Hong Kong Baptist University
Faculty of Science – Department of Physics

Title (Units): **PHYS 4026 SURFACE ANALYSIS AND CHARACTERIZATION (3,3,1)**

Course Aims: This course provides students an insight on understanding the most commonly used techniques for materials characterization with emphasis on surface analysis, and analytical methods that are widely used for application in characterizing surface properties of chemicals, polymers, ceramics, semiconductors, alloys, metals and composites.

Target Student: Analytical and Testing Science major students

Pre-requisite: PHYS3015 Structure and Properties of Matter or CHEM 3027 Materials Testing and Characterization or consent of instructor.

Course Reviewed by: Dr. Zhifeng Huang and Prof. Furong Zhu

Course Intended Learning Outcomes (CILOs):

Upon successful completion of this course, students should be able to:

No.	Course Intended Learning Outcomes (CILOs)
1	Explain the scientific approaches of various material analytical techniques outlined in the course content
2	Describe the current concepts and applications of contact angle, kinetic energy of photoelectrons, binding energies of atoms, molecules and solids in material testing.
3	Describe the concepts and applications of modern electron and photoelectron spectroscopy technologies used to characterize morphologic, surface chemical and electronic properties of materials.
4	Become familiar with relevant surface analysis technologies by illustrating the application of each technique for solving surface-related problems through topical assignments. (Assignments may include giving presentations and reports of the field visits to the advanced testing labs at universities, Science Park, local companies, and Culture Heritage Museum, etc.)

Hong Kong Baptist University
Faculty of Science – Department of Physics

Teaching and Learning Activities (TLAs):

CILOs	TLAs will include the following:
1-4	Students will learn from lectures on the concepts and related issues of the topics outlined in the course content.
1-4	Emphasis is placed on the applications of different surface analysis and characterization techniques in material testing.
1-4	Applications to typical analytical problems will be discussed to highlight the unique capabilities of each surface sensitive technique, for example, trace element detection, surface sensitivity, chemical state determination, depth-profiling, qualitative and quantitative analysis.
1-4	5 out of 6 topics listed in the content will be covered, reading assignments including book chapters and journal articles, and field trips, e.g., visits to the advanced testing labs at universities, Science Park and the Cultural Heritage Museum etc., will be arranged as part of the effort to learn this course. Appropriateness of different surface techniques for many typical analysis situations will be discussed. Students will have a good background to the most commonly used techniques for surface analysis, understanding the advantages and limitations of each.

Assessment:

No.	Assessment Methods	Weighting	CILOs to be addressed	Remarks
1	Continuous Assessment (assignments and quizzes)	30%	1-4	Assignments and quizzes are designed to measure how well the students have learned the basic principles and applications of various testing techniques used in modern laboratories.
2	Presentation and report	20%	1-4	Group project presentations, reading assignment and field trip reports are graded based on students' understanding on the characterization techniques and critical discussions by giving actual examples in material applications.
3	2-hour Final Examination	50%	1-4	Final Examination questions are designed to see how far students have achieved their intended learning outcomes. Questions will be primarily based on the analysis of students' ability to select and apply appropriate characterization techniques in material applications.

Hong Kong Baptist University
Faculty of Science – Department of Physics

Learning Outcomes and Weighting:

Content	**LO No.**	**Teaching (in hours)**
I. Contact Angle in Surface Analysis	1-4	4
II. Scanning Probe Microscopy	1-4	6
III. Electron Spectroscopy for Chemical Analysis	1-4	6
VI. Ultraviolet Photoelectron Spectroscopy	1-4	6
V. Secondary Ion Mass Spectrometry	1-4	6
VI. Topics of Current Interests	1-4	10

Textbook: None.

References:

1. John C. Vickerman, Ian S. Gilmore, Surface Analysis: The Principal Techniques, J. Wiley, 2009.
2. Peter Eaton and Paul West, Atomic Force Microscopy, Oxford, 2010.
3. D. Sarid, Scanning Force Microscopy: With Applications to Electric, Magnetic and Atomic Forces, Oxford Series in Optical and Imaging Sciences, Oxford, 1994.
4. H. Bubert, H. Jenett, Surface and Thin Film Analysis: Principles, Instrumentation, Applications, Wiley-VCH, 2002.
5. D. Briggs, Surface Analysis of Polymers by XPS and static SIMS, Cambridge University Press, 1998.
6. A. Benninghoven, F.G. Rudenauer, H.W. Werner, Secondary Ion Mass Spectrometry: Basic Concepts, Instrumental Aspects, J. Wiley, 1987.
7. L. C. Feldman, J. W. Mayer, Fundamentals of Surface and Thin Film Analysis, North-Holland, 1986.

Hong Kong Baptist University
Faculty of Science – Department of Physics

Course Contents in Outline:

		Hours
I.	Contact Angle in Surface Analysis	4
	A. How do we define surface?	
	B. Contract angle measurement	
	C. Surface energy of a homogeneous solid surface	
	D. Application of contact angle measurement	
II.	Scanning Probe Microscopy	6
	A. Basics of scanning tunneling microscopy	
	B. Atomic Force Microscopy	
	C. Analysis of AFM images	
	D. Examples of AFM in material characterization	
III.	Electron Spectroscopy for Chemical Analysis (ESCA)	6
	A. The basic ESCA experiment	
	B. Quantification of data	
	C. Elemental analysis	
	D. ESCA in chemical analysis	
IV.	Ultraviolet Photoelectron Spectroscopy	6
	A. Basic concepts	
	B. Experimental considerations	
	C. Analysis of UPS spectrum	
	D. Examples of UPS in material characterization	
V.	Secondary Ion Mass Spectrometry (SIMS)	6
	A. What is SIMS?	
	B. Use of SIMS in near surface regions	
	C. SIMS depth profiling	
	D. Examples of SIMS in material characterization	
VI.	Topics of Current Interests	10
	A. Guest lectures	
	B. Case studies	
	C. Group project presentations	
	D. Field trips	