King Fahd University of Petroleum & Minerals
MECHANICAL ENGINEERING DEPARTMENT
ME 205: Materials Science

Catalogue Description: (2-3-3)
Atomic bonding in solids, bonding forces and energies, primary and secondary bonds. The structure of crystalline solids, lattice, unit cell, and crystal systems, density computation, crystal directions and planes, linear and planar atomic densities. Impurities and imperfections in solids: point, linear and interfacial defects. Atomic movement and diffusion. Mechanical properties of metallic materials, elastic and plastic deformation. Strengthening mechanisms, recrystallization and grain growth. Phase diagrams of single phase and multiphase materials with emphasis on iron-iron carbide system. Impact, fracture, fatigue, and creep properties.

Status in Curriculum (Required or Elective): Required Service Course (offered Fall & Spring)

Prerequisites:CHEM 102, MATH 102

Co-requisites: None

Prerequisites by Topics:
- General Chemistry (CHEM 102)
- Integration (MATH 102)

Textbook:**Materials Science and Engineering: An Introduction,** William Callister, 9th Edition, John Wiley & Sons, Inc., 2014.

References:
1) Donald R. Askeland, **The Science and Engineering of Materials,** PWS-Kent Publishing Company 6th Edition

Coordinator:**Dr. Muzafferuddin Mahmood,** Instructor of Mechanical Engineering

Goals: (General objectives)
This course is intended to provide basic knowledge of the crystal structure, microstructure, properties, and applications of materials. Also, it emphasis conducting laboratory experiments and writing technical reports.

Course Outline (Lecture Topics):
1. Introduction to Materials: *Definitions of Materials, Periodic Table ,Bonding and Bonding energies, etc* (4 hours)
2. Metallic Crystal Structures, Crystallographic directions and planes, Linear and Planar densities, Polymorphism etc: (6 hours)
3. Imperfections in solids and Dislocations(2 hours)
4. Diffusion, Introduction, Diffusion Mechanisms and factors influencing diffusion(3 hours)
5. Mechanical Properties of Metals, Elastic Deformation, Concepts of Stress and Strain, Plastic deformation, True Stress and Strain etc.(4 hours)
6. Dislocations and Strengthening Mechanisms, Slip Systems, Recovery, Recrystallization and Grain Growth(6 hours)
7. Phase Diagrams, Binary Iso-morphous Systems, Interpretation of Phase Diagrams, Mechanical properties, Binary Phase Diagrams, Equilibrium Diagrams Having Intermediate Phases, Iron-Iron Carbide Phase Diagram, Microstructure in Iron-Carbon Alloys (5 hours)

Design Activities/Projects:
Students will learn how to use appropriate diagrams and design suitable treatments to obtain materials with specific microstructures and mechanical properties. This includes heat treatment of steels, cold work, and hardenability.

Computer Usage:
Students are encouraged to use simple spreadsheet based data analysis using the hardness, tensile, fatigue and creep tests results.

Laboratory Experiments
1. Safety issues and safety regulations.
2. Metallography and grain size determination.
3. X-ray diffraction and identification of unknown samples.
4. Tensile test.

5. Hardness test.
6. Fatigue test.
7. Creep test.
8. Impact test.
9. Phase Diagrams.
10. Heat treatment and microstructure of steels.
11. Cold working.
12. Hardenability of steel (Jominey test).

Assessment Tools:

I- Mid-term Examinations
II- Homework Assignments
III- Laboratory Work
IV- Quizzes
V- Final Exam

CourseLearningOutcomes:

I- Students shall demonstrate basic understanding of the structure of materials.
II- Students shall demonstrate basic understanding of the mechanical behavior of materials.
III- Students shall demonstrate the ability to understand the relationship between structure and properties of materials.
IV- Students shall demonstrate the ability to use appropriate diagrams and design suitable treatments to obtain materials with specific microstructures and mechanical properties.
V- Students shall demonstrate the ability to plot, analyze, and interpret experimental data.
VI- Students shall demonstrate the ability to write technical laboratory reports.

Course Learning Outcomes mapped to Student Outcomes:

Student Outcomes	*a*	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*
Course-to-Student outcome mapping	I, II, III,	V	IV		II, III		VI				
Emphasis*	**M**	**S**	**S**		**M**		**S**				

* **L**:: Little/None **M**: Moderate **S**: Strong

Status of Continuous Improvement review of this Course:

Prepared by: Dr. M Mahmood **Date prepared:** Dec, 2014