NE202 - MATERIAL SCIENCE II

Course Code	Course Name		Semester	
NE 202	MATERIAL SCIENCE II		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 to deepen students' understanding of advanced material classes such as ceramics, polymers, composites, and their mechanical, thermal, and electrical properties and applications.
Course Content	This course covers the structures, properties, and applications of ceramics and polymers; composites; electrical, thermal, magnetic, and optical properties of materials; corrosion and degradation; materials selection and sustainability.
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	**Review of Crystal Structures and Phases:** Review unit cells, crystal systems, Miller indices; introduction to solid solutions, phase equilibria, phase diagrams; transition from metallic to non-metallic materials.	Callister, Chapter 3, 9
2	**Ceramic Structures and Bonding:** Ceramic crystal structures; ionic bonding and charge neutrality; defects in ceramics; mechanical behavior and brittleness; fracture and toughness.	Callister, Chapter 12
3	**Properties of Ceramics:** Mechanical behavior (brittleness, fracture toughness); thermal properties; electrical and optical behavior of ceramics.	Callister, Chapter 12
4	**Applications and Processing of Ceramics:** Fabrication methods (glass forming, sintering, powder pressing); advanced applications (bioceramics, magnetic ceramics, superconductors).	Callister, Chapter 13
5	**Polymer Structures:** Polymerization mechanisms; chain structures (linear, branched, crosslinked, network); molecular weight; polymer crystallinity and configuration.	Callister, Chapter 14
6	**Properties of Polymers:** Stress-strain behavior; viscoelasticity; temperature effects (Tg, Tm); comparison with metals and ceramics.	Callister, Chapter 15
7	**Applications and Processing of Polymers:** Processing methods (extrusion, injection molding); recycling; degradation mechanisms; common engineering polymer families.	Callister, Chapter 15

8	**Midterm Exam**	
9	**Introduction to Composite Materials**: Types (particle-reinforced, fiber-reinforced, structural); matrix materials; reinforcement mechanisms; rule of mixtures.	Callister, Chapter 16
10	**Processing and Applications of Composites:** Composite fabrication methods (lay-up, pultrusion, resin transfer molding); applications in aerospace, automotive, bioengineering.	Callister, Chapter 16
11	**Corrosion of metals:** Electrochemical corrosion, galvanic series, localized corrosion types, prevention methods.	Callister, Chapter 22
12	**Degradation of Polymers:** Environmental degradation, UV and thermal effects, bio-degradation	Callister, Chapter 22
13	**Materials Selection and Design:** Criteria for materials selection; performance indices; Ashby charts; material indices for stiffness, strength, cost, sustainability.	Callister, Chapter 23
14	**Sustainable Materials and Future Trends:** Eco-friendly materials, life-cycle analysis; materials for energy (batteries, fuel cells, solar cells); biodegradable polymers; emerging trends (e.g., nanomaterials, smart materials).	Callister, Chapter 23
15	**Final Review and Problem Solving**	Covers Weeks 9–15
16	**Final Exam**	

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	Describe the structures, properties, and applications of advanced materials including ceramics, polymers, and composites.
L2	Analyze the relationships between processing, structure, properties, and performance for non-metallic engineering materials.
L3	Compare and evaluate the electrical, thermal, magnetic, and optical properties of different material classes.
L4	Identify mechanisms of material degradation such as corrosion and propose appropriate prevention strategies.
L5	Apply principles of materials selection in engineering design based on performance and sustainability criteria.

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**	
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	