



香港城市大學
City University of Hong Kong

SYL

Course Syllabus

**offered by Department of Materials Science and Engineering
with effect from Semester B 2023/24**

This form is for the completion by the Course Leader. The information provided on this form is the official record of the course. It will be used for the City University's database, various City University publications (including websites) and documentation for students and others as required.

Please refer to the Explanatory Notes on the various items of information required.

Prepared / Last Updated by:

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Part I Course Overview

Course Title:	Theory and Practice of Transmission Electron Microscopy and Related Spectroscopy
Course Code:	MSE8015
Course Duration:	One Semester
Credit Units:	3
Level:	R8
Medium of Instruction:	English
Medium of Assessment:	English
Prerequisites: <i>(Course Code and Title)</i>	Nil
Precursors: <i>(Course Code and Title)</i>	Nil
Equivalent Courses: <i>(Course Code and Title)</i>	Nil
Exclusive Courses: <i>(Course Code and Title)</i>	Nil

Part II Course Details

1. Abstract

The basically mathematics tools, Fourier transform and Convolution to illustrate the imaging theory of electron microscopy will be firstly introduced. The Abbe microscopy theory and lens aberration in Fourier optics will be discussed. The physics of electron Beam-Sample Interaction that gives the structural signal and radiation damage will be explained. Several imaging modes at atomic resolution in parallel (HRTEM) and focus beam modes will be discussed in detail. The electron beam effect on the dose (rate) dependent in-situ TEM experiment will be explored in detail. Finally, the theory and practice of the future trend of high space / time resolution TEM for atomic resolution dynamics will be discussed in depth. In the end, the theory of atomic resolution EDX and EELS will be lectured.

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 mathematics tools: Fourier transform and Convolution			√	
2.	Describe Abbe Imaging Theory and Aberration Theory and Fourier Optics			√	
3.	Describe Electron Beam-Sample Interaction: Elastic Scattering and In-elastic Scattering, Signal and / Radiation Damage			√	
4	Analyze of Structure via Diffraction Pattern			√	
5	Describe Imaging Modes and Imaging Interpretation: Bright Field/ Dark Field, Atomic Resolution in HRTEM and STEM modes			√	
6	In-Situ Transmission Electron Microscopy: Seeing and Believing is Wrong. What do we control to get it right? Dose vs Dose Rate			√	
7	The Future Trend: High Space/ Time Resolution Electron Microscopy: The theory and practice of atomic resolution dynamics for materials science			√	
8	Atomic Resolution Spectroscopy: EELS and EDX			√	
* 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	5	6	7	8	
Lectures	Detail Theory on Fourier Optics, Abbe Microscopy Imaging, Electron Beam Sample interaction, Atomic Resolution Imaging of Parallel and Focus Beams, Radiation Damage, In-Situ Electron Microscopy, High Space/ Time Resolution TEM...	√	√	√	√	√	√	√	√	2 hours/ wk
Tutorial	Homework	√	√	√	√	√	√	√	√	1 hours/ wk

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	5	6	7	8		
Continuous Assessment: <u>50</u> %										
Assignments	√	√	√	√	√	√	√	√	15	
Midterm test	√	√	√	√	√	√	√	√	35	
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. Assignments	Understanding and becoming familiar with mathematical tools and theories in the field of electron optics and advanced electron microscopy	High	Moderate	Basic	Not even reaching the marginal levels
2. Midterm	Understanding of the imaging theory and electron beam-sample interaction	High	Moderate	Basic	Not even reaching the marginal levels
3. Examination	Understanding of the good, the bad and the ugly of each imaging mode and the fundamental physics for future trend of atomic resolution electron microscopy	High	Moderate	Basic	Not even reaching the 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. Assignments	Understanding and becoming familiar with mathematical tools and theories in the field of electron optics and advanced electron microscopy	High	Significant	Moderate	Basic	Not even reaching the marginal levels
2. Midterm	Understanding of the imaging theory and electron beam-sample interaction	High	Significant	Moderate	Basic	Not even reaching the marginal levels
3. Examination	Understanding of the good, the bad and the ugly of each imaging mode and the fundamental physics for future trend of atomic resolution electron microscopy	High	Significant	Moderate	Basic	Not even reaching the 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.)

- Fourier Optics
- Abbe Microscopy Theory
- Electron Optics and Aberration Theory
- Elastic Scattering and In-elastic Scattering
- Dose, Dose Rate and Radiation Damage
- High Resolution Electron Microscopy and Scanning Transmission Electron Microscopy
- Electron Beam Effect on In-Situ Electron Microscopy
- High Space/ Time Resolved Electron Microscopy

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.	Lecture Notes
2.	D.B.Williams 2009 Transmission Electron Microscopy A Textbook for Materials Science.pdf
3.	L.Raimer 2008 Transmission Electron Microscopy: physics of image formation
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2.2 Additional Readings

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

1.	
2.	
3.	
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