

Applied Magnetism and Magnetic Materials

EEL 4412 Class# 20291

EEL 5417 Class# 20296

Class Periods: MWF 2 (8:30am – 9:20am)

Location: LAR 239

Academic Term: Spring 2022

Instructor:

David Arnold

darnold@ufl.edu

LAR 213

Office Hours: TBD

Teaching Assistant/Peer Mentor/Supervised Teaching Student:

None

Course Description

(3 credits) Introduction to magnetism, magnetic materials, and magnetic devices. The course offers a balance of theory and application from an applied engineering perspective.

Course Pre-Requisites / Co-Requisites

Undergraduates: EEL 3008 Physics of EE (or consent of instructor)

Course Objectives

The objective of this course is to introduce the fundamentals of magnetism and explore applications of magnetic materials, primarily hard and soft ferromagnets. The course complements theory with practical design and application principles and is intended primarily to equip scientists and engineers to employ magnetic materials in functional systems.

Materials and Supply Fees

None

Relation to Program Outcomes (ABET):

Outcome	Coverage*
1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	Medium
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors	
3. An ability to communicate effectively with a range of audiences	Medium
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts	
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	

7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies	Medium
---	--------

Required Textbooks and Software

None. Supplemental materials provided on Canvas and course Wiki page.

<http://www.darnold.ece.ufl.edu/Magnetics>

Recommended Materials

Additional book references:

Good introductory:

E.P. Furlani, *Permanent Magnet and Electromechanical Devices: Materials, Analysis and Applications*, Academic Press, 2001 [my favorite, but expensive]

J.M.D. Coey, *Magnetism and Magnetic Materials*, Cambridge University Press, 2009. [excellent book on materials and applications]

B.D. Cullity and C.D. Graham, *Introduction to Magnetic Materials, 2nd Ed.*, Wiley, 2009 [a “classic” and very accessible.. emphasis on materials, but decent section on engineering applications]

N. Spaldin, *Magnetic Materials: Fundamentals and Device Applications*, Cambridge Univ. Press [excellent intro to the materials and atomic aspects]

D. Jiles, *Introduction to Magnetism and Magnetic Materials, 2nd Ed.*, CRC Press, 1998. [good interesting intro text, covering all areas, but not very well organized]

P. Campbell, *Permanent Magnet Materials and their Application*, Cambridge University Press, 1994 [good on permanent magnets and engineering aspects (especially PM manufacturing), but fairly brief]

E. du Trémolette de Lacheisserie, D. Gignoux, and M. Schlenker (editors), *Magnetism: Fundamentals*, Springer, 2005

Available: <http://uf.catalog.fcla.edu/permalink.jsp?20UF003304724>

E. du Trémolette de Lacheisserie, D. Gignoux, and M. Schlenker (editors), *Magnetism: Materials & Applications*, Springer, 2005

Available: <http://uf.catalog.fcla.edu/permalink.jsp?20UF003304643>

More detailed:

F. Fiorillo, *Characterization and Measurement of Magnetic Materials*, Elsevier, 2004 [best book on “engineering” aspects and experimental methods]

R.C. O’Handley, *Modern Magnetic Materials: Principles and Applications*, Wiley, 2000. [emphasis on materials]

Course Schedule (subject to change)

Week	Topic	Due Dates (estimated)	
1	History & Overview		Test 1
2	Magnetic Fields & Forces		
3	Magnetism in Materials	Wiki1	
4	Classic Observations and Magnetic Laws (Biot-Savart, Ampere, Faraday, Lorentz)	HW1	Test 2
5	Maxwell Equations, Modeling of Magnets	Wiki2	
6	Magnetic Circuit Analysis		
7	Demagnetization and Magnetic Energy		

8	Experimental Magnetic Field Sources (coils, electromagnets, permanent magnets)	HW2	Test 3
9	Magnetic Field Measurement Technologies (induction, Hall, MR, flux gate, etc.)	Wiki3	
10	Magnetic Material Characterization (permeameter, VSM, AGM, force/torque magnetometers, SQUID)		
11	Atomic Magnetic Theory	HW3	
12	Diamagnetism, Paramagnetism, Ferromagnetism, Domain Theory	Wiki4	
13	Advanced Topics – Student Presentations	HW4	
14	Advanced Topics – Student Presentations	Projects	

Attendance Policy, Class Expectations, and Make-Up Policy

Live attendance of Zoom broadcasts is required. Zoom requires a webcam and stable internet connection. During live zoom meetings, I prefer that students keep their camera on during the class so that I can see you as I would during normal face-to-face classes. Studies show that if we can see each other's faces then we will have more engagement, more student success, and more faculty success. However, this is not a requirement. I understand if on certain days you can't have your camera on due to internet bandwidth limitations, other family members, health issues, or any other reasons.

Excused absences must be consistent with university policies in the undergraduate catalog (<https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx>) and require appropriate documentation.

Evaluation of Grades

UNDERGRAD SECTION (EEL 4412)

Homeworks	20%	~4 assignments + various additional activities
In-Class Demo (team)	20%	Demonstration of something magnetic + Wiki page
Tests	<u>60%</u>	3 tests (equal weighting)
	100%	

GRAD SECTION (EEL 5417)

Homeworks	15%	~4 assignments + various additional activities
In-Class Demo (team)	15%	Demonstration of something magnetic + Wiki page
Tests	50%	3 tests (equal weighting)
Class Project (individual)	<u>20%</u>	Presentation + Wiki page on an advanced topic
	100%	

Grading Policies

Grading Scale

Numeric Cutoff	Letter Grade	Grade Points
90.00	A	4.00
86.67	A-	3.67
83.33	B+	3.33
80.00	B	3.00
76.67	B-	2.67
73.33	C+	2.33
70.00	C	2.00
66.67	C-	1.67

63.33	D+	1.33
60.00	D	1.00
56.67	D-	0.67
<56.67	E	0.0

Late Submission Policy

All assignments are due at 11:59 pm on the due date. A deduction of -20% if submitted within 24 hr, and -40% if submitted within 48 hr. Zero credit after 48 hr late.

More information on UF grading policy may be found at:

<https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

Students Requiring Accommodations

Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting <https://disability.ufl.edu/students/get-started/>. It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

Course Evaluation

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at <https://gatorevals.aa.ufl.edu/students/>. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via <https://ufl.bluera.com/ufl/>. Summaries of course evaluation results are available to students at <https://gatorevals.aa.ufl.edu/public-results/>.

In-Class Recording

Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A “class lecture” is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.

Publication without permission of the instructor is prohibited. To “publish” means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

University Honesty Policy

UF students are bound by The Honor Pledge which states, “We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: “On my honor, I have neither given nor received unauthorized aid in doing this assignment.” The Honor Code (<https://sccr.dso.ufl.edu/process/student-conduct-code/>) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Commitment to a Safe and Inclusive Learning Environment

The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

- Your academic advisor or Graduate Program Coordinator
- Robin Bielling, Director of Human Resources, 352-392-0903, rbielling@eng.ufl.edu
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

Software Use

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Student Privacy

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: <https://registrar.ufl.edu/ferpa.html>

Campus Resources:

Health and Wellness

Covid-19 Protocols:

Refer to university policies, which are constantly evolving.

U Matter, We Care:

Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Counseling and Wellness Center: <http://www.counseling.ufl.edu>, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Discrimination, Harassment, Assault, or Violence

If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the **Office of Title IX Compliance**, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

Sexual Assault Recovery Services (SARS)

Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or <http://www.police.ufl.edu/>.

Academic Resources

E-learning technical support, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu.
<https://lss.at.ufl.edu/help.shtml>.

Career Resource Center, Reitz Union, 392-1601. Career assistance and counseling. <https://career.ufl.edu>

Library Support, <http://cms.uflib.ufl.edu/ask>. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring.
<https://teachingcenter.ufl.edu/>.

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers.
<https://writing.ufl.edu/writing-studio/>.

Student Complaints Campus: <https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/>;
<https://care.dso.ufl.edu>.

On-Line Students Complaints: <http://www.distance.ufl.edu/student-complaint-process>.