

MSE 2001 – Spring 2025
Principles and Applications of Engineering Materials
Tuesdays, Thursdays @ 3:30-4:45 PM

Course Description: Developing new materials remains a main challenge to follow and predict the fast evolution of our society. Materials science and engineering must offer the possibility of developing such novel high-performance materials respecting environmental constraints. However, a mechanism-based tailoring of the performances requires constant improvements of experimental and theoretical techniques to unravel fundamental mechanisms. Such is the background of this course. The MSE 2001 course is based on the unifying principle that the performance of materials is controlled by their structure, properties, and processing. In this course we will first learn how to describe and quantify the structure of materials from the atomic scale to the macroscopic scale. The structure will then be related to specific materials properties and how temperature, deformation, and other processing parameters can be used to change the structure and performances of materials.

Instructor:

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Office Hours: My minimal office hours are on Tuesdays from 2:00-3:30 PM and from 4:45-5:45 PM.

Email Policy: You must use your Georgia Tech issued email address. Email originating from outside the Georgia Tech network may be ignored to protect your personal information and comply with Georgia Tech policies.

Textbooks: These textbooks are suggested as further readings. Note that they do not replace an active participation during lectures.

- James P. Schaffer, Ashok Saxena, Stephen D. Antolovich, Thomas H. Sanders, Jr. and Steven B. Warner, *The Science and Design of Engineering Materials*, Irwin, Chicago, IL.
- Charles Kittel, *Introduction to Solid State Physics*, John Wiley and Sons (WIE)
- D. Hull and D.J. Bacon, *Introduction to dislocations*, Butterworth-Heinemann 2011

Course Website: My personal webpage will be used to post the course syllabus, lecture notes, homework, and homework-solutions.

Exams: All exams will be closed book. No formula sheets other than the ones provided with the exam paper will be allowed. The exams will emphasize topics that are detailed as outlined below.

1. Partial exam #1 (Ch. 1-3)
2. Partial exam #2 (Ch. 1-5)
3. Partial exam #3 (Chap. 1-7)
4. Final exam #4 (Chap. 1-10)

Grades: Your grade in the course will be determined based on your performance on three written partial exams, and one final exam. The partial and final exams will be closed notes, closed book tests (*i.e.*, no supplementary materials of any kind are to be used).

- The three partial exams (60 minutes long) will be held during the regular meeting time of the class on the dates indicated on the syllabus.
- The final exam (2 hours 50 minutes) will be administered during the final exam period at the time and location set by the administration.

<u>Grade</u>	<u>Exam (Tentative Chapters and Date)</u>	<u>Percentage of Final</u>
	Partial exam #1 (Ch. 1-3)	16%
	Partial exam #2 (Ch. 1-6)	16%
	Partial exam #3 (Chap. 1-7)	16%
	Final exam (Chap. 1-10)	52%


Each of the questions will be graded as follow:





- All correct: 100% of the question grade.
- Partially correct: 50% of the question grade.
- All wrong: 0% of the question grade.

Note that there will be no other intermediate grade.

Homework: Homework is not to be turned-in, and you are responsible for using the provided solutions to gauge your understanding of the material. Students are strongly encouraged to work on the homework. Neglecting the homework will likely jeopardize your performance in the class. Students are allowed/encouraged to study together (including working together on the homework assignments). You can ask question regarding your homework, although you should try to think about the problems before asking me. Note that some problems can be corrected during the lectures.

Homework problems have 4 levels of difficulty:

	Level 1: potentially painful but must not be neglected
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	<u>Level 2:</u> sure value; must be redone in any circumstance
	<u>Level 3:</u> rather twisted, but not to be skipped systematically.
	<u>Level 4:</u> only 50% of students will pass it
	<u>Level 5:</u> you shall not pass!

Make up policy: Those with Institute sanctioned activity excuses will be allowed to take missed exams, per Institute policy. Make-up exams will only be permitted when absences are due to legitimate reasons. In any case, you must contact me in advance of the test in writing (email is fine) to schedule a make-up exam. If you do not contact me in advance, it may not be possible to schedule a make-up test. Whenever possible, make-ups will be administered during the week following the scheduled date of the exam. Make-up exams may be different from those administered during the regular examination period.

Extenuating circumstances: Please be sure to meet with the Dean of Students if you encounter extenuating circumstances that interfere with your ability to attend class and/or prepare for exams. The Dean's office is your best resource when you would prefer to not discuss the details of your personal situation.

Grade Accuracy: *Errare humanum est.* Errors in grading and/or recording of scores for exams must be addressed within seven days of posting by contacting me in writing via email. Disputes after this one-week period will not be considered. Note that I will not be returning exams during class. However, you may access your own exam during my office hours by scheduling an appointment with me through email. Note also, that grades may be curved at the instructor's discretion.

Academic Integrity: All students in this class are expected to respect the *Georgia Tech honor code* and behave in a professional manner when it comes to academic integrity. Any students violating the honor code or suspected of academic misconduct will be turned over to the office of Academic Integrity, Dean of Students to investigate the incident(s). Cheating off of another person's test is unethical and unacceptable. Cheating off of anyone else's work is a direct violation of the GT Academic Honor Code and will be dealt with accordingly.

Electronic Devices: The only electronic device that you may use during an exam is a commercially available calculator that cannot communicate with other devices without a direct physical connection (i.e., no wireless, IR or other

communication capabilities). Programmable and graphing calculators are allowed, but their memories should be appropriately cleared. Your use of a calculator should be consistent with the class policy that reference materials of any kind are *not permitted* on exams. The use of any mobile/wireless communication device (smart watch, cell phone, smart phone, etc.) in any way, shape, or form during an exam is strictly forbidden. Please be sure to put away your cell phones and watches before the exam begins. If you have *any* electronic device available/in your possession during an exam, you will be considered in violation of the academic integrity policy and referred to the office of Academic Integrity. All electronic devices must be placed inside of and remain in a closed bag, purse, or backpack during exams. Sharing or passing of calculators is also strictly forbidden: all persons involved in the sharing or passing will be in violation of the academic integrity policy and referred to the office of Academic Integrity.

Word: Use of any previous semester course materials is allowed for this course; however, I remind you that while they may serve as examples for you, they are not guidelines for any tests, exams, homework, or any other coursework that may be assigned during the semester.

Special needs: The Georgia Institute of Technology encourages qualified persons with disabilities to participate in its programs and activities. If you anticipate needing any type of accommodation in this course or have questions about physical access, please tell me as soon as possible.

Course objectives: Students will learn the fundamentals of structure-property-processing-performance relationships of engineering materials; learn the fundamentals of mechanical, chemical, electrical, and thermal properties of materials; be prepared to undertake more in-depth courses in specialized areas within materials science and engineering.

Course outcomes: Students should be able to demonstrate their understanding by qualitatively and quantitatively describing: 1. the five microstructural elements-atomic/molecular structure, defects, solute, precipitates, and grain boundaries and how they manifest themselves in each class of material. 2. how the key microstructural elements are controlled by composition, temperature, time, and deformation. 3. how material structure relates to mechanical and electrical performance. 4. the structure, chemistry, and phase fractions in solids. 5. how materials properties are calculated from empirical data.

MSE 2001 – Spring 2024
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Tentative Schedule

Class number	Topics	Chapters
#1	Save the world with Materials Sciences!	Chap. #1
#2	Atomic bonding	Chap. #2
#3	Crystal structures	Chap. #3
#4	Homework corrections	Chap. #1-#3
#5	Homework corrections	Chap. #1-#3
#6	Partial exam #1	Chap. #1-#3
#7	Correction of partial exam #1	Chap. #1-#3
#8	Defects in materials	Chap. #4
#9	Phase equilibria	Chap. #5
#10	Phase transformations	Chap. #6
#11	Homework corrections	Chap. #4-#6
#12	Homework corrections	Chap. #4-#6
#13	Partial exam #2	Chap. #1-#6
#14	Correction of partial exam #2	Chap. #1-#6
#15	Materials properties: mechanical properties	Chap. #7
#16	Materials properties: mechanical properties	Chap. #7
#17	Materials properties: mechanical properties	Chap. #7
#18	Materials properties: electrical properties	Chap. #7
#19	Materials properties: electrical properties	Chap. #7
#20	Homework corrections	Chap. #7
#21	Homework corrections	Chap. #7
#22	Partial exam #3	Chap. #1-#7
#23	Correction of partial exam #3	Chap. #1-#7
#24	Elaboration of materials	Chap. #8
#25	Tailoring material properties	Chap. #9
#26	Characterization techniques	Chap. #10
#27	Characterization techniques	Chap. #10
#28	Characterization techniques	Chap. #10
#29	Homework corrections	Chap. #10
#30	Homework corrections	Chap. #10
	Final exam	Chap. #1-#10