EM 280 FOUNDATIONS OF MATERIALS SCIENCE AND ENGINEERING

IES Abroad Madrid

DESCRIPTION:

The main objective of this course in MATERIALS SCIENCE AND ENGINEERING is to develop in the engineering student the ability to analyse a given problem in a simple and logical manner and to apply to its solution a few fundamental and principles according to the state of the art. This course is designed at an introductory level of Material Science and it is of interest for any branch of engineering, not only for students majoring in Mechanical Engineering. Material Science is an essential course to engineers and scientists from all disciplines. The course will assume previous knowledge of basic Chemistry, such as knowledge of the periodic table, electron distribution and types of bonds.

At a minimum, all material science and engineering students must have the 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 everyday rudimentary problems. We will focus on key concepts in science of materials (basic knowledge) followed by application of scientific principles in 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 plus 4 labs (2 hours each)

LANGUAGE OF INSTRUCTION: English

PREREQUISITES: Basic Chemistry, Calculus I.

METHOD OF PRESENTATION:

1) **Lecture sessions:** 2 hours per week: the instructor will present the theory and cover examples and exercises
2) **Laboratory sessions:** 4 labs of 2 hours each during the course. Students will practice the theory presented in class with concrete examples.

REQUIRED WORK AND FORM OF ASSESSMENT:

- **Midterm Exam (30% of final grade):**
  - Chapters 1-7 from the textbook. The test will be administered on session 15th
- **Final Exam (30% of final grade):**
  - Final exam is comprehensive. It covers chapters 1-15 from the textbook. It contains worked-out exercises and multiple-choice questions. It will be administered on session 30th.
- **Homework (15% of final grade):**
  Homework will be assigned for each Chapter. All the assignments are mandatory and no late homework will be accepted. It consists of different readings and problem solving.. The completion of the assignment (reading and writing) should take 3-4 hours.
- **Laboratory reports (15% of final grade**) (written assignments to be completed after each lab session)
- **Participation (10% of final grade):**
  This includes the interaction of the student in the classroom, the ability to answer questions made by the instructor and the general interest shown in the course. Some of the in-class assignments will use tools such us Kahoot verifying understanding of concepts.

LEARNING OUTCOMES:
By the end of this content area, students will be able to have:

- Knowledge and understanding of key points about materials science, technology and engineering.
- Awareness of the wider multidisciplinary context of engineering related with material science.
- The ability to apply their knowledge and understanding to identify, formulate and solve problems of materials science using established methods.
- The ability to design and conduct appropriate experiments, interpret data and draw conclusions related to materials.
- The ability to select and use appropriate equipment, tools and methods in materials science.
- The ability to combine theory and practice to solve problems of science of materials.
- Understanding of applicable techniques and methods in materials science and their limitations.

ATTENDANCE POLICY:
Class attendance is mandatory. Please consult in Moodle and in the orientation booklet IES Abroad Madrid Attendance Policy.

CONTENT:

Session	Content	Assignments:
Session 1	Introduction to Materials Science and Engineering.	Read Chapter 1. Introduction to Materials Science and Engineering.
Session 2	Atomic Structure and Bonding.	Read Chapter 2.1-2,3 Atomic Structure and Bonding.
Session 3	Atomic Structure and Bonding.	Read Chapter 2.4-2.6 Atomic Structure and Bonding. **Hw 1**
Session 4	LAB 1	**Write lab report 1**
Session 5	Crystal and Amorphous Structure in Materials.	Read Chapter 3.1-3.6 Crystal and Amorphous Structure in Materials.
Session 6	Crystal and Amorphous Structure in Materials.	Read Chapter 3.7 to 3.13 Crystal and Amorphous Structure in Materials. **Hw 2**
Session 7	Solidification and Crystalline Imperfections.	Read Chapter 4.1 to 4.3 Solidification and Crystalline Imperfections.
Session 8	Solidification and Crystalline Imperfections.	Read Chapter 4.4 to 4.6 Solidification and Crystalline Imperfections. **Hw 3**
Session 9	Thermally Activated Processes and Diffusion in Solids.	Read Chapter 5.1 to 5.2 Thermally Activated Processes and Diffusion in Solids.

Session 10	LAB 2	**Write lab report 2**
Session 11	Thermally Activated Processes and Diffusion in Solids.	Read Chapter 5.3 to 5.5 Thermally Activated Processes and Diffusion in Solids. **Hw 4**
Session 12	Mechanical Properties of Metals 1/4.	Read Chapter 6.1 to 6.4 Mechanical Properties of Metals. I
Session 13	Mechanical Properties of Metals 2/4.	Read Chapter 6.4 to 6.7. Mechanical Properties of Metals I. **Hw 5**
Session 14	Mechanical Properties of Metals 3/4.	Read Chapter 7.1 to 7.3 Mechanical Properties of Metals. II
Session 15	Mechanical Properties of Metals 4/4.	Read Chapter 7.4 to 7.8 Mechanical Properties of Metals. II **Hw 6**
Session 16	LAB 3	**Write lab report 3**
Session 17	**MIDTERM EXAM.**	Workbook prepared for lab in Moodle. Review of quizzes and homework done for each lesson.
Session 18	Phase Diagrams.	Read Chapter 8. Phase Diagrams.
Session 19	Engineering Alloys 1/2.	Read Chapter 9.1 to 9.5. Engineering Alloy

Session 20	Engineering Alloys 2/2.	Read Chapter 9.6 to 9.11 Engineering Alloy **Hw 7**
Session 21	Polymeric Materials.	Read Chapter 10. Polymeric Materials.
Session 22	Ceramics Materials.	Read Chapter 11. Ceramics Materials. **Hw 8**
Session 23	Composite Materials.	Read Chapter 12. Composite Materials.
Session 24	Corrosion.	Read Chapter 13. Corrosion.
Session 25	Electrical Properties of Materials.	Read Chapter 14. Electrical Properties of Materials. **Hw 9**
Session 26	Optical Properties and Superconductive Materials.	Read Chapter 15. Optical Properties and Superconductive Materials.
Session 27	Lab 4	**Write lab report 4**
Session 28	Review for Final exam (session I)	Do the review exercises posted in Moodle Review of quizzes and homework done for Ch1 to Ch7.
Session 29	Review for Final exam (session II)	Review of quizzes and homework done for Ch8 to Ch14.
Session 30	**FINAL EXAM.**	Review of quizzes and homework done for Ch8 to Ch14.

REQUIRED READING:

- Foundation of Materials Science and Engineering, 7th Edition
  By Smith William F. and Javad Hashemi
  LCCN: 2021031235 (print) 2021031236 (ebook) ISBN: 9781260721492, 9781262079212 (pdf)

RECOMMENDED READING:

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

- Introduction to Dislocations, 5th Edition, Elsevier, 2011. Hull & Bacon.

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