The University of Jordan
School of Engineering
Chemical Engineering Department

0905351 Engineering Materials Science
Second Semester 2016/2017

Course Catalog
3 Credit hours.All engineering structures and devices utilize materials which have been selected based on theirproperties. These properties along with design considerations enable a desired performance level.Therefore, engineers of every type are well served in their careers by an understanding of thescientific foundations of materials that govern these properties. Accordingly: This course is designedto provide an introduction to engineering materials with an emphasis on how atomic and molecularbonding, structure, composition and processing influence material properties.

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	*Principles II*
Prerequisites by course	*0905212*

	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. [a, h] 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. [a, h] 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. [a, c, e]	Upon successful completion of the Introduction to Engineering Materials Science course, students should be able to: 1. Distinguish the different classes of engineering materials. [a, e] 2. Describe and comment on structure, processing and properties of the main classes of materials and the relationships between them. [a, h] 3. Describe the structure and properties of a range of advanced materials. [a] 4. Describe processing-microstructure-property relationships. [a, c, e] 5. Support their understanding of the above areas with quantitative analyses where appropriate. [a] 6. Demonstrate an awareness of the principles underpinning engineering design. [c, e]

***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	Thursday 16/3/2017	20 %
Second Exam	Thursday 13/4/2017	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 Program Outcomes (%)

A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
70	0	10	-	10	-	-	10	-	-	-

Relationship to Chemical Engineering Program Objectives

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

Document control

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Last Modified	January 23, 2017