UNIVERSIDADE DA CORUÑA

Teaching Guide				
Identifying Data				**2023/24**
Subject (*)	Heterogeneous Programming		**Code**	614973103
Study programme	Mestrado Universitario en Computación de Altas Prestacións / High Performance Computing (Mod. Virtual)			
Descriptors				
Cycle	**Period**	**Year**	**Type**	**Credits**
Official Master's Degree	1st four-month period	First	Obligatory	6
Language	Spanish			
Teaching method	Non-attendance			
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	
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	
Code	**Study programme competences**
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**		
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	-
Optimization techniques	-
Programming using Streams	-
Programming of heterogeneous CPU-GPU systems using OpenCL	-
Heterogeneous systems with FPGAs	-

Planning				
Methodologies / tests	**Competencies**	**Ordinary class hours**	**Student?s personal work hours**	**Total hours**
Workbook	B6	0	19	19
Objective test	A7 B7	1	0	1
Supervised projects	A4 A5 B1 B2 B7 C1	0	82	82
Laboratory practice	A2 A4 B2	2	38	40
Personalized attention		8	0	8
(*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.				

Methodologies	
Methodologies	**Description**
Workbook	Reading of teaching material, viewing videos and consulting multimedia material. Sklli worked: B6
Objective test	Examination on the contents of the subject that will combine theory questions with problem solving. Skills worked: A7, B7
Supervised projects	Consultation of bibliography, autonomous study, development of program activities, preparation of presentations and works. Competencies worked: A4, A5, B1, B2, B7, C1
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

Personalized attention	
Methodologies	**Description**
Laboratory practice	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**	**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
Objective test	A7 B7	Corresponds to knowledge imparted in the lectures.	20

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

Assessment comments

In the second opportunity the criteria and evaluation activity are the same as in the first opportunity.

Failure qualification in the call in which the fault is committed and respecting the subject in which it was committed: the student will be qualified with "suspenso" (numerical grade 0) in the corresponding call of the academic year, whether the commission of the fault occurs in the first opportunity or in the second one. For this, the student's grade will be modified in the record of the first opportunity, if necessary.

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	- B. R. Gaster, L. Howes, D. R. Kaeli, P. Mistry, D. Schaa (2013). Heterogeneous Computing with OpenCL. Morgan Kaufmann - Jason Sanders (2010). CUDA by Example: An Introduction to General-Purpose GPU Programming. Addison Wesley - 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

According to the different regulations applicable to university teaching, the gender perspective must be incorporated in this subject: - non-sexist language will be used, bibliography of authors of both sexes will be used, the intervention of male and female students in class will be encouraged.- we work will be done to identify and modify sexist prejudices and attitudes, and the environment will be influenced to modify them and promote values of respect and equality. - If situations of gender discrimination are detected, actions and measures to correct them will be proposed.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.

(*)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.