Corso di Laurea in
SCIENZA E TECNOLOGIA
DEI MATERIALI

Prof. Luigi Gentile
Coordinatore Interclasse
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SYLLABUS – L.Sc.Mat.

General information	
Academic subject	***Analytical Chemistry 2 + Laboratory***
Degree course	*Science and Materials Technology L-Sc.Mat*
Academic Year	*2023/2024*
European Credit Transfer and Accumulation System (ECTS)	6
Language	*Italian/English*
Academic calendar (starting and ending date)	*III Year – II semester*
Attendance	*Not mandatory (but "strongly recommended")*

Professor/ Lecturer	
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Department and address	*Department of Chemistry, Via Orabona 4, 70125 Bari*
Virtual headquarters	*Teams*
Tutoring (time and day)	Office hours upon appointment

Syllabus	
Learning Objectives	*Provide students with the theoretical knowledge of the main instrumental analytical techniques applied in materials science; Acquire skills in the use of analytical instrumentation applied in materials science. Spectroscopic techniques and applied electrochemistry in the study of surfaces. Acquire skills in choosing the optimal analytical method for a specific material. Analysis of practical cases.*
Course prerequisites	*Basic knowledge of General Chemistry: Nomenclature, Redox Equilibria, Acid-Base Equilibria, Chemical Thermodynamics.* *Basic knowledge of Analytical Chemistry I: Analysis methods based on titrations (e.g., acid-base, precipitation, redox, etc.) and electroanalytical chemistry.*
Contents	***Course Presentation:*** *Introduction to Analytical Chemistry 2 + LAB.* ***Introduction to Instrumental Analytical Chemistry:*** *Definition of Instrumental Analytical Chemistry. Definition of the problem and analytical method. Sample preparation and statistical data management. Measurement execution and data evaluation. Limit of detection and other performance figures.* ***Analytical Spectroscopy:*** *Principles of analytical spectroscopy. Molecules and molecular spectroscopy. Lambert-Beer Law: derivation, deviations, and associated errors. Optical systems used in spectroscopy. Nomenclature of instruments. UV/Vis molecular spectroscopy. Instrumentation for UV/Vis molecular spectroscopy. Analytical applications (structural qualitative analysis, quantitative analysis, reaction kinetics, spectrophotometric titrations, solid analysis, spectroelectrochemistry). Numerical exercises. Nephelometry and turbidimetry. Molecular emission spectrometry (fluorescence and phosphorescence). Luminescence and its analytical applications.* ***Atomic Absorption Spectroscopy (AAS):*** *Absorption of radiant energy by atoms. AAS instrumentation. AAS sources. Atomization systems for AAS. Flame and electrothermal atomization. Spectrometer optics. Flame and graphite furnace atomization processes. Interferences in AAS technique. Analytical applications of AAS technique. Sample analysis.*

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	Atomic Emission Spectroscopy (AES): *Flame atomic emission spectroscopy. Interferences and analytical applications. Optical atomic emission spectroscopy. Plasma emission spectroscopy. Atomic fluorescence spectroscopy.* ***X-ray Spectroscopy:*** *Fundamental principles. X-ray fluorescence. X-ray absorption. X-ray emission and diffraction. Instrumentation. Surface and powder analysis.* ***X-ray Photoelectron Spectroscopy (XPS):*** *Principles of electron beam spectroscopy. Instrumentation. Applications of ESCA. Applications of Auger spectroscopy.* ***Electrochemical Impedance Spectroscopy (EIS) and enzymatic biosensors:*** *Electroanalytical chemistry recalls (cyclic voltammetry, formal potential). Direct and alternating currents. Responses to alternating voltage. Impedance of elements in parallel and in series. Impedance in complex fields. Impedance measurements. RC series and parallel. Semi-infinite diffusion. EIS surface analysis. Construction of an enzymatic biosensor. Marcus electron transfer theory. Examples of enzymatic biosensors.* ***Laboratory Experiences:*** 1. *Construction of printed electrodes and electrochemical characterization.* 2. *Construction of an Enzymatic Amperometric Biosensor.* 3. *Surface analysis with electrochemical impedance spectroscopy.*
Books and bibliography	• *Skoog, Holler, Crouch. Chimica Analitica Strumentale, EdiSES, Napoli, ISBN: 9788879593427. (some chapters)* • *Robinson, Skelly Frame, Frame II. Chimica Analitica Strumentale. Un'introduzione, PICCIN, ISBN: 9788829932269. (alternative,some chapters)* • *Chapter provided for electrochemical impedancespectroscopy and enzymatic biosensors.*
Additional materials	*All slides and additional material will be supplied as complementary study material.*

Work schedule			
Total	Lectures	Hands on (Laboratory, working groups, seminars, field trips)	Out-of-class study hours/ Self-study hours
Hours			
145	*40*	*15*	*90*
ECTS			
6	*5*	*1*	
Teaching strategy			
	Lectures with slides, laboratory activities followed by individual and group management of the obtained results. The use of materials distributed by the instructor, which are projected in the classroom during the lectures and made available online, will be crucial. At the end of each lesson, there will be an interactive quiz with students to assess immediate learning of some key concepts discussed during the lecture. The course will be delivered in person. In the presence of ERASMUS students, the course will be delivered in English.		
Expected learning outcomes			

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Knowledge and understanding on:	The course Analytical Chemistry 2 with Lab provides students with knowledge of the main methodologies of spectroscopic analysis, the ability and competence in the use of instrumental analytical methods, and the capacity to choose the analytical method.
Applying knowledge and understanding on:	Ability to design analytical analyses and process experimental data.
Soft skills	*• Judgment autonomy Being able to choose the correct analytical method and select the appropriate instrumental technique.* *• Communication skills Competence in writing laboratory reports; Presentation of concepts during written and oral exams. Skills in processing and presenting laboratory data; Use of appropriate technical terminology.* *• Learning ability Comparing results even from complex instrumental approaches.*

Assessment and feedback	
Methods of assessment	***2 Mid-term exams during the course:*** *Mid-term exams on the topics covered during the course with multiple-choice, numerical exercises and open-ended questions. If the average of the two exemptions is higher than 25/30, one can directly access the oral exam. Optional oral exam with a grade of ≥ 25/30.* ***Written Exam at the End of the Course (Alternative/exemption recovery):*** *Mixed exam with multiple-choice questions, open-ended questions, and numerical problems.* ***Oral Exam at the End of the Course:*** *Discussion of the written test and questions on the syllabus (optional with a grade of ≥ 25/30).* ***Written and oral (optional) exams constitute 80% of the final grade.*** ***Laboratory and Laboratory Reports (20%):*** *Laboratory exercises and reports prepared by the student based on the obtained data.*
Evaluation criteria	• *Knowledge and understanding: Evaluation through written and oral exams with questions related to the covered program. Terminology used for the presentation of theoretical concepts. Knowledge of equations and their dimensional expression.* • *Applied knowledge and understanding: Evaluation through laboratory activities, laboratory reports, and written exams. Knowledge of equations and their application to practical cases.* • *Judgment autonomy: Assessment of the level of understanding and therefore judgment autonomy through interactive quizzes at the end of the lesson. Clarifications to any doubts will be provided during office hours.* • *Communication skills: Ability to organize knowledge discursively; ability for critical reasoning on the conducted study; quality of presentation, proficiency in the use of specialized vocabulary, effectiveness, linearity, etc.* • *Learning ability: Comparing results even from complex instrumental approaches.*
Criteria for assessment and attribution of the final mark	*For the topics covered in the classroom teaching, evaluation is based on the knowledge of the presented content, which will be demonstrated through written, oral exams, and interactive quizzes. A positive evaluation is achieved by demonstrating knowledge of the topic/concept/definition.* *For topics involving laboratory activities: the evaluation is based on the ability to work correctly in the laboratory and interpret the obtained data accurately in written reports. The final grade will be assigned on a scale of thirty with a minimum of 18/30 (minimum passing grade) and a maximum of 30/30 with honors (maximum distinction).*

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Additional information	