Carleton College Physics 260: Materials Science     Fall 2005

Class Meeting Time: MW 11:10-12:20, F 12:00-1:00; Olin 204

My Contact Information:
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Office: Olin 325
While I check my e-mail regularly and try to respond in a timely manner, I prefer that you talk to me in person if you have a content-based question about course material. My office hours will be MW 1:30-3 and F 9:30-10:30, but I am happy to engage in discussions, answer questions, and listen to your suggestions at other times. Anytime the door to my office is open, you are welcome to drop by.

Course Description/Overview:
This course is meant to provide a taste of the vibrant, interdisciplinary, and growing field of materials science. Drawing on chemistry and physics principles, we will focus primarily on the relationship between the structure and physical properties of materials. We will also spend time discussing the technological and societal impacts of materials development. In addition to providing an introduction to the discipline, I have built in some flexibility that will allow us to explore a few current topics in materials science. Some of these topics we will explore as a class, and one topic you will be expected to explore in depth on your own as part of a final project. Finally, I believe that knowledge is only useful if it can be clearly shared with others so this course will provide plenty of opportunities to practice your communication skills, both written and oral.

What I expect of you:
I expect you to: actively participate during class; interact collegially with other members of the class; complete readings, problem sets, and writing assignments on time; seek out help from other students or from me when you run into difficulty.

What you can expect of me:
I will: organize class discussions, activities, and lectures so that you can successfully tackle the problem sets and exams; promote exploration of concepts and provide help when difficulties arise; and seek and respond to input about the course content and structure.

Text:
I chose this textbook because it provides a very broad introduction to materials science, and it introduces concepts at a level that assumes only a background in introductory physics and chemistry. I realize that you all have different science backgrounds, and this book should provide equal access for everyone. If you have had many advanced courses in physics or chemistry, some of the readings may start at a very basic level, in which case treat it as a review. If, on the other hand, you haven’t seen some of the topics that are introduced only briefly in text, please feel free to stop by my office and ask for a more thorough introduction. While this text is widely used in the field of materials science, it includes much more material than we can cover in one term. Therefore, be forewarned that we will be skipping around in the text, but I will clearly let you know what readings need to be done before each class.

Supplemental texts:
Keeping an introductory physics and an introductory chemistry text book handy will probably be helpful to you. In addition, I have put several relevant books from the library in Olin 204 for everyone to reference. These books are checked out in my name, so please treat them well and do not remove them from Olin 204.
Course Procedures:
During class, you can expect a mix of lectures, group activities, and discussions. In order to maximize our class time, I will occasionally ask you to do brief preparations prior to coming to class (write a microtheme, develop a list of questions, etc). However, it is always better to come to class unprepared than to skip class because you didn’t have time to prepare.

The problem sets and essays are most helpful to you when they compliment what we are covering in class. Thus I encourage you to make every effort to get your assignments in on time. However, I will allow extensions for one problem set and one exploration/reflection writing assignment during the course of the term. (This means a problem set due Friday must be turned in by Monday’s class, and a writing assignment due Wednesday must be turned in by Friday’s class.) Beyond that, however, no late assignments will be allowed.

Assignments/Exams:
Problem sets will be due each week on Friday at 5 pm. I encourage you to collaborate with classmates while working on the problem sets, but I expect the final write-up to be written solely by you. Occasionally the problem sets will include a designated group problem. In those cases, you will be assigned a group to work with and only one solution per group will be turned in.

Exploration/reflection writing assignments will due at the start of class every Wednesday. These are not formal essays, but are intended to encourage reflection of topics covered or expand your thinking to issues not covered in class. These assignments will be graded on a scale of 1-4.

4: clearly written and insightful response with no errors in the scientific content.
3: good ideas that are perhaps not fully thought out or clearly presented; there are perhaps small errors in the science.
2: ideas need to be further developed, or grammar errors make the work difficult to read, or there are significant errors in the science.
1: the response lacks substance or is extremely difficult to follow.

In addition to the above assignments, I will often ask you to do various types of brief exercises as part of your assigned reading or during class. For these activities, I am simply looking for evidence of engaged thinking. These will compose the class participation portion of your grade.

Two self-scheduled exams will be given, one the week of October 3 and one the week of October 31. The exams are intended to be standard hour-long exams, but you can use as much time as you need. The exams can be taken anytime between 8 am and 8 pm during the designated week, but the exam must be completed in a single sitting.

The final project will allow you to explore a materials science application of your choice. I will provide an in-depth handout about what is expected for this assignment next week. While the end product is a final paper due by 5pm on the last day of the exam period, I will ask you to do various pre-work (in problem sets or as part of reflection/exploration essays) throughout the term; in addition, prior to turning in the final paper, I will ask you to present your work to several of your peers through informal interviews. An initial prospectus for the final project will be due on Wednesday, October 19th.

Contribution of assignments to final grade:
Exams 1 and 2 25%
Final project 30%
Weekly problem sets 25%
Exploration/reflection writing 15%
Class participation 5%
(Tentative) Class Schedule:

**September**
- 12 M Introduction; atomic structure
- 14 W Bonding
- 16 F Bonding; crystal structure
- 19 M Crystal structure; defects and disorder
- 21 W Crystal structure; defects and disorder
- 23 F Techniques for studying the structure of materials (x-ray, SEM, TEM, AFM, STM)
- 26 M Techniques for studying the structure of materials
- 28 W Mechanical properties, dislocations and strengthening mechanisms
- 30 F Mechanical properties, dislocations and strengthening mechanisms

**October**
- (Self-scheduled exam #1 10/3-10/7)
  - 3 M Electronic properties of metals, insulators, semiconductors
  - 5 W Semiconductors: doping and devices
  - 7 F Scaling down devices, dielectric materials
  - 10 M Ferroelectrics, piezoelectrics
  - 12 W Superconductors: magnetic and electronic properties
  - 14 F Magnetic properties of materials
  - 17 M Midterm break!
  - (Final project prospectus due 10/19 in class)
  - 19 W Magnetic properties of materials; magnetic data storage
  - 21 F In-class activities
- 24 M Optical properties; color
- 26 W Optical properties of nanoparticles
- 28 F Optical devices: LEDs, lasers, optical data storage

- (Self-scheduled exam #2 10/31-11/4)

**November**
- 31 M Polymers: structure and properties
- 2 W Polymers: structure and properties
- 4 F Polymers: applications
- 7 M Ceramics and glasses
- 9 W Ceramics and glasses
- 11 F No formal class meeting—group interviews for final projects
- 14 M Special topics
- 16 W Special topics
- 21 M (Final project paper due at 5 pm)