EM 280 FOUNDATIONS OF MATERIALS SCIENCE AND ENGINEERING

IES Abroad Madrid

DESCRIPTION:

The main objective of this course is to develop the ability to analyze a given problem in a simple and logical manner and apply a few fundamental principles. This course is designed at an introductory level of materials science and is of interest to any branch of engineering, not only for students majoring in mechanical engineering. The course will assume previous knowledge of basic chemistry, such as the periodic table, electron distribution, and types of bonds.

At a minimum, all materials science and engineering students must have basic knowledge of the structure, properties, processing, and performance of various classes of materials. This is a crucial first step in the materials selection decisions in rudimentary everyday problems. We will focus on key concepts in the science of materials (basic knowledge) followed by the application of scientific principles in the selection and engineering of materials (applied knowledge). The basic and applied concepts are integrated through concise textual explanations, relevant and stimulating imagery, detailed sample problems, electronic supplements, and homework problems.

CREDITS: 4 credits

CONTACT HOURS: 60 hours

LANGUAGE OF INSTRUCTION: English

PREREQUISITES: Basic Chemistry, Calculus I

ADDITIONAL COST: None

METHOD OF PRESENTATION:

During the lectures, the instructor will present the theory and cover examples and exercises. There will be assignments for each chapter with theory and exercises

REQUIRED WORK AND FORM OF ASSESSMENT:

- Midterm exam - 30%
- Final Exam - 30%
- Homework - 15%
- Laboratory reports - 15%
- Participation - 10%

Laboratory reports

Written assignments to be completed after each of the 4-lab session.

Course Element

1. Introduction to Materials Science and Engineering.
2. Atomic Structure and Bonding.
3. Crystal and Amorphous Structure in Materials.
4. Solidification and Crystalline Imperfections.
5. Thermally Activated Processes and Diffusion in Solids.
6. Mechanical Properties of Metals I.
7. Mechanical Properties of Metals II.
8. Phase Diagrams.
9. Engineering Alloys.

10. Polymeric Materials.
11. Ceramics Materials.
12. Composite Materials.
13. Corrosion.
14. Electrical Properties of Materials
15. Optical Properties and Superconductive Materials

LEARNING OUTCOMES:
By the end of the course, students will be able to:

- Demonstrate appropriate breadth and depth of key points about materials science, technology, and engineering.
- Demonstrate appropriate breadth and depth in the wider multidisciplinary context of engineering related to material science.
- Apply their knowledge and understanding to identify, formulate and solve problems of materials science using established methods.
- Design and conduct appropriate experiments, interpret data, and draw conclusions related to materials.
- Select and use appropriate equipment, tools, and methods in materials science.
- Combine theory and practice to solve problems of science of materials.
- Demonstrate appropriate breadth and depth in applicable techniques and methods in materials science and their limitations.

ATTENDANCE POLICY:
As a member of our class community, you are expected to be present and on time every day. Attending class has an impact on your learning and academic success. For this reason, attendance is **mandatory for all IES Madrid classes**, including course-related excursions. Absences will only be excused in cases of documented medical or family emergencies. Any assessed work, including exams, tests, and presentations, will be rescheduled if the absence is justified; otherwise, it will be graded as 0. You are allowed a maximum of 1 unexcused absence for once-a-week courses and 2 unexcused absences for twice-a-week courses. Each additional absence will deduct 5 points from your final grade. **Accumulating 7 or more absences in twice-a-week courses, or 4 or more in once-a-week courses, may lead to a failing grade.** Students arriving more than 11 minutes after the scheduled start time will be marked as 'late.' Three 'late' arrivals will be counted as 1 absence. Any student arriving 30 minutes or more after the scheduled start time will be marked as 'absent.' For more information, please refer to the full Attendance and Punctuality Policy document.

CONTENT:

Choose an item	Content	Assignments
Session 1	**Introduction to Materials Science and Engineering I**	Read Chapter 1. Introduction to Materials Science and Engineering.
Choose an item	**Content**	**Assignments**
Session 2	**Introduction to Materials Science and Engineering II**	• Read Chapter 1. Introduction to Materials Science and Engineering. **Hw1.**

Session 3	**Atomic Structure and Bonding I**	• Read Chapter 2.1-2,3 Atomic Structure and Bonding
Session 4	**Atomic Structure and Bonding II**	• Read Chapter 2.4-2.6 Atomic Structure and Bonding. **Hw 2**
Session 5	**Crystal and Amorphous Structure in Materials (I)**	• Read Chapter 3.1-3.4 Crystal and Amorphous Structure in Materials.
Session 6	**Crystal and Amorphous Structure in Materials (II)**	• Read Chapter 3.5-3.8 Crystal and Amorphous Structure in Materials.
Session 7	**Crystal and Amorphous Structure in Materials (III)**	• Read Chapter 3.9-3.13 Crystal and Amorphous Structure in Materials. **Hw3.**
Session 8	**Solidification and Crystalline Imperfections (I)**	• Read Chapter 4.1 to 4.3 Solidification and Crystalline Imperfections.
Session 9	**Solidification and Crystalline Imperfections (II)** Lab session 1	• Read Chapter 4.4 to 4.6 Solidification and Crystalline Imperfections. **Hw 4.** • **Lab Report 1**
Session 10	**Thermally Activated Processes and Diffusion in Solids (I)**	• Read Chapter 5.1 to 5.2 Thermally Activated Processes and Diffusion in Solids.
Session 11	**Thermally Activated Processes and Diffusion in Solids (II)**	• Read Chapter 5.3 to 5.5 Thermally Activated Processes and Diffusion in Solids. **Hw 5**
Session 12	**Mechanical Properties of Metals I. (I)**	• Read Chapter 6.1 to 6.4 Mechanical Properties of Metals. I
Session 13	**Mechanical Properties of Metals I. (II)**	• Read Chapter 6.5 to 6. Mechanical Properties of Metals. I
Choose an item	**Content**	**Assignments**
Session 14	**Mechanical Properties of Metals I. (III)** **Lab session 2**	• Read Chapter 6.6 to 6.7 Mechanical Properties of Metals. I. **Hw 6**. **Lab Report 2**

Session 15	**Review for preparation of midterm Exam**	
Session 16	**MIDTERM EXAM**	
Session 17	**Mechanical Properties of Metals II (I)**	• Read Chapter 7.1 to 7.4 Mechanical Properties of Metals. II
Session 18	**Mechanical Properties of Metals II (II)**	• Read Chapter 7.5 to 7.8 Mechanical Properties of Metals. II. **Hw 7**
Session 19	**Phase Diagrams** **Lab session 3**	• Read Chapter 8. Phase Diagrams. **Hw 8 Lab Report 3**
Session 20	**Engineering Alloys (I)**	• Read Chapter 9.1 to 9.5 Engineering Alloy
Session 21	**Engineering Alloys (II)**	• Read Chapter 9.6 to 9.11 Engineering Alloy **Hw 9**
Session 22	**Polymeric Materials (I)**	• Read Chapter 10.1 to 10.5. Polymeric Materials.
Session 23	**Polymeric Materials (II)**	• Read Chapter 10.6 to 10.13 Polymeric Materials. **Hw 10**
Session 24	**Ceramics Materials (I)**	• Read Chapter 11.1 to 11.5 Ceramics Materials.
Session 25	**Ceramics Materials (II)**	• Read Chapter 11.6 to 11.10 Ceramics Materials. **Hw 11**
Session 26	**Composite Materials** **Lab session 4**	• Read Chapter 12. Composite Materials. **Hw 12**. **Lab Report 4.**
Choose an item	**Content**	**Assignments**
Session 27	**Corrosion**	• Read Chapter 13. Corrosion.

Session 28	**Electrical Properties of Materials**	• Read Chapter 14. Electrical Properties of Materials.
Session 29	**Optical Properties and Superconductive Materials**	• Read Chapter 15. Optical Properties and Superconductive Materials.
Session 30	**FINAL EXAM**	

COURSE-RELATED TRIPS:

- No trips planned for this course.

REQUIRED READINGS:

1. Smith, William and Javad Hashemi. Foundation of Materials Science and Engineering, 7th Edition. McGraw Hill, 2023. LCCN: 2021031235 (print) 2021031236 (ebook) ISBN: 9781260721492, 9781262079212 (pdf).

RECOMMENDED READINGS:

1. Ashby, Michael F., Hugh Shercliff, and David Cebon. *Materials Engineering, Science, Processing and Design*, 4th Edition. Butterworth-Heinemann, 2019. ISBN: 978-0081023761
2. Callister Jr., William D. and David G. Rethwisch. *Materials Science and Engineering: An Introduction*, 10th Edition. Wiley, 2018. ISBN: 978-1-119-40549-8.
3. Gaskell, D.R. *Introduction to Thermodynamics of Materials,* 5th Edition. Taylor & Francis, 2008.
4. Hertzberg, R.W. *Deformation & Fracture Mechanics of Engineering Materials*. John Wiley & Sons, 1976.
5. Higgins, R.A. and Edward Arnold. *Materials for the Engineering Technicians*.
6. Hull, Derek and D.J. Bacon. *Introduction to Dislocations*, 5th Edition. Elsevier, 2011.
7. Porter, David and Kenneth Easterling. *Phase Transformations in Metals & Alloys*, 2nd Edition. CRC Press, 1992.
8. Regone, D.V. *Thermodynamics of Materials*, Volume I. John Wiley & Sons, 1995.
9. Russ, John. *Materials Science – A Multimedia Approach* (electronic resource), PWS Publishing Co.
10. Shackelford, J.F. and Maxwell Macmillan. *Introduction to Materials Science for Engineers*.