

MODERN MAGNETISM

PHYS 5240, Spring 2026, MW 4:45 pm – 6:00 pm Osborne A204.

Prof. Ezio Iacocca

Office: ENG 216

E-mail: eiacocca@uccs.edu

Office Hours: TBD.

One-on-one office hours at other times can be scheduled via e-mail.

Course description

A comprehensive view into magnetism in matter. The course focuses on magnetism and magnetic phenomena in solid-state matter, but the concepts can be also applied to molecular magnetism. The course delves into the physical origins of magnetism at the atomic level and its manifestation in solids and multilayers. Applications will be discussed, including spin waves, magnonics, and spintronics. Several magnetic phenomena will be investigated via numerical simulations.

Course objectives

1. Understand the origin of magnetism and magnetic order.
2. Understand the Hamiltonian of magnetic systems.
3. Calculate dispersion relation of spin waves.
4. Learn how to use standard micromagnetic software.
5. Attain an introductory understanding of spintronics.

Teaching philosophy

Physics is the study of our world and the identification of the laws that make it work. Our understanding of the world has evolved since ancient times, slowly completing a puzzle. My teaching philosophy is that learners should partake in that process of discovery. To this end, I believe it is fundamental to both solve problems using appropriate techniques and explain physical phenomena with words. This means that we will work on “translating” formulas into discussions and be able to explain how the world works to someone else.

Diversity statement

As a scientific topic, Physics relies on the free flow of ideas to achieve a common truth. The scientific method is the canon that has enabled scientific discovery since ancient times. This method relies on five steps: problem statement, hypothesis, experiment, analysis, and reproducibility. In this class, we will follow the scientific method both to study and as our basis for an inclusive environment. It is not only encouraged but critical to express ideas, formulate hypotheses, and discuss the implications. To be effective, a scientific discussion must focus on the ideas per se in a manner that is respectful and impersonal. Even when our best ideas are strongly opposed and challenged, a civil discussion enables progress, learning, and excellence.

Requisites

Pre-requisite: None **Co-requisite:** None.

While there are not pre-requisites, you are expected to have knowledge of modern physics as well as an introductory understanding of solid-state physics and quantum mechanics. Fluency in numerical methods is necessary because you will have to solve numerical problems, plot results, and the project is based on numerical simulations.

Textbooks

1. J. M. D. Coey, *Magnetism and Magnetic Materials*. Cambridge University Press (2010) (**required**)
2. M. Getzlaff, *Fundamentals of Magnetism*, Springer-Verlag (2008)
3. J. Stöhr and H. C. Siegmann, *Magnetism: from fundamentals to nanoscale dynamics*, Springer (2006)
4. D. D. Stancil and A. Prabhakar, *Spin waves: theory and applications*, Springer (2009)

Assessment

Assignments	Final Weighted Percentage
6 Homework assignments	30%
1 Project	15%
2 Exams	30%
1 Final	25%
Total	100%

Grades

This scheme is **tentative** and may be adjusted based on the class performance.

A	A-	B+	B	B-	C+	C	C-	D+	D	D-	F
>90%	89%- 85%	85%- 80%	79% - 75%	74%- 70%	69%- 67%	66% - 64%	63%- 60%	59%- 57%	56% - 54%	53%- 51%	<50%

Course Information

- Magnetism is not trivial and combines a wide range of topics and knowledge. **You are expected to read the book carefully and ensure proper understanding of concepts.**
- **Late assignments** will not be accepted in this class, except for exceptional circumstances (see below).

Grades and grading policy

- **Homework:** you are expected to solve problems and report them in a clear, organized, and understandable manner. Often, homeworks will require some degree of computational work. Each homework assignment will be worth 5%. You will have 1.5 weeks to work on each homework.
- **Project:** Many effects in magnetism are nonlinear and require numerical simulations. The project is envisioned to have hands-on experience in numerical simulations. This is important for theoreticians and experimentalists alike. There will be a pool of projects to choose from. **There will be a dedicated week to work on the project but you should start earlier!** The project is equivalent to an exam.
- **Exam:** The exam is a checkpoint of fundamental knowledge on magnetism. A cheat sheet is **not** allowed. Relevant equations should be known or will be provided during the exam.
- **Final:** The final is **cumulative**. You are expected to have a good understanding of the fundamentals of magnetism as well as its applications, numerical techniques, and experimental techniques.

Grading policy

- Graded homework assignments and exams will be returned as soon as possible. Goal is within a week.
- All grades will be posted in Canvas but the official grade will be kept in a spreadsheet to accommodate for unforeseen circumstances.

Exceptional circumstances

You must **communicate in advance** any situation that will not allow you to attend midterms or hand in assessments. These include, but are not limited to, doctor's appointments, religious observances, and participation in sports. Military students should discuss any potential activity including training and deployment by the first week of class as per UCCS policy (see below). For any situation, be prepared to provide proof, e.g., explanatory letters from your doctor, coach, superior, etc. Unexpected events happen, and we will do what we can to reach a suitable solution on a case-by-case basis.

Tentative course schedule

Week	Day	Date	Topics	Activity	Book chapter
1	W	Jan-21	Introduction and review of Electricity and Magnetism		Coey 2
2	M	Jan-26	Magnetostatics, susceptibility and types of magnetism		Coey 2 Getzlaff 1
	W	Jan-28	Atomic magnetism: magnetic moment and Hund's rules	HW 1 posted	Coey 3.1-3.2, 4.1-4.2
3	M	Feb-2	Magnetism in metals: free-electron model, Pauli susceptibility, molecular field		Coey 3.2.5, 3.2.6, 3.4, 5.1 Getzlaff 3
	W	Feb-4	Ferromagnetism: Band magnetism, Curie temperature	HW2 posted	Coey 3.4.1, 4.3.1, 5.1, 5.3 Getzlaff 2, 5 Stohr and Siegmann 7
4	M	Feb-9	Exchange interaction and magnons	HW1 Due	Coey 5.2, 5.4 Getzlaff 4, 6.6
	W	Feb-11	Magnons redux (semi-classical) and Bloch's 3/2 law		Stohr and Siegmann 6.5
5	M	Feb-16	Review	HW2 Due	
	W	Feb-18		Exam 1	
6	M	Feb-23	Magnetic energies including crystalline anisotropy and the Landau-Lifshitz equation		Coey 7.1, 2.2.4, 5.5, 9.1, 9.2.2. Getzlaff 7.1-7.5
	W	Feb-25	Domains and domain walls	HW3 posted	Coey 7.2 Getzlaff 8.2-8.3
7	M	Mar-2	Stoner-Wohlfarth model of magnetization reversal, Barkhausen noise, domain patterns		Coey 7.3.1 Getzlaff 8.4, 12.5
	W	Mar-4	Critical length, thin films, surface anisotropy, and perpendicular magnetic anisotropy	HW4 posted	Coey 7.3.3, 8.1, 8.2, 8.2.2 Getzlaff 7.6, 12.1 Stohr and Siegmann 7.9
8	M	Mar-9	Antiferromagnetism: superexchange, susceptibility, magnons, and hysteresis. Survey on other types of magnetic order with antiferromagnetic exchange.	HW3 Due	Coey 5.2.1, 6-6.2 Getzlaff 4.3, 5.2

	W	Mar-11	Exchange bias, RKKY interaction, weak ferromagnetism, and roughness		Coey 5.2.1, 8.3 Getzlaff 4.3, 14.5, 15
9	M	Mar-16	Work on project	HW4 Due	
	W	Mar-18	Work on project		
10	M	Mar-23	SPRING BREAK		
	W	Mar-25			
11	M	Mar-30	Ferromagnetic resonance and relaxation	Project due	Coey 9 Getzlaff 9.4
	W	Apr-1	Magnetostatic spin waves in thin films	HW5 posted	Stancil 5
	F	Apr-3	Last day to withdraw		
12	M	Apr-6	Experimental methods: growth, patterning, fields, and static magnetization measurements		Coey 10
	W	Apr-8	Experimental and numerical methods: dynamic magnetization, micromagnetic simulations, and atomistic spin dynamics.		
13	M	Apr-13	Lab Tour	HW5 Due	
	W	Apr-15	Electronic conduction and magneto-resistance		Coey 8.3.4-8.3.6 Getzlaff 16 Stohr and Siegmann 14
14	M	Apr-20	Review		
	W	Apr-22		Exam 2	
15	M	Apr-27	Spin valves and spin-transfer torques	HW6 posted	Coey 14.1.4, 14.1.5 Stohr and Siegmann 14
	W	Apr-29	Magnetic textures: dimensionality and topology		
16	M	May-4	Ultrafast magnetism: history, the 3T model, experimental techniques, and current advances		Stohr and Siegmann 9, 15
	W	May-7	Review	HW6 Due	

UCCS Policies:

In addition to the course policies, all UCCS students are also expected to know and comply with policies set by the campus and the Regents of the University of Colorado. The most important include:

Disability Services (or Accommodations) Syllabus statement

If you are a student with a disability and believe you will need accommodations for this class, it is your responsibility to register with Disability Services and provide them with documentation of your disability. They will work with you to determine what accommodations are appropriate for your situation. To avoid any delay, you should contact Disability Services as soon as possible. Please note that accommodations are not retroactive and disability accommodations cannot be provided until a Faculty Accommodation Letter has been given to me. Please contact [Disability Services](#) for more information at Main Hall room 105, 719-255-3354 or dservice@uccs.edu.

Military Students Syllabus Statement

"Military students who have the potential to participate in military activities including training and deployment should **consult with faculty** prior to registration for any course, but no later than the end of the first week of classes." [Office of Veteran and Military Student Affairs](#)

Student Code of Conduct

It is the responsibility of students to read and understand the ethical and social behavior that underlies the principles of the University. This is a collection of policies regarding student behavior including ethics, cheating, plagiarism, and a whole list of student conduct infractions that cover participation in class or in online forums.

Withdrawal from course

You may choose to withdraw from your class. **Please note the last date for withdrawal without instructor/dean's approval is April 3, 2026.** Please e-mail me (eiacocca@uccs.edu) if you are facing difficulties with the course so I can help you avoid withdrawing. Even if you consider withdrawing, it is a good idea to discuss first and find a solution, if possible.

Help - Technology and Student Support

Technology Help

In Canvas, help is available through the Help link at the bottom of the global navigation in the Canvas course (black navigation bar at the far left of the window).

- **Canvas Support 24/7 Hotline 844-802-9230**
- [Canvas Support Live Chat](#) - you do not have to be logged in to Canvas to access the hotline or chat.
- **UCCS Helpdesk** - 719-255-3536 or [Contact the Help Desk online](#).

Academic Help

The Excel Centers

The UCCS Excel Centers include the Language and Social Sciences Center, the Mathematics Center, the Communication Center, the Science Center, and the Writing Center. These five academic centers are designed to provide critical academic and individual support to all students in the University in all major academic areas, both within and beyond the classroom. All Excel Centers offer [online services by appointment](#).

Academic Advising

Advising for degree programs and ask questions about all things regarding your academic career