

## MSE 2090, Section 1 (Spring 2025):

## INTRODUCTION TO MATERIALS SCIENCE

There are three essential factors in all human activity: spirit, **materials**, and action. *Chiang Kai-shek*

**Instructor:** McDonnell: [mcdonnell@virginia.edu](mailto:mcdonnell@virginia.edu) 222 Wilsdorf Hall 434-982-5872

Instructor for: Section 1: Rob Kelly, Section 3: Liheng Cai

**TAs:** Ryan Grimes

Meeting Time and Place: Tues/Thurs 11:00am In Person

- McDonnell office hours: TBA Wilsdorf 222
- Grimes Office Hours: TBA Wilsdorf ???

Textbook: (**See information on the final page**) *Summary - Materials Science and Engineering, An Introduction – 10<sup>th</sup> Edition*, by William D. Callister and David G. Rethwisch, Zybooks edition

Learning Catalytics: Go to <https://learningcatalytics.com> and buy a 6 month subscription. You don't need to 'join a class' or anything like that. I provide a new code at the start of each lecture.

Equipment: you will need a web-enabled device (smart phone, tablet or laptop) to complete assignments in class assignments. If you do not have one of these, please contact me.

**Note: This syllabus is an honest attempt to outline the course logistic, however it is subject to change at the instructors discretion.**

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### Materials Science?

- Could we, and should we, make a bridge out of glass?
- Why can we write with graphite, but not with diamond? They're both just carbon...
- Airplanes are made of aluminum. Why aren't cars?

Materials are used to construct every technology used by our society, spanning the *seemingly* mundane materials like steel, concrete and plastic, to sophisticated materials like silicon, carbon nanotubes and light-emitting polymers. But what science underlies the making and the design of these materials? While physics and chemistry are important, Materials Science looks into a different and unique place — the *microstructure* – of a material. In this course, you will learn how the **properties** of a material are influenced by its underlying **structure**, and how we can control this structure using **processing**. By the end of the course, you will see your smart phone, your car, your home, and your world, through different eyes.

## Big Objectives:

At the end of the semester, here is what you will be able to do:

1. Develop an analytical approach to solving numerical calculations in materials science.
2. Connect materials to engineering technologies and applications.
3. Apply knowledge and concepts from chemistry and physics to help understand the fundamental science behind materials.
4. Be able to elucidate the connections between processing, structure, and properties of materials
5. Describe key concepts defining the process-structure-properties paradigm as the intellectual foundation of materials science
6. Work in a team to solve materials science problems

## Assessments:

These activities will help you and I measure your progress towards the Big Objectives above. More details will be provided when the activities are assigned.

Evaluation:

**Homework – Skills:** Homework (HW) will help you master each module shown in the schedule below, allowing you to exercise key concepts and equations to develop your knowledge and comfort level. These HW problems will mimic exam questions and will be submitted via gradescope which is withing CANVAS.

**Team Projects:** There will be two in depth problems for you to work on in teams and prepare 'reports' to be graded

**Exams:** Three 75 min exams covering Concepts, Skills and Applications. The two mid-term exams will be in the evening (two options for each), the third will be at the regular 'final exam' time assigned to us by the university.

### Participation:

Reading: I cannot over emphasize the value of reading the textbook. Zybooks contains in-text questions with feedback and multiple (infinite) attempts to get the right answer. You will complete all of the assigned readings and associated questions for participation credit.

Attendance: The teaching style for this section (and section 1) is active, team-based, learning. As such, attendance is important. I will periodically use Learning Catalytics, to get real time feedback on your understanding of a topic. Responses to these questions will be used to track attendance. I also use this format for given you practice with concept connections:

*Concept Connections:* This class puts about a 50% emphasis on understanding the material, with the other 50% on your ability to apply knowledge to mathematical problems. Since many of you may not be familiar with open ended concept style questions, we will provide a question on each topic up to the first mid-term so that you can you get a feel for them. Answers will be for participation credit which will be given for any honest attempt at answering.

**Grading (Subject to change):**

Activity	Percentage of Total Grade
Homework	15
Reading	15
Exams	45 (14 each)
In class participation	5
Team Problems	20

**Schedule of Activities: (*warning: this will evolve*)**

Module #	Date	Concept (# sessions)	Textbook Chapter
0	Jan 14	The Course (1)	
1	Jan 16	<i>Guided Inquiry</i> : What is MSE? (1)	1
2	Jan 21/23	<i>Guided Inquiry</i> : Bonding (1.5)	2
3	Jan 28	<i>Guided Inquiry</i> : Crystal Structure (4)	3
4	Feb 11	<i>Lecture</i> : Defects in Crystals (2)	4
5	Feb 18	<i>Guided Inquiry</i> : Diffusion (2)	5
6	Feb 25	<i>Guided Inquiry</i> : Phase Diagrams (5)	6
<i>Exam 1</i>	<i>Feb 19 or 20 (evening)</i>	Modules 1-4 6:30-8:00PM MEC 341	To be confirmed
	<i>Mar 8-16</i>	<i>Spring Break</i>	
7	Mar 20	<i>Lecture</i> : Phase Transformations (3)	7
8	April 1	<i>Guided Inquiry</i> : Mechanical Properties (2)	8
9	April 8	<i>Lecture</i> : Dislocations and Strengthening (3)	9
<i>Exam 2</i>	<i>April 4 or 5 (evening)</i>	Modules 5-7	To be confirmed
10	April 17/22/24	<i>Guided Inquiry</i> : Electrical Properties (4)	10
<i>Exam 3</i>	May 9 <sup>th</sup> 9am-noon	Modules 8-10	Set by registrar Please check for updates!!!

## Expectations and Policies

My expectation is that if you are signing up for this, you will come in with the intention to keep up with the pace of the class, engage with faculty and TAs for help when need, and in general seek to take responsibility for your own success. We are here to help you achieve that success. People who are most successful in this course tend to be organized and proactive with regard to their work.

**Assignments:** Late work is penalized. Negative 25% of maximum grade for first 24 hours late, negative 50% for the second 24 hours late. Anything later than this will not be graded.

In the case of individual assignments in Zybooks or gradscope, exemptions for extenuating circumstances will be self-approved. I understand that life can get in the way and that it can happen more than once. Therefore, rather than asking me for permission to submit late or simply not submit an individual assignment, I am handing you the power to exempt yourself up to two assignments days.

Assignment Days: I try to have assignments for the same topic all due on the same day since they are all highly complementary and it helps to work on them in parallel. As such, if you cannot submit one such assignment, I have to assume that you cannot submit the other either.

That same policy goes for class attendance. If you must miss class, you can self-approve that absence twice before spring break and twice after. (4 times total in the semester).

**Honor System:** Every student in this course must comply with all provisions of the UVa honor system. On tests and exams you are to pledge that you have neither received nor given unauthorized aid.

**From your Honor Reps:** *The School of Engineering and Applied Science relies upon and cherishes its community of trust. We firmly endorse, uphold, and embrace the University's Honor principle that students will not lie, cheat, or steal, nor shall they tolerate those who do. We recognize that even one honor infraction can destroy an exemplary reputation that has taken years to build. Acting in a manner consistent with the principles of honor will benefit every member of the community both while enrolled in the Engineering School and in the future.*

*If you have questions about your Honor System or would like to report suspicions of an Honor Offense, please contact a SEAS Honor Committee member.*

## 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 three 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](mailto:cmacmasters@virginia.edu) to schedule an appointment. For general questions please visit the [SDAC website](http://sdac.studenthealth.virginia.edu): [sdac.studenthealth.virginia.edu](http://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 \(EOCR\)](mailto:UVAEOCR@virginia.edu) at [UVAEOCR@virginia.edu](mailto: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](mailto: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](http://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](#) ([justreportit.virginia.edu](http://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.

### **Textbook Information**

This course will take part in a new inclusive access program with The UVA Bookstore. This new service enables The UVA Bookstore to offer students instant access to the course materials your professor requires at the lowest price! The UVA Bookstore has implemented this program to save students as much money as possible.

What does this mean for you, the student? It means you immediately have access to your digital course materials through UVA Canvas until the drop date — for free.

1. Go to Canvas
2. Click Modules
3. Click the link to the textbook (Intro to Mat Sci and Eng)
4. Subscribe
5. From then on, you can access the text book through modules, or through any ‘assignment’ that I have linked to the book (reading assignments and challenge assessments)

**After SEAS add-date**, your student account will be charged. If for some reason you decide you do not want to purchase these required materials, you can opt out of the program by clicking “OPT OUT” on your student portal page. If you opt out by the add-date deadline, your student account will not be charged. However, your access to the materials through UVA Collab/Blackboard/or Canvas will be removed.

For **MSE 2090**, if you drop your class between add and drop dates please contact the bookstore with proof of the dropped class and we will credit your student account. **Please remember that drop dates are different for each school across the university**

Due to the special pricing, refunds are subject to review and may not be processed.

This program aims to offer all students accessibility and affordability.

If you have any questions regarding the program, please email us at [UVAInclusiveAccess@Virginia.edu](mailto:UVAInclusiveAccess@Virginia.edu) or call us at **434-924-1045**.

We wish you great success in your studies.



To enhance your learning experience and provide affordable access to the right course material, this course is part of the Inclusive Access program. You can easily access the required materials for this course at a discounted price, and benefit from single sign-on access with no codes for WileyPlus.

### **How to Opt-Out of Inclusive Access**

If you do not wish to participate in Inclusive Access, you must opt out of the program online before the opt-out deadline. If you opt out by the deadline given, access to the online content will be turned off and you will not be billed.

It is NOT recommended that you Opt-Out, as these materials are required to complete the course. You can choose to Opt-Out by the opt-out deadline, but you will be responsible for purchasing your course materials at the full retail price and access to your materials may be suspended.

**To opt-out of the program**, you will need to access the link sent to you in your welcome email. This will direct you to the student portal where you will be able to see costs and opt out tabs.