NE201 - MATERIAL SCIENCE I

Course Code	Course Name			Semester	
NE 201	MATERIAL SCIENCE I			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	The objective of this course is to provide students with a fundamental understanding of materials science by exploring the interrelationships between structure, properties, processing, and performance. Through topics such as atomic structure, crystallography, mechanical behavior, phase diagrams, and microstructural evolution, students will gain the foundational knowledge necessary for material selection, processing decisions, and engineering design.
Course Content	This course introduces the fundamental principles of materials science and engineering, with an emphasis on the relationship between structure and properties of materials. Topics include atomic structure and bonding, crystallography, crystal defects, diffusion, mechanical behavior, strengthening mechanisms, failure analysis (fracture, fatigue, creep), phase diagrams, the iron–carbon system, microstructural development, and phase transformations.
Course Method/ Techniques	Lecture ☒ Question & Answer ☒ Presentation ☒ Discussion ☒
Prerequisites/ Corequisites	No
Work Placement(s)	No

Textbook/References/Materials
Textbook: Callister, W.D., & Rethwisch, D.G. (2018). *Materials Science and Engineering: An Introduction* (10th ed.). Wiley. **References:** Smith, W.F., & Hashemi, J. (2010). *Foundations of Materials Science and Engineering* (5th ed.). McGraw-Hill. Askeland, D.R., & Wright, W.J. (2015). *The Science and Engineering of Materials* (7th ed.). Cengage Learning.

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

Weekly Schedule

No	Topics	Materials/Notes
1	**Introduction to Materials Science:** Overview of material types (metals, ceramics, polymers, composites); historical development; role of materials in engineering design. **Atomic Structure and Bonding:** Fundamentals of atomic structure; quantum numbers; types of bonding	Callister, Chapter 1,2
2	**Crystal Structures and Crystallography:** Point defects, dislocations, and grain boundaries; vacancy and interstitial atoms; significance of imperfections.	Callister, Chapter 3
3	**Imperfections in Solids:** Point defects, dislocations, and grain boundaries; vacancy and interstitial atoms; significance of imperfections.	Callister, Chapter 4
4	**Diffusion Mechanisms:** Fick's First and Second Laws; steady and non-steady state diffusion; factors affecting diffusion.	Callister, Chapter 5
5	**Mechanical Properties of Materials:** Stress-strain behavior; elastic and plastic deformation; modulus of elasticity; ductility; resilience and toughness.	Callister, Chapter 6
6	**Dislocations and Strengthening Mechanism:** Edge and screw dislocations; slip systems; mechanisms of strengthening (grain size reduction, solid solution strengthening, strain hardening).	Callister, Chapter 7
7	**Failure I: Fracture Mechanisms:** Ductile vs brittle fracture; fracture toughness; Griffith theory; stress concentration and flaw sensitivity.	Callister, Chapter 8
8	**Midterm Exam**	
9	**Failure II: Fatigue and Creep:** S-N curves; fatigue limit; fatigue crack growth; creep mechanisms; creep curve; rupture and steady-state creep.	Callister, Chapter 8
10	**Introduction to Phase Diagrams:** Phase rule; single-component systems; interpretation of phase diagrams; equilibrium phases.	Callister, Chapter 9
11	**Binary Phase Diagrams:** Binary isomorphous and eutectic systems; tie line and lever rule; microstructural development in alloys.	Callister, Chapter 9
12	**Iron-Carbon Phase Diagram:** Cementite and ferrite; eutectoid and eutectic reactions; pearlite, bainite, martensite transformations.	Callister, Chapter 9
13	**Development of Microstructures:** Effects of cooling rates; microstructure-	Callister, Chapter 9

	property relationships; heat treatment concepts.	
14	**Phase Transformations:** Nucleation and growth; TTT and CCT diagrams; austenite decomposition; transformation kinetics.	Callister, Chapter 10
15	**Review and Problem-Solving**	Chapter 8-10
16	**Final Exam**	Chapter 1-10

Assessment Methods and Criteria		
In-term studies	**Quantity**	**Percentage**
Attendance		
Lab	4	15%
Practice		
Fieldwork		
Course-specific internship		
Quiz/Studio/Criticize	2	10%
Homework		
Presentation / Seminar		
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	3	42
Lab	4	2	8
Practice			
Fieldwork			
Course-specific Work Placement			
Out-of-class study time	14	3	42
Quiz/Studio/Criticize	2	7	14
Homework			
Presentation / Seminar			
Project			
Report			
Midterm Exam and Preparation for Midterm	1	20	20
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	Understand the fundamental concepts of materials science, including atomic structure, bonding, and crystallography.
L2	Analyze material imperfections, diffusion mechanisms, and their effects on properties.
L3	Evaluate mechanical properties, strengthening mechanisms, and material failure types.
L4	Interpret phase diagrams, phase transformations, and microstructural evolution.
L5	Apply problem-solving skills to material selection and engineering applications

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**	**3**	**4**	**3**	**2**	**2**	**3**	**3**	**2**	**2**	
L2	**5**	**5**	**3**	**3**	**3**	**2**	**2**	**3**	**2**	**2**	**2**	
L3	**4**	**5**	**4**	**4**	**3**	**3**	**3**	**4**	**3**	**3**	**2**	
L4	**3**	**4**	**5**	**5**	**4**	**3**	**4**	**5**	**4**	**4**	**3**	
L5	**2**	**3**	**4**	**5**	**4**	**4**	**4**	**5**	**5**	**5**	**4**	
											Total	