The University of Jordan
School of Engineering
Chemical Engineering Department

0915351 Materials Science and Engineering
Semester /

Course Catalog
3 Credit hours. Understanding the structure of materials in term of crystal geometry, structural disorder, and solid solution and phase diagram. Material classification, metals, polymers, ceramics, glass, and composites. Material properties (mechanical, thermal, chemical, optical, and electrical).

Instructor		
Instructor	**Dr. Yousef Mubarak** **E-mail**: ymubarak@ju.edu.jo	**Office**: CHE 3rdFloor Office 315 **Tel**: 22891 **Web**: http://eacademic.ju.edu.jo/ymubarak/default.aspx

Prerequisites	
Prerequisites by topic	Engineering Workshops, Physical Chemistry (1)
Prerequisites by course	0966111, 0303241

	Text book
Title	***Materials Science and Engineering***
Author(s)	William D. Callister
Publisher	John Wiley & Sons
Year	2010
Edition	8thEdition

References	
Books	1. Ashby, M. F. and Jones, D. R. H., "*Engineering Materials: an Introduction to their Properties and Applications*", 1st Edn.,Pergamon Press, 1980. 2. Deighton, M., Mead, J. A., "*Introduction to Materials Science*", Oxford U. P., 1978. 3. Brick, R. M., Pense, A. W., and Gordon, R. B., "*Structure and Properties of Engineering Materials*", 4th Edn., McGraw-Hill, 1977. 4. Budworth, D. W., "*Intorudction to Ceramic Science*", Pergamon Press, 1970. 5. Van, V. and Lawrence, H., "*Materials Science for Engineers*", Addison-Wesley, 1970. 6. Raghavan, V., "*Materials Science and Engineering: a First Course*", 2nd Edn., Prentice-Hall, 1982. 7. Van, V. and Lawrence, H., "*Elements of Materials Science and Engineering*", 6th Edn., Addison-Wesley, 1989. 8. Shackelford, J. F., "*Introduction to Materials Science for Engineers*", 4th Edn., Prentice-Hall International, 1998. 9. Smith, W. F., "*Principles of Materials Science and Engineering*", 2nd Edn., McGraw-Hill, 1990. 10. Alper, Allen M., "*Phase Diagrams: Materials Science and Technology*", Academic Press, 1970.

	11. Askeland, D. R., "*The Science and Engineering of Materials*", 2nd SI Edn., Chapman & Hall, 1990.

Objectives and Outcomes	
Objectives	***Outcomes***
1) To provide an understanding of the influence of bonding, nano- and micro-structure,composition and processing on the properties of materials. [1, 4] 2) To provide students with an understanding of various types of materials, their ranges ofproperties, and how their properties can be tailored for engineering purposes. [1, 4] 3) To provide the students with an understanding of the various advantages and disadvantagesoffered by specific classes of materials, and an awareness of the possible tradeoffs associatedwith optimization of a specific material's properties. [1,2]	Upon successful completion of the Introduction to Engineering Materials Science course, students should be able to: 1. Distinguish the different classes of engineering materials. [1] 2. Describe and comment on structure, processing and properties of the main classes of materials and the relationships between them. [1, 4] 3. Describe the structure and properties of a range of advanced materials. [1] 4. Describe processing-microstructure-property relationships. [1, 2] 5. Support their understanding of the above areas with quantitative analyses where appropriate. [1] 6. Demonstrate an awareness of the principles underpinning engineering design. [1,2]

***Course Assessment*:** The assessment of objectives will be achieved through homework assignments, quizzes, and common examinations with common grading.

Evaluation		
Assessment Tool	**Expected Due Date**	**Weight**
Homework& Quizzes	One week after homework problems are assigned and there will be a quiz every week.	10 %
First Exam	Later	20 %
Second Exam	Later	20%
Final Exam	According to the University final examination schedule	50 %

Topics Covered		
Week	**Topics**	**Chepters in Text**
1	***Introduction*** ○ *Historical Perspective* ○ *Materials Science and Engineering* ○ *Why Study Materials Science and Engineering* ○ *Classification of Materials* ○ *Advanced Materials* ○ *Modern Materials Needs*	Chapter 1
2-3	***Atomic Structure and Interatomic Bonding*** ○ *Introduction* ○ *Atomic Structure* ▪ *Fundamental Concepts* ▪ *Electrons in Atoms* ▪ *The Periodic Table* ○ *Atomic Bonding in Solids* ▪ *Bonding Forces and Energies* ▪ *Primary Interatomic Bonds* ▪ *Secondary Bonding or van der Waals Bonding* ▪ *Molecules*	Chapter 2
4-6	***The Structure of Crystalline Solids*** ○ *Introduction* ○ *Crystal Structure* ▪ *Fundamental Concepts* ▪ *Unit Cells* ▪ *Metallic Crystal Structures*	Chapter 3

	▪ *Density Computations* ▪ *Polymorphism and Allotropy* ▪ *Crystal Systems* o *Crystallographic Points* ▪ *Crystallographic Directions* ▪ *Crystallographic Planes* ▪ *Linear and Planar Atomic Densities* ▪ *Close-Packed Crystal Structures* o *Crystalline and Noncrystalline Materials* ▪ *Single Crystals* ▪ *Polycrystalline Materials* ▪ *Anisotropy* ▪ *X-Ray Diffraction Determination of Crystalline Structure* ▪ *Noncrystalline Solids*	
7	***Imperfections in Solids*** o *Introduction* o *Point Defects* ▪ *Vacancies and Self-Interstitials* ▪ *Impurities in Solids* o *Discellanceous Imperfections* ▪ *Dislocations—Linear Defects* ▪ *Interfacial Defects* ▪ *Bulk or Volume Defects* ▪ *Atomic Vibrations* o *Microscopic Examination* ▪ *General* ▪ *Microscopy* ▪ *Grain Size Determination*	Chapter4
8-9	***Mechanical Properties of Metals*** o *Introduction* o *Concepts of Stress and Strain* o *Elastic Deformation* ▪ *Stress—Strain Behavior* ▪ *Anelasticity* ▪ *Elastic Properties of Materials* o *Plastic Deformation* ▪ *Tensile Properties* ▪ *True Stress and Strain* ▪ *Elastic Recovery During Plastic Deformation* ▪ *Compressive, Shear, and Torsional Deformation* ▪ *Hardness* o *Property Variablity and Design Safety Factors* ▪ *Variability of Material Properties* ▪ *Design/Safety Factors*	Chapter6
10	***Failure*** o *Introduction* o *Fracture* ▪ *Fundamentals of Fracture* ▪ *Ductile Fracture* ▪ *Brittle Fracture* ▪ *Principles of Fracture Mechanics* ▪ *Impact Fracture Testing* o *Fatigue* ▪ *Cyclic Stresses* ▪ *The S—N Curve* ▪ *Crack Initiation and Propagation* ▪ *Crack Propagation Rate* ▪ *Factors That Affect Fatigue Life* ▪ *Environmental Effects* o *Creep* ▪ *Generalized Creep Behavior* ▪ *Stress and Temperature Effects*	Chapter 8

	▪ *Data Extrapolation Methods* ▪ *Alloys for High-Temperature Use*	
11-12	***Phase Diagrams*** o *Introduction* o *Definitions and Basic Concepts* ▪ *Solubility Limit* ▪ *Phases* ▪ *Microstructure* ▪ *Phase Equilibria* ▪ *One-Component Phase Diagram* o *Binary Phase Diagrams* ▪ *Binary Isomorphous Systems* ▪ *Binary Eutectic Systems* ▪ *Equilibrium Diagrams Having Intermediate Phases or Compounds* ▪ *Eutectoid and Peritectic Reactions* ▪ *Congruent Phase Transformations* ▪ *Ceramic and Ternary Phase Diagrams* ▪ *The Gibbs Phase Rule* o *The Iron-Carbon System* ▪ *The Iron—Iron Carbide (Fe—Fe3C) Phase Diagram* ▪ *Development of Microstructures in Iron—Carbon Alloys* ▪ *The Influence of Other Alloying Elements*	Chapter 9
13	***Phase Transformations in Metals:*** o *Introduction* o *Phase Transformation* ▪ *Basic Concepts* ▪ *The Kinetics of Solid-State Reactions* ▪ *Multiphase Transformations* o *Microstructural and Property Changes in Iron-Carbon Alloys* ▪ *Isothermal Transformation Diagrams* ▪ *Continuous Cooling Transformation Diagrams* ▪ *Mechanical Behavior of Iron—Carbon Alloys* ▪ *Tempered Martensite* ▪ *Review of Phase Transformations for Iron—Carbon Alloys*	Chapter 10
14	***Thermal Processing of Metal Alloys*** o *Introduction* o *Process Annealing* o *Stress Relief* o *Annealing of Ferrous Alloys* o *Hardenability* o *Influence of Quenching Medium, Specimen Size, and Geometry* o *Heat Treatments* o *Mechanism of Hardening* o *Miscellaneous Considerations*	Chapter 11
15	• ***Structures and Properties of Ceramics*** o *Introduction* o *Ceramic Structure* ▪ *Crystal Structures* ▪ *Silicate Ceramics* ▪ *Carbon* ▪ *Imperfections in Ceramics* ▪ *Ceramic Phase Diagrams* o *Mechanical Properties* ▪ *Brittle Fracture of Ceramics* ▪ *Stress-Strain Behavior* o *Types and Applications of Ceramics* ▪ *Glasses* ▪ *Glass-Ceramics* ▪ *Clay Products* ▪ *Refractories* ▪ *Abrasives*	Chapter 12

	▪ *Cements* ▪ *Advanced Ceramics* ○ *Fabrication and Processing of Ceramics* ▪ *Fabrication and Processing of Glasses and Glass-Ceramics* ▪ *Fabrication and Processing of Clay Products* ▪ *Powder Processing* ○ *Tape Casting*	

Relationship to Chemical Engineering Program Objectives

PEO1	PEO2	PEO3	PEO 4	PEO 5	PEO 6
√	√	√	√	√	√

Document control

Prepared by	Dr. Yousef Mubarak
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