

Materials for Electronic, Magnetic and Optical Applications

MSE 3670

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Office Hours: Thursday noon-1pm & Friday 3-4pm

What is this course?

- Why were there no cell phones in 1970?
- What device will our next generation not be able to survive without, but that hasn't yet been invented?
- How are these devices possible?

Devices based on the electrical, magnetic, and optical materials are a huge part of our lives. If you accessed this syllabus from the internet, then you used an electronic device (computer, cell phone) that interfaces with optoelectronics (the screen) to allow you to view this document. If the device has a disk drive then the motor functions due to the electromagnetic properties of the materials.

The overall goal of this course is to understand why materials have electronic, magnetic, or optical properties, and how these can be manipulated. In materials science we call this the process-structure-property relationship. We will investigate the underlying physics behind these properties and also how they lead to exciting applications. With the fundamental properties understood, we will explore the material combinations and interfaces that make modern nanoelectronics and optoelectronics possible.

What will you learn?

At the end of this course you will be able to:

- Articulate process-structure-property relationship for electronic, magnetic and optical properties.
- Solve problems relating to electronic, magnetic and optical properties of materials
- Demonstrate that you can understand how this subject integrates with other courses (e.g. Intro to MSE, Thermo, Nanoscale Devices, Nanoscience..... Others?)
- Define an interest area and explore it beyond the scope of the lecture notes in a project assignment.
- Learn how to interact scientifically with others through a team-based presentation.

How will your learning be quantified?

The following is a draft of the grade distribution. This may change at the instructors' discretion. No one area is likely to change by more than 5%.

General: Our goal should be to demonstrate mastery of what we wanted to learn. Therefore you will have an opportunity to complete homework assignments correctly. To achieve this you will be asked to resubmit homework assignments if they were not 100% correct. The partial credit for the resubmission will be specific to each assignment.

Why? Is it O.K. to be almost right? Do you want a car that can do everything..... except turn left? So is it O.K. to do a problem correctly..... except you're out by a factor of 1000 because you forgot to convert kg to g?

The specific breakdown of assignment grades is an estimate based on previous years and may vary at the discretion of the instructor.

You will be allowed to drop your lowest homework and your lowest quiz.

Homework (17%): Your homework assignments will typically be a problem-solving format to test how you apply the foundational knowledge of this course.

Why? This is a chance to demonstrate problem-solving skills and application of knowledge.

Quizzes (15 %): In class quizzes focused on concepts, derivations, and definitions. (10-15 minutes)

Why? This is to test your basic foundational knowledge of the material in the course. Doing this regularly will help you stay prepared for each new topic we advance to.

Exams (12/12/18%): Test how you apply foundational knowledge and problem solving.

Why? This allows you to demonstrate that you can use the foundational knowledge. The exam setting also simulates the pressures that can exist when working in a stressful environment in the real world such as working to a hard deadline or under observation of a superior.

Learning reflection (6%): You will complete a descriptive assignment that demonstrates how various sections of this course integrated with each other and courses beyond MSE 3670.

Why? There is evidence based research suggesting that taking the time to consider what you have learned and integrated with current knowledge can lead to a deeper learning and longer retention.

Presentation (20%): The presentation will be on a self-selected electronic, optical, and/magnetic based technology that was not covered in our class (I will give a list of off-limit technologies). You will be required to prepare and present a powerpoint presentation where you describe the underlying material science that enables this technology, discuss how this application impacts society, comment on how this technology may be further improved, and why has this not happened yet.

Why? This presentation allows you the opportunity to solidify many sections of your learning objectives in this class. You will integrate your knowledge with a real world example that you find interesting. The learning will be self-guide; which will enhance your ability to learn new material. Similar to the reflection activities, deliberately considering how this topic relates to other courses you study and also the 'real' world will help you to more fully retain what you have learn.

What are the specific topics covered in this course?

-Review of Materials Science, Classical Theory of Conduction, Basic Quantum Mechanics, Semiconductors, Insulators, Magnetic Properties, Optical Properties.

Where will you get the information?

- Primary Text Book.

Electronic Materials and Devices – Kasap – McGraw Hill

- Lectures – I expand on key points in the text. Often using a combination of basic and complex topics as case studies.
- I am listing this as a 'required' this year. While I will not force you to 'answer question 37' without giving you the question, I do expect you to be able to turn to the text if you want example problems and deeper explanations. If you choose not to get the text, you can succeed, but will be at a disadvantage because the text has many examples. Contact me if you have questions about this.
- 4th edition is new, 3rd edition copies are perfectly fine and both available through the bookstore.
- **This is covered with 'inclusive access'.**
- Secondary Textbook
Physical Properties of Materials by Mary Anne White, 3rd Edition
- Used for Optical Properties
- Other texts include:

Properties of electronic materials – Hummel

ISBN-13: 978-1441981639

ISBN-10: 1441981632

How should we conduct ourselves in class?

- Get engaged.
 - o Ask questions, answer questions, engage in discussions when I ask you to.
 - o Attempt problems even if they are not graded.
- Be respectful to me and to others.
 - o Be on time.
 - o Be courteous even when you are disagreeing with another person's opinion.

Illness

If you are feeling unwell. Please DO NOT come to class. This includes on days there are examinations and/or quizzes. It will always be possible to make accommodations in a fair way. We've learned a lot on how to accommodate these situations over the last few years.

Students with disabilities or learning needs

It is my goal to create a learning experience that is as accessible as possible. If you anticipate any issues related to the format, materials, or requirements of this course, please meet with me outside of class so we can explore potential options. Students with disabilities may also wish to work with the Student Disability Access Center (SDAC) to discuss a range of options to removing barriers in this course, including official accommodations. We are fortunate to have an SDAC advisor, Courtney MacMasters, physically located in Engineering. You may email her at cmacmasters@virginia.edu to schedule an appointment. For general questions please visit the [SDAC website](http://sdac.studenthealth.virginia.edu): sdac.studenthealth.virginia.edu. If you have already been approved for accommodations through SDAC, please send me your accommodation letter and meet with me so we can develop an implementation plan together.

Religious accommodations

It is the University's long-standing policy and practice to reasonably accommodate students so that they do not experience an adverse academic consequence when sincerely held religious beliefs or observances conflict with academic requirements.

Students who wish to request academic accommodation for a religious observance should submit their request to me by email as far in advance as possible. Students who have questions or concerns about academic accommodations for religious observance or religious beliefs may contact the [University's Office for Equal Opportunity and Civil Rights](#) (EOCR) at UVAEOCR@virginia.edu or 434-924-3200.

Support for your career development

Engaging in your career development is an important part of your student experience. For example, presenting at a research conference, attending an interview for a job or internship, or participating in an extern/shadowing experience are not only necessary steps on your path but are also invaluable lessons in and of themselves. I wish to encourage and support you in activities related to your career development. To that end, please notify me by email as far in advance as possible to arrange for appropriate accommodations.

Student support team

You have many resources available to you when you experience academic or personal stresses. In addition to your professor, the School of Engineering and Applied Science has staff members located in

Thornton Hall who you can contact to help manage academic or personal challenges. Please do not wait until the end of the semester to ask for help!

Learning

[Lisa Lampe](#), Director of Undergraduate Education

[Blake Calhoun](#), Director of Undergraduate Success

Courtney MacMasters, Accessibility Specialist, cmacmasters@virginia.edu

[Free tutoring](#) is available for most classes.

Health and Wellbeing

[Assistant Dean of Students](#), Student Safety and Support

Elizabeth Ramirez-Weaver, CAPS counselor

Katie Fowler, CAPS counselor

You may schedule time with the CAPS counselors through [Student Health](#) (<https://www.studenthealth.virginia.edu/getting-started-caps>). When scheduling, be sure to specify that you are an Engineering student. You are also urged to use [TimelyCare](#) for either scheduled or on-demand 24/7 mental health care.

Community and Identity

The [Center for Diversity in Engineering](#) (CDE) is a student space dedicated to advocating for underrepresented groups in STEM. It exists to connect students with the academic, financial, health, and community resources they need to thrive both at UVA and in the world. The CDE includes an open study area, event space, and staff members on site. Through this space, we affirm and empower equitable participation toward intercultural fluency and provide the resources necessary for students to be successful during their academic journey and future careers.

Harassment, Discrimination, and Interpersonal Violence

The University of Virginia is dedicated to providing a safe and equitable learning environment for all students. If you or someone you know has been affected by power-based personal violence, more information can be found on the [UVA Sexual Violence website](#) that describes reporting options and resources available - www.virginia.edu/sexualviolence.

The same resources and options for individuals who experience sexual misconduct are available for discrimination, harassment, and retaliation. [UVA prohibits discrimination and harassment](#) based on age, color, disability, family medical or genetic information, gender identity or expression, marital status, military status, national or ethnic origin, political affiliation, pregnancy (including childbirth and related conditions), race, religion, sex, sexual orientation, veteran status. [UVA policy](#) also prohibits retaliation for reporting such behavior.

If you witness or are aware of someone who has experienced prohibited conduct, you are encouraged to submit a report to [Just Report It](https://justreportit.virginia.edu) (justreportit.virginia.edu) or [contact EOCR](#), the office of Equal Opportunity and Civil Rights.

If you would prefer to disclose such conduct to a confidential resource where what you share is not reported to the University, you can turn to [Counseling & Psychological Services \(“CAPS”\)](#) and [Women’s Center Counseling Staff and Confidential Advocates](#) (for students of all genders).

As your professor and as a person, know that I care about you and your well-being and stand ready to provide support and resources as I can. As a faculty member, I am a responsible employee, which means that I am required by University policy and by federal law to report certain kinds of conduct that you report to me to the University's Title IX Coordinator. The Title IX Coordinator's job is to ensure that the reporting student receives the resources and support that they need, while also determining whether further action is necessary to ensure survivor safety and the safety of the University community.

Artificial Intelligence

The ethical use of artificial intelligence technologies is strictly at the discretion of the course’s professor and is otherwise prohibited without the professor’s explicit written or verbal permission. Artificial Intelligence tools may not be cited as authors, though the tools used must be fully disclosed as a source along with the capacity in which they were used. All outputs of artificial intelligence, both explicitly used and as inspiration in one’s submission, must be properly cited to its appropriate source.

This is an approximate schedule to allow you to plan. Some flexibility is inevitable as our goal is to master the topic rather than merely adhere to a strict schedule.

Topic	Topic/Event	Relevant Chapters	Relevant Sub-sections
1	Introductions & EMOP in a nutshell Syllabus overview		
2	Understanding Conduction	Chapter 2	2.1, 2.2, 2.3, 2.4, 2.5, 2.7
4	When things don't conduct	Chapter 7	7.1.1-3, 7.2, 7.3.1
5	Healing the sick and frightening away evil spirits – The power of magnets	Chapter 8	8.1-8.6
6	Let there be light	Chapter 9 Chapter 2-4 2 nd	9.1-9.4 Physical Properties of Materials by Mary Anne White, 3rd Edition
7	More Than a Cat in Box -Practical Quantum Mechanics	Chapter 3	3.1-3.8
9	How does that change our perception of materials	Chapter 4	4.1-4.8
10	Is it a conductor? Is it an insulator? No, it's Silicon	Chapter 5/6	5.1-5.5, 5.10, 5.11, 6.1-6.3 (Chapter 6, only if we have time)

Known absences (virtual lectures were possible):

Oct 23rd – 30th

Nov 5-7th