MSE 598: Magnetic Materials and Applications, Fall 2020

Lectures: Tuesday and Thursday 11:00 am – 12:20 pm, Engineering Hall 106B1
Lecture recordings and presentation slides will also be made available online via Compass

Instructor: Prof. Axel Hoffmann
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Office Hours: Tuesdays or Thursdays 2:00 pm – 3:30 pm, or via prior appointment
All office hour meetings will be via Zoom Meeting ID 929 5399 3898
The passcode for the Zoom Meeting will be made available in class

Course Description
This course will introduce the fundamental concepts that underly the practical use of magnetic materials. We will discuss the different types of magnetic materials, and the basic energies that drive their physical behaviors. A particular focus will also be on the dynamic properties of magnetic materials and their interactions with electrical excitations. These concepts will be reinforced via a micromagnetic simulation project, which allows to directly explore the intricate interplay between different magnetic interactions. The course will discuss these magnetic phenomena in the context of different applications, ranging from biomedical applications to current information technologies. At the same time, we will discuss frontiers of magnetism research, which will be reinforced through the literature review of recently published results.

Grading:

Homework:	25%
Micromagnetic simulation project	15%
Midterm:	15%
Literature review and presentation:	15%
Final:	30%

All assessment scores will be stored in the gradebook in Compass.

Textbook:
Magnetism and Magnetic Materials
By J. M. D. Coey
Cambridge University Press (2012)
also available electronically from UIUC library

Lecture policy:
Attendance and class participation is encouraged, although all lecture material will also be made available online via Compass. All the material presented in class is fair game for the homework and examinations. Furthermore, you are expected to check Compass, Piazza, and your email regularly for course updates.

Course Materials, Discussions and Announcements:
Course materials, including homework, lecture notes, and lecture recordings will be made available through our course Compass website at https://compass2g.illinois.edu/. Furthermore, the lecture recordings will also be accessible through a dedicated channel in Mediaspace. Discussions and announcements related to course material will be facilitated by using Piazza. You should register for this course on Piazza at: https://piazza.com/illinois/fall2020/mse598 and will need to provide a valid email address that you check regularly for subsequent communications. If you desire then you can post anonymously or make a private post just to the instructor (rather than sending an email). If you have any problems or feedback for the developers, email team@piazza.com.

Homework policy:
Homework will be assigned bi-weekly on Tuesdays. The homework should be worked on independently and is due within two weeks. No late homework unless receiving prior approval. All homework will be submitted and graded via Gradescope. For submission you will need to submit a PDF file by scanning a paper copy of your homework. After grading, any regrade requests will have to be submitted via Gradescope within *one week* of receiving the graded homework. Further information about using Gradescope is available at:
https://www.gradescope.com/help#help-center-section-student-workflow

Micromagnetic simulation project:
A micromagnetic simulation project will be assigned at the end of week 3 to groups of 3 ± 1 students during the second week of class. Using an online simulation tool will allow to investigate basic magnetic problems that have relevance to typical current research questions. Presentation of the results will be given during class in week 11 and reports will be due at the end of week 11.

Literature review:
Objective: Read a recent (< 10 years old) journal article on a new magnetic phenomena, material or application. Provide a detailed report that fully discusses the approach, summarizes current state-of-the-art in the topic area, and evaluate novelty of the results.

Length and formatting:
Maximum of 5 pages (8.5" x 11" paper with 1 inch margins and 11 point minimum font size);
Maximum of 2 figures
Cite all references; bibliography does not count towards page limit

Presentation:
15 minutes + 5 minutes for discussion (times may be adjusted depending on class attendance);
presentations will be given during week of November 19

Literature review papers and presentations will be graded on substance and clarity.

Examinations:
There will be a Mid-Term Exam on October 15, and a Final Exam during the week of December 7. Both exams will be closed book and closed notes. The exams will be available via Gradescope and proctored remotely through the Computer-Based Testing Facility (CBTF). Conflict-exam arrangements (e.g., for remote students in inconvenient time-zones) will be handled through CBTF.

Accommodations:
To obtain disability-related academic adjustments and/or aids, students should contact the course instructor and the Disability Resources and Educational Services (DRES) as soon as possible. To contact DRES, you may visit 1207 S. Oak St., Champaign, e-mail disability@illinois.edu, or go to the DRES website: https://www.disability.illinois.edu. If you are concerned you have a disability related condition that is impacting your academic progress, academic screening appointments are available on campus that can help diagnose a disability.

For rare circumstances, such as extended illness and family emergencies that make it difficult for you to keep up with coursework, you should contact Professor Hoffmann via a Piazza private message as soon as possible to discuss options. In these cases, I encourage you to reach out to the Dean of Students office, which can help you contact and manage accommodations with all of your courses.

Academic Integrity:
Honesty and integrity are fundamental to our community. Guidelines for academic integrity are detailed in Article 1, Part 4 of the Illinois Student Code. Any confirmed violations of that code will be taken seriously and may result in failure for the course.

Course outline: (topics may be adjusted as needed)

Week 1 *8/25 and 27*	Introduction to magnetism, magnetic order, dipolar fields, anisotropy	Problem set #1 assigned
Week 2 *9/1 and 3*	Basic energies, reversal and thermal stability, single domain particles, domain formations	
Week 3 *9/8 and 10*	Dynamics and micromagnetic modeling	Problem set # 1 due (9/10) Problem set #2 assigned
Week 4 *9/15 and 17*	Spin waves and magnetic excitations	
Week 5 *9/22 and 24*	Biomagnetism and magnetic nano-particles, biomedical application	Problem set # 2 due (9/24) Problem set #3 assigned
Week 6 *9/29 and 10/1*	Magnetic imaging and microscopy	
Week 7 *10/6 and 8*	Permanent magnets and soft magnets	Problem set # 3 due (10/6) Problem set #4 assigned
Week 8 *10/13 and 15*	Midterm review and Midterm Exam	
Week 9 *10/20 and 22*	Interfacial and surface effects, magnetic heterostructures	Problem set # 4 due (10/22) Problem set #5 assigned
Week 10 *10/27 and 29*	Interlayer exchange coupling, giant and tunneling magnetoresistance, spintronics	
Week 11 *11/3 and 5*	Spintronics and magnetic recording Student presentations on micromagnetic simulation projects	Problem set # 5 due (11/5) Problem set #6 assigned
Week 12 *11/10 and 12*	Magnetic solid-state memory	
Week 13 *11/17 and 19*	Student presentations of literature reviews	Problem set # 6 due (11/19)
Week 14 *11/24 and 26*	No classes	Happy Thanksgiving!
Week 15 *12/1 and 3*	Topological phenomena and other current hot topics	
Week 16 *12/8 and 10*	Final Review and Final Exam	