Bachelor in Physics
(Academic Year 2023-24)

Scientific Computer Laboratory		Code	800496	Year	1º	Sem.	1º
Module	Basic Core	**Topic**	Computer Science	**Character**	Basic		

	Total	Theory	Laboratory
ECTS Credits	6	1	5
Hours in to attend	70	10	60

Learning Objectives

The course aims to:

- Get to know the computer as a useful tool for numerical analysis and for experimental data analysis.
- Learn how to use computational tools for solving physics problems and illustrating mathematical concepts.
- Learn basic, general-purpose programming structures.
- Learn, program and use basic algorithms of numerical analysis.

Brief description of contents

Introduction to computer programming. Graphical representation. Application to physics problems.

Prerequisites

Only basic computer user's skills are required.

Related Subjects

Scientific computing has a global impact. Nowadays, the development of science is, in some way, linked to the development of computers.

Thus, The Scientific Computing Laboratory has an impact on almost any other subject of the Physics degree.

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Theory/Problems – Schedule and Teaching Staff

Group	Lecture Room	Day	Time	Professor	Period/ Dates	Hours	T/E	Dept.
B	7	T	13:00 – 14:00	Joaquín Recas Piorno	Full term	10	T	DACYA

Office hours				
Group	**Professor**	**Schedule**	**E-mail**	**Location**
B	Joaquín Recas Piorno	Mon 15:00-16:00 Tue 14:00-16:00 + 3 h online (email, virtual campus,...)	jrecas@fis.ucm.es	02.227

Laboratory Schedule			No. of sessions:	28
Group	**Computer Lab**	**Day - Hours**	**Remarks**	
LB1	A2	Mo 12:00-14:00 Th 13:45-16:00	Practical work is split into two sessions per week: one of two hours and another one of two and a quarter hours. There are four and a quarter hours of practical work per week. Tutorials are conducted via e-mail. Face-to-face tutorials can be requested by e-mail.	
LB2	A3			

Laboratory Teaching Staff					
Group	**Computer Lab**	**Professor**	**Hours**	**Dpt.**	**e-mail**
LB1	A2	Joaquín Recas Piorno	60	DACYA	recas@ucm.es
LB2	A3	Segundo Esteban San Román	60	DACYA	segundo@dacya.ucm.es
LB1-2	A2/A3	Shane Patrick O'Sullivan	30	FTA	shanepos@ucm.es

Syllabus

Topic 1: Introduction to scientific computing — 1 hour

- Main parts of a computer
- Computer description levels: hardware and software
- Introduction to scientific software

Topic 2: Floating-point Arithmetic — 2 hours

- Numerical representation: Integers and real numbers
- Round-off Errors. Relative errors. Error units in last place (ulps)

Topic 3: Roots (zeros) of a function — 2 hours

- Local methods for root computing
- Fundamentals of successive approximation methods.
- Convergence
- Numerical instability

Topic 4: Systems of linear algebraic equations — 2 hours

- Solving linear systems by direct methods
- Solving linear systems by iterative methods

Topic 5: Curve Fitting and Data interpolation — 2 hours

- Curve Fitting and Data interpolation fundamentals
- Global interpolation methods

● Local interpolation methods ● Least Square Regression Methods Topic 6: Differentiation and Integration ● Finite difference approximations for derivatives ● Numerical Integration ● Discrete solution for initial value problems	1 hour

Laboratory Exercises	Sessions
Exercise 1: Introduction to Matlab & GNUs Tools ● Development Environment ● Variables and operators ● Internal Functions ● Loops and conditional statements ● Creating functions and Scripts ● Graphical representation	10
Exercise 2: Roots (zeros) of a function ● Iterative methods ● Matlab functions	4
Exercise 3: Systems of linear algebraic equations ● Direct methods ● Iterative methods ● Convergence análisis	4
Exercise 4: Curve fitting and Data interpolation ● Global interpolation methods ● Local interpolation methods ● Least Square Regression Method	4
Exercise 5: Differentiation and Integration ● Finite difference approximations for derivatives ● Numerical Integration ● Discrete solution for initial value problems	4
Exercise 6: Introduction to Symbolic Computation	2

Bibliography

Recommended reading

- Lindfield GR, Penny JET. Numerical Methods Using Matlab. 4th ed. Upper Saddle River, New Jersey: Prentice Hall; 2019.
- John H. Mathews, Kurtis D. Fink (2005) Numerical Methods Using Matlab. Prentice Hall.
- Jiménez, J. (2014). *Laboratorio de Computación Científica,* e-prints-UCM. http://eprints.sim.ucm.es/21710/

Complementary reading

- Stormy Attaway, (2009). *Matlab: A practical introduction to programming and problem solving.* Ed Butterwrth-Heinemann (Elsevier)
- Dianne P. O'Leary, (2009). *Scientific Computing with case studies*. Ed. SIAM

Online Resources

The course has a dedicated page at the UCM CAMPUS VIRTUAL

Methodology
The course is mainly practical. Course Activities: ● Lectures: Theoretical presentations covering the main topics for each subject. Lectures will introduce the basic problems and methods that will be fully developed during the laboratory sessions. ● Laboratory sessions: A series of guided exercises of Matlab programming undertaken by the students. Each laboratory exercise covers one or more laboratory sessions. The student should prepare beforehand these sessions, using the laboratory exercise sheets available at CAMPUS VIRTUAL. Upon exercise completion, the student should submit to the professor a written report for assessment. ● Students may optionally undertake a project applying the methods covered in the course to some physics problem. The subject of this project must be previously agreed with the professor. During the laboratory sessions every student will have a computer available with Matlab software installed to perform his or her exercises individually. Students can attend tutorial sessions individually or in group, at the established times.

Assessment procedure		
Exams	**Weight:**	40%
There will be two examinations, one in the ordinary call and another one in the extraordinary call. The examination will include theoretical questions, problems and practical exercises with the computer, similar to those covered during the practical sessions. The exam will be performed through the CAMPUS VIRTUAL, so it may be done in a possible confinement scenario. A minimum mark of 3.5 points out of 10 in the examinations is needed to compensate with the laboratory work.		
Laboratory	**Weight:**	60%
Laboratory practical work assessments will consist of tests and exercises. They will be performed during laboratory sessions. These tests will be performed through the CAMPUS VIRTUAL, so a possible confinement scenario will not affect them. Assistance to laboratory sessions, submission of guided exercise reports in the deadline data and performing of tests and exercises are mandatory to pass the course. Only in exceptional and justified cases can the delivery of reports and tests be recovered. The assessment of Other Activities (rank 0-10) results of the mean of the test marks. Some type of weighting may be adopted according to the development of the course.		
Final Mark		
In the ordinary call the final examination (Exm) will count the 40% of the final course mark, provided the minimum examination mark has been achieved. The Other activities mark (Lab) will count 60% of the final course mark, provided the minimum examination mark has been achieved. FinalMark = 0.4 x Exm + 0.6 x Lab if Exam >= 3.5 FinalMark = Exm if Exam < 3.5 **In the extraordinary call** the final mark will be the higher of these two options: Option 1: the final examination will count the 40% of the final course mark, provided the minimum examination mark has been achieved. The laboratory mark will count 60% of the final course mark, provided the minimum examination mark has been achieved. Option 2: the final examination will count the 100%. In all the cases the realization of the laboratory practical work will be mandatory. Marks rewarded for optional coursework will be used to improve the course mark, according to criteria established by the professor.		