

Syllabus – ME/MSE 6796

Structure-Property Relationships in Materials

ME/MSE 6796, Fall 2020, Credits: 3-0-3

Modality: Hybrid Class with primarily synchronous online lectures

Lecture: MW, 9:30 am – 10:45 am* (MRDC 3403)

*Class will meet *intermittently* with <25% population; see “class policies” below. All lectures will be available online through the Canvas.

Instructor: Prof. Matthew McDowell, MRDC 4408

G. W. Woodruff School of Mechanical Engineering

School of Materials Science and Engineering

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Website: <http://mtmcdowell.gatech.edu>

Office Hours: Tuesdays 4-5 pm, BlueJeans

General Information

Description

This course introduces students to the relationship between atomic bonding, crystallographic symmetry, and properties of materials. Using the knowledge developed throughout this course, students will be able to design materials with optimal microstructure and properties for a given application.

Course Modality Information

This course is “hybrid” and will feature remote lectures mixed with a limited number of in-person learning experiences, including lectures and concept sessions. Attendance for in-person sessions is not required, and all course material will be available remotely. A tentative schedule of in-person interactions will be provided. Remote lectures will mostly be synchronous, with some asynchronous modules built in. All lectures will be available via Canvas. Office hours will be virtual.

Pre-Requisites: Graduate standing in engineering or a related discipline.

Course Materials

Course Texts

Properties of Materials: Anisotropy, Symmetry, Structure. Robert E. Newnham, Oxford University Press, 2005. (Available digitally via GT Library)

Materials Engineering: Bonding, Structure, and Structure-Property Relationships. Susan Trolier-McKinstry, Robert E. Newnham, Cambridge University Press, 2017. (Useful, but not required)

Physical Properties of Crystals: Their Representation by Tensors and Matrices. J. F. Nye, Oxford University Press, 1985. (Useful, but not required)

Course Website and Other Classroom Management Tools

All class updates, announcements, discussion, and grades will be posted on **Canvas**.

Grading

Grade Allotment

- Homework (four problem sets): 5%
- Quiz 1: 15% (*Likely September 2*)
- Quiz 2: 15% (*Likely September 30*)
- Quiz 3: 20% (*Likely October 28*)
- Quiz 4: 20% (*Final Exam period*)
- Final Report/Project 25% (*Likely November 23, 2020*)

Grading Scale

Your final grade will be assigned as a letter grade according to the following scale:

A	89.5%-100%
B	79.5-89.4%
C	64.5-79.4%
D	49.5%-64.4%
F	0-49.4%

Course Outline

Topic

Interatomic bonding

Review of crystallography and crystal symmetry

Tensor descriptions of materials properties

Tensor transformations

First and second rank tensors, associated properties

Stress and strain

Piezoelectricity and third rank tensors

Elasticity

Survey of other properties

Effect of crystal defects

Course Goals and Learning Outcomes

Upon successful completion of this course, you will have learned to perform the following tasks:

1. Understand how interatomic bonding impacts materials properties
2. Predict how atoms will arrange into crystals based on their bonding characteristics

3. Determine how the symmetry of material properties is affected by crystallographic symmetry
4. Use tensors to describe materials properties
5. Understand when and why to use first, second, third, and fourth rank tensors to describe properties
6. Describe the key features of different materials properties and how these properties are defined mathematically
7. Explain symmetry of polycrystalline materials, and the relationship between single crystals and polycrystals in the context of materials properties
8. Explain how properties of a material are determined by bonding characteristics, crystal structure, symmetry, and microstructure
9. Design a material (composition, crystallographic structure, microstructure, and bonding characteristics) for optimal performance in a given application

Class Policies**

The class will be taught in a “hybrid” mode. Most of the lectures will be provided fully online, with in person-meetings being held intermittently on certain days with a very limited number of people present. Dr. McDowell will clearly lay out the schedule for the class so that students know when lectures will be held online, or when an opportunity for in-person social-distancing interaction will be available. All lectures, whether hybrid or fully online, will be held over BlueJeans (synchronous) and/or will be recorded (asynchronous). For synchronous lectures, Canvas will likely need to be accessed during class.

Social distancing means a limited number of people will be present, with at least 6 feet between people, and cloth or surgical masks required. Do not come to class if you have any symptoms of COVID-19. The people allowed to come to class during a given period will be decided and notified ahead of time.

BlueJeans office hours will be held every week. Furthermore, in-person social-distancing interactions with limited numbers of students and Dr. McDowell may also be scheduled to go over big-picture ideas and concepts.

Other notes:

- Announcements and assignments will be posted on Canvas and/or sent out to the class via email
- Documented excuse: you must provide a note from the Dean of Students confirming approved Institute activities (section IV.B.3 of the Student Rules and Regulations). Please provide name, email, and phone number.
- All class updates, announcements, discussion, and grades will be posted on **Canvas**.

**Details regarding class layout and schedule are subject to change based on instructor discretion and the trajectory of COVID-19.

Homework

Homework will be graded for completion. While group discussion is encouraged on homework, individuals are expected to submit their own version of the homework assignment. Authorized aid on homework assignments includes discussing the interpretation of the problems, sharing ideas or approaches for solving the problems, and explaining the concepts involved in the problems. Any other aid would be unauthorized and considered a violation of the academic integrity policy. ***For homework that was worked on in groups, all written answers must be written independently and NOT duplicated—duplicated written answers will be considered in violation of the Academic Honor Code.*** All cases of academic misconduct will be submitted to Office of Student Integrity.

Homework will be assigned and will be due on Canvas.

Exams

Exams will be given online and will be synchronous with the class period. If you miss an exam without either a certified medical excuse or prior instructor approval, you will earn zero credit for that exam. Tests missed with certified medical excuses or prior instructor approval will be dealt with on an individual basis.

Exam Proctoring

Honorlock **MAY** be used to proctor your quizzes this semester.

Honorlock is an online proctoring service that allows you to take your exam at home. You **DO NOT** need to create an account, download software or schedule an appointment in advance. Honorlock is available 24/7 and all that is needed is a computer, a working webcam, and a stable Internet connection.

To get started, you will need Google Chrome and to download the Honorlock Chrome Extension. You can download the extension at www.honorlock.com/extension/install

When you are ready to test, log into Canvas, go to your course, and click on your exam. Clicking "Launch Proctoring" will begin the Honorlock authentication process, where you will take a picture of yourself, show your ID, and complete a scan of your room. Honorlock will be recording your exam session by webcam as well as recording your screen. Honorlock also has an integrity algorithm that can detect search-engine use, so please do not attempt to search for answers, even if it's on a secondary device.

Other notes regarding exams:

- No makeup exams unless there is an extreme and exceptional situation (must be documented)
- If you require accommodations through ADAPTS, please notify Dr. McDowell ASAP
- Check for final exam conflicts

Final Report/Project

This class will feature a final report/project that will involve applying concepts learned throughout the semester to materials and systems of interest to you. More information and details will be provided later in the course.

Health-Related Considerations

Effective July 15, 2020, University System of Georgia (USG) institutions require all faculty, staff, students, and visitors to wear an appropriate face covering while inside campus facilities/buildings where six feet social distancing may not always be possible. All members of the campus community will be provided reusable cloth face coverings.

Face covering use will be in addition to and is **not** a substitute for social distancing. Anyone not using a face covering when required will be asked to wear one or must leave the area. Refusal to comply with the requirement may result in discipline through the applicable conduct code for faculty, staff or students.

There are a few exemptions. Reasonable accommodations may also be made for those who are unable to wear a face covering for documented health reasons.

For more information about face masks and coverings, review the [guidelines from Human Resources](#).

Academic Honor Code

Academic misconduct is any act that does or could improperly distort student grades or other student academic records. Students suspected of academic misconduct will be dealt with according to the policies within the Georgia Tech academic honor code (<http://honor.gatech.edu/content/2/the-honor-code>).

Honor code violations include but need not be limited to the following:

- Accessing restricted information during online exams
- Possessing, using, or exchanging improperly acquired written or verbal information in the preparation of any essay, laboratory report, examination, or other assignment included in an academic course
- Substitution for, or unauthorized collaboration with, a student in the commission of academic requirements
- **Submission of material that is wholly or substantially identical to that created or published by another person (plagiarism)**
- False claims of performance or work that has been submitted
- Alteration or insertion of any academic grade or rating so as to obtain unearned academic credit
- Deliberate falsification of a written or verbal statement of fact to a member of the faculty so as to obtain unearned academic credit
- Forgery, alteration, or misuse of any Institute document relating to the academic status of the student.

Student-Faculty Expectations

At Georgia Tech we believe that it is important to continually strive for an atmosphere of mutual respect, acknowledgement, and responsibility between faculty members and the student body. In the end, simple respect for knowledge, hard work, and cordial interactions will help build the environment we seek. Therefore, I encourage you to remain committed to the ideals of Georgia Tech while in this class.

This is especially critical given the unprecedented nature of this semester: I will do everything I can to ensure that you have a full educational experience, and I ask that you contribute to the same.

Mental Health & Wellness

As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, depression, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance or reduce a student's ability to participate in daily activities. GT offers services to assist you with addressing these and other concerns you may be experiencing. If you or someone you know is experiencing any of the issues noted above, consider utilizing the confidential mental health services available on campus. I encourage you to reach out to GT CARE (www.care.gatech.edu, 404-894-3498) or the Counseling Center (www.counseling.gatech.edu, 404-894-2575) for support. An on-campus counselor or after-hours services are available to assist you.

Students with Disabilities

The Office of Disability Services serves Georgia Tech students with documented qualifying disabilities and operates under the guidelines of Section 504 of the Rehabilitation Act of 1973 and the Americans with Disabilities Act and its amendments (ADAAA). In accordance with Georgia Tech Policy, "Reasonable accommodations are provided to self-identified students with disabilities who meet the academic and technical standards requisite to admission or participation in the program of study. Consideration may be given to the substitution or modification of certain course requirements as long as such changes do not detract from the quality of the educational experience and the changes remain within the accreditation criteria for the degree program." More information can be found here: <http://www.adapts.gatech.edu>. Self-identified

students with disability should speak with Dr. McDowell during the first week of classes, so that suitable arrangements can be organized.