MNE8106: ELECTRON MICROSCOPY

Effective Term
Semester A 2025/26

Part I Course Overview

Course Title
Electron Microscopy

Subject Code
MNE - Mechanical Engineering
Course Number
8106

Academic Unit
Mechanical Engineering (MNE)

College/School
College of Engineering (EG)

Course Duration
One Semester

Credit Units
3

Level
R8 - Research Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
Nil

Precursors
Nil

Equivalent Courses
MNE6119 Electron Microscopy

Exclusive Courses
Nil

Part II Course Details

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. The 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).

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Describe the theory and applications of electron microscopy and spectroscopy techniques (SEM/TEM/EDS).		x		
2	Explain the SEM/TEM/EDS principles and the basic instrumentation and hardware.			x	
3	Apply SEM/TEM/EDS for imaging, diffraction and spectroscopy experiments and data analysis.				x

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 real-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.

Learning and Teaching Activities (LTAs)

	LTAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lecture	lectures on the topics of the keyword syllabus; total 39 hours.	1, 2, 3	3 hours per week

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks ("-" for nil entry)	Allow Use of GenAI?
1	Test	1, 2	20	In-class test (mid-term)	No
2	Homework and virtual lab	3	30	Homework and lab report	Yes

Continuous Assessment (%)

50

Examination (%)

50

Examination Duration (Hours)

2

Minimum Continuous Assessment Passing Requirement (%)

30

Minimum Examination Passing Requirement (%)

30

Additional Information for ATs

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

Assessment Rubrics (AR)

Assessment Task

1. Test (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

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.

Excellent

(A+, A, A-) High

Good

(B+, B, B-) Significant

Fair

(C+, C, C-) Moderate

Marginal

(D) Basic

Failure

(F) Not even reaching marginal levels

Assessment Task

2. Homework and virtual lab (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

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.

Excellent

(A+, A, A-) High

Good

(B+, B, B-) Significant

Fair

(C+, C, C-) Moderate

Marginal
(D) Basic

Failure
(F) Not even reaching marginal levels

Assessment Task
3. Examination (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion
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.

Excellent
(A+, A, A-) High

Good
(B+, B, B-) Significant

Fair
(C+, C, C-) Moderate

Marginal
(D) Basic

Failure
(F) Not even reaching marginal levels

Assessment Task
1. Test (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion
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.

Excellent
(A+, A, A-) High

Good
(B+, B) Significant

Marginal
(B-, C+, C) Moderate

Failure
(F) Not even reaching marginal levels

Assessment Task

2. Homework and virtual lab (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

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.

Excellent

(A+, A, A-) High

Good

(B+, B) Significant

Marginal

(B-, C+, C) Moderate

Failure

(F) Not even reaching marginal levels

Assessment Task

3. Examination (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

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.

Excellent

(A+, A, A-) High

Good

(B+, B) Significant

Marginal

(B-, C+, C) Moderate

Failure

(F) Not even reaching marginal levels

Part III Other Information

Keyword Syllabus

- 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.

Reading List

Compulsory Readings

	Title
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).

Additional Readings

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