City University of Hong Kong
Course Syllabus

offered by Department of Materials Science and Engineering
with effect from Semester A 2022/23

Part I Course Overview

Course Title:	**Instrumentation for Materials Characterization**
Course Code:	**MSE5301**
Course Duration:	**One semester**
Credit Units:	**3**
Level:	**P5**
Medium of Instruction:	**English**
Medium of Assessment:	**English**
Prerequisites: *(Course Code and Title)*	**Nil**
Precursors: *(Course Code and Title)*	**Nil**
Equivalent Courses: *(Course Code and Title)*	**AP5301 Instrumental Methods of Analysis and Laboratory (From the old curriculum)**
Exclusive Courses: *(Course Code and Title)*	**AP8301 Instrumental Methods of Analysis and Laboratory (From the old curriculum)**

Part II Course Details

1. Abstract

This course introduces fundamental theoretical framework for instrumentation techniques used in characterizing structural, compositional, and surface properties in materials. It aims to provide knowledge on characterization in terms of materials properties and corresponding physics, instrumentation consideration, strength and limitations. Hands-on experience in laboratory will be provided for several selected analytical techniques.

Topics covered: diffraction of x-ray and electron beam; crystal structure representation; Fourier analysis; reciprocal space; x-ray generation; electron beam generation and focusing; detection technique; atomic force microscope; photoemission spectroscopy; and scanning electron microscope et. Selected topics on advanced characterization will be provided, such as Grazing-Incidence Wide-Angle X-ray Scattering (GIWAXS), Kelvin probe force microscope; and high-resolution atomic scale imaging etc.

2. Course Intended Learning Outcomes (CILOs)

(CILOs state what the student is expected to be able to do at the end of the course according to a given standard of performance.)

No.	CILOs	Weighting* (if applicable)	Discovery-enriched curriculum related learning outcomes (please tick where appropriate)		
			A1	*A2*	*A3*
1.	Theoretical framework of various analytical instruments.			√	
2.	Materials properties and corresponding theory for quantitative analysis.			√	
3.	Instrumental and material design from source generation to detection.			√	
4.	Knowledge of strength and limitations of various instrumentation techniques.				
** If weighting is assigned to CILOs, they should add up to 100%.*		100%			

A1: Attitude
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to self-life problems.

A3: *Accomplishments*
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

3. Teaching and Learning Activities (TLAs)

(TLAs designed to facilitate students' achievement of the CILOs.)

TLA	Brief Description	CILO No.				Hours/week (if applicable)
		1	2	3	4	
Lectures	Explain the relevant concepts and applications	√	√	√	√	26 hrs / 13 wks
Term Paper	Apply the knowledge to solve practical problems	√	√	√	√	
Laboratories	Conduct relevant experiments to obtain practical understanding	√	√	√	√	2 hrs / 6 wks

4. Assessment Tasks/Activities (ATs)

(ATs are designed to assess how well the students achieve the CILOs.)

Assessment Tasks/Activities	CILO No.						Weighting*	Remarks
	1	2	3	4				
Continuous Assessment: 50%								
Laboratories	√	√	√	√			35%	
Term Paper	√	√	√	√			15%	
Examination (duration: 2 hours)	√	√	√	√			50%	
** The weightings should add up to 100%.*							100%	

5. Assessment Rubrics

(Grading of student achievements is based on student performance in assessment tasks/activities with the following rubrics.)

Applicable to students admitted in Semester A 2022/23 and thereafter

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B)	Marginal (B-,C+, C)	Failure (F)
1. Laboratory and Term Paper	Ability to understand and explain the relevant materials	High	Moderate	Basic	Not even reaching marginal levels
2. Final Examination	Ability to understand and explain the relevant materials	High	Moderate	Basic	Not even reaching marginal levels

Applicable to students admitted before Semester A 2022/23

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B, B-)	Fair (C+, C, C-)	Marginal (D)	Failure (F)
1. Laboratory and Term Paper	Ability to understand and explain the relevant materials	High	Significant	Moderate	Basic	Not even reaching marginal levels
2. Final Examination	Ability to understand and explain the relevant materials	High	Significant	Moderate	Basic	Not even reaching marginal levels

Part III Other Information (more details can be provided separately in the teaching plan)

1. Keyword Syllabus

- Overview of analytical techniques
- Crystal structure and material composition
- Optical Microscopy
- Electron Microscopy
- X-ray analysis
- Diffraction techniques
- Scanning probe microscopy
- Atomic force microscopy
- Surface techniques
- Instrument and material design
- Advanced development in characterization

2. Reading List

2.1 Compulsory Readings

(Compulsory readings can include books, book chapters, or journal/magazine articles. There are also collections of e-books, e-journals available from the CityU Library.)

1.	Encyclopedia of Materials Characterization, edited by C Richard Brundle, Charles A Evans, Jr, and Shaun Wilson, Butterworth-Heinemann (1992)

2.2 Additional Readings

(Additional references for students to learn to expand their knowledge about the subject.)

1.	X-ray Microanalysis in the Electron Microscope (4th Edition), by J A Chandler, North Holland (1987)
2.	Methods of Surface Analysis: Techniques and Applications, edited J M E Walls, Cambridge University Press (1990)
3.	Secondary Ion Mass Spectrometry, by Benninghoven, Rudenauer, and Werner, John Wiley & Sons (1987)
4.	Surface Analytical Techniques, by J C Riviere, Oxford University Press (1990)
5.	Modern Techniques of Surface Science, by D P Woodruff and T A Delchar, Cambridge University Press (1994)
6.	Analysis of Microelectronic Materials and Devices, edited by M. Grasserbauer and H W Werner, John Wiley & Sons (1991)