Department of Mechanical Engineering

Summary of ABET course information for BSME degree

ME 254 Materials Engineering

Course Description

Catalog Data: **ME 254 Materials Engineering** 4 (3,1,2)

Introduction to materials engineering; Atomic bonding; Structure and characteristics of metals; polymers and ceramics; Imperfections; Mechanical properties of metals, polymers, ceramics; Equilibrium-phase diagrams; Microstructures of alloys; Heat treatment of plain-carbon steels, cast irons and precipitation hardening; Annealing; Structural Materials.

Number of Credits: 4

Level: 3

Prerequisite by Course: CHEM 101, PHYS 104

Prerequisites by Topic: General Chemistry and Physics.

Textbook: Materials Science and Engineering - An Introduction, W.D. Callister, John Wiley. 9th Edition

Reference: Introduction to Materials Science for Engineers, J. F. Shackelford, Prentice Hall.

Course Topics:

1.	Introduction to materials, Materials science and engineering, Classification (metals, ceramics, polymers, composites. Advanced Materials.	(2 classes)
2.	Structure of atom, bonding and coordination in metals, polymers and ceramics. Effect of atomic bonding on thermal and mechanical properties.	(2 classes)
3.	Structure of metals (lattices, crystals, crystal directions, planes). Crystalline and non crystalline solids. Indices and densities, polymorphism and allotropy. Structure of Ceramics. Structure of polymers.	(6 classes)
4.	Imperfections in crystalline solids; point, linear and planar defects. Microscopic Examinations.	(4 classes)
5.	Diffusion mechanisms, Steady state diffusion	(2 classes)
6.	Mechanical properties (elastic and plastic deformation, slip systems and deformation mechanisms). Mechanical testing (tensile, torsion, bending, impact, hardness). Mechanism of Strengthening in Metals, Annealing; recovery, recrystallization and grain growth.	(8 classes)
7.	Equilibrium-phase diagrams, their construction and types, phase changes, and phase quantities. Relation between phases and properties.	(7 classes)
8.	Applications and processing of metal alloys. Ferrous and nonferrous alloys, Thermal processing of metals.	(6 classes)
9.	Ceramics and Glasses.	(4 classes)
10.	Polymers	(4 classes)

Laboratory classes:

1. Equilibrium-phase diagrams and their construction (Example Sn-Pb system).
2. Metallographic specimen preparation.
3. Quantitative metallography.
4. Microstructures of plain-carbon steel and cast iron.
5. Heat treatment of plain-carbon steel.
6. Tension testing of materials.
7. Impact testing of materials.
8. Hardness testing.

Course Objectives: (Entries in brackets are links to program educational objectives)

1. To familiarize the student with the fundamentals of materials of engineering significance, their classification and their diverse applications. (1)
2. Develop familiarity with different level of structures (atomic, crystal, and microscopic) in engineering materials, and how atomic bonding and microstructure affect the properties of materials. (1)
3. Understand the basis of microstructure development in materials.(1).
4. Appreciate the effects of processing, microstructure and crystal imperfections on mechanical properties of materials. (1,2)
5. Understand and be able to use phase diagrams and specially the Iron - Carbon phase diagram to design alloys that covers certain properties. (1)
6. Understand the effect of different heat treatment and processing on various alloys to tailor and achieve a required microstructure. (1)
7. Develop skills needed for metallographic inspections to analyze and understand different microstructures of engineering materials. (1)
8. Design and implement experiments to determine different mechanical properties of engineering components. (1)

Course Outcomes: (Entries in brackets are links to program educational outcomes)

1. Understand conceptual classification of engineering materials and be able to select a material for a certain application based generally on the required performance. (a)
2. An ability to apply knowledge of material science to solve an engineering problem or work with a team of other disciplinary to realize an engineering product. (a, d)
3. An ability to apply knowledge of material science to tailor a microstructure through processing and heat treatment, that best suits certain application requirements. (a, c)
4. Understand and explain how the properties of a material may be

modified by processing and alloying and innovate techniques that are capable of being used by industry to realize necessary properties changes. (a, c)

5. Understand and explain the hardening mechanisms that occur in metallic alloys, and the heat treatments as well as other techniques that allow these mechanisms to be realized. (a)
6. Analyze and interpret mechanical test data, as well as microstructure, and be able to report and achieve these data by either searching for it or conducting the appropriate experimental testing. (b, i, g)

Class/Laboratory Schedule :	Three-50 minutes lectures, one-50 minutes recitation and one-100 minutes lab. Session per week.
Laboratory reports	After each lab session, a lab report will be required. (mandatory)
Science/Design Contents:	3/0
Assessment tools:	Lab report + Lab exam ---------- 20% Two mid-term exams ---------- 40% Final exam---------- 40%
Prepared by	Dr. Magdy El Rayes and Dr. Md Irfanul Haque Siddiqui
Date of Preparation	January 2020

ME 254: MATERIALS ENGINEERING

First Semester 1441(2019-2020)

Instructors: Prof. Mahmoud Soliman (2C 60), and Dr. Magdy El Rayes (2C44), Dr. M. Farzik Ijaz (2C-46)

TEXTBOOK: Materials Science and Engineering, W. D. Callister, Ninth Edition, Wiley Publishing.

Chapter	Topic Concepts	Duration (lectures)	Articles	Homework Problems
1	Introduction to materials, Materials science and engineering, Classification (metals, ceramics, polymers, composites. Advanced Materials.	(2 classes)	All sections	
2	Structure of atom, bonding and coordination in metals, polymers and ceramics. Effect of atomic bonding on thermal and mechanical properties.	(2 classes)	2.1, 2.2, 2.6, 2.7, 2.8	2.1, 2.18, 2.22, 2.23
3,4,5	The Structure of metals (lattices, crystals, crystal directions, planes). Crystalline and non crystalline solids. Indices and densities, polymorphism and allotropy. Metal structures, Structure of Ceramics, Polymeric structure. Imperfections in crystalline solids; point, linear and planar defects. Polymer molecules.	(9 classes)	3.1 to 3.15 and 3.17and 4.1-4.7, 4.10,12,14,16,17. 5.3, 4 , 7 and 10	3.3, 3.4, 3.8, 3.10, 3.14, 3.16, 3.21, 3.31, 3.32, 3.36, 3.41, 3.45, 4.2,4,7,10,21,25,32
6	Imperfections in solids	3 classes	6.1 to 6.4,6.6,7,8	6.9, 10, 15
7	Diffusion mechanisms, Steady state diffusion	(2 classes)	7.1,2,35	7.7
8, 9	Mechanical properties (elastic and plastic deformation, slip systems and deformation mechanisms). Mechanical testing (tensile, hardness). Mechanism of Strengthening in Metals, Annealing; recovery, recryatallization and grain growth.	(8 classes)	8.1 to 8.5 9.1 to 9.6, 9.8-13	8.4, 8, 16, 21, 29, 40, 45, 9.5, 9.11, 15, 27
11	Equilibrium-phase diagrams, their construction and types, phase changes, and phase quantities. Relation between phases and properties.	(9 classes)	11.1 to 11.14 and 11.17-20	11.7, 23, 35, 53, 56
12	Isothermal transformation Diagrams Ferrous and nonferrous alloys, Thermal processing of metals.	(7classes)	12.5-12.8	

Exams schedule

1st. Mid-Term Exam: week no. 6 (9 Oct. 2019).
2nd. Mid-Term Exam: week no. 12. (20 Nov. 2019)