City University of Hong Kong
Course Syllabus

offered by
Department of Mechanical Engineering
with effect from Semester A 2019 / 2020

Part I Course Overview

Course Title:	Electron Microscopy
Course Code:	MNE6119
Course Duration:	One Semester
Credit Units:	3 credits
Level:	P6
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)*	MBE6119/MBE8106/MNE8106 Electron Microscopy
Exclusive Courses: *(Course Code and Title)*	Nil

Part II Course Details

1. Abstract

This course focuses on theories and applications of modern electron microscopy including Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM) and X-Ray Energy Dispersive Spectroscopy. Lectures cover basic electron optics, electron-beam and specimen interactions, electron diffraction, advanced electron imaging techniques and image interpretation, vacuum system and instrumentations, qualitative and quantitative X-ray microanalysis. The theoretical understanding gained by students will help them understand and interpret experimental data as well as perform electron microscopy experiments. Hands-on experience is also emphasized, which includes sample preparation techniques and use electron microscope(s).

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.	Describe the theory and applications of electron microscopy and spectroscopy techniques (SEM/TEM/EDS)			✓	
2.	Explain the SEM/TEM/EDS principles and the basic instrumentation and hardware			✓	
3.	Apply SEM/TEM/EDS for imaging, diffraction and spectroscopy experiments and data analysis			✓	
		N.A.			

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	
Lecture	lectures on the topics of the keyword syllabus; total 39 hours	✓	✓	✓		3 hours per week
Laboratory	lab experiments; total 6 hours			✓		2 lab sessions of 3 hours each

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: 40%						
Test	✓	✓			20%	In-class test (mid-term)
Laboratory			✓		20%	Lab reports
Examination: 60% (duration: 2 hours)			✓	✓	60%	
					100%	

For a student to pass the course, at least 30% of the maximum mark for both coursework and examination should be obtained.

5. Assessment Rubrics

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

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B, B-)	Fair (C+, C, C-)	Marginal (D)	Failure (F)
1. Test	Ability to explain the basic theories and applications of electron microscopy and spectroscopy techniques, including basic electron optics, electron-beam and specimen interactions, electron imaging techniques and image interpretation; and the basic knowledges and applications of EDS for X-ray microanalysis.	High	Significant	Moderate	Basic	Not even reaching marginal levels
2. Lab reports	Ability to demonstrate the theoretical understanding gained from lectures to understand and interpret experimental data as well as perform the SEM/TEM experiments; and the evidence of background work done by the students before and after experiments, presentation of results, discussion on the observations and measurements, references, and organization and quality of presentation.	High	Significant	Moderate	Basic	Not even reaching marginal levels
3. Examination	Ability to explain the electron microscopy (SEM/TEM) principles, including basic electron optics, electron-beam and specimen interactions, electron diffraction, advanced electron imaging techniques and image interpretation; the basic theories of X-Ray Energy Dispersive Spectroscopy (EDS) and its applications for qualitative and quantitative X-ray microanalysis; the fundamentals of the modern electron microscope hardware, including vacuum system, and other basic instrumentations.	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

(An indication of the key topics of the course.)

- This course covers theory and applications of electron microscopy techniques with an emphasis on transmission and scanning electron microscopy (TEM, SEM). Topics include modern electron microscope and instrumentation, electron optics, electron diffraction, imaging techniques, tomography (electron backscatter diffraction, EBSD), and X-ray microanalysis (energy dispersive spectroscopy, EDS), as well as recently developed in situ electron microscopy techniques.

- Hands-on laboratory using the instruments in the CSE advanced microscopy platform (FEI Quanta 450 FE-SEM) and department's SEM (JEOL JSM-5600, FEI Quanta 250) and TEM (JEOL 2100F). The students will gain the knowledge and ability necessary to prepare the samples, operate the instruments and analyze data independently.

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.	J. Goldstein et al., "Scanning Electron Microscopy and X-Ray Microanalysis" Springer (3rd edition)
2.	D.B. Willams and C.B. Carter, "Transmission Electron Microscopy: A Textbook for Materials Science" Springer (2nd edition)

2.2 Additional Readings

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

1.	P.J. Goodhew, J. Humphreys and R. Beanland, "Electron Microscopy and Analysis" Taylor & Francis Group 3rd edition