King Fahd University of Petroleum & Minerals
MECHANICAL ENGINEERING DEPARTMENT
ME 216: Materials Science and Engineering

Catalogue Description: (3-0-3)
ME 216 Materials Science and Engineering (3-0-3)
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, line and interfacial defects. Atomic vibration and diffusion. Mechanical properties of materials. Elastic and plastic deformation and recrystallization. Phase diagrams of single phase & multiphase materials with emphasis on iron-iron carbide system (steel & cast iron). Thermal processing of metals & alloys: annealing, normalizing, quenching and tempering, composite materials, polymers. Impact, fracture, fatigue and creep properties and introduction to fracture mechanics.

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

Prerequisites:CHEM 101, MATH 102, PHYS 102

Co-requisites: 217

Prerequisites by Topics:
- General Chemistry (CHEM 101)
- Integration (MATH 102)
- General Physics (PHYS 102)

Textbook: Callister and Rerthwisch, **Materials of Science and Engineering**, 9th Edition, John Wiley & Sons, Inc., 2015.

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

Coordinator:Dr. Zafarullah Khan, Professor of Mechanical Engineering

Goals: (General objectives)
This course is intended to cover theory and basic understanding of materials, their structures, properties and applications by introducing the fundamental concepts of material science and engineering. The course introduces structure- properties-processing-performance relationships of materials used in mechanical components.

Course Outline (Lecture Topics):
1. Atomic structure and interatomic bonding: the periodic table, bonding forces and energies, primary and secondary bonds, molecules.
2. The structure of crystalline solid: metallic crystal structures, density computation, polymorphism, crystal systems, crystallographic directions, crystallographic planes, linear and planar atomic densities, single crystals, polycrystalline materials, anisotropy.
3. Imperfection of solids: imperfection in solids, point defects, vacancies and self-interstitials, impurities in solids, specification of composition, dislocations-linear defects, interfacial defects (external surface and grain boundaries only).
4. Diffusion: fiffusion, introduction, diffusion mechanisms, steady-state diffusion, non-steady state diffusion, factors that influence diffusion, other paths.
5. Mechanical properties of metals: elastic deformation, concepts of stress and, strain, stress-strain behavior, elastic properties of materials, plastic deformation, tensile properties, ductility, true stress-true strain, elastic recovery during plastic deformation.
6. Dislocations and strengthening mechanisms: dislocations and strengthening mechanisms, basic concepts, characteristics of dislocations, slip systems, slip in single crystals, plastic deformation of polycrystalline materials, strengthening mechanisms, recovery, recrystallization and grain growth.

7. Phase diagrams: phase diagrams, solubility limit, binary isomorphous system, interpretation of phase diagrams, lever rule, development of microstructure, mechanical properties, binary eutectic phase diagrams, binary eutectic phase diagrams, intermediate phases, iron-carbide phase diagram
8. Phase transformations of metals: phase transformation basic concepts, bianite, spherlodite, martensite, continuous cooling and mechanical properties.
9. Ferrous alloys and steels: microstructure characteristics, applications. Cast irons: classifications, microstructure characteristics, applications.
10. Polymers structures: hydrocarbons, molecular weight, molecular structure, thermoplastics and thermosetting polymers.

Design Activities/Projects:

A few problems which emphasize the design aspects are covered in some of the chapters.

Computer Usage:

Students are encouraged to solve some assigned homework problems using the available engineering software.

Assessment Tools:

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

Course Learning Outcomes:

I- Students will become familiar with different properties of materials, alloys and composites used in mechanical components.
II- Students shall demonstrate specific analytical skills pertinent to mechanical properties, deformation. Phase diagrams, and Phase transformation.
III- Students shall demonstrate the ability to use general purpose software to solve for several material properties including homework problems.
IV- Students shall demonstrate the ability to give a professional and well-organized presentation of their analysis through the use of oral and written 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, IV,	I, II IV,	II,		I II, III, IV	II		I, II, III, IV	IV,		
Emphasis*	**S**	**M**	**L**		**S**	M		**L**	**L**		

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

Status of Continuous Improvement review of this Course:

Prepared by: Dr. Zafarullah Khan **Date prepared:** Jan, 2015