Electrical, Optical and Magnetic Properties of Materials (MAT 204), Spring 2021

Course Motivation: All around us, technological innovation has been enabled by exciting developments in the engineering of materials. Through understanding the electrical, optical, and magnetic properties of the underlying materials, we can upgrade existing devices or even design revolutionary new ones. The advantages are evident in not only your cell phone and laptop computer, but also in energy-efficient window coatings and portable, lightweight batteries, to name a few important examples. In this course, we seek to understand how electrons control material properties through the structure of materials and the electronic structure of the constituent atoms. With this goal in mind, we will apply the principles of classical mechanics, Maxwellian electricity and magnetism, and quantum mechanics. Although the material covered in this course is merely an introduction into the physics and chemistry of solid materials, it should enable you to understand what's happening when you characterize a material with light or with an applied electric or magnetic field, as well as when you take courses that specifically focus on the physical properties of ceramics, polymers, and semiconductor materials.

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Teaching assistants:	Arzu COŞGUN ERGENE: arzucosgun@sabanciuniv.edu Z. Semih PEHLIVAN: pehlivan@sabanciuniv.edu	
Peer mentors:	Deniz ALBAYRAK Defne CIRCI Faiqa DAWOOD Mehmet Can DURSUN Asad-ur-Rehman (Asad) SHAHZAD	
Lecture hours:	Wednesdays, 08:40-10:30 Fridays, 13:40-14:30	on Zoom/in FENS G032 on Zoom/in FENS G032
Recitation hour:	Thursdays, 17:40-19:30	on Zoom
Office hours:	***By appointment*** for Cleva Hoca; please email at least 24 hours in advance. The TAs will announce their office hours via SUCourse.	

1. This document defines the expectations for the course. **These rules are applied equally to all students**. Therefore, please, have some pride and do not attempt to negotiate for special privileges or special projects to boost your grade. The grade that you earn for the course only reflects your degree of mastery of the course material during the 15 weeks of the semester.
2. **Lecture notes:** Take notes. From time to time, I will post *some* material to SUCourse to help you follow along in lecture. I recommend recopying your lecture notes to aid digestion of the concepts covered. Lectures are delivered synchronously so you can ask questions immediately. Use the video archive to review and fill in your notes.
3. **Time management:** As listed above, you are expected to spend at least 3 ***waking*** hours a week in lecture. I strongly recommend spending 1 hour for each lecture hour reviewing the lecture notes and

supplementing your understanding with reading from the textbook. Don't let yourself get behind, because the material in this course is cumulative (once you begin to feel lost, get help from the teaching staff ***immediately*** ☺).

4. **Homework:** The problem sets are intended be challenging, educational, and to be done in ***small groups***[1]. However, each student is expected to write-up his or her own solutions. Homework should serve as a learning tool. If you find yourself spending ~4 hours per week struggling with the problems, then you are on the right track. The grades are less important than making sure you understand the concepts well enough to explain it to your peers. The TAs will answer questions during recitation, so come prepared with specific questions. Solutions will NOT be posted, so take good notes during recitation and ***ask*** questions.
5. **Quizzes:** There will be quizzes in every lecture. They are open notes and open book, but NOT open friend. They will be 5-10 minutes long and must be submitted through SUCourse. Questions will be based on concepts discussed in the previous lecture or recitation. If you miss too many quizzes and are concerned about your grade, you may take an oral make-up exam (*your camera must be open*) with Cleva Hoca at the end of the semester.
6. **Grading:** 40% of your course grade will come from the term project, to be presented during the final exam time slot. 10% will come from the problem sets. The remaining 50% of your grade will come from in-class quizzes. There will be a quiz in every lecture and recitation. *Plagiarism and cheating are not tolerated and will be referred to the Disciplinary Court of the university.*
7. **Labs:** There will be a few optional labs to develop some intuition for topics we discuss in lecture. These labs will be held during the Common Free Hours. Instructions for the lab kits will be provided around the Add/Drop.
8. **Textbook:** Electronic Properties of Engineering Materials, by James D. Livingston will be the course textbook, although I will supplement it on occasion with material from other sources. *It will be available on course reserve in the IC.*
9. Supplemental reading, all available at the Information Center or on-line:
    a. The YouTube Channel of Prof. Walter Lewin contains many lectures on specific topics in classical mechanics, electricity, magnetism, and wave physics.
    b. R. Hummel (2000) Electronic Properties of Materials, Springer-Verlag, New York, USA.
    c. L. Solymar and D. Walsh (1998) Lectures on the Electrical Properties of Materials, 6th Ed., Oxford University Press, Oxford, United Kingdom.
    d. C.R. Barrett, W.D. Nix, A.S. Tetelmann (1973) The principles of engineering materials , Prentice-Hall, Englewood Cliffs, New Jersey, USA. (***or your ENS 205 notes and textbook***)
    e. M.A. Omar (1975) Elementary solid state physics : principles and applications, Addison-Wesley
    f. K. Nassau (2001) The Physics and Chemistry of Color, Wiley, New York, USA.
    g. Numerous books on electricity and magnetism, wave physics, and quantum mechanics

[1] In the past, I have heard excuses like, "I work better alone." Although your approach in high school may have prepared you well for a multiple-guess exam, that experience is very far from real life. You chose to attend university, presumably to equip yourself better for getting a job and keeping it. It's time to adapt and learn new skills.

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MAT 204 Course Syllabus

Semester Week #	Dates	Lecture Topic
Week 1	24/02-26/02	Course introduction; electrical properties of conductors (Math Toolbox in recitation)
Week 2	03/03-05/03	Steady-state and time-varying properties of conductors—electrical and optical properties (PS1 discussed in recitation)
Week 3	10/03-12/03	Electrical and optical properties of insulators (PS2 discussed in recitation)
Week 4	17/03-19/03	Electrical and optical properties of insulators (PS3 discussed in recitation)
Week 5	24/03-26/03	Magnetic properties of materials (PS4 discussed in recitation)
Week 6	31/03-02/04	Intro to Quantum Mechanics (QM) (PS5 discussed in recitation)
Week 7	07/04-09/04	Applied QM: Bonding and Molecules (PS6 discussed in recitation)
Week 8	14/04-16/04	Electrical and optical properties in organic materials (PS7 discussed in recitation)
Week 9	21/04-23/04	Electrical and optical properties in organic materials (no recitation due to the holiday on 23/04)
Week 10	28/04-30/04	Nearly free electrons in solids and energy bands (PS8 discussed in recitation)
Week 11	05/05-07/05	QM phenomena in metals & insulators (PS9 discussed in recitation)
Week 12	12/05-14/05	Ramadan Holidays (no classes)
Week 13	19/05-21/05	Semiconductors (PS10 discussed in recitation)
Week 14	26/05-28/05	Term project presentations