| Course code and name: | MECA306 Science des Matériaux Section: 1 | | | 1 | |
|-----------------------|--|--------|-------------------------|--------|---|
| Credits: | - | | | | |
| Semester: | Semester 5 / Fall 2021 | | | | |
| Coordinator: | Dr. Hassan Shraim | Email: | hassan.shraim@ul.edu.lb | | |
| Instructor: | Ali Harkous | Email: | ali.harkous.1@ul.edu.lb | | |
| Office Hours: | - | Room: | - | Phone: | 1 |

Textbook

- [T1] Materials Science and Engineering: An Introduction, 9th edition, William D. Callister and David G. Rethwisch, Wiley, 2014.
- [T2] Fundamentals of Modern Manufacturing, 6th edition, M. P. Groover, John Wiley & Sons, 2016.

Additional Material

External resources.

References

- [R1] Materials Science and Engineering: A First Course, 5th edition, V. Raghavan, PHI Learning Private Limited, 2011.
- [R2] Essentials of Modern Materials Science and Engineering, J. Newell, Wiley, 2009.

Course Description

The course introduces the fundamental concepts in science of materials as applied to engineering: atomic structure, crystalline structures, imperfections, mechanical behavior and failure.

In the first chapter, this course presents a state of art describing briefly the different types of classical (metal, ceramic, glass, polymer and composite) and modern materials (electronic materials, optical materials, smart materials ...).

Having several types of classical materials with different structures and behaviors, the second and third chapters focus on the crystal structure of metallic materials as a basic example.

Then, an important part is dedicated to explain the different types of imperfections (for all classical materials), the Stress–Strain diagram (mechanical behavior, types of deformation...), the mechanism of failure and the thermal treatment processes. Finally, the different types of materials (Metals, Ceramics, Polymers and Composites) are elaborated with presentation of their structure, classification and applications.

Therefore, engineering materials course allows the students to have the basic skills to distinguish materials, understand their behaviors, choose the corresponding material for each application, evaluate the quality of a material and realize new designs.

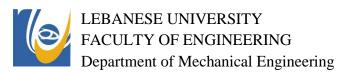
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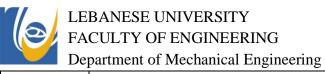
| Course Assessment | | | | | |
|-------------------|---------------------------------|-----------|----------|--------|----------------|
| Number | Assessment type and description | Session # | Duration | Weight | Link to CLO |
| 1 | Attendance | - | - | - | - |
| 2 | Midterm Exam | - | - | - | LO 1-4 |
| 3 | Final Exam | - | - | - | LO 5-8 |
| 4 | Assignments | - | - | - | - |

| Course Learning Outcomes (CLO) | | | | |
|---|---|--|--|--|
| Students who successfully completes this course will able to: | | | | |
| LO 1: | Select appropriate materials for various engineering applications. | | | |
| LO 2: | Predict basic physical properties of materials based on the knowledge of their atomic | | | |
| LO 2. | structure. | | | |
| LO 3: | Recognize the crystal structure systems of metals. | | | |
| LO 4: | Discuss the mechanisms of defect, dislocation and imperfection. | | | |
| LO 5: | Analyze the mechanical behavior of materials and Identify the different types of | | | |
| | deformation. | | | |
| LO 6: | Distinguish the different types of failure and describe their principles and related tests. | | | |
| LO 7: | Recognize the different types of materials (Metals, Ceramics, Polymers and Composites), | | | |
| | their properties and applications. | | | |
| LO 8: | Discuss the different methods of thermal treatment. | | | |

Detailed List of Covered Topics Session **Topic Book Chapter Comment** Number Syllabus overview -Grade distribution -Course outline and Goals -Topics **Chap 1: Introduction to Materials Science** and Engineering Lecture 1 [T1] Chap 1 -Historical Perspective -Materials Science and Engineering -Why to study Materials Science and Engineering? -Classification of Materials -Advanced Materials -Modern Materials' Needs **Chap 2: Atomic Structure & Bonding** Lecture 2 [T1] Chap 2 -Atomic Structure **Chap 2: Atomic Structure & Bonding** Lecture 3 [T1] Chap 2 -The Ionic Bond



| | -The Covalent Bond | | |
|------------------------|---|-------------------------|--|
| | -The Metallic Bond | | |
| | Chap 2: Atomic Structure & Bonding | | |
| T | The Secondary, or Van der Waals, Bond | | |
| Lecture 4 | -Materials: The Bonding Classification | [T1] Chap 2 | |
| | -Exercises | | |
| | Chap 3: Crystalline Structure— Perfection | | |
| | -Crystal Structures Fundamentals | [T1] Chap 3 | |
| Lecture 5 | -Metallic Structures | 3.1 - 3.15 | |
| Zeetare e | -Crystal Systems, Positions, Directions, and | | |
| | Planes | | |
| | Chap 3: Crystalline Structure—Perfection | | |
| | -Linear and planar densities | [T1] Chap 3 | |
| Lecture 6 | -Close-packed crystal structures | 3.1 – 3.15 | |
| Lecture | | 3.1 3.13 | |
| | -Crystalline and Non-crystalline Materials -Exercises | | |
| | | [T1] Chap 3 | |
| Lecture 7 | Chap 3: Crystalline Structure— Perfection | 3.1 – 3.15 | |
| Eccure 7 | -Exercises | 3.1 3.13 | |
| | Chap 3: Crystalline Structure— Perfection | [T1] Chap 3 | |
| Lecture 8 | -Exercises | 3.1 – 3.15 | |
| | Excluses | | |
| | | | |
| | Chap 4: Imperfections in Solids | | |
| | Chap 4: Imperfections in Solids -Introduction | | |
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| Lecture 9 | -Introduction | [T1] Chap 4 | |
| Lecture 9 | -Introduction -Point Defects | [T1] Chap 4 | |
| Lecture 9 | IntroductionPoint Defects■ Vacancies and Self-interstitials | [T1] Chap 4 | |
| Lecture 9 | Introduction Point Defects Vacancies and Self-interstitials Impurities in Solids | [T1] Chap 4 | |
| Lecture 9 | Introduction Point Defects Vacancies and Self-interstitials Impurities in Solids Specification of Composition | [T1] Chap 4 | |
| Lecture 9 | Introduction Point Defects Vacancies and Self-interstitials Impurities in Solids Specification of Composition Chap 4: Imperfections in Solids | [T1] Chap 4 | |
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| Lecture 10 | Introduction Point Defects Vacancies and Self-interstitials Impurities in Solids Specification of Composition Chap 4: Imperfections in Solids Linear Defects or Dislocations Planar Defects 3D Imperfections: Bulk or Volume Defects Examples Chap 4: Imperfections in Solids Exercises Chap 5: Mechanical Behavior Introduction | [T1] Chap 4 | |
| Lecture 10 Lecture 11 | -Introduction -Point Defects ■ Vacancies and Self-interstitials ■ Impurities in Solids -Specification of Composition Chap 4: Imperfections in Solids -Linear Defects or Dislocations -Planar Defects -3D Imperfections: Bulk or Volume Defects -Examples Chap 4: Imperfections in Solids -Exercises Chap 5: Mechanical Behavior -Introduction -Concepts of stress and strain | [T1] Chap 4 [T1] Chap 4 | |
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| Lecture 10 Lecture 11 | -Introduction -Point Defects ■ Vacancies and Self-interstitials ■ Impurities in Solids -Specification of Composition Chap 4: Imperfections in Solids -Linear Defects or Dislocations -Planar Defects -3D Imperfections: Bulk or Volume Defects -Examples Chap 4: Imperfections in Solids -Exercises Chap 5: Mechanical Behavior -Introduction -Concepts of stress and strain -Elastic deformation ■ Stress-Strain behavior | [T1] Chap 4 [T1] Chap 4 | |



| | partment of Mechanical Engineering | 1 | 1 |
|---|--|-------------|---|
| | -Plastic deformation | | |
| | Tensile properties | | |
| | True stress and Strain | | |
| | Elastic recovery after plastic deformation | | |
| | Compressive, shear, and torsional | | |
| | deformations | | |
| | Hardness | | |
| | Chap 5: Mechanical Behavior | | |
| Lecture 14 | -Property variability and design/safety factors | [T1] Chap 6 | |
| | -Exercises | | |
| T 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 | Chap 5: Mechanical Behavior | FTT-1 CI | |
| Lecture 15 | -Exercises | [T1] Chap 6 | |
| | Chap 6: Failure | | |
| | -Fracture | | |
| | Fundamentals of Fracture | | |
| Lecture 16 | Ductile fracture | [T1] Chap 8 | |
| | Brittle fracture | | |
| | Principles of fracture mechanics | | |
| | Fracture toughness testing | | |
| | Chap 6: Failure | | |
| | -Fatigue | | |
| | • Cyclic stresses | | |
| Lecture 17 | ■ The S–N curve | [T1] Chap 8 | |
| 100001017 | Crack initiation and propagation | [11] emap e | |
| | Factors that affect fatigue life | | |
| | ■ Environmental effects | | |
| | Chap 6: Failure | | |
| | -Creep | | |
| | Generalized creep behavior | | |
| Lecture 18 | Stress and temperature effects | [T1] Chap 8 | |
| | Data extrapolation methods | | |
| | Alloys for high-temperature use | | |
| | Chap 6: Failure | | |
| Lecture 19 Lecture 20 | -Exercises | [T1] Chap 8 | |
| | | | |
| | Chap 6: Failure | [T1] Chap 8 | |
| | -Exercises | | |
| Lecture 21 | Chap 7: Metals and Phase diagrams | FTT11 CI | |
| | -Alloys and Phase Diagrams | [T1] Chap 9 | |
| | -Triple point | [T2] Chap 6 | |
| | -Ferrous Metals | | |
| Lecture 22 | Chap 7: Metals and Phase diagrams | [T1] Chap 9 | |
| | -Nonferrous Metals | L J T | |



-Superalloys **Chap 8: Thermal Processing of Metals** -Annealing processes Process Annealing Stress Relief [T1] Chap 11 Lecture 23 Annealing of Ferrous Alloys 11.7 - 11.9-Heat treatment of steels Hardenability ■ Influence of Quenching Medium, Specimen Size, and Geometry **Chap 8: Thermal Processing of Metals** -Precipitation hardening [T1] Chap 11 Lecture 24 11.7 - 11.9Heat Treatments Mechanism of Hardening **Chap 9: Ceramics** -Structure and Properties of Ceramics Lecture 25 -Traditional Ceramics [T2] Chap 7 -New Ceramics -Glass **Chap 10: Polymers** -Fundamentals of Polymer Science and Lecture 26 Technology [T2] Chap 8 -Thermoplastic Polymers -Thermosetting Polymers **Chap 10: Polymers** Lecture 27 -Elastomers [T2] Chap 8 -Polymer Recycling and Biodegradability **Chap 11: Composites** -Technology and Classification of Composite Materials Lecture 28 [T2] Chap 9 -Metal Matrix Composites -Ceramic Matrix Composites -Polymer Matrix Composites

Edited by Dr. Ali HARKOUS, on October 07, 2021.