2026 年度シラバス

科目分類/Subject Categories			
学部等/Faculty	/大学院工芸科学研究科（博士前期課程）：/Graduate School of Science and Technology (Master's Programs)	今年度開講/Availability	/有 ：/Available
学域等/Field	/物質・材料科学域 ：/Academic Field of Materials Science	年次/Year	/１～２年次 ：/1st through 2nd Year
課程等/Program	/機能物質化学専攻 ：/Master's Program of Functional Chemistry	学期/Semester	/春学期 ：/Spring term
分類/Category	/授業科目 ：/Courses	曜日時限/Day & Period	/ : /

科目情報/Course Information				
時間割番号 /Timetable Number				
科目番号 /Course Number	61960020			
単位数/Credits	3			
授業形態 /Course Type	講義 ：Lecture			
クラス/Class				
授業科目名 /Course Title	Microscopy and structural characterization techniques : Microscopy and structural characterization techniques			
担当教員名 / Instructor(s)	/ベニス大学教員（機能物質化学専攻ダブル・ディグリープログラムコース）：Related teacher of Ca' Foscari University of Venice (Double Degree Program course in the Master's Program of Functional Chemistry)			
その他/Other	インターンシップ実施科目 Internship	国際科学技術コース提供科目 IGP	PBL 実施科目 Project Based Learning	DX 活用科目 ICT Usage in Learning
	実務経験のある教員による科目 Practical Teacher			
科目ナンバリング /Numbering Code				

授業の目的・概要 Objectives and Outline of the Course	
日	
英	This course is one of the core educational activities in the Master's degree in Science and Technology of Bio and Nanomaterials, that describes some of the common approaches to characterise materials. The aim of the course is to give the basic of crystallography and diffraction as a tool to characterize solid state materials. Learning objectives involve understanding of basic principles of crystallography and X-ray diffraction and applying these principles to master the underlying concepts of structural characterisation. The basic principle of symmetries in solids will be outlined and developed in order to have a quantitative tool in the characterisation of materials. These knowledges will be then used to interpret the X-ray diffraction data. At the end of the course the students will be able to identify crystalline phases present in any kind of material, to determine the mean particle size, o understand the structural modifications due, for example, to doping. Learning objectives involve developing an understanding of electron microscopy principles, and applying these principles to master the underlying concepts of image interpretation. The basic principle of electron microscopy will be outlined and developed in order to understand the characteristic and properties of these modern instruments used in the characterisation of nanostructured materials. The course will start from the basic principle of geometrical optics and then the new knowledge necessary to understand the functioning of an electron microscope will be built step by step. At the end of the course the students will be able to interpret an electron microscopy image and to obtain from it the atomic and structural-morphological properties of interest. The practical part (laboratory end exercises) will be mainly focused on the study of nanoparticles and of nanostructured and hybrid materials.

学習の到達目標 Learning Objectives	
日	
英	to understand basic principles of crystallography and X-ray diffraction and to apply these principles to master the underlying concepts of structural characterisation to learn the basic principle of symmetries in solids and to utilize it as a quantitative tool in the characterisation of materials for interpretation of the X-ray diffraction data. to understand electron microscopy principles and to apply these principles to master the underlying concepts of image interpretation.

学習目標の達成度の評価基準 / Fulfillment of Course Goals（JABEE 関連科目のみ）	
日	
英	

授業計画項目 Course Plan			
No.		項目 Topics	内容 Content
1	日		
	英	Introduction to crystallography (1)	Bravais lattices, point groups, space groups
2	日		
	英	Introduction to crystallography (2)	Definition of Zone Axis, Weiss law
3	日		
	英	Introduction to crystallography (3)	Reciprocal space, reciprocal lattice, Ewald sphere
4	日		
	英	X-ray technique (1)	Interaction X-photon-matter, Instrumentation
5	日		
	英	X-ray technique (2)	X-ray technique (2)
6	日		
	英	X-ray technique (3)	Application of X-ray diffraction in the study of hard and soft matters
7	日		
	英	X-ray technique (4)	Scherrer equation, Rietveld method.
8	日		
	英	Methods used in materials characterisation （Theoretical 1)	The Human eye: how it works and its limitation
9	日		
	英	Methods used in materials characterisation （Theoretical 2)	Geometrical optics: thin lens equation, lens aberration, lens systems
10	日		
	英	Methods used in materials characterisation （Theoretical 3)	Light-optic Microscopy
11	日		
	英	Methods used in materials characterisation (Practical)	Practical lessons of various microscopic instruments
12	日		
	英	Electron microscopy (Theoretical 1)	Electron Optics; properties of a thin magnetic lens, defect of electron lenses;Electron gun: thermoionic and field emission
13	日		

	英	Electron microscopy (Theoretical 2)	Kinematic of scattering by an atomic nucleus; electron-electron scattering; the dynamic of scattering
14	日		
	英	Electron microscopy (Practical 1)	Transmission electron microscopy: types of contrast: scattering contrast, diffraction contrast. Electron diffraction; bright field and dark field images; phase contrast. High resolution TEM. TEM specimen preparation.
15	日		
	英	Electron microscopy (Practical 2)	Scanning electron microscopy: operating principles, secondary electrons, backscattered electrons. The environmental SEM; SEM specimen preparation. Analytical electron microscopy.

履修条件 Prerequisite(s)	
日	
英	

授業時間外学習（予習・復習等） Required study time, Preparation and review	
日	
英	This is a math-intensive course, and it is expected that students have previous experience with calculus. In addition, students should be familiar with the concepts learned in calculus-based physics.

教科書／参考書 Textbooks/Reference Books	
日	
英	Christopher Hammond, The Basic of Crystallography and Diffraction, 4th edition, Oxford science publication, 2015. Pecharsky Vitalij, Zavalij Peter, Fundamentals of Powder Diffraction and Structural Characterization of Materials,Springer. Berlin, 2008. Fultz Brent, Howe James, Transmission Electron Microscopy and Diffractometry of Materials, Springer 4th edition 2013.

成績評価の方法及び基準 Grading Policy	
日	
英	The knowledge acquired by the students will be verified through oral examinations. The students will be asked to solve some numerical exercises related to the arguments explained during lessons. Furthermore the students will be asked to answer some theoretical questions about topics developed during classes.

留意事項等 Point to consider	
日	
英	