Corso di Laurea in
SCIENZA E TECNOLOGIA DEI MATERIALI

Triennale – L30

General information		
Academic subject	***Analytical Chemistry 2 and Laboratory***	
Degree course	*Science and Materials Tecnology L-30*	
Academic Year	*Third year BSc (Second Semester)*	
European Credit Transfer and Accumulation System (ECTS)		6
Language	*Italian/English*	
Academic calendar (starting and ending date)	*According to academic calendar*	
Attendance	*Not mandatory (but "strongly recommended")*	

Professor/ Lecturer	
Name and Surname	Paolo Bollella
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Telephone	
Department and address	*Department of Chemistry, Floor 0, Office n. 15*
Virtual headquarters	*Virtual Room for office hours: Analytical Chemistry 2 (Sci Mat BSc)* *Team code:* ***xuhv81k***
Tutoring (time and day)	Office hours upon appointment

Syllabus	
Learning Objectives	*Share with the students the theoretical concepts about the main instrumental analytical methods applied in materials science; Learn how to use some instruments for materials analysis. Spectroscopic and electrochemical methods applied to surface analysis. Learn how to choose the correct analysis method based on the sample. Practical examples.*
Course prerequisites	*General Chemistry: nomenclature, Redox reactions, acid base equilibrium, Thermodynamic.* *Analytical Chemistry: Titrimetric analysis and electroanalytical chemistry*
Contents	***Course Introduction:*** *Description of Course Syllabus. Studying materials and evaluation methods.* ***Instrumental Analytical Methods:*** *Instruments. Definition of the analytical problem. Instrumental Performance: Figures of merit. Precision. Errors. Sensitivity. Limit of detection. Dynamic linear range. Selectivity.* ***Analytical Spectroscopy:*** *Principles of analytical spectroscopy. Absorption and emission spectra at atomic and molecular level. Qualitative and quantitative analysis in analytical spectroscopy. Lambert-Beer equation: mathematical derivation and exceptions. Absorbance measurement and errors associated. Molar absorptivity. Chromophores. Photometric titrations. Fluorescence and phosphorescence. Emission Spectroscopy: Photoluminescence, chemiluminescence and bioluminescence.* ***Practical Aspects in Analytical Spectroscopy:*** *Source; wavelength selectors: filters, monochromators: prisms or diffraction grating. Passband. Detectors: phototube, photomultiplier, diodes. Spectrophotometer single and double beam in time and space, background noise removal by using a chopper.*

	Atomic Spectroscopy with Flame and Thermoelectric Atomizers: *Atomic Spectra. Samples Atomization. Flame Atomizers. Thermoelectric Atomizers. Flame Emission Spectroscopy. Atomic Fluorescence Spectroscopy.* ***X-ray Spectroscopy:*** *Principles. X-ray emission. X-ray absorbance. X-ray fluorescence and diffraction. Instrumentation. Surface and powder analysis.* ***Electronic Spectroscopy:*** *Principles. Instrumentation. ESCA applications. Auger Spectroscopy.* ***Electrochemical Impedance Spectroscopy (EIS):*** *Direct and alternated current. Principles of EIS. History of EIS. Circuit elements. Graphic representation of EIS data. Equivalent circuit and associated errors. EIS applications to corrosion phenomena. In situ application (e.g., cultural heritage, car industry and infrastructure).* ***Spectroelectrochemistry (UV-Vis, IR, Raman):*** *Principles. Instrumental apparatus. Surface analysis and electrochemical processes.* ***Laboratory:*** 1. *UV-Vis spectrophotometer construction.* 2. *Photometric titration of an acid-base indicator.* 3. *Surface analysis with EIS.*
Books and bibliography	• *D. C. Harris, Quantitative Analytical Chemistry, 7th edition, 2010* • *Skoog, West, Holler, Crouch. Fundmentals of Analytical Chemistry, 10th edition.* • *Electrochemical Methods A.J. Bard, L.R. Faulkner –Wiley*
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			
150	*40*	*15*	*95*
ECTS			
6	*5*	*1*	
Teaching strategy			
	Lectures with projected slides, lab activity followed by data analysis. It is extremely important to use the material projected during the lectures. At the end of each lecture, there will be interactive questions to verify the key concept disclosed during the lecture (e.g., kahoot etc.). The course will be held in class. In case of COVID-19 restrictions, the course will be held as Blended Learning, meaning lectures delivered online through TEAMS, while the lab will be carried out on campus by using individual protection devices (e.g., face shields, masks FFP2, lab coat, etc.), social distancing and all rules officially applied by the government. In case of ERASMUS students, lectures will be delivered in ENGLISH.	
Expected learning outcomes			

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Knowledge and understanding on:	The course Analytical Chemistry 2 will supply the student with knowledge about analytical spectroscopy, theoretical knowledge, and practical skills. The class will teach how to select the correct analytical methods depending on the material that needs to be analysed.
Applying knowledge and understanding on:	Ability to develop an analytical method and analyse the final results.
Soft skills	• *Making informed judgments and choices* Ability to select the correct analytical method. • *Communicating knowledge and understanding* Ability to write lab reports; Ability to discuss the knowledge acquired about the different topics both during the written and oral exam. Use the appropriate terminology. • *Capacities to continue learning* Compare data obtained by using complex analytical methods.

Assessment and feedback	
Methods of assessment	
Evaluation criteria	• *Knowledge and understanding* Evaluation at the written and oral exam with questions about the different topics encountered during the course. Correct terminology. Knowledge of equations. • *Applying knowledge and understanding* Evaluation of lab activity. Knowledge of equations and their application to practical cases. • *Autonomy of judgment* Auto-evaluation through the interactive questions at the end of each lecture. Additional explanations and clarifications will be given during office hours. • *Communicating knowledge and understanding* Ability to discuss about a specific topic with the correct terminology, with a critic evaluation of the analytical methods discussed during the class. • *Capacities to continue learning* Ability to compare results obtained with complex analytical approaches.
Criteria for assessment and attribution of the final mark	***2 Mid-term exams (35%):*** *Exams on the topics encountered during the class with multiple choices and open questions. With a grade above 25/30 the student can proceed to the oral exam.* *Alternatively* ***Final written Exam (35%):*** *Mixed exam with multiple choices and open questions.* ***Oral Exam (35%):*** *Discussion of written exam and questions on the topics encountered during the course.* ***Lab experiments and reports (20%):*** *Lab experiments and final reports with data analysis.* ***Interactive questions (10%):*** *Correct answers to the interactive questions.* *For the different topics discussed during the lectures, the knowledge will be assessed through a written exam, oral exam, and interactive questions (during the lectures). The positive evaluation is a result of the correct knowledge about specific topics and definitions. For the lab part, the attitude to work in the lab and the final report will be both evaluated. The final grade will be assigned in fractions of 30 with a minimum of 18/30 and a maximum of 30/30 cum laude.*
Additional information	

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