NE 311 – NANOSCALE CHARACTERIZATION TECHNICS

Course Code	Course Name		Semester	
NE 311	NANOSCALE CHARACTERIZATION TECHNIQUES		Fall ☒ Spring ☐ Summer ☐	
Hours			Credit	ECTS
Theory	Practice	Lab	4	6
3	0	2		

Course Details	
Department	Nanotechnology Engineering
Course Language	English
Course Level	Undergraduate ☒ Graduate ☐
Mode of Delivery	Face to Face ☒ Online ☐ Hybrid ☐
Course Type	Compulsory ☒ Elective ☐
Course Objectives	To introduce the principles and applications of advanced characterization techniques used for materials and devices at the nanoscale. To develop students' ability to select and evaluate appropriate techniques for morphological, structural, compositional, and surface analysis.
Course Content	This course covers key nanoscale characterization methods including electron microscopy (SEM, TEM, STEM); scanning probe techniques (AFM, STM); various spectroscopy methods (EDS, EELS, XPS, Raman, FTIR); X-ray-based techniques (XRD, SAXS, XRR); focused ion beam systems; surface and thin film analysis tools; sample preparation; and recent developments in the field.
Course Method/ Techniques	Lecture ☒ Question & Answer ☒ Presentation ☒ Discussion ☒
Prerequisites/ Corequisites	
Work Placement(s)	

Textbook/References/Materials
Textbook: Materials Characterization Techniques and Applications, Springer, 2017. **References:** B.D. Cullity and S.R. Stock, Elements of X-Ray Diffraction; D.B. Williams & C.B. Carter, Transmission Electron Microscopy; R.F. Egerton, Physical Principles of Electron Microscopy.

Course Category				
Mathematics and Basic Sciences	☐		Education	☐
Engineering	☒		Science	☒
Engineering Design	☐		Health	☐
Social Sciences	☐		Profession	☒

Weekly Schedule

No	Topics	Materials/Notes
1	Introduction to Nanoscale Characterization	Overview
2	Spatial Resolution, Interaction Volume	Limitations
3	Scanning Electron Microscopy (SEM)	Basics, detectors
4	Transmission Electron Microscopy (TEM)	Contrast, diffraction
5	Scanning TEM and EELS	Analytical techniques
6	Atomic Force Microscopy (AFM)	Contact, tapping, force curves
7	Scanning Tunneling Microscopy (STM)	Tunneling current, resolution
8	**Midterm Exam**	
9	Spectroscopy: EDS, XPS, FTIR	Surface & elemental analysis
10	Raman Spectroscopy	Molecular vibrations
11	X-ray Techniques: XRD, XRR, SAXS	Crystallography
12	Focused Ion Beam (FIB)	Milling, imaging
13	Surface Profilometry, Ellipsometry	Thin film thickness
14	Sample Prep and Artifacts	Contamination, cross-sectioning
15	Applications and Recent Developments	Case studies
16	**Final Exam**	

Assessment Methods and Criteria		
In-term studies	**Quantity**	**Percentage**
Attendance		
Lab	4	15%
Practice		
Fieldwork		
Course-specific internship		
Quiz/Studio/Criticize		
Homework		
Presentation / Seminar	1	10%
Project		
Report		
Seminar		
Midterm Exam	1	25%
Final Exam	1	50%
	Total	**100%**
Contribution of Midterm Studies to Success Grade		50%
Contribution of End of Semester Studies to Success Grade		50%
	Total	**100%**

ECTS Allocated Based on Student Workload			
Activities	**Quantity**	**Duration (Hrs)**	**Total Workload**
Course Hours	14	4	56
Lab	4	2	8
Practice			
Fieldwork			
Course-specific Work Placement			
Out-of-class study time	14	3	42
Quiz/Studio/Criticize			
Homework			
Presentation / Seminar	1	5	5
Project			
Report			
Midterm Exam and Preparation for Midterm	1	15	15
Final Exam and Preparation for Final Exam	1	24	24
Total Workload			**150**
Total Workload / 25			**150/25**
ECTS Credit			**6**

Course Learning Outcomes	
No	**Outcome**
L1	Explain the principles and limitations of nanoscale characterization techniques.
L2	Compare different microscopy and spectroscopy tools used for nanoscale materials.
L3	Select appropriate characterization techniques based on material type and analysis objectives.
L4	Interpret and critically evaluate data obtained from nanoscale characterization methods.
L5	Identify common artifacts and sources of error in sample preparation and imaging, and propose solutions.

Contribution of Course Learning Outcomes to Program Competencies/Outcomes

Contribution Level: 1: Very Slight, 2: Slight, 3: Moderate, 4: Significant, 5: Very Significant

	P1	**P2**	**P3**	**P4**	**P5**	**P6**	**P7**	**P8**	**P9**	**P10**	**P11**	**Total**
L1	5	4	2	3	2	1	2	3	2	1	1	
L2	4	3	2	5	2	2	3	3	2	1	1	
L3	3	5	4	5	3	2	3	3	2	2	2	
L4	3	3	3	5	5	3	3	4	3	3	3	
L5	2	3	3	4	5	3	4	5	5	4	4	
											Total	