SUBJECT TEACHING GUIDE

G39 - Computational Tools in the Laboratory

Degree in Physics

Academic year 2018-2019

1. IDENTIFYING DATA					
Degree	Degree in Physics			Type and Year	Compulsory. Year 1
Faculty	Faculty of Sciences				
Discipline	Subject Area: Computation Tools Central Module				
Course unit title and code	G39 - Computational Tools in the Laboratory				
Number of ECTS credits allocated	6	Term	Semester based (1)		
Web	http://personales.unican.es/palencij/HerramientasComputacionales.htm				
Language of instruction	Spanish	English Friendly	No	Mode of delivery	Face-to-face

Department	DPTO. INGENIERÍA INFORMÁTICA Y ELECTRÓNICA
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Other lecturers	JULIO LARGO MAESO PABLO ALBELLA ECHAVE

3.1 LEARNING OUTCOMES

- To acquire an elementary knowledge of statistical methods for the treatment of random errors , which constitutes a fundamental tool for the experimental work. It is intended that the student can also use it in the experimental subjects of first year (Basic Experimental Physics I-IV) and of later courses.
  Understand that the estimation of errors is necessary because without it we can not draw meaningful conclusions from the experimental results. Know how to estimate the systematic and random errors of a measurement process, establishing uncertainties. Know how to make different representations of a set of measures
  To know the modes of numerical representation of the information and the components of a simple computer application .
  Know the basic elements and tools for the development of computer applications.
  Know how to build basic algorithms to process the information and how to use them in the corresponding applications in a computer.
  To know the mechanisms of data acquisition of instruments from the computer (using a programming language like MatLab).

4. OBJECTIVES

Specific objectives: Knowledge.
To know the basic concepts of probability, Gaussian distribution and sampling, mean and standard deviation, propagation of errors and, very briefly, correlations.
Know the different types of errors, the systematic and random errors of a measurement process.
To know and to handle the different procedures to present experimental results that facilitate the analysis and the interpretation of the same ones: tables, graphs, diagrams ..., with the help of a computer.
Find out in what type of problems or analysis it is appropriate to apply a method of fitting to a straight line.
Know the uses that Matlab offers for the treatment and handling of different types of data (vectors, matrices, polynomials, etc.).
Know the concept of algorithm, control instructions and pseudocode as a description of basic algorithms.
To know the mechanisms for the exchange of information between computers and instrumentation equipment and the bases of the applications of control and acquisition of information of the instruments using MatLab

Apply the theory of random errors to the results of an experiment. Apply the propagation of errors to the indirect measures of physical magnitudes. Use a program to represent bar diagrams, histograms, functions, etc. And for treatment and analysis of data: statistics, integrals, adjustment of points to different curves, etc.
Use and know the basics of the method of least squares adjustment of a set of data to a straight line. Apply the method in cases where the functional dependence among the magnitudes under study is not linear.
Construct associated Gaussian histograms. Calculate mean and standard deviation applied to a sample. Evaluate error propagation and, at an elementary level, correlations. Apply these concepts in simple practical exercises and the numerical results of the student's own experimental observations.
Know how to use the basic resources and services provided by the operating system.
Know how to handle and operate with the most common MATLAB data structures: vectors, matrices, polynomials, etc.
Know how to make different graphical representations of data (2-D and 3-D)
Be able to write small algorithms in MatLab.
Know how to acquire, store, process and present information that is generated in an experimental environment controlled by MatLab computer.

6. COURSE ORGANIZATION	
CONTENTS	
1	BLOCK 1: MEASUREMENT PROCESSES. ESTIMATION OF ERRORS. OBSERVATION STATISTICS.
1.1	Measurement and uncertainty. Uncertainty in measure. Importance of estimation of errors. Absolute error and relative error. Significant numbers and rounding. Discrepancy. Systematic and random errors. Measuring instrument error. Expression of the result of a direct measurement: best estimate ± uncertainty. Registration of the information: Preparation of tables and graphs. Examples and exercises
1.2	Propagation of errors. Indirect measures. Propagation of errors. Sum in square. Arbitrary functions of one or more variables. Some cases of special interest. Exercises.
1.3	Statistical analysis of random errors. The mean and standard deviation as the uncertainty of a single measurement. The standard deviation of the mean. Exercises.
1.4	The method of least squares. Linear regression. Least squares adjustment of non-linear functions. Exercises.
1.5	The normal distribution. Sets of measurements. Histograms. Distribution of measures. Limiting distributions. Gaussian or normal distribution. The integral function. Properties. Exercises.
1.6	REGRESSION AND CORRELATION. Linear correlation. Linear regression. Waste analysis: evaluation of the model.
2	BLOCK 2: MATLAB PROGRAMMING
2.1	Introduction to Matlab. Basic Matlab features. Programming Environment
2.2	Data and expressions. Simple variables and simple mathematical operations. Data storage, retrieval and visualization. Trigonometric functions. Complex numbers. Other operations
2.3	Algorithmic structures. Relational and logical operations. Sentences if. Loop instructions: for and while loops
2.4	Structured variables. Vectors and matrices. Definition, construction and basic operations
2.5	Polynomials. Representation and operations with polynomials. Calculation of roots.
2.6	Graphical Representations: Graphs 2-D and 3-D.
2.7	Analysis of data. Statistical estimation with Matlab. Calculation of uncertainties

7. ASSESSMENT METHODS AND CRITERIA

Description	Type	Final Eval.	Reassessn	%
Block 1. Written controls	Written exam	Yes	Yes	30,00
Block 2. Exercises	Work	Yes	Yes	10,00
BLOCK 1 - If the written test is not exceeded, a similar examination will be carried out (30%). - If you did not overcome the problem part, you can return it (10%). - If the practices were not exceeded, they can be delivered, in computerized format, and a	Written exam	Yes	No	0,00
Block 2. Exam with computer	Laboratory evaluation	Yes	Yes	5,00
Block 1. Problems and proposed activities	Activity evaluation with Virtual Media	Yes	Yes	30,00
Block 2. Practices	Laboratory evaluation	Yes	Yes	20,00
Final Exam of September	Laboratory evaluation	Yes	No	5,00
TOTAL				100,00

Observations

Any activity delivered after the deadline will be evaluated with a grade of 0.
In the exams of the first part will be supplied a form. For the second part you can take all kinds of notes and books.

Observations for part-time students

Part-time students are required to submit the course assignments. As far as possible, we will try to facilitate the monitoring of the subject.

Each student must also carry out a final written examination, equivalent to those made by the rest of the students. The dates of these exams will be established according to each student in this situation.

8. BIBLIOGRAPHY AND TEACHING MATERIALS

BASIC

Jay L. Devore. Probability and Statistics for Engineering and the Sciences. CENGAGE Learning, 9th edition, 2014.

Mario F. Triola. Elementary Statistics. Pearson, 12th edition, 2012.

Aprenda Matlab 7.0 como si estuviera en primero. Javier García de Jalón, José Ignacio Rodríguez, Jesús Vidal. Universidad Politécnica de Madrid, 2005