Fundamentals of Materials Science - Syllabus

Course Description

There are few fields of science or engineering that are not concerned in some way with materials. **Materials science** is an interdisciplinary field involving establishing the relationship between the structure of materials at atomic or molecular scale and their macroscopic properties. The study of materials science has evolved to the point at which scientists from physics, engineering and applied mathematics are working on problems of common interest.

Course PHY 615, cross-listed as CSI 685 and PHY 385, covers fundamentals of materials science with emphasis on physical topics including crystal structure and space group, X-ray crystallography, dislocation theory, phase diagrams, theory of nucleation and grow, and renewable energy materials. Includes a term project, assignments from current literature and topics in materials science.

Course Website

https://sites.google.com/view/materials2022f/

Instructor

Prof. Howard Sheng
Office: Planetary Hall, Room 211
Email: hsheng@gmu.edu
Phone: 703-993-8576

Lectures Hours

Mondays 4:30 – 7:10 PM, Planetary Hall 220

Important: if public heath factors make it necessary, this course will be taught online.

Objectives

1. Familiarize students with basic concepts in materials science. Understand the basic principles of modern physics as pertain to the physical behavior of materials.
2. Establish connections between materials science and other fields of science and engineering.
3. Be able to identify and solve physical problems in materials science, both in course work and in his/her future research.
4. Keep abreast with new materials used in renewable energy. Understand the principles, challenges, and strategies for renewable energy technologies.

Textbooks:

Graduate students (PHY 615 & CSI685):

Physical Foundations of Materials Science. Gunther Göttstein, Springer Verlag, 2003. ISBN:

Fundamentals of Materials Science PHY 615 Syllabus
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Fundamentals of Materials Science and Engineering: An Introduction. W.D. Callister, Wiley, 2007. ISBN: 0470125373

Undergrads (PHY 385)

Fundamentals of Materials Science and Engineering: An Introduction. W.D. Callister, Wiley, 2007. ISBN: 0470125373

Important: More advanced course materials will be distributed in class and posted on the website.

Additional reference books:

Introduction to Solid State Physics. C. Kittle, Wiley, 2007. ISBN: 047141526X

Physical Metallurgy. R.W. Cahn and P. Haasen, North Holland, 1996. ISBN 0444898751

Structure and Bonding in Crystalline Materials. G. Rohrer, New York, NY: Cambridge University Press, 2001. ISBN: 9780521663793

Physical Chemistry. T. Engel and P. Reid. San Francisco, CA: Benjamin Cummings, 2005. ISBN: 9780805338423

Prerequisite

There is no special prerequisites, just permission of the instructor.

Office Hours

I will have an open-door policy. Students are welcome to drop by my office at any time. If you would like to make an appointment with me at a specific time, send emails to: hsheng@gmu.edu

Evaluation

Each student will be responsible to cover the material in the textbook and lecture notes, do the assigned homework exercises. There will be mid-term and final exams.

1. Composition of Final Grades:

- 20% problem sets
- 20% attendance, in-class quizzes, and presentations
- 25% mid-term exam
- 35% final exam

Two of the exams are 3 hour quizzes given during lecture sessions, the last exam will fall during finals' week. **The final exam is not cumulative**.

Prof. H.W. Sheng

2. Final Letter Grades:

Final letter grades will be determined by total weighted scores from the composition o the final grades. The approximate score breakdown will be different for PHY 615 and PHY 385 students (see below).

PHY 615 & CSI 685

Weighted Scores	**Grades**
90 and Above	A
75-89	B
60-74	C
Less than 60	Failing

PHY 385

Weighted Scores	**Grades**
85 and Above	A
70-84	B
55-69	C
Less than 55	Failing

Note that these are the approximate score assignments: if your score falls at the border (e.g., between an A and B), your effort will decide the final grade: improvement over the course of the term; attitude in doing the problem sets; interactions with the lecturer during class etc.

3. Problem Sets:

Each problem set containing 3-5 problems will be given and graded. Problem sets can be turned in before or on the due date (in class, or slip them in underneath my office door no later than 11:00 pm on the due date). Files in the pdf format are also acceptable in emails. The homework assignments are announced on the course website https://sites.google.com/view/materials2022f/

Problem Set Turn-in Policy - Generally, the problem set solutions will be provided immediately after the turn-in deadline. Late problem sets will not be accepted (**they will be scored as zero points**).

4. Projects:

Each student is required to complete a final project, and deliver a presentation on his/her project. Project topics and requirements will be available to students as class progresses.

Ethics

We will strictly follow the Honor code issued by the University. For more details, see the university's Honor Code statement: http://honorcode.gmu.edu/

I expect students to be honest and truthful. Ethical violations include cheating on exams, plagiarism, unauthorized collaboration, alteration of graded assignments, forgery, falsification, lying, facilitating academic dishonesty, and unfair competition.

Lecture topics (Tentative):

Lecture 1 Introduction to Materials Science

Lecture 2 Atomic Bonding and Crystal Structure

Lecture 3 Crystal Structure and Symmetry

Lecture 4 X-ray Crystallography I

Lecture 5 X-ray Crystallography II

Lecture 6 Crystal Defects

Lecture 7 Alloys and Phase Diagram

Lecture 8 Diffusion

Lecture 9 Mechanical Properties

Lecture 10 Nucleation and Growth (Solid State Transformation)

Lecture 11 Physical Properties I *

Lecture 12 Physical Properties II *

(*) *optional*

Final Exam

December 12, 2022. Monday 4:30 – 7:30 pm.