MATSCEN 2010 Introduction to Engineering Materials

Course Description

Introduction to the properties (mechanical, electrical, thermal, diffusive, degradative, magnetic, optical), structure, and processing of engineering materials, including ceramic, metals, polymers, biological, and composite materials.

Prior Course Number: MSE205
Transcript Abbreviation: Intro Engin Mater
Grading Plan: Letter Grade
Course Deliveries: Classroom
Course Levels: Undergrad
Student Ranks: Sophomore
Course Offerings: Autumn, Spring
Flex Scheduled Course: Never
Course Frequency: Every Year
Course Length: 14 Week
Credits: 3.0
Repeatable: No
Time Distribution: 3.0 hr Lec
Expected out-of-class hours per week: 6.0
Graded Component: Lecture
Credit by Examination: No
Admission Condition: No
Off Campus: Never
Campus Locations: Columbus
Prerequisites and Co-requisites: Physics 1250 or 1260, and Math 1151 or 1161, and Chemistry 1210 or 1250, or permission of instructor.
Exclusions: Not open to students with credit for MSE205
Cross-Listings:

Course Rationale: Existing course.

The course is required for this unit's degrees, majors, and/or minors: Yes
The course is a GEC: No
The course is an elective (for this or other units) or is a service course for other units: Yes

Subject/CIP Code: 14.3101
Subsidy Level: Baccalaureate Course

Programs

Abbreviation	Description
MATSCEN	Materials Science and Engineering

Course Goals

Define engineering material properties and their range of values.
Demonstrate the relation between material properties and underlying structure and atomic bonding.
Demonstrate how structure can be manipulated via thermal and mechanical processing.
Provide examples of how materials selection can enable improved performance in engineering applications (e.g., structural, thermal, electrical, optical, magnetic).

Course Topics

Topic	Lec	Rec	Lab	Cli	IS	Sem	FE	Wor
Inter-relation between properties, structure, and processing	1.0							
Electronic structure, bonding, and properties that are inferred from these features	2.0							
Structures of metals, ceramics, and polymers	3.0							
Imperfections in solids	2.0							
Diffusion in solids	2.0							
Mechanical properties: ceramics, metals, and polymers	3.0							
Strategies to strengthen materials	2.0							
Mechanical failure: ceramics, metals, and polymers	2.0							
Thermal properties: ceramics, metals, and polymers	1.0							
Composite materials: thermal and mechanical response	1.0							
Hard and soft tissue: structure and mechanical response	1.0							
Electrical properties: metals, insulators, and semiconductors	4.0							
Magnetic materials	2.0							
Optical properties	2.0							
Corrosion and degradation	1.0							
Phase diagrams	3.0							
Phase transformations	2.0							
Synthesis, fabrication, and processing of materials	2.0							
Case studies involving materials selection in engineering applications: structural, electrical, thermal, biological, magnetic, optical	3.0							

Representative Assignments

Homework: Bonding and Structure -Predict dominant bonding in a material. -Identify elementary properties based on bonding type. -Compute theoretical density. -Predict crystal structure of ionic materials. -Distinguish between isotropic vs. anisotropic materials.
Homework: Imperfections and Diffusion -Compute point defect concentration -Solve 1D steady-state and non-steady-state diffusion examples -Estimate diffusivity for simple systems
Homework: Mechanical Properties, Strengthening Strategies, Mechanical Failure -Convert between force and stress, between dimensional changes and strain -Estimate elastic and permanent dimensional changes -Estimate elastic modulus and tensile strength from 3-pt bend data -Estimate strengthening effect in metals due to grain size, impurity additions, precipitates, and cold work -Estimate strengthening effect in sintered ceramics due to particle size reduction, sintering time -Estimate strengthening of polymers due to drawing -Predict the critical load/stress for fracture -Estimate fatigue life -Estimate creep rate -Estimate time-dependent mechanical response of bone, soft tissue -Rank mechanical properties among different engineering materials.

Homework: Thermal and Composite Properties -Predict dimensional changes due to heating/cooling -Estimate heat conducted through a component (1D) -Estimate the energy to heat/cool an object -Rank thermal properties among different engineering materials.
Homework: Electrical, Magnetic, and Optical Properties -Calculate resistance for a given geometry and material. -Calculate resistivity for a 4-pt test. -Estimate critical wire diameter for an application -Estimate semiconductor conductivity vs. temperature -Calculate electron or hole density from a given concentration of donor/acceptor impurities. -Estimate the external magnetic field from a coil. -Use Hund's rules to estimate if a compound could be ferro- or para-magnetic. -Given a hysteresis loop, identify the coercive field, saturation magnetization, remnant magnetization. -Select whether a hard vs. soft magnet is desirable for a given application. -Select a material for a wavelength of application -Calculate a critical angle for total internal reflection
Corrosion and Degradation -Select materials to avoid galvanic corrosion -Select materials for cathodic protection -Select materials for passivation -Select irradiation tolerant materials
Homework: Phase Equilibria, Phase Transformation, and Materials Synthesis -Estimate melting temperature -Estimate the number of phases, their composition, and their volume fraction -Estimate volume fraction of nonequilibrium products -Estimate the amount of polymer crystallization -Estimate equilibrium volume fraction of precipitates

Grades

Aspect	Percent
Homework	25%
Participation and Assessment in Class	10%
Exam I	20%
Exam II	20%
Exam III	25%

Representative Textbooks and Other Course Materials

Title	Author
Fundamentals of Materials Science and Engineering: An Integrated Approach, 3rd ed. (2007)	WD Callister and DG Rethwisch

ABET-EAC Criterion 3 Outcomes

Course Contribution		College Outcome
***	a	An ability to apply knowledge of mathematics, science, and engineering.
**	b	An ability to design and conduct experiments, as well as to analyze and interpret data.
**	c	An ability to design a system, component, or process to meet desired needs.
	d	An ability to function on multi-disciplinary teams.
**	e	An ability to identify, formulate, and solve engineering problems.
	f	An understanding of professional and ethical responsibility.
	g	An ability to communicate effectively.

Course Contribution		College Outcome
	h	The broad education necessary to understand the impact of engineering solutions in a global and societal context.
	i	A recognition of the need for, and an ability to engage in life-long learning.
*	j	A knowledge of contemporary issues.
**	k	An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

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