



Lahore University of Management Sciences

PHY 633 –Magnetism: Theory and Experiment Fall 2016

Instructor	Dr. Muhammad Sabieh Anwar
Room No.	
Office Hours	
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Secretary/TA	Ali Akbar, PhD student
TA Office Hours	
Course URL (if any)	http://physlab.org/courses-taught/

Course Basics				
Credit Hours	3			
Lecture(s)	Nbr of Lec(s) Per Week	2	Duration	75 minutes
Recitation (per week)	Nbr of Rec (s) Per Week	0	Duration	N/A
Lab (if any) per week	Nbr of Session(s) Per Week	0	Duration	See timetable issued by Registrar's office.
Tutorial (per week)	Nbr of Tut(s) Per Week	1	Duration	60 minutes

Course Distribution	
Core	
Elective	For Physics Majors and Physics Graduate (MS) Students
Open for Student Category	SSE
Closed for Student Category	N/A

COURSE DESCRIPTION
<p>This course is a rigorous survey of magnetism in condensed matter. It will connect the phenomenon of magnetism and its various manifestations to atomic and electronic systems and their interactions. The electronic systems could be localized or itinerant. We will traverse a trajectory of discussion wherein we will find the origins of magnetism within angular momentum and start exploring the magnetism of isolated</p>



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systems. We will then assemble these angular momentums into crystal structures and will begin exploring the impact of crystal environments and interactions. We will spend considerable time on the exchange interaction and how the interplay of exchange effects and crystal structure leads to long range magnetic order of multiple kinds. We will investigate order and broken symmetry and look at specific examples of magnetism in metals, glasses, low dimensional systems and will survey the burgeoning field of spintronics.

COURSE PREREQUISITE(S)

- Quantum Mechanics I and Condensed Matter Physics (for undergraduates)

COURSE OBJECTIVES

- Connecting macroscopic magnetism with its microscopic origins
- Studying how interactions led to various kinds of magnetic materials

Learning Outcomes

- After successful completion of this course, students should be able to:
1. explain the atomic origins of magnetism,
 2. enumerate and describe the various kinds of magnetic materials, and magnetism in the condensed matter state,
 3. be able to understand the major experimental techniques that are employed in the investigation of magnetism.

Grading Breakup and Policy

Grading will be absolute if number of students is less than 10. I have the liberty of changing the grading criterion by 5%.

Quizes	20%
Homework	10%
Mid-Term	30%
Final Exam	40%



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Examination Detail

Midterm Exam	Yes. Closed book, closed notes.
Final Exam	Yes. Closed book, closed notes.

COURSE OVERVIEW



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Week/ Lecture/ Module	Topics	Recommended Readings	Objectives/ Application
1.	Origin of magnetism is the spin		What happens when an electron or proton is placed inside a magnetic field?
2.	Isolated magnetic moments and paramagnetism		Understanding the magnetism of rare earth ions
3.	Environments		Crystal field splitting, Jahn-Teller effect
4-6.	Interactions: dipolar, exchange (direct and indirect)		Ferromagnetism, antiferromagnetism, helical magnetism
Mid-Term Exam			
8.	Order and broken symmetry		Heisenberg, Ising models, magnons
9-11.	Magnetism in metals		Landau diamagnetism, Pauli paramagnetism, RKKY interactions, spin density waves, Kondo effect, Hubbard model
12-13	Low dimensional systems		Spin chains, spin glasses, superparamagnetism, thin films, two-dimensional magnets
Final Exam			

Textbook(s)/Supplementary Readings

1. Magnetism in Condensed Matter, Stephen Blundell, Oxford University Press (2001).
2. Magnetism: From Fundamentals to Nanoscale Dynamics, J. Stohr and H.C. Siegmann, Springer (2006).