UNIVERSIDADE DA CORUÑA

Teaching Guide				
Identifying Data				**2022/23**
Subject (*)	Heterogeneous Programming		**Code**	614473103
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	Spanish			
Teaching method	Hybrid			
Prerequisites				
Department	Departamento profesorado másterEnxeñaría de Computadores			
Coordinador	Amor Lopez, Margarita	**E-mail**	margarita.amor@udc.es	
Lecturers	Amor Lopez, Margarita	**E-mail**	margarita.amor@udc.es	
	González Domínguez, Jorge		jorge.gonzalezd@udc.es	
	López Vilariño, David		david.lopez.vilarino@col.udc.es	
	Pichel Campos, Juan Carlos		j.pichel@col.udc.es	
Web				
General description	Os e as estudantes adquirirán a formación básica para analizar as arquitecturas heteroxéneas con aceleradores tales como unha GPU, como alternativa aos sistemas multi-núcleo en procesadores de propósito xeral, e quedarán capacitados/as para contrastar as súas prestacións e rendemento. Adicionalmente, desenvolverán software eficiente para estas novas plataformas a través das linguaxes que xurdiron nos últimos anos para aplicacións de propósito xeral. Así, iniciarase aos e as estudantes a algunhas das aproximacións máis estendidas para a programación de sistemas heteroxéneos. Para finalizar, familiarizaremos aos e as estudante coas técnicas de optimización orientadas ás xeracións máis avanzadas dos sistemas heteroxéneos.			

Study programme competences / results	
Code	**Study programme competences / results**
A2	CE2 - Analyze and improve the performance of a given architecture or software
A4	CE4 - Deepen in the knowledge of different programming tools and programming languages in the field of the high performance computing
A5	CE5 - Analyze, design and implement efficient parallel algorithms and applications
A7	CE7 - Know the emerging technologies in the supercomputing 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
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
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**

Analyze and improve the performance of a given architecture or software	AJ2	BJ1 BJ2	CJ1
Deepen the knowledge of programming tools and different languages in the field of high performance computing	AJ4	BJ6	CJ1
Analyze, design and implement efficient parallel algorithms and applications	AJ5	BJ2	
Know the technologies and tools available for computing in distributed systems over a network	AJ7	BJ7	

Contents	
Topic	**Sub-topic**
Structure of heterogeneous CPU-GPU systems	-
Introduction to programming in CUDA	-
Architecture of usual heterogeneous systems	-
Programming models and compilers for heterogeneous systems.	-
General purpose programming in heterogeneous systems.	-
Optimizations for heterogeneous systems.	-

Planning				
Methodologies / tests	**Competencies / Results**	**Teaching hours (in-person & virtual)**	**Student?s personal work hours**	**Total hours**
Laboratory practice	A2 A4 B2	19	19	38
Supervised projects	A4 A5 B1 B2 B7 C1	4	80	84
Objective test	A7 B7	1	0	1
Guest lecture / keynote speech	B6	23	0	23
Personalized attention		4	0	4

(*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies	
Methodologies	**Description**
Laboratory practice	n the laboratory practice, problem-based learning and case studies will be conducted. An introduction to the programming of heterogeneous systems logical processor on Zynq-7000 architecture will be made with the development environment Vivado de Xilinx. The GPUs with CUDA will be programmed on the cluster of the CESGA or of the GAC-UDC; and, will be compared with other programming methods such as OpenCL. Competencies worked: A2, A4, B2
Supervised projects	consultation of bibliography, autonomous study, development of program activities, preparation of presentations and works. Competencies worked: A4, A5, B1, B2, B7, C1
Objective test	Examination on the contents of the subject that will combine theory questions with problem solving. Competencies worked: A7, B7
Guest lecture / keynote speech	The student will be informed in advance of the necessary material to read in order to correctly follow the teacher's explanation. In class, the teacher will clarify the most relevant aspects of the topic, interactively with the student. Competencies worked: B6

Personalized attention	
Methodologies	**Description**
Laboratory practice Supervised projects	Laboratory practices: Attend and resolve student doubts in relation to the practices proposed or performed in the laboratory. Tutored work: Address and resolve doubts of students in relation to the proposed tutelage.

Assessment

Methodologies	Competencies / Results	Description	Qualification
Laboratory practice	A2 A4 B2	In the laboratory sessions, the development of practical dunes is proposed. At the end of these sessions, the correct functioning of the practice, the structuring of the code and the understanding of the concepts worked through a written test are valued.	50
Supervised projects	A4 A5 B1 B2 B7 C1	The student has to solve a job where he will present a memory and the correct functioning of the work in the laboratory is valued.	30
Objective test	A7 B7	Corresponds to knowledge imparted in the lectures.	20

Assessment comments
In the second opportunity the criteria and evaluation activity are the same as in the first opportunity.   The fraudulent performance of the tests or evaluation activities, once verified, will directly imply the qualification of failure "0" in the matter in the opportunities it corresponds to you. The students with recognition of part-time dedication and academic exemption of exemption of assistance teniente exemption of attendance would follow the same criteria as the non-attendance modality.

Sources of information	
Basic	- David Kirk and Wen-mei Hwu (2016). Programming Massively Parallel Processors. Morgran Kauffmann - Ryan Kastner, Janarbek Matai, and Stephen Neuendorffer (2018). Parallel Programming for FPGAs. http://hlsbook.ucsd.edu
Complementary	- Jason Sanders (2010). CUDA by Example: An Introduction to General-Purpose GPU Programming. Addison Wesley - B. R. Gaster, L. Howes, D. R. Kaeli, P. Mistry, D. Schaa (2013). Heterogeneous Computing with OpenCL. Morgan Kaufmann - D. R. Kaeli, P. Mistry, Dana Schaa, and D. P. Zhang (2015). Heterogeneous Computing with OpenCL 2.0.. Morgan Kaufmann Publishers Inc. - L. H. Crokett, R. Elliot and M. Ederwitz (2014). The Zynq Book: Embedded Processing with the ARM Cortex-A9 on the Xilinx Zynq-7000. All Programmable SoC. Strathclyde Academic Media

Recommendations
Subjects that it is recommended to have taken before
Subjects that are recommended to be taken simultaneously
High Performance Architecture/614473101
Parallel Programming/614473102
Subjects that continue the syllabus
Advanced Parallel Programming/614473107
Other comments
It is advisable to read the assigned material for each theory class before attending it.Those students who submit papers or perform evaluation tests in a non-contact manner, may also request their dixital signature and / or a sworn statement about the authorship of the same.