ELEG667/PHYS667 Magnetism & Spintronics

University of Delaware
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Office: 217C Evans Hall — Phone: x3295

Mondays and Wednesdays 4PM - 5:15PM
Colburn 109
Office Hours: Anytime
Course Website: http://www.ee.udel.edu/∼ appelbau/ELEG667-06

Goals:
This course is meant to be an introduction to magnetism and magnetic materials, and a survey of the rapidly expanding and progressing field of Spintronics. While we will attempt to cover many topics from the field, we must necessarily disregard others. This syllabus has been designed to provide not only an introduction to the major applications of spintronics but also give motivation for the discovery of electron spin and future spintronics materials and techniques. At the end of the semester, you will:

1. Be familiar with the concept of electron spin
2. Understand simple models of (ferro/para/antiferro...)magnetism
3. Understand the basic mechanisms underlying major spintronics devices
4. Be familiar with the seminal literature on spintronics
5. Gain an appreciation for the goals of the field

Teaching Philosophy:
The student's access to Spintronics is somewhat diluted by theories only a few can adequately comprehend. I don't pretend to understand the most obscure arguments so I don't expect students to understand them either. Emphasis is on actual experimental results reported in the literature, which give an idea of the achievements and potential of Spintronics at the present time. For most of the semester, I will present lectures on major ideas and concepts, providing suitable background to explore the most interesting and promising aspects of the field. The rest of the class will be a seminar on more advanced and specific topics from the literature.

Book:
Partly because Spintronics is a new field, there is no suitable textbook for classroom study. I have culled important sections on magnetism from a variety of sources for lecture material, and intend to have notes available for use outside class.

If you want to buy books related to Spintronics, I recommend the following:

- Hirota, Sakakima, and Inomata, "Giant Magneto-Resistive Devices": most suitable for the electrical engineer.
- Awschalom, Loss, and Samarth, "Semiconductor Spintronics and Quantum Computation": Particularly good for review of optical methods.
- Ziese, "Spin Electronics": Early attempt at creating an inclusive volume.

Note that all three are edited texts with contributing authors. This is characteristic of what's available on the subject, not particularly suitable for introduction to the wide range of topics.

Grading:
There will be homework due approximately every two weeks during the lecture period. These assignments will be 5-6 problems related to the lecture material. In addition, there will always be the possibility to gain bonus points (10% of each assignment grade) for synthesis of an original problem (with solution) related to the homework material. No late homeworks will be accepted for any reason.

The rest of the class will be in the form of a seminar course. You will be expected to give a presentation on a journal paper or series of journal papers and discuss the major results and significance of the work, and answer questions from the rest of the class, leading a discussion after the presentation.

In lieu of a final exam, you will be graded on a formal write-up of one of your presentation topics. You are expected to use LaTeX, the standard typesetting program for scientific journal papers.

- Presentations: 30%
- Final Paper: 10%
- "Participation": 10%

Participation is a crucial element in this class and does not simply mean attendance. In addition to forming and answering questions in class, I expect feedback to make this course more enjoyable for future generations of students.

Course Outline:

1. Origins of Spin
2. Spin Mechanics
3. Magnetism in Solids
4. Micromagnetics
5. Fabrication and Measurement
6. Origins of Spintronics
7. Magnetic Sensors
8. Giant Magneto-Resistance (GMR)
9. Magnetic Tunnel Junctions
10. Hot-Electron Spintronics
11. Semiconductor Spintronics
12. Magnetic Semiconductors
13. *Research Reviews*