the evaluation process.

Sources of information	
Basic	Dado que se tratan de reflectir non soamente os fundamentos da arquitectura de supercomputadores senón tamén os avances máis recentes, moita da información bibliográfica consultarase en artigos publicados en revista e dispoñibles online e noutras fontes de consulta dispoñibles online. A bibliografía básica necesaria para seguir cada parte da materia a irá indicando o profesor durante as clases. Bibliografía básica. Os libros polos que se segue máis directamente partes da materia son:1. Arquitectura de Computadores, Xullo Ortega, Mancia Anguita e Alberto Prieto. Thompson. 2005.2. High Performance Cluster Computing, Rajkumar Buyya, ed., Prentice Hall PTR, 1999. ISBN 0-13-013784-7, 0-13-013785-5.
Complementary	Bibliografía complementaria. Os seguintes son libros que permiten consultar máis en profundidade algúns contidos:1. Parallel Computer Architecture, David E. Culler, Jaswinder Pal Singh e Anoop Gupta. Morgan Kaufmann Publishers. 1999.2. In Search of Clusters, 2ª ed., Gregory Pfister, Prentice Hall, 1998, ISBN: 0138997090.3. Organización e Arquitectura de Computadores (7ª edición), W. Stallings. Prentice Hall. 2007.4. Computer Architecture: a Quantitative Approach (6ª edición), John L. Hennessy e David A. Patterson. Morgan Kaufmann Publishers. 2017.

Recommendations
Subjects that it is recommended to have taken before
Subjects that are recommended to be taken simultaneously
Parallel Programming/614473102
Subjects that continue the syllabus
Heterogeneous Programming/614473103 HPC on the Cloud/614473106 Advanced Parallel Programming/614473107
Other comments

(*)The teaching guide is the document in which the URV publishes the information about all its courses. It is a public document and cannot be modified. Only in exceptional cases can it be revised by the competent agent or duly revised so that it is in line with current legislation.