ECE5332 002 – Topics in Electrical Engineering: Introduction to Magnetic Materials

Fall 2023

Department of Electrical and Computer Engineering, Texas Tech University

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Class Meeting Time: M, W, F 9:00 am – 9:50 am
Classroom: Civil Engineering 00211
Office Hours: Friday 10 am – 11 am
Class Website: Blackboard

Textbooks:
"Introduction to Magnetic Materials" (2nd Edition) B.D. Cullity and C.D. Graham
Lectures slides will be distributed on Blackboard.

Course Overview:
Principals of quantum mechanics and band theory. Physics of diamagnetism, paramagnetism, ferromagnetism, antiferromagnetism, ferrimagnetism, and associated properties. Instruments for measuring material magnetic properties. Static and dynamic theory of micromagnetics, magnetic particles and thin films, and other emerging magnetic materials.

Course Outcomes:
1. A solid understanding of the distinction between fundamental types of magnetism, such as diamagnetism, paramagnetism, ferromagnetism, ferrimagnetism, antiferromagnetism, and their relationship to quantum mechanics.
2. General understanding and ability to perform simple calculations on secondary phenomena such as magnetic anisotropy, magnetostriction and spin transport.
3. Have a general understanding of micromagnetic phenomena such as domain walls and hysteresis loops and the ability to perform simple calculations.
4. Ability to use micromagnetic simulation tool OOMMF for modeling dynamic magnetization of materials.

Methods of Assessment of Learning Outcomes

The learning outcome will be evaluated based on students' performance in homework, individual presentations and micromagnetic simulation projects.

Grading:

Homework: 60% (homework assigned bi-weekly).
Mid-term Project: 20%
Final Presentation: 20%

Course Outline (42 lectures):

1. Introduction (1 lecture)
2. Introduction to Quantum Mechanics (4 lectures)
3. Crystals and Introduction to Band Theory (3 lectures)
4. Origin of Magnetization (3 lectures)
5. Definition And Units (2 lectures)
6. Demagnetization and Magnetic Shielding (2 lectures)
7. Instruments for Measuring Magnetizations (2 lectures)
8. Diamagnetism (1 lecture)
9. Paramagnetism (2 lectures)
10. Ferromagntism (2 lectures)
11. Ferrimagnetism (1 lecture)
12. Antiferromgnetism (1 lecture)
13. Magnetic Anisotropy (3 lectures)
14. Magnetostriction (3 lectures)
15. Magnetic Domains and Domain Walls (3 lectures)
16. Magnetic Dynamics and the LLG Equation (4 lectures)
17. Interactions and Couplings (2 lectures)
18. Micromagnetic Simulation (3 lectures): OOMMF

Safety and Wellness

The Texas Tech University (TTU) and Edward E. Whitacre Jr. College of Engineering are committed to the safety and wellness of our students by providing various services and resources.
Make sure you register with Tech Alert to get emergency notification by phone call, text, or email. You are encouraged to review the Emergency Action Plans (EAPs) and watch the videos of Know What To Do In Emergency Events and Surviving an Active Shooter Event Training to be prepared for those emergency situations. Additionally, due to the nature of laboratory or design courses, it is mandatory for you to follow the university safety policies and any additional safety protocols required by the course instructor(s).
For your wellbeing, various services are available at Student Counseling Center and Student Health Services. The Student Wellness Center provides convenient walk-in services M-F from 8 AM to 5 PM. Furthermore, the Texas Tech Crisis HelpLine (806-742-5555) provides 24/7/365 assistance for students experiencing a crisis or distress.

Emergency/Crisis Phone Number

TTU Police (UPD) Emergency	911
TTU Police (UPD) Non-Emergency	806.742.3931
TTU Emergency Maintenance	806.742.4OPS (4677)

TTU EHS (M-F, 8 am – 5 pm)	806.742.3876
SafeRide	806.742.RIDE (7433)
TTU Crisis HelpLine	806.742.5555
Student Wellness Center (From Urgent Care to a Full-Service Pharmacy on site)	806.742.2848
Title IX Reporting	806.742.7233
The Dean of Students	806.742.2984