



# Bachelor in Physics (Academic Year 2021-22)

<b>Scientific Computer Laboratory</b>			<b>Code</b>	800496	<b>Year</b>	1º	<b>Sem.</b>	1º
<b>Module</b>	Basic Core	<b>Topic</b>				<b>Character</b>	Basic	

	Total	Theory	Laboratory
<b>ECTS Credits</b>	6	1	5
<b>Hours in to attend</b>	70	10	60

Learning Objectives
<p>The course aims to:</p> <ul style="list-style-type: none"> <li>• Get to know the computer as a useful tool for numerical analysis and for experimental data analysis.</li> <li>• Learn how to use computational tools for solving physics problems and illustrating mathematical concepts.</li> <li>• Learn basic, general-purpose programming structures.</li> <li>• Learn, program and use basic algorithms of numerical analysis.</li> </ul>
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
<p>Scientific computing has a global impact. Nowadays, the development of science is, in some way, linked to the development of computers.</p> <p>Thus, The Scientific Computing Laboratory has an impact on almost any other subject of the Physics degree.</p>

<b>Coordinator:</b>	María Guijarro Mata-García			<b>Dpt.:</b>	DACYA
	<b>Room:</b>	233c, 2 <sup>nd</sup> Floor	<b>E-mail</b>	mgujarro@ucm.es	
	Teresa Losada Doval			<b>Dpt.:</b>	FTA
	<b>Room:</b>	107, 4th floor	<b>E-mail</b>	tlosadad@ucm.es	

Theory – Schedule and Teaching Staff						
Group	Lecture Room	Day	Time	Professor	Hours	Dpt.
B	3	Tu	13:00-14:00	Segundo Esteban San Román	10	DACYA

Tutoring – Schedule and Teaching Staff				
Group	Professor	Schedule	E-mail	Location
B	Segundo Esteban San Román	Mo 10:00-12:00 Th 16:00-17:00	segundo@dacya.ucm.es	236, 2 <sup>nd</sup> Floor

Laboratory Schedule			No. of sessions:	30
Group	Computer Lab	Day - Hours	Remarks	
LB1	M2	Mo 12:00-14:00 Th 14:00-16:00	Practical work is split into two two-hour sessions per week. There are four hours of practical work per week. Tutorials are conducted via e-mail. Face-to-face tutorials can be requested by e-mail.	
LB2	M2			

Laboratory Teaching Staff					
Group	Computer Lab	Professor	Hours	Dpt.	e-mail
LB1	M2	Segundo Esteban San Román	60	DACYA	segundo@dacya.ucm.es
LB2	M2	Joaquín Recas Piorno	60	DACYA	recas@ucm.es
LB1-2	M2	Pablo Zurita	30	FTA	pzurita@fis.ucm.es

Syllabus	
Topic 1: Introduction to scientific computing • Main parts of a computer • Computer description levels: hardware and software • Introduction to scientific software	1 hour
Topic 2: Floating-point Arithmetic • Numerical representation: Integers and real numbers • Round-off Errors. Relative errors. Error units in last place (ulps) • IEEE 754 floating point standard	2 hours
Topic 3: Roots (zeros) of a function • Local methods for root computing • Fundamentals of successive approximation methods. • Convergence • Numerical instability	2 hours
Topic 4: Systems of linear algebraic equations • Solving linear systems by direct methods • Solving linear systems by iterative methods	2 hours
Topic 5: Curve Fitting and Data interpolation • Curve Fitting and Data interpolation fundamentals • Global interpolation methods • Local interpolation methods • Least Square Regression Methods	2 hours
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 <ul style="list-style-type: none"> <li>● Development Environment</li> <li>● Variables and operators</li> <li>● Internal Functions</li> <li>● Loops and conditional statements</li> <li>● Creating functions and Scripts</li> <li>● Graphical representation</li> </ul>	10
Exercise 2: Roots (zeros) of a function <ul style="list-style-type: none"> <li>● Iterative methods</li> <li>● Matlab functions</li> </ul>	4
Exercise 3: Systems of linear algebraic equations <ul style="list-style-type: none"> <li>● Direct methods</li> <li>● Iterative methods</li> <li>● Convergence analysis</li> </ul>	5
Exercise 4: Curve fitting and Data interpolation <ul style="list-style-type: none"> <li>● Global interpolation methods</li> <li>● Local interpolation methods</li> <li>● Least Square Regression Method</li> </ul>	5
Exercise 5: Differentiation and Integration <ul style="list-style-type: none"> <li>● Finite difference approximations for derivatives</li> <li>● Numerical Integration</li> <li>● Discrete solution for initial value problems</li> </ul>	4
Exercise 6: Introduction to Symbolic Computation	2

Bibliography
<p><b>Recommended reading</b></p> <ul style="list-style-type: none"> <li>▪ Kincaid, D. y Cheney, W. (1994). Numerical Analysis. Ed. Addison-Wesley.</li> <li>▪ John H. Mathews, Kurtis D. Fink (2005) <i>Numerical Methods Using Matlab</i>. Prentice Hall.</li> <li>▪ Jiménez, J. (2014). <i>Laboratorio de Computación Científica</i>, e-prints-UCM. <a href="http://eprints.sim.ucm.es/21710/">http://eprints.sim.ucm.es/21710/</a></li> </ul> <p><b>Complementary reading</b></p> <ul style="list-style-type: none"> <li>● Stormy Attaway, (2009). <i>Matlab: A practical introduction to programming and problem solving</i>. Ed Butterwrth-Heinemann (Elsevier)</li> <li>● Dianne P. O’Leary, (2009). <i>Scientific Computing with case studies</i>. Ed. SIAM</li> </ul>

Online Resources
The course has a dedicated page at the UCM CAMPUS VIRTUAL

Methodology
On-campus teaching 100% (Scenario 0)
<p>The course is mainly practical.</p> <p>Course Activities:</p> <ul style="list-style-type: none"> <li>● 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.</li> <li>● Laboratory sessions: A series of guided exercises undertaken by the students.</li> </ul> <p>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.</p>

<ul style="list-style-type: none"> <li>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.</li> </ul> <p>During the laboratory sessions every student will have a computer available to perform his or her exercises individually.</p> <p>Students can attend tutorial sessions individually or in group, at the established times.</p>
<b>Semi-attendance modality (Scenario 1)</b>
<p>The professor will provide all the material for the theoretical lessons, including videos with the explanations of each one of the lectures. The semi-attendance sessions will be devoted to solving doubts and to practical explanations with Matlab for each subgroup of students. This methodology is similar to the one followed by the rests of the groups.</p>
<b>Virtual modality (Scenario 2)</b>
<p>The professor will provide all the material for the theoretical lessons, including videos with the explanations of each one of the lectures. On-line sessions, with Google Meet/Teams apps, will be devoted to solving doubts and to practical explanations with Matlab. Online tutorial sessions will be held through Teams/Google Meet upon student request. This methodology is similar to the one followed by the rests of the groups.</p>

<b>Assessment procedure</b>		
<b>Exams</b>	<b>Weight:</b>	40%
<p>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.</p> <p>The exam will be performed through the CAMPUS VIRTUAL, so it may be done in a possible confinement scenario.</p> <p>A minimum mark of 3.0 points out of 10 in the examinations is needed to compensate with the laboratory work.</p>		
<b>Laboratory</b>	<b>Weight:</b>	60%
<p>Laboratory practical work assessments will consist of tests and exercises. They will be performed during laboratory sessions.</p> <p>These tests will be performed through the CAMPUS VIRTUAL, so a possible confinement scenario will not affect them.</p> <p>Assistance to laboratory sessions, submission of guided exercise reports and performing of tests and exercises are mandatory to pass the course.</p>		
<b>Final Mark</b>		
<p>In the ordinary call 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.</p> <p>In the extraordinary call the final mark will be the higher of these two options:</p> <p>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.</p> <p>Option 2: the final examination will count the 100%.</p> <p>In all the cases the realization of the laboratory practical work will be mandatory.</p> <p>Marks rewarded for optional coursework will be used to improve the course mark, according to criteria established by the professor.</p>		