



# Bachelor in Physics (Academic Year 2021-22)

<b>Physics Laboratory I</b>			<b>Code</b>	800497	<b>Year</b>	1st	<b>Sem.</b>	2nd
<b>Module</b>	Basic Core	<b>Topic</b>	Physics			<b>Character</b>	Obligatory	

	Total	Theory	Exercises
<b>ECTS Credits</b>	6	1	5
<b>Semester hours</b>	67	12	55

Learning Objectives (according to the Degree's Verification Document)
<ul style="list-style-type: none"> <li>▪ Carry out laboratory measurements following established protocols that involve calibration, data collection and mathematical treatment of data, including the estimation of systematic and random uncertainties, and the management of orders of magnitude and units.</li> <li>• Learn to prepare reports related to the measurement processes and the analysis of results.</li> <li>• Consolidate the understanding of the core areas of Physics through the observation, characterization and interpretation of phenomena and the realization of quantitative determinations in predesigned experiments.</li> </ul>
Brief description of contents
General Physics Laboratory. Nature and extent of physical phenomena. Units Data analysis. Uncertainty evaluation. Basic notions of Statistics.
Prerequisites
General physics at the Baccalaureate level. It is recommended to have completed the subject Computer Lab.
Related Subjects
General physics II. Physics Laboratory II and III.

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Theory – Schedule and Teaching Staff					No. of Sessions	8
Group	Lecture Room	Day	Time	Professor (12 h)	Dept.	
B	2	Th	13:00-14:30	José Luis Contreras González	EMFTEL	

Office hours				
Group	Professor	Schedule	E-mail	Location
B	J. L. Contreras	Tues. 14:00-15:30 Thur. 11:30-13:00	jlcontreras@fis.ucm.es	Mid Module 3 <sup>rd</sup> Fl. 217

Laboratory Teaching Staff			
Group	Data Analysis Laboratory – Professor (6h)	Dpt.	e-mail
LB	J.L. Contreras J.Blasco	EMFTEL FTA	<a href="mailto:jcontreras@fis.ucm.es">jcontreras@fis.ucm.es</a> <a href="mailto:jblasco@ucm.es">jblasco@ucm.es</a>
Group	Laboratory - Professor	Dpt.	e-mail
LB	J. L. Contreras V.C. Ruiz <b>Por determinar</b>	EMFTEL FTA FTA	<a href="mailto:jcontreras@fis.ucm.es">jcontreras@fis.ucm.es</a> <a href="mailto:ycarlos@fis.ucm.es">ycarlos@fis.ucm.es</a>

Data Analysis Laboratory- Schedule				No. of sessions:	4
Group	Day	Hours	Dates	Location	
LB1*	Wed.	13:00-14:30	2/2,9/2,23/2,2/3	M2	
LB2*	Th.		3/2,10/2,24/2,3/3	15	

Laboratory Schedule				No. of sessions:	13
Group	Day	Day - Hours	Location	Remarks	
LB	Tue	15:30-19:00	General Physics Laboratory, basement Physics Faculty	Students should deliver a written report of the practices in approximately 50% of the assignments. In the rest of them, it will suffice to fill a form with the results and uncertainties during the Lab session. Part of each session will be devoted to small group discussions of the results obtained and reports delivered in the previous session. If needed sessions will be organized to make for missed ones.	

\*Choice of data analysis groups LB1 and LB2 will take place during the course.

Syllabus
It comprises a total of 8 sessions of 1.5 hours, grouped into five topics: <ul style="list-style-type: none"> <li>• <b>Measures:</b> Units. Types of measures. Error and uncertainty. Systematic uncertainty. Random uncertainty. Estimation of uncertainties. Presentation of results.</li> <li>• <b>Data treatment.</b> Linear regression. Weighted mean. Linear interpolation. Preparation of reports.</li> <li>• <b>Descriptive statistics:</b> Discrete and continuous data. Frequency. Accumulated frequency. Histograms</li> <li>• <b>Random variable.</b> Concept. Probability density. Mean and variance.</li> <li>• <b>Probability distributions.</b> Discrete and continuous distributions. Uniform distribution, Normal distribution, Student's t. Estimation of parameters.</li> </ul>

Laboratory experiments	Sessions
<b>Introduction.</b> Data analysis.	1
<b>Mechanics:</b> Pendulum. Torsion pendulum. Surface tension. Hooke's law	3
<b>Thermodynamics.</b> Mechanical equivalent of heat. Enthalpy of melting ice	5
<b>Electricity and magnetism.</b> Wheatstone bridge. Characteristic curve of a lamp. Oscilloscope operation. Alternating current: RC circuit. Measurement of magnetic fields.	2
<b>Optics.</b> Determination of refractive indexes. Power of lenses.	1
<b>Structure of matter.</b> Measurement of the charge / mass ratio of the electron.	1
<b>Data analysis with spreadsheets.</b> Linear regression. Histograms. Graphics Data analysis module. (Taught in the computer classroom). Four sessions of 1.5 hours.	4

Bibliography
<p><b>Basic</b></p> <ul style="list-style-type: none"> <li>▪ <i>Class notes</i>, available on the web.</li> <li>▪ <i>Experimental Methods. An introduction to the analysis of Data</i>. L. Kirkup. Ed. J. Wiley &amp; Sons. 1994.</li> <li>▪ <i>Probability &amp; Statistics for Engineers and Scientists</i>. R. Walpole et al. Prentice Hall</li> </ul> <p><b>Complementary</b></p> <ul style="list-style-type: none"> <li>▪ <i>Practical Physics. G.L. Squires. Ed. Cambridge University Press., 2001.</i></li> <li>▪ <i>Curso y ejercicios de estadística</i>, Quesada, Isidoro &amp; López. Ed. Alhambra. 1989.</li> <li>▪ <i>Estadística Básica para Estudiantes de Ciencias</i>, J. Gorgas, N. Cardiel y J. Zamorano (available online).</li> </ul>

Online Resources				
<p>The subject is registered in the Virtual Campus.                  There is also a website at <a href="http://fisicas.ucm.es/lab-fis-gen">http://fisicas.ucm.es/lab-fis-gen</a>                  Extra links are available on the web site and virtual campus.</p> <table style="width: 100%; border: none;"> <tr> <td style="padding-right: 20px;"><a href="https://www.phyphox.org">https://www.phyphox.org</a></td> <td>Physics experimets with mobile phones</td> </tr> <tr> <td><a href="https://www.ucm.es/theoscarlab">https://www.ucm.es/theoscarlab</a></td> <td>Videos and tutorials of Physics experiments</td> </tr> </table>	<a href="https://www.phyphox.org">https://www.phyphox.org</a>	Physics experimets with mobile phones	<a href="https://www.ucm.es/theoscarlab">https://www.ucm.es/theoscarlab</a>	Videos and tutorials of Physics experiments
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Methodology
On-campus teaching 100% (Scenario 0)
<p>The subject consists of theory classes, laboratory, and data analysis sessions.                  The theory classes will consist of expositions of the instructor, with projection of slides and realization of exercises.                  Guided experiences will be carried out, with a prior script, during laboratory sessions (3.5 hours each) or catch-up sessions. Throughout each lab practice, students will have a tutor who will introduce it and answer their questions. During the experiment, a form will be filled with the measurements and calculations made. Additionally, in approximately half of the cases, a written report will be delivered in the following session. The forms and reports will be corrected and evaluated by the teachers and discussed with the students during the laboratory sessions.                  The "data analysis with spreadsheet" sessions aim at students being able to use this tool in their calculations and reports. They will be held in the Computer Room and consist of 4 sessions of 1.5 hours each.</p>
Semi-online teaching (Scenario 1)
<p><b>Theory:</b>                  Scenario B: For theory classes, videos would be recorded in advance and students would be given access to notes, presentations, and videos. The face-to-face classes would be reserved for solving problems, questions and exercises, with the assistance of the number of students allowed by the restrictions</p> <p><b>Data analysis:</b>                  We aim to carry out data analysis sessions on place in 100% of the cases for all students. If this were not possible, students would be provided with access to the material necessary for their realization: slides and class notes. We would then hold both: face-to-face and online sessions. The face-to-face sessions would be held in the computer room with the number of students allowed by the restrictions, and at the same time a remote session would be organized for those who cannot attend in person.</p>

<p><b>Laboratory:</b> Fundamentally all laboratory sessions would be carried out on place. For this goal, different measures would be taken in terms of organization of the groups, use of protection equipment, careful selection of the experiences to be carried out, rotation of sessions, etc., which ensure that the minimum distances are respected and the safety of the participants is not compromised. Furthermore:</p> <ul style="list-style-type: none"> <li>- If necessary the occupation of the groups would be balanced to avoid groups with many students andv if necessary, groups or sessions would be split.</li> <li>- The already recorded videos about the experiences would be used, explaining their objectives and the instructions to carry them out, since this point in the development of the laboratory sessions is the most critical in order to respect the minimum distance between people.</li> </ul>
<b>Online teaching (Scenario 2)</b>
<p><b>Theory:</b> For theory classes, videos would be recorded in advance and students would be granted access to notes, presentations, and videos. Synchronous online sessions to resolve doubts would be held.</p> <p><b>Data analysis:</b> Videos would be prepared for the data analysis sessions and students would be granted access to the material. Synchronous online sessions to resolve doubts would be held.</p> <p><b>Laboratory:</b> The Laboratory sessions would be replaced by online or at-home experiences during the period of the restrictions.</p>

<b>Evaluation Criteria</b>		
<b>Exams</b>	<b>Weight:</b>	30%
Theoretical-practical exam at the end of the semester.		
<b>Other activities</b>	<b>Weight:</b>	70%
Laboratory and data analysis experiments. Online quizzes. For each laboratory experiment, a report of the measures taken will be delivered. In approximately 50% of the cases, it will be a complete report, including a description of the method used, estimation of the associated uncertainties, and a discussion of the results obtained. In the rest of the cases, only the measurements and results will be presented.		
<b>Final Mark</b>		
It is mandatory to assist to all the lab sessions and deliver the reports and filled forms. The final grade will be the weighted mean of the two previous values, with a minimum score of 4.0 out of 10 demanded in both the assignments and the exam. If needed, the marks of both activities will be kept for the extraordinary call, which will also offer the possibility of completing the exercises not performed during the course. The grading of the extraordinary call for will be obtained following the same evaluation procedure described above.		