

**COURSE DATA****Data Subject**

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|----------------------|---------------------------|
| Code | 34192 |
| Name | Informatics for Chemistry |
| Cycle | Grade |
| ECTS Credits | 6.0 |
| Academic year | 2021 - 2022 |

Study (s)

| Degree | Center | Acad. year | Period |
|-------------------------|----------------------|-------------------|---------------|
| 1110 - Chemistry Degree | Faculty of Chemistry | 1 | First term |

Subject-matter

| Degree | Subject-matter | Character |
|-------------------------|-----------------------|------------------|
| 1110 - Chemistry Degree | 4 - Informàtica | Basic Training |

Coordination

| Name | Department |
|---------------------------|--------------------------|
| SANCHEZ DE MERAS, ALFREDO | 315 - Physical Chemistry |

SUMMARY

This subject aims to familiarize students with useful computer tools in the learning and practice of the degree in chemistry and the acquisition of a critical attitude towards the results obtained.

The subject has an eminently practical and applied approach. The contents are adapted both to the needs of the student of the degree in chemistry when addressing other subjects, as well as other professional activities: office automation, applications of scientific utility and use of the Internet and its basic communication tools and access to information.

The basic lines of the subject are directed to the knowledge of the contents and utilities of certain applications and in the realization of exercises that use the different tools of each application. Specifically:

- Basic tools for accessing the user environment and electronic learning of the University of Valencia.
- Learning of various applications, among which:
 - 1) A spreadsheet for data processing, graphical representations, statistical adjustment of data to functions and basic numerical calculation. The Microsoft Excel program is used.
 - 2) An algebraic manipulator capable of performing symbolic as well as numerical computation. The Mathematica program is used
 - 3) A molecular modeling and representation program. Depending on availability, ChemBioOffice / ChemOffice, MarvinSketch or ChemSketch programs are used.



PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

There are no specified enrollment restrictions with other subjects of the curriculum.

Other requirements

Operation of the keyboard and mouse.
Sound Management of the windows GUI system.
Run programs in multiprocessing environments and acknowledge the characteristic menu of a given program.
Basics of web browsing and search engines.
Sound handling of files.
Sound knowledge of the practical aspects of developing: arithmetic, symbolic algebra.

OUTCOMES

1108 - Grado de Química

- Demonstrate leadership and management skills, entrepreneurship, initiative, creativity, organization, planning, control, leadership, decision making and negotiation.
- Solve problems effectively.
- Demonstrate ability to work in teams both in interdisciplinary teams and in an international context.
- Demonstrate ability to communicate information, ideas, problems and solutions to both specialist and non-specialist audiences and using information technology, as appropriate.
- Demonstrate a commitment to ethics, equality values and social responsibility as a citizen and as a professional.
- Learn autonomously.
- Evaluate, interpret and synthesise chemical data and information.
- Relate theory and experimentation.
- Students must have acquired knowledge and understanding in a specific field of study, on the basis of general secondary education and at a level that includes mainly knowledge drawn from advanced textbooks, but also some cutting-edge knowledge in their field of study.
- Students must be able to apply their knowledge to their work or vocation in a professional manner and have acquired the competences required for the preparation and defence of arguments and for problem solving in their field of study.
- Students must have the ability to gather and interpret relevant data (usually in their field of study) to make judgements that take relevant social, scientific or ethical issues into consideration.
- Students must be able to communicate information, ideas, problems and solutions to both expert and lay audiences.
- Students must have developed the learning skills needed to undertake further study with a high degree of autonomy.
- Express oneself correctly, both orally and in writing, in any of the official languages of the Valencian Community.
- Have basic skills in the use of information and communication technology and properly manage the information obtained.

**LEARNING OUTCOMES**

The previous section includes the competences contained in the document VERIFICA. This subject addresses part of the learning results of the subject Informatics for Chemistry that allow to acquire both specific knowledge of chemistry, cognitive skills and general skills recommended by the EUROPEAN CHEMISTRY THEMATIC NETWORK (ECTN) for the Chemistry Eurobachelor® Label. The following table lists the learning outcomes acquired in the subject Informatics for Chemistry related to the competences of the degree in Chemistry.

| SPECIFIC KNOWLEDGE OF CHEMISTRY | |
|--|---|
| The learning process should allow the degree graduates to demonstrate: | |
| | Competences of the subject INFORMATICS FOR CHEMISTRY that contemplate the learning outcomes EUROBACHELOR® |
| Major aspects of chemical terminology, nomenclature, conventions and units. | Demonstrate knowledge of the main aspects of chemical terminology, nomenclature, conventions and units..(CE1) |
| The principles of thermodynamics and their applications to chemistry | Demonstrate knowledge of the principles of thermodynamics and kinetics and their applications in chemistry..(CE6). |
| The kinetics of chemical change, including catalysis; the mechanistic interpretation of chemical reactions | Demonstrate knowledge of the principles of thermodynamics and kinetics and their applications in chemistry..(CE6). |
| The structural features of chemical elements and their compounds, including stereochemistry. | Ability to recognise chemical elements and their compounds: preparation, structure, reactivity, properties and applications..(CE7). |



| COMPETENCES AND COGNITIVE SKILLS | |
|---|--|
| The learning process should allow the degree graduates to demonstrate: | |
| | Competences of the subject INFORMATICS FOR CHEMISTRY that contemplate the learning outcomes EUROBACHELOR® |
| Competences for the evaluation, interpretation and synthesis of information and chemical data. | Evaluate, interpret and synthesise chemical data and information..(CE16). |
| Competences to present and argue scientific issues orally and in writing to a specialized audience. | Demonstrate ability to communicate information, ideas, problems and solutions to both specialist and non-specialist audiences and using information technology, as appropriate. (CG6). Students must be able to communicate information, ideas, problems and solutions to both expert and lay audiences..(CB4). |
| Ability to calculate and process data, related to information and chemistry data. | Solve qualitative and quantitative problems following previously developed models..(CE14). Recognise and analyse new problems and plan strategies to solve them..(CE15). |



| COMPETENCES AND COGNITIVE SKILLS RELATED TO THE PRACTICE OF CHEMISTRY | |
|---|--|
| The learning process should allow the degree graduates to demonstrate: | |
| | Competences of the subject INFORMATICS FOR CHEMISTRY that contemplate the learning outcomes EUROBACHELOR® |
| GENERAL COMPETENCES | |
| The learning process should allow the degree graduates to demonstrate: | |
| | Competences of the subject INFORMATICS FOR CHEMISTRY that contemplate the learning outcomes EUROBACHELOR® |
| Calculation and arithmetic capabilities, including aspects such as analysis error, estimates of orders of magnitude, and correct use of the units. | Develop capacity for analysis, synthesis and critical thinking.. (CG1). Show inductive and deductive reasoning ability..(CG2). Solve problems effectively..CG4). |
| Competences in information management, in relation to primary and secondary sources, including information retrieval through on-line searches. | Demonstrate ability to communicate information, ideas, problems and solutions to both specialist and non-specialist audiences and using information technology, as appropriate..(CG6). Have basic skills in the use of information and communication technology and properly manage the information obtained.(CT2). |
| Skills related to information technology such as word processing, spreadsheet, recording and storage of data, internet use related to the subjects. | Demonstrate ability to communicate information, ideas, problems and solutions to both specialist and non-specialist audiences and using information technology, as appropriate..(CG6). Have basic skills in the use of information and communication technology and properly manage the information obtained.(CT2). |
| Planning and time management skills. | Develop capacity for analysis, synthesis and critical thinking. (CG1). Solve problems effectively..CG4). |
| Interpersonal skills to interact with other people and get involved in team work. | Demonstrate ability to work in teams both in interdisciplinary teams and in an international context..(CG5). Demonstrate the ability to adapt to new situations..(CG9). |



| | |
|--|---|
| Study skills necessary for professional development. These will include the ability to work autonomously. | Demonstrate leadership and management skills, entrepreneurship, initiative, creativity, organization, planning, control, leadership, decision making and negotiation..(CG3). Demonstrate ability to work in teams both in interdisciplinary teams and in an international context..(CG5). Learn autonomously.(CG8). Demonstrate the ability to adapt to new situations..(CG9). Students must have developed the learning skills needed to undertake further study with a high degree of autonomy.(CB5). |
| Ethical commitment to the European Code of Conduct: http://ec.europa.eu/research/participants/data/ref/h2020/other/hi/h2020-ethics_code-of-conduct_en.pdf | Students must have the ability to gather and interpret relevant data (usually in their field of study) to make judgements that take relevant social, scientific or ethical issues into consideration. (CB3). |

The following results of learning are allocated to the subject "Informatics Applications in Chemistry" of the BSc "Degree in Chemistry":

- 1.Effective capacity of management of the information.
- 2.Capacity of correct use of the ICT, i.e. "information and communication technologies".
- 3.Effective use of the ICT environment for electronic education supported by the Universitat de València.
- 4.Capacity of organization and planning.
- 5.Capacity for solving chemical problems using the ICT environment.
- 6.Autonomous learning capacities for simulated construction and 2D and 3D visualization of organic and inorganic molecules.
- 7.Capacity to team work.

Minimum learning outcomes: are assessable and mandatory for obtain the passing grade:

At the end of the course, the student, in an **indispensable way**, must be able to:

- Create a folder on the drive and directory and the name indicated.



- Use the user environment the University of Valencia to:
 - Send an e-mail with attachments through the mail server of the University
 - Search selectively information of interest in a scientific database (accessible to UV users)
- Use the functionality of the spreadsheet to:
 - Write formulas without basic syntax errors
 - Use numbers in scientific format ($n.nn \times 10^n$)
 - Propagate formulas (copy and paste operatively)
 - Perform basic scientific plots, from small data sets in the right way for it
 - Handle axe scale, limits and format of a graph
 - Plot multiple data series in one chart
 - Fit data to a straight line and obtain the equation of the fitted line
 - Use the tool "Goal Seek" to numerically solve single-variable equations
- Know the basic syntax of the algebraic manipulator for use variables, operators, expressions, functions, and lists and use their capabilities to:
 - Plot a single variable function
 - Plot a list of points
 - Symbolically solve a single-variable equation
 - Numerically solve a single- variable equation
 - Symbolically solve a system of several variable linear equations
 - Calculate explicit derivatives of single variable functions
 - Calculate indefinite integrals of single variable functions
 - Calculate definite integrals of single variable functions
- Use functionalities of the 2D Molecular Modeler to:
 - Build simple organic and inorganic molecules
 - Replace functional groups and change atoms in a controlled way
- Use molecular functionalities 3D Modeler:
 - Build simple organic and inorganic molecules
 - Replace functional groups and change atoms in a controlled way
 - Measure distances and bond angles on 3D molecular representations
 - Obtain simple molecular structures that be chemically reasonable

Additional learning outcomes: are assessable and required for obtaining **grades higher than passing grade**.

In addition to the skills required in the preceding subparagraph ("minimal learning outcomes"), at the end of the course, the student receiving a grade higher than the passing grade, must be able to:



- Use the functions of the operating system and computer network to:
 - Accurately situate in the directory tree, disks, and servers from the computer being used
 - Know the extended use of the keyboard and mouse (text field editing, write non-alphanumeric characters, main keyboard functions and services, character sets, etc.)
 - Recognize applications, open them to execute them and leave them in a position to start working, where appropriate, into a new document
 - Create and manage documents from active applications
 - Perform in a controlled manner copies, duplicates, rename and back up of both documents and directories
 - Find information relevant to the Degree subjects in the Web in a controlled way
 - Find information of interest in a controlled way in scientific data bases accessible by network
 - Organize and plan information in accordance with instructions received
 - Export and import data between applications
 - Develop an organized scientific document using combined computing resources
- Use the functionality of the spreadsheet to:
 - Recognize the most common error conditions using expressions
 - Program simple algebraic mathematical expressions
 - Program transcendent mathematical expressions or simple functional
 - Generate numerical series in a controlled way
 - Perform basic operations on matrices and determinants
 - Build crosstabs with the results obtained from data supplied, using relative and absolute cell addresses
 - Perform and control the XY plots from data tables
 - Plot different sets of data with very different ranges on a single graph
 - Fit data to straight lines with error estimates of the slope and intercept
 - Fit data to various types of curves obtaining the corresponding equation
 - Graphically interpolate a value from a fitted equation
 - Numerically interpolate a value from a fitted equation
 - Graphically extrapolate a value from a fitted equation
 - Numerically extrapolate a value from a fitted equation
- Use the functions of algebraic manipulator to:
 - Make effective use of basic performance standards
 - Make effective use of the basic rules of syntax
 - Find information in a useful way from the program help
 - Acknowledge error and warning messages
 - Symbolically manipulate basic algebraic and transcendental expressions
 - Perform operations using isolated data and using data lists
 - Replace an expression in another
 - Generate lists of values in a programmed way using indexes
 - Use basic control structures (conditional "if" and "for" loops or equivalent)
 - Symbolically solve equations and systems of equations



- Derive and integrate functions
- Perform basic operations on vectors and matrices
- Perform in a controlled way graphical plots of functions
- Plot two single variable functions on the same graph
- Use the functions of 2D and 3D Molecular Modeler (MM2D and MM3D) to:
 - Plot and recognize the 3D structure of organic molecules with common functional groups
 - Plot and recognize the 3D structure of common inorganic molecules
 - Recognize and measure dihedral bond angles in 3D molecular representations
 - Get chemically reasonable structures from assumed structures and optimize molecular geometries
 - Critically analyze the results of molecular optimizations
 - Optimize 3D molecular structures with theoretical models of molecular mechanics (MM) and quantum mechanics (MQ)
 - 3D Plot of several molecules in the same document
 - Calculate molecular properties with MM2D and MM3D
 - Plot molecular surfaces with MM3D
 - Use molecular surfaces as graphic support to display molecular properties
 - 2D Plot of molecules, reactions, processes, etc. using the conventions of chemical representation
 - Recognize the terminology, nomenclature and basic structural properties of molecules

Learning outcomes that follow correspond to transferable skills progressively acquired throughout the curriculum. They are listed here because this subject can contribute relevantly to their achievement:

- Improve the ability to work collaboratively in small teams
- Understand the names and expressions that form the basic scientific or technical vocabulary in English related with applications and procedures seen in the course (Although the basic course documentation is given in the official languages of the CV, much of the relevant chemical information can be obtained from the Web, the commands of the algebraic manipulation program and the molecular modeler (2D and 3D), and the "help" of these programs are in English, which allows students to familiarize themselves with an important part of the basic English vocabulary related to the contents taught)
- Write and make presentations in the native language correctly

Improve the ability to choose among many options. It is common for applications to resolve problems choosing among several options without that substantially alters the content or nature of the solution. Students must choose and justify their choices. This is excellent training in decision making with immediate effects



DESCRIPTION OF CONTENTS

1. UV user environment. Electronic resources

Presentation of the course. Running applications: editing math expressions. Internet and LAN at the UV. User environment: Mail. Virtual Disk. Virtual services. UV e-learning environment: UV virtual classroom. The UV bibliographical information service. Scientific databases: searches in databases and management of search results.

2. Worksheet 1. Expressions, formulas and functions

General concept of worksheet: the cell as a computer variable. Cell formats. Absolute and relative cells. Formulas and functions. Matrices and vectors. Programming simple problems on the worksheet.

3. Worksheet 2. Graphical presentation of data

Representation of data. Generation of series. Graphical representations with parametric dependencies. Representation (X, Y) of functions of a known expression. Applications to problem solving.

4. Worksheet 3. Adjustment of data

Settings. Linear regression. Interpolation and extrapolation. Applications to problem solving.

5. Worksheet 4. Numerical solution of equations

Search for values that meet conditions. Search target. Solver. Applications to problem solving.

6. Algebraic manipulator 1. Variables, operators, expressions

Introduction to the use of the AM. Basic concepts of syntax of the AM. Symbolic algebraic manipulations. Substitution rules. Numerical results. Applications to problem solving.

7. Algebraic manipulator 2. Lists, matrices, vectors

Lists. Operations between lists. Vectors and matrices as lists. List generation. Lists of pairs of numbers (x,y). Graphical representation of lists of points. Applications to problem solving.

8. Algebraic manipulator 3. Functions and equations

Predefined functions and functions defined by the programmer. Solving equations and systems of equations. Derivation and integration of functions. Control structures (conditions, loops). Applications to problem solving.

9. Algebraic manipulator 4. Graphical representations



Graphical representations in the AM. 2D and 3D graphical representations. Parametric representations. Applications to problem solving.

10. Molecular representation 1. 2D molecular representations

2D chemical representation conventions. Construction and management of 2D molecular structures. Calculation of properties.

11. Molecular representation 2. 3D molecular representation

Construction and management of 3D molecular structures. Fast obtainment of stationary configurations. Calculation of properties of molecular structures.

WORKLOAD

| ACTIVITY | Hours | % To be attended |
|--|---------------|------------------|
| Computer classroom practice | 48,00 | 100 |
| Tutorials | 12,00 | 100 |
| Development of group work | 10,00 | 0 |
| Study and independent work | 50,00 | 0 |
| Preparation of evaluation activities | 10,00 | 0 |
| Preparation of practical classes and problem | 20,00 | 0 |
| TOTAL | 150,00 | |

TEACHING METHODOLOGY

The nature of the course implies intensive and almost exclusively use of "ICT" ("information and communication technologies"), in particular computer based tools. All the technically available issues in the classroom computers will be used in a practical way.

Through a website the students have information and materials that are common to all groups, as a complement of the virtual learning platform provided by the UVEG ("aula virtual") which is more group specif.

Since the work plan (section III) includes predominantly "directly supervised computer classroom practices" and, to a lesser extent, "seminars, activities related to acquisition of transversal skills, tests and exams", the development of the directly supervised part of the course is structured around the following points:

- Computer hands-on sessions supervised by a teacher.
- Seminars where students present their homework done and exposed by means of computational tools.
- Hands-on workshops where the students use the classroom computer resources to provide results aimed to complete a cooperative project.
- Evaluation sessions.



The students will be provided with exercise collections of chemical, physical and mathematical content to be solved with the applications they are introduced to. Teachers use “pilot” exercises to introduce each application, its procedures, commands, tools, and menus; then, the students can practice with proposed exercises under direct supervision. Additional students homework includes solving the collections of exercises and loading them up into mandatory terms. Additional exercises may be proposed that require using several applications and data exporting.

EVALUATION

In any case, **the minimum learning outcomes** (see section LEARNING OUTCOMES) have to be **COMPLETELY** credited to pass the course.

First call: the course grade is calculated from two grades:

- That from the continuous assessment
- That from the final exam

As regards the continuous evaluation, a set of tasks, both individual and collective, will be developed throughout the semester, whose main function is to obtain information on a continuous basis on the progress of each student regarding the learning outcomes outlined in this guide, and thus be able to guide him/her more efficiently. These tasks can be divided into three sections:

- Work done during class sessions
- Exercises worked autonomously and delivered by students throughout the course
- Small team projects

The weight of each of these sections on the final grade for the course is as follows:

- Work done in practical classes and exercises delivered throughout the year: 30%
- Teamwork: 15%

Thus, the sum of these elements (i. e., those corresponding to the continuous assessment part) gives 45% of the final grade. The average rating of this set of activities must be at least a 4.0 out of 10.



The other 55% of the grade will be a final exam consisting in an individual practical test that will include a series of exercises for each of the three parts of the syllabus:

Part 1: Introduction, user environment and molecular representation (items 1 and 10-11).

Part 2: Spreadsheet (items 2-5)

Part 3: Algebraic Manipulator (items 6-9)

The weight of each part in the final grade for the course is as follows:

- Part 1: 10%
- Part 2: 25%
- Part 3: 20%

To be considered the exam grade must be at least 4.0 out of 10 in each of these three parts. Otherwise, the grade for the course will be fail. To pass the course it is required to obtain an overall rating of 5.0 out of 10.

For the **second call**, one final exam will be held with the same characteristics and conditions that at first call. The grades of the sections of continuous assessment will be kept, as well as the percentages to be applied. However, if a student wishes to improve the grade corresponding to section of exercises performed autonomously, he/she can do it by performing new exercises.

REFERENCES

Basic

- BILLO, E.J. EXCEL for Chemists, A Comprehensive Guide, 2nd. Ed., Wiley-VCH, New York, 2001. ISBN 9780470381236
- PLANELLES, J., SERRANO, R. Informática aplicada a la química. Publicaciones de la Universitat Jaume I. Colección Universitas. Castellón, 2002. ISBN 9788480213875
- Help on line of the Spreadsheet, Molecular Modelizer, Computer Algebra System (CAS) and other software used in the course.
- Tutoriales de WXMaxima:
http://andrejv.github.io/wxmaxima/tutorials/10minute_es.zip
<https://vimeo.com/channels/maximajaj>
<http://maxima.sourceforge.net/docs/manual/es/maxima.html>



ADDENDUM COVID-19

This addendum will only be activated if the health situation requires so and with the prior agreement of the Governing Council

Contents

2.- *The contents initially included in the teaching guide are maintained, unless the facilities are closed, in which case the molecular modeling program used will be MarvinBeans for being open access and easier to install.*

Workload and temporary teaching planning

Regarding the workload:

1.- *The different activities described in the Teaching Guide are maintained with the intended dedication.*

Regarding the temporary teaching planning:

2.- *The material to follow the theory/tutoring/classroom-seminar classes allows to continue the temporary teaching planning both in days and schedule, whether the teaching is face-to-face in the classroom or not, although in some of the activities the student has the freedom to follow the non-face-to-face sessions according to his own planning.*

Teaching Methodology

Computer-classroom courses: The occupation of computer classrooms will be 50% compared to the usual occupation. If the number of students enrolled exceeds the capacity of 50% of the classroom, students will attend the face-to-face course in weekly rotating shifts (preferably in alphabetical order). However, the rotation system will be fixed once the actual enrollment data is known, guaranteeing, in any case, that the percentage of face-to-face teaching of all students enrolled in the subject is the same.

The methodology used for non-face-to-face classes shall be:

1. Synchronously using virtual classroom tools (Teams, Blackboard ...)
2. Asynchronously using locut power-point presentations or other virtual classroom tools
3. Resolution of exercises and questionnaires

If there is a closure of the facilities for health reasons that totally or partially affects the classes of the course, they will be replaced by non-face-to-face sessions following the established schedules and using the tools of the virtual classroom.

Evaluation



1. *The possibility of exam-only evaluation is eliminated.*
2. 1. *The evaluation system described in the Teaching Guide of the subject in which the different evaluable activities have been specified is maintained, but the weight of each contribution to the continuous evaluation part is modified, so that the individual work will suppose a 35% of the overall grade and teamwork only 10%.*

If there is a closure of the facilities for health reasons affecting the development of any face-to-face evaluable activity of the subject, it will be replaced by a test of a similar nature that will be carried out in virtual mode using the computer tools licensed by the University of Valencia. The contribution of each evaluable activity to the final grade of the subject will remain unchanged, as set out in this guide.

References

(Indicate the option applicable to the subject)

- 1.- *The literature recommended in the Teaching Guide is maintained since it is accessible.*