MATSCEN 7862 (Proposed): Microstructural Elasticity

Course Description

Study how elastic interaction between vacancies, dislocations, faults, grain boundaries, interfaces, precipitates, transforming particles, cracks, and indentations controls material properties, primarily mechanical.

Prior Course Number: 862
Transcript Abbreviation: Micros. Elast.
Grading Plan: Letter Grade
Course Deliveries: Classroom
Course Levels: Graduate
Student Ranks: Masters, Doctoral
Course Offerings: Autumn, Spring
Flex Scheduled Course: Never
Course Frequency: Even Years
Course Length: 7 week or 14 week
Credits: 2.0
Repeatable: No
Time Distribution: 4.0 hr Lec
Expected out-of-class hours per week: 8.0
Graded Component: Lecture
Credit by Examination: No
Admission Condition: No
Off Campus: Never
Campus Locations: Columbus
Prerequisites and Co-requisites: MATSCEN-6765
Exclusions: Not open to students with credit for MATSCEN-862
Cross-Listings:

Course Rationale: Existing course.

The course is required for this unit's degrees, majors, and/or minors: No
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: 14.1801
Subsidy Level: Doctoral Course

Programs

Abbreviation	Description
MATSCEN	Materials Science and Engineering

General Information

Introduce students to the fundamental solutions for elastic fields generated by point, line, area, and volume based microstructural features in materials. These include vacancies, dislocations, faults, grain boundaries, interfaces, precipitates, transforming particles, cracks, and indentations. Students will also learn about the role of stress on the energy to form such microstructural features. This energy formalism will be used to understand why microstructural events such as vacancy formation, crack nucleation and propagation, and dislocation motion are affected by both applied stress and internal stress from nearby microstructural features.

Course Goals

Develop the capacity to accurately describe material defects in crystallographic terms.
Develop analytic and computational skills to determine the elastic stress and strain fields for a variety of defects.
Understand the nature and computation of interaction energies between defects, calculation of energetic forces on defects, and the role of energetic forces on the kinetics of defect motion or evolution.
Apply course principles to determine the threshold for yield or fracture and the dependence on microstructural defects.
Apply course principles to an independent student project.
Use elementary computer codes that implement course concepts.

Course Topics

Topic	Lec	Rec	Lab	Cli	IS	Sem	FE	Wor
Overview of defects	2.0							
Overview of elasticity and internal and external work	3.0							
Continuum and lattice Green's functions	2.0							
Applications of Green's functions to transforming particles, dislocations, point sources of dilatation.	4.0							
Dislocations and modeling of dislocation mobility and evolution	4.0							
Grain boundaries and modeling of energy and mobility	4.0							
Cracks and conditions for propagation, microstructural toughening, path independent integrals	4.0							
Contact stress fields and wear models	2.0							
Effective elastic properties of aggregates	2.0							

Representative Assignments

Calculate finite deformation descriptions caused by crystal slip or phase transformations.
Compute bounds on elastic moduli based on crystal symmetry and energy/work principles.
Construct simple computer codes for the elastic fields of defects such as inclusions, cracks, or grain boundaries.
Calibrate lattice Green's functions to macroscopic crystal properties; contrast lattice and continuum Green's function solutions for an interstitial disk or other defect.
Calculate the fracture toughening effect of nearby dislocations, phase transformations, grain boundaries.

Grades

Aspect	Percent
Problem sets (homework)	40%
Course project	20%
Final exam	40%

Representative Textbooks and Other Course Materials

Title	Author
Crystals, Defects, and Microstructures	Phillips
Micromechanics of Defects in Solids	Mura

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.
	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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