General information	
Academic subject	Experimentations of Crystallography
Degree course	Bachelor degree in MATERIALS SCIENCE AND TECHNOLOGY (L30)
Academic Year	2021/2022
European Credit Transfer and Accumulation System (ECTS)	3
Language	Italian
Academic calendar (starting and ending date)	Second semester of the third year (from March to June)
Attendance	According to Didactic Regulation

Professor/ Lecturer	
Name and Surname	Rosa Anna Fregola
E-mail	rosaanna.fregola@uniba.it
Telephone	080 5443469
Department and address	Dipartimento di Scienze della Terra e Geoambientali (Bari)
Virtual headquarters	Teams Platform (Team "Esperimentazioni di Cristallografia")
Tutoring (time and day)	By appointment to be agreed upon e-mail

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Syllabus	
Learning Objectives	Acquisition of practical skills about the application of knowledge on morphological crystallographic symmetry to the analysis of models of crystalline solids, and to its representation by stereographic projection; application of knowledge on structural crystallographic symmetry to practical cases by analyzing X-ray diffraction figures.
Course prerequisites	Basis of: trigonometry; vector calculus; matrix calculus; structural crystallography.
Contents	Recall of crystallographic symmetry with exercises. Analysis of crystalline solids with cubic, tetragonal, trigonal, hexagonal, orthorhombic, and monoclinic symmetry: morphological symmetry elements and point group determination, crystallographic faces indexing, stereographic projection of the morphological symmetry elements and faces. Recall of structural crystallography (X-ray diffraction from crystal lattices, Laue conditions, Bragg law, Ewald sphere, reciprocal lattice, relations between direct and reciprocal space). Application of crystallographic calculus for unit cell parameters determination of crystals with different symmetry properties. X-ray diffraction techniques for crystallographic characterization of crystalline materials (methods of Laue, Buerger, rotating crystal, Weissenberg, X-ray diffraction topography, four-circles single crystal diffractometer and area detector, powder diffractometer); interpretation of X-ray diffraction figures for determining the cell parameters of crystals with different symmetry; recognition of systematic extinction rules on diffraction figures and their application for determining space group structural symmetry.
Books and bibliography	Stout & Jensen, X-ray structure determination: A practical guide (Collier-Macmillan); Carobbi, Fondamenti di cristallografia e ottica cristallografica

	(UTET); Giacovazzo, Fundamentals of Crystallography (Oxford University Press); Giacovazzo, Introduzione alla cristallografia moderna (Laterza); Prince, International Tables for Crystallography Volume C: Mathematical, physical and chemical tables (Kluwer Academic Publishers).
Additional materials	Only selected chapters. The reference books are available to everybody for consultation at the Library of the Department of Earth and Geo-environmental Sciences – Slides and lecture notes are also provided

Work schedule			
Total	Lectures	Hands on (Laboratory, working groups, seminars, field trips)	Out-of-class study hours/ Self-study hours
Hours			
75		45	30
ECTS			
3		3	

Teaching strategy	Blended learning
	Theoretical lessons with projection of slides aimed at the acquisition of the required knowledge, interspersed with guided exercises and laboratory activities aimed at the practical application of the acquired knowledge. The active participation of students will be stimulated with questions, discussions, and ongoing evaluations.
Expected learning outcomes	
Knowledge and understanding on:	○ Knowledge of the morphological crystallographic symmetry of crystalline solids and of its representation methods in stereographic projection; ○ Knowledge of the structural crystallographic symmetry of crystalline solids and of the main X-ray diffraction techniques useful for its determination.
Applying knowledge and understanding on:	○ Ability to autonomously determine and represent the morphological crystallographic symmetry of crystalline solids by simple experiments; ○ Ability to autonomously determine the structural crystallographic symmetry of crystalline solids by simple experiments and to interpretate experimental data.
Soft skills	• *Making informed judgments and choices* At the end of the course, students must be able to: ○ Evaluate and identify autonomously the most appropriate methods and procedures to be adopted for the crystallographical characterization of crystalline materials; ○ Interpret experimental data useful for the crystallographic characterization of crystalline materials, through the practical solution of case studies. • *Communicating knowledge and understanding* At the end of the course, students must be able to: ○ express themselves clearly and with appropriate scientific language in the presentation and dissemination of the

	acquired knowledge; ○ explain how to deal with a practical case study and to properly present results. • *Capacities to continue learning* ○ Ability to independently investigate the contents provided during the lessons with the reference texts, and possibly with other sources, knowing how to critically judge their reliability; ○ Ability to autonomously establish relationships and make connections between the contents of this course and other knowledge acquired in the course of study.

Assessment and feedback	
Methods of assessment	Partial written tests with a brief discussion during the oral examination; or, alternatively, only in-depth oral examination.
Evaluation criteria	• *Knowledge and understanding* ○ Minimum level: basic knowledge of the morphological symmetry properties of crystalline materials, of its representation methods in stereographic projection, of structural symmetry and of the different X-ray diffraction techniques of characterization, is evaluated as sufficient; ○ Higher level: the in-depth and detailed knowledge of the same topics is also positively evaluated. • *Applying knowledge and understanding* ○ Minimum level: basic ability to autonomously determine and represent the morphological crystallographic symmetry of crystalline solids, and to determine the structural crystallographic symmetry by simple experiments and interpretation of experimental data; ○ Higher level: the in-depth and detailed knowledge of the same topics is also positively evaluated. • *Autonomy of judgment* ○ Minimum level: the ability to identify the most appropriate methods and procedures, and to interpret the experimental data for the crystallographic characterization of crystalline materials, through the practical solution of case studies, is evaluated as sufficient; ○ Higher level: the critical and argumentative capacity of the choices and procedures adopted is also positively evaluated. • *Communication skills* ○ Minimum level: the ability to express themselves clearly and with appropriate scientific language in the presentation and dissemination of the acquired knowledge, and of experimental results in oral and /or written form, is evaluated as sufficient; ○ Higher level: the rigor and depth of the exposition, as well as the ability to make connections between different topics, are also positively evaluated. • *Capacities to continue learning*

	○ Minimum level: the ability to deepen the contents provided during the lessons by integrating them with the reference texts is evaluated as sufficient; ○ Higher level: the ability to independently find other sources, knowing how to recognize their reliability, and the ability to establish relationships and make connections between the contents of this course and other knowledge acquired during the course of study, are positively evaluated.
Criteria for assessment and attribution of the final mark	The final grade is awarded out of thirty. The exam is passed when the grade is greater than or equal to 18. In formulating the final judgment, the way of carrying-out the partial written tests and/or the oral interview will be taken into account. The commitment, the degree of autonomy and the method of approach shown by the student in dealing with the practical exercises, carried out during the course of the lessons, will also be positively judged. To achieve a high evaluation, the student must have developed autonomy of judgment and adequate capacity for argumentation and presentation.
Additional information	