UNIVERSIDAD DE CASTILLA - LA MANCHA

GUÍA DOCENTE

1. General information

Course: CHEMICAL ANALYSIS II
Code: 14312
Type: CORE COURSE
ECTS credits: 6
Degree: 376 - UNDERGRADUATE DEGREE PROGRAMME IN PHARMACY
Academic year: 2023-24
Center: 14 - FACULTY OF PHARMACY
Group(s): 10
Year: 2
Duration: First semester
Main language: Spanish
Second language: English
Use of additional languages:
English Friendly: Y
Web site: https://www.uclm.es/es/albacete/farmacia/guias-docentes
Bilingual: N

Lecturer: **FERNANDO DE ANDRES SEGURA** - Group(s): **10**

Building/Office	Department	Phone number	Email	Office hours
Faculty of Pharmacy / 1st floor	Q. ANALÍTICA Y TGIA. ALIMENTOS	967599200/2200	Fernando.deAndres@uclm.es	Tuesday and Thursday, from 16 to 17,30 h. To arrange with the professor via email in order to organize a tutoring session that fits the schedule of both the student and the teacher.

Lecturer: **VIRGINIA RODRIGUEZ ROBLEDO** - Group(s): **10**

Building/Office	Department	Phone number	Email	Office hours
Faculty of Pharmacy / 1st floor	Q. ANALÍTICA Y TGIA. ALIMENTOS	967599200/8240	virginia.rrobledo@uclm.es	Monday and Wednesday, from 18 to 19,30 h. To arrange with the professor via email in order to organize a tutoring session that fits the schedule of both the student and the teacher.

Lecturer: **MOHAMMED ZOUGAGH ZARIOUH** - Group(s): **10**

Building/Office	Department	Phone number	Email	Office hours
Faculty of Pharmacy / 1st floor	Q. ANALÍTICA Y TGIA. ALIMENTOS	926052675	Mohammed.Zougagh@uclm.es	To arrange with the professor via email in order to organize a tutoring session that fits the schedule of both the student and the teacher.

2. Pre-Requisites

Although no previous requirements are stablished, it is highly recommended, to ensure a certain guarantee of success, that the student has previously studied General Chemistry and Lab Introduction, and to possess basic knowledge on Physics and Mathematics as well.

To this extent, it is also recommended for the students to have studied and passed Chemical Analysis I.

3. Justification in the curriculum, relation to other subjects and to the profession

JUSTIFICATION IN THE CURRICULUM:

The Pharmacist, as a health professional at the degree level, and according to the 2005/36/CE Guideline by the European Parliament and the European Council, from the 7th of September of 2005, is competent for performing the activities related to the production, preservation, and distribution of medicines, as well as to collaborate in the analytical, pharmacotherapeutic, and public health surveillance processes (article 6.2b). To develop these activities is necessary to have a wide knowledge, among others, of the contents and to acquire the competences related to the subject of Chemical Analysis II.

As described in the study program for the degree of Pharmacy, the contents of the subject Chemical Analysis II, within the framework of the Chemistry Module, are mainly based on the study of the main prevailing analytical methods such as optical spectroscopy and non-spectroscopy methods, electrochemical methods, and methods of separation, with a special focus on chromatographic and electrophoretic techniques, which are the most prevalent separation techniques in the pharmaceutical field nowadays. Furthermore, part of the contents of the subject will be focused on other instruments of additional interest, such as mass spectrometry, sensors and automation in pharmaceutical analysis.

RELATION TO OTHER SUBJECTS:

Chemical Analysis II is a subject taken in the first semester of the second course, as the continuation to the subject of Chemical Analysis I, which is taken in the first course of the degree.

Furthermore, to become the pharmacist a competent professional, capable of assuming all the challenges existent in a continuously growing field, which constantly demands new experts, it will be essential to give the students a multidisciplinary education, which has permitted in the past to many pharmacists to give extraordinary contributions in many different fields of knowledge (i.e. botany, chemistry, biochemistry, bromatology, edaphology, parasitology, microbiology, etc.). It is, therefore, clearly exposed the multidisciplinary relation and links among the different basic subjects described in the Degree of Pharmacy.

RELATION TO THE PROFESSION:

Because of this multidisciplinary formation in the scientific, technical, and health science fields, the student who obtained the degree in Pharmacy will be capable to perform the profession of pharmacist, at pharmaceutical companies, in hospital and non-hospital specialized positions, in health analytical laboratories, in the field of health management, and in education or research works.

The subject of Chemical Analysis gives the professional a solid basis of knowledge in classical and instrumental analytical chemistry, in the validation of analytical methods in the pharmaceutical field, as well as in the chemical analysis using separation techniques coupled with different detection techniques (e.g., mass spectrometry) which allow to identify and determine many different compounds of pharmaceutical interest.

taking it out of that context and sharing it with individuals outside of that platform without their consent will be considered a violation of copyright. Furthermore, recording classes and various activities without the explicit consent of the teacher is not allowed.

Engaging in different tests with unauthorized assistance or materials will be considered fraud. In accordance with Article 9 of the Student Evaluation Regulations, any test in which fraud is detected will be deemed invalid and graded as a fail (0), including any detected act of plagiarism. This is without prejudice to any disciplinary proceedings that may be initiated against the student, in accordance with the offenses and penalties specified in the current disciplinary regime.

4. Degree competences achieved in this course

Course competences

Code	Description
B01	Proficiency in a second foreign language at level B1 of the Common European Framework of Reference for Languages.
B02	Knowledge of Information and Communication Technologies (ICT).
B03	A correct oral and written communication
B04	Ethical commitment and professional deontology.
B05	Ability to develop those learning skills necessary to undertake further studies.
EQ01	Identify, design, prepare, analyse and produce active principles, drugs and other materials and products of sanitary interest.
EQ02	Adequately choose the techniques and methodologies for the evaluation, design and application of chemical reagents, laboratory methodologies and analytical techniques.
EQ03	Complete standard laboratory processes including the employment of scientific equipment related to synthesis and analysis.
EQ04	Evaluate risks/hazards associated to the use of chemical substances and lab processes.
EQ09	Know origin, nature, design, production, analysis and drugs quality control and sanitary products.
EQ10	Know principles and procedures for the analytical determination of compounds: analytical techniques applied to water, food and environment analysis.
EQ11	Know and apply the main structural determination techniques, including spectroscopy.
G01	Identify, design, obtain, analyze, control and produce drugs and medicines, as well as other products and raw materials of sanitary interest for human or veterinary use.
G10	Design, apply and evaluate clinical reagents, methods and analytical techniques, knowing the basic principles of clinical analysis and the characteristics and contents of laboratory diagnostic reports.
G11	Evaluate the toxicological effects of substances and design and apply appropriate tests and trials.
G12	Develop hygienic-sanitary analyses, especially those related to food and environment.
G15	Recognise own limitations and the need to maintain and update professional competence, with particular emphasis on self-learning of new knowledge based on scientific evidence.
T01	Critical thinking skills based on the application of the scientific method
T02	Ability to manage quality scientific information, bibliography, specialized databases and resources accessible through the Internet.
T03	Handling of basic and specific software for the treatment of information and experimental results.
T04	Motivation for quality, safety at work and awareness of environmental issues, with knowledge of the internationally recognised systems for the correct management of these aspects.
T05	Organizational, planning and implementation skills.
T07	Ability to work as a team and, where appropriate, exercise leadership functions, encouraging entrepreneurship.

5. Objectives or Learning Outcomes

Course learning outcomes

Description

Application of the gained knowledge on solution reactions for the qualitative analysis of substances of pharmaceutical interest.

To understand the validation strategies of analytical methodologies.

To understand the basis of the quality assurance program and of good laboratory practices with application in the pharmaceutical industry, as well as to learn about the control on raw materials, excipients, intermediary and final products.

To understand the physicochemical principles in which the different techniques of instrumental analysis are based.

Ability to apply the general system of the analytical process to solve simple practical issues with application in different fields.

Capacity to estimate the analytical results reliability together with a deep understanding of the statistical criteria applied for their evaluation, especially those related to accuracy and precision.

Good environmental practices for the management of chemical substances and residues.

Ability to select the ideal instrumental technique for the analytical and structural study of substances of pharmaceutical interest.

To identify and to understand the importance of each stage of the analytical process.

Capacity to elaborate reports on the analytical results obtained, also understandable for no experts in the field.

Self-learning: organization capacity, ability to analyze and to manage the information.

To learn the different automatic systems of analysis developed to obtain better productivity in a pharmaceutical lab.

Teamwork: critical and self-critical ability.

Additional outcomes

The student will demonstrate its ability at the use of the ICTs

The student will correctly use the language for oral and written communication.

The student will be capable of undertaking advanced subjects within the Area of Chemistry.

6. Units / Contents

Unit 1: Introduction to Instrumental Chemical Analysis.

Unit 2: PART I. OPTICAL TECHNIQUES OF ANALYSIS APPLIED TO PHARMACY. (Unit 2. Introduction to Optical Techniques)

Unit 3: Ultraviolet-visible molecular absorption spectrophotometry

Unit 4: Molecular fluorescence spectroscopy

Unit 5: Atomic spectroscopy

Unit 6: Atomic absorption

Unit 7: Atomic emission

Unit 8: PART II. ELECTROANALYTICAL TECHNIQUES APPLIED TO PHARMACY. (Unit 8. Basics of electrochemical techniques)
Unit 9: Potentiometry
Unit 10: Voltammetry. Polarography
Unit 11: PART III. SEPARATION TECHNIQUES APPLIED TO PHARMACY (Unit 11. Introduction to separation techniques)
Unit 12: Introduction to chromatography
Unit 13: Planar Chromatography
Unit 14: Column Liquid Chromatography
Unit 15: Gas Chromatography
Unit 16: Non-chromatographic techniques: Electrophoresis
Unit 17: PART IV. CURRENT ANALYSIS TRENDS (Unit 17. Mass Spectrometry)
Unit 18: Automated methods in analytical chemistry
Unit 19: PART V. LABORATORY PRACTICES

Unit 19.1 Optical methods: 1. Colorimetric determination of nitrites in water samples

Unit 19.2 Optical methods: 2. Determination of veterinary drugs (sulfaquinoxaline and sulfamethazine). Resolution of mixtures using UV-vis spectrophotometry.

Unit 19.3 Electroanalytical methods: 1. Determination of conductivity, salinity, and pH in biological fluids (urine). 2. Determination of Fluorides in mouth rinses using ESI.

Unit 19.4 Separation methods: 1. Separation and determination of AAS and paracetamol by HPLC in pharmaceutical formulations.

Unit 19.5 Separation methods: 2. Separation and determination of antidepressants (sertraline and citalopram) in pharmaceutical formulations by gas chromatography (GC-FID).

7. Activities, Units/Modules and Methodology

Training Activity	Methodology	Related Competences (only degrees before RD 822/2021)	ECTS	Hours	As	Com	Description
Class Attendance (theory) [ON-SITE]	Combination of methods	B01 B02 B03 B04 B05 EQ01 EQ02 EQ03 EQ04 EQ09 EQ10 EQ11 G01 G10 G11 G12 G15 T01 T02 T03 T04 T05 T07	1.44	36	Y	N	The availability of teaching resources will be accessible on the Moodle platform prior to the start of each activity. Additionally, students will have access to supplementary bibliographic and audiovisual material (books, review articles, videos, etc.) in the university library on the Albacete campus. This methodology consists of a combination of methods including EXPOSITORY/LECTURE METHOD and CASE STUDY, which requires active participation from the students through cooperative work, both inside and outside the classroom, as well as the preparation and defense of assignments, problem-solving, and seminars that will be actively resolved throughout the course. This will be considered in the final assessment of the subject.
Class Attendance (practical) [ON-SITE]	Practical or hands-on activities	B01 B02 B03 B04 B05 EQ01 EQ02 EQ03 EQ04 EQ09 EQ10 EQ11 G01 G10 G11 G12 G15 T01 T02 T03 T04 T05 T07	0.8	20	Y	Y	The practical teaching will be conducted in small groups within the periods established in the academic calendar, which do not overlap with other teaching activities. These practical sessions will take place in laboratories equipped with appropriate resources to achieve the proposed objectives. The student will not be able to pass the course if they do not obtain a PASS grade in the practical module (PASS=grade equal to or higher than 4.0). The laboratory for the Analytical Chemistry II course will involve supervised practical sessions closely related to each of the blocks that make up the theoretical contents of the course.
Study and Exam Preparation [OFF-SITE]	Self-study	B01 B02 B03 B04 B05 EQ01 EQ02 EQ03 EQ04 EQ09 EQ10 EQ11 G01 G10 G11 G12 G15 T01 T02 T03 T04 T05 T07	3.6	90	Y	N	Individual work that the student will dedicate to studying and learning the subject content. The student may request personal tutorials on specific subject matter by scheduling an appointment in advance with the corresponding professor.
Formative Assessment [ON-SITE]	Assessment tests	B01 B02 B03 B04 B05 EQ01 EQ02 EQ03 EQ04 EQ09 EQ10 EQ11 G01 G10 G11 G12 G15 T01 T02 T03 T04 T05 T07	0.16	4	Y	N	Specific dates for assessment tests have been scheduled in the academic calendar, which do not overlap with other teaching activities.

Total: 6 150	
Total credits of in-class work: 2.4	Total class time hours: 60
Total credits of out of class work: 3.6	Total hours of out of class work: 90

As: Assessable training activity
Com: Training activity of compulsory overcoming (It will be essential to overcome both continuous and non-continuous assessment).

8. Evaluation criteria and Grading System

Evaluation System	Continuous assessment	Non-continuous evaluation*	Description
Final test	70.00%	70.00%	The student may pass the course through continuous assessment during the semester. To do so, they must take two partial exams that will cover theoretical content as well as problem-solving, seminars, and/or practical cases. 70% of the final grade for the course will be distributed among these two non-compulsory, recoverable partial exams, with each one accounting for 35% of the total course grade. The final grade will be calculated as the average of the two exams ((Exam1 + Exam2) / 2). To pass the course, the student must obtain an overall average grade in the partial exams that allows them to achieve a score of 5.0 or higher, taking into account the remaining grades (laboratory work - 20% - + active participation - 10%).
Laboratory sessions	20.00%	20.00%	Application in the laboratory of the knowledge previously acquired in the theoretical module. The skills acquired in handling chemical substances and laboratory equipment, the attitude of the student, and the proper completion of the laboratory notebook will be evaluated. In addition, a practical exam will be conducted to assess practical content. The overall grade for the practical module will account for 20% of the final grade for the course. Once a PASS grade (equal to or higher than 4.0) is obtained in the practical module, the grade will be retained for the following two academic years, provided that the grade for the practical module is equal to or higher than 5.0. Attendance to the laboratory practical classes is mandatory to pass the module in the regular assessment period. In order to pass the course, the student must have obtained a PASS grade (equal to or higher than 4.0 out of 10) in the practical content module (Block V). If a student does not attend the practical sessions, misses any session without a valid justification, or fails to obtain a PASS grade in the module, they will have to make up for this activity by completing a test (written, oral, or experimental) along with the submission of a practical report that includes the content covered in the practical sessions. The schedule and date for the practical sessions will be provided to the student with sufficient advance notice in order to facilitate course planning. The location where the sessions will take place, the necessary materials, and other relevant details will be provided on the Moodle platform prior to the start of the practical sessions.
Assessment of active participation	10.00%	10.00%	The professor will request the completion of a maximum of two individual assignments (topic development) from the students through the virtual campus and via email (if necessary) during the first three weeks of the first semester. Active participation of the student will be evaluated in both lectures and tutorials, workshops, or other daily in-person activities. Group and individual workshops will be conducted to monitor the student's learning progress, covering theoretical content, seminar solving, and practical cases related to the subject. The student's autonomous work in developing the assigned task(s) throughout the course, as well as oral presentations and/or cooperative work, if applicable, will be positively assessed. Model exercises will be solved on the board (or similar) to help students reinforce the concepts acquired in the theory classes. Active participation of the student in seminars will be evaluated. Students who have not obtained a score in "active participation in class" can improve their grade by submitting one or more

			activities developed during the course (workshop, written assignment, oral presentation, etc.) as defined by the professor, and this will be described on the virtual campus (Moodle platform) at the beginning of the course.
Total:	**100.00%**	**100.00%**	

According to art. 4 of the UCLM Student Evaluation Regulations, it must be provided to students who cannot regularly attend face-to-face training activities the passing of the subject, having the right (art. 12.2) to be globally graded, in 2 annual calls per subject , an ordinary and an extraordinary one (evaluating 100% of the competences).

Evaluation criteria for the final exam:

Continuous assessment:

The professor will assume that all students choose the continuous mode (face-to-face), unless otherwise informed (non-continuous mode, blended learning) via email addressed to the responsible professor of the subject, provided they have not participated in assessable activities during the teaching period that collectively account for at least 50% of the total evaluation of the subject. If a student has achieved that 50% of assessable activities or if, in any case, the teaching period has ended, they will be considered in continuous assessment without the possibility of changing the evaluation mode.

The course will be passed when a minimum of 5.0 points out of 10 is obtained in the WEIGHTED FINAL grade, with a minimum grade of 4.0 in the practical block.

THEORETICAL BLOCK EVALUATION (70% of the final grade): It will consist of 2 non-compulsory partial exams, or 1 compulsory and recoverable final exam. The partial exams will have a weight of 50% each on the theoretical block. The student will have the opportunity to recover this module in a final exam.

PRACTICAL BLOCK EVALUATION (20% of the final grade): ATTENDANCE to laboratory practical sessions is MANDATORY to pass the course in the regular assessment period, and the practical sessions will NOT be recoverable (except for duly justified situations). Evaluation will be based on the presentation of a laboratory notebook, attitude and performance in the laboratory, compliance with safety regulations and waste management, as well as a final exam at the end of the practical sessions. To pass the practical module in the regular assessment period, the student must attend all practical sessions and obtain a grade of at least 4.0 out of 10 in the arithmetic mean between the grade of the notebook, the practical sessions themselves, and the practical exam. This grade will be retained for the following two academic years if the grade for the practical module is equal to or higher than 5.0.

PARTICIPATION EVALUATION (10% of the final grade): Evaluation will be carried out through the development and submission of different activities that the professor will indicate at the beginning of the course and will propose on the virtual campus (Moodle platform) and in the classroom. These activities are NON-COMPULSORY and NOT RECOVERABLE.

Non-continuous evaluation:

As already specified in the previous section, in order to choose the non-continuous assessment mode (blended learning), interested students must request it via email addressed to the responsible professor of the subject, provided they have not participated in assessable activities during the teaching period that collectively account for at least 50% of the total evaluation of the subject. If a student has achieved that 50% of assessable activities or if, in any case, the teaching period has ended, they will be considered in continuous assessment without the possibility of changing the evaluation mode. The course will be passed when a minimum of 5.0 points out of 10 is obtained in the overall grade, and a PASS grade (equal to or higher than 4.0 points) is obtained in the practical block.

THEORETICAL BLOCK EVALUATION (70% of the final grade): It will consist of ONE compulsory and recoverable FINAL exam.

PRACTICAL BLOCK EVALUATION (20% of the final grade): ATTENDANCE to laboratory practical sessions is MANDATORY to pass the course in the regular assessment period, and the practical sessions will NOT be recoverable (except for duly justified situations).

The practical module will be evaluated as follows:
OPTION 1: Students who have NOT obtained a PASS grade in the practical module in the regular assessment, but have attended all practical sessions, will take a practical knowledge test (oral or written) in the extraordinary assessment period. The specific format will be indicated to the student through the virtual campus and via email (individually) with sufficient notice to ensure proper information.

OPTION 2: Students who have not obtained a PASS grade in the practical module in the regular assessment because they have not attended all practical sessions will be evaluated through a test that requires them to demonstrate their acquired competencies in the subject through a practical test (written, oral, or experimental), along with the submission of a report that includes the work carried out in the test. To obtain a PASS grade in the practical module, the student must achieve an overall grade of at least 4.0 out of 10. This grade will be retained for the following two academic years if the grade for the practical module is equal to or higher than 5.0, and if the student indicates their intention to do so (see the section on Specifics of the extraordinary assessment). The day and time of the practical module recovery test will be communicated to the student in advance through the virtual campus and email (if necessary).

PARTICIPATION EVALUATION (10% of the final grade): It applies only to students who have not obtained a score in the continuous assessment activities. To earn points in participation activities, specific activities will be proposed to the student, which will be indicated by the professor through the virtual campus and via email (if necessary). These activities are NON-COMPULSORY and RECOVERABLE (see the section on Specifics of the extraordinary assessment).

Specifications for the resit/retake exam:

The course will be passed when a minimum of 5.0 points out of 10 is obtained in the overall grade, calculated using the following equation: THEORY block grade x (0.7) + PRACTICAL block grade x (0.2)* + PARTICIPATION grade x (0.1).

THEORY BLOCK EVALUATION (70% of the final grade): It will consist of a compulsory and non-recoverable final exam.

PRACTICAL MODULE EVALUATION (20% of the final grade): Students who have not obtained a PASS grade in the practical module in the regular assessment but have attended all practical sessions will take a practical knowledge test (oral or written) in the extraordinary assessment period (OPTION 1). On the other hand, students who have not obtained a PASS grade in the practical module in the regular assessment and have not attended the practical sessions (e.g., students who have chosen the non-continuous assessment model) will need to follow OPTION 2.

PARTICIPATION EVALUATION (10% of the final grade): The grade obtained during the regular assessment will be maintained. However, for students who have not participated in this module during the regular assessment, they will have the opportunity to recover it by completing and submitting activities that will be indicated by the professor with sufficient time for development through the virtual campus or email (if necessary).

Specifications for the second resit / retake exam:

Only students who meet the requirements stated in the Student Evaluation Regulations of the University of Castilla-La Mancha will be eligible for this assessment period, and they will be evaluated according to the criteria applied in the extraordinary assessment.

9. Assignments, course calendar and important dates

Not related to the syllabus/contents	
Hours	**hours**
Class Attendance (theory) [PRESENCIAL][Combination of methods]	36
Class Attendance (practical) [PRESENCIAL][Practical or hands-on activities]	20
Study and Exam Preparation [AUTÓNOMA][Self-study]	90
Formative Assessment [PRESENCIAL][Assessment tests]	4

Global activity	
Activities	**hours**
Class Attendance (theory) [PRESENCIAL][Combination of methods]	36
Class Attendance (practical) [PRESENCIAL][Practical or hands-on activities]	20
Study and Exam Preparation [AUTÓNOMA][Self-study]	90
Formative Assessment [PRESENCIAL][Assessment tests]	4
Total horas:	150

10. Bibliography and Sources

Author(s)	Title/Link	Publishing house	Citv	ISBN	Year	Description
Ángel Ríos Castro, María Cruz Bondi Moreno y Bartolomé M. Simonet Suau	Técnicas espectroscópicas en química analítica Volumen I. Aspectos básicos y espectrometría molecular	Síntesis	Madrid		2012	
	https://www.sintesis.com/biblioteca%20de%20qu%C3%ADmica-138/t%C3%A9cnicas%20espectrosc%C3%B3picas%20en%20qu%C3%ADmica%20anal%C3%ADtica.%20volumen%20i-ebook-1714.html					
Ángel Ríos Castro, María Cruz Bondi Moreno y Bartolomé M. Simonet Suau	Técnicas espectroscópicas en química analítica. Volumen II. Espectrometría atómica, de iones y electrones	S	Madrid	978-84-995893-1-2	2012	
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Gary D. Christian	Química Analítica (6ª Edición)	Mc Graw Hill		0-471-21472-8	2009	
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R. Cela, R.A. Lorenzo, M.C. Casais	Técnicas de separación en Química Analítica	Síntesis	Madrid	84-9756-028-0	2002	
Schwedt, G.	The Essential Guide to Analytical Chemistry	John Wiley and Sons	Chichester	0471974123	1999	
Skoog D. A., West D. M., Holler F. J. y Crouch S.R.	Fundamentos de Química Analítica	Thomson Editores		8497323335	2005	
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R. Compañó y A. Ríos	Garantía de la calidad en los laboratorios analíticos	Síntesis	Madrid	84-9756-024-8	2002	
Skoog, D. A.; Leary, J.J.	Análisis Instrumental	McGraw-Hill	Madrid	84-481-0191-X	1998	
Bard, A. J.; Faulker, L. R	Electrochemical Methods: Fundamentals and Applications	John Wiley and Sons	Chichester	0471043720	2001	
Rubinson K. A.; Rubinson J.F.	Análisis Instrumental	Ed. Prentice Hall		8420529885	2004	
Skoog, D. A; Holler, F. J.; Nieman, T. A	Principios de Análisis Instrumental	McGraw-Hill	Madrid	8448127757	2010	