

PHY5937, Introduction to Spintronics (Spring 2024)

Instructor: Dr. Inna Ponomareva; Office: ISA 5103; E-mail: iponomar@usf.edu; telephone: 974-7286

Text 1: Quantum Mechanics v2, 2nd ed; Publisher: Wiley; Authors: Claude Cohen-Tannoudji, Bernard Diu, Franck Laloë ([available online through USF library, perhaps with some restrictions](#)),

Text 2: Introduction to Spintronics, Publisher CRC Press; Authors: Bandyopadhyay, Supriyo, Cahay, Marc

([available online through USF library, perhaps with some restrictions](#))

Recommended books:

Hack Your Brain: Secrets of an Elite Manhattan Tutor, by Elie Venezky and Patrycja Slawuta

The Little Book of Talent: 52 Tips for Improving Your Skills, by y Daniel Coyle

Make It Stick: The Science of Successful Learning, by Peter C. Brown, Henry L. Roediger III, Mark A. McDaniel

Other requirements: computer, internet connection, webcam and microphone, in case we have to switch to on-line mode

Class: TR 9:30am-10:45am ISA 4010

Office Hours: W 8:30-9:30am, F 8:30-9:30 am and by appointment.

Course Outline and Objectives

The course introduces students to the fundamentals of spin and spintronics. The field of spintronics deals with the science and technology of using spin degrees of freedom of a charge carrier to store, encode, access process/or transmit information. The course will cover spin matrices, Pauli and Dirac equations, Bloch sphere, spinors, spin dynamics, coherence, density matrix, spin orbit coupling, spin relaxation. Emphasis will be on the fundamental concepts and outline of their applications. The main ideas are understood and re-enforced by developing conceptual knowledge and problem-solving skills. The course is best suited for students who already took a foundational Quantum Mechanics course. Problems will be assigned from each chapter of the text. In addition, conceptual questions will be offered. Up to two randomly chosen problems from the homework may be graded. The homework will be due at the beginning of the first lecture of the next chapter. In addition, there will be a quiz after each chapter that emphasizes basic concepts of the material learned. I will give exact dates for these quizzes about one week in advance. In studying for the quizzes and examinations you are encouraged to work on problems in the book in addition to those assigned. Please read the text before each lecture. Although I will not require attendance, it is paramount that you come to every lecture in order to keep up with the work. Please come see me during office hours if you have missed a lecture to get 'up to speed' on the course work.

Course Grading Breakout	Homework Problems	20 %
	Quizzes	20 %
	Mid-term Exam	30 %
	Final	30 %

Course Grading: each problem/question will be graded on a scale 0-4, and the average grade for the assignment will be computed. More specifically,

- 0 the concept comprehension/skill has not been demonstrated or attempt at solution is not sound
- 1 the problem solved or question answered about 25%
- 2 the problem is half solved or question is half answered
- 3 the problem solved or question answered about 75%
- 4 the problem is fully solved or question is fully answered

The GPA-inspired scale will be used to assign final letter grade for the course:

3.7 – 4.0 A	1.7 – 1.9 C
3.3 – 3.6 A-	1.3 – 1.6 C-
3.0 – 3.2 B+	1.0 – 1.2 D+
2.7 – 2.9 B	0.7 – 0.9 D
2.3 – 2.6 B-	0.3 – 0.6 D-
2.0 – 2.2 C+	0.0 – 0.2 F

Students who earned C and above can choose S grade.

Tentative Schedule and Examination Dates

Week Beginning	Topics (Chapters in Text 1, Chapter in Text 2)
Jan 7	Electron spin (IX + complements, 2)
Jan 14	
Jan 21	The Bloch Sphere, Evolution of a Spinor on the Bloch sphere (3-4)
Jan 28	
Feb 4	The Density Matrix, the Bloch Ball (5)
Feb 11	Addition of Angular Momenta (X +complements)
Feb 18	Stationary Perturbation Theory and Its Applications (energy bands) (XI+complements)
Feb 25	Mid-term on Chapters IX-XI, 2-5 + Ch. XI, Quiz on February 29th,
Mar 3	Spin Orbit Interactions in an Atom and Solids (XII+complements, 6)
Mar 10	Spring Break
Mar 17	
Mar 24	Magneto-Electric Subbands in the presence of Spin-Orbit Interaction, Hall effects (7)
Mar 31	
Apr 7	Spin Relaxation (8)
Apr 14	Exchange Interactions (XIV+complements, 9)
Apr 21	
Apr 28	FINAL on Chapters XII, XIV, Chapters 6-9 + Chapter XIV and 9 Quiz on May ? (tentative)

NOTES

Students who anticipate being absent from exams due to a major religious observance must provide notice of the date(s) and event(s) to the instructor, in writing, by the second class meeting. Notes and Tapes are not permitted for purposes of sale.

Any student with a disability is encouraged to meet with me privately during the first week of class to discuss accommodations. Each student must bring a current Memorandum of Accommodations from the Office of Student Disability Services (974-4309, SVC1133) which is prerequisite for receiving accommodations. Accommodated examinations through the Office of Student Disability Services require at least two weeks notice.

USF has a set of central policies related to student recording class sessions, academic integrity and grievances, student accessibility services, academic disruption, religious observances, academic continuity, food insecurity, and sexual harassment that apply to all courses at USF. Be sure to review these online: usf.edu/provost/faculty-success/resources-policies-forms/core-syllabus-policy-statements.aspx

COVID NOTE

If class is to be moved on-line due to COVID we will continue meeting during the regular class times via zoom or other software. Webcamera, microphone, computer and internet are required for that. For examinations we will use on-line proctoring (honorlock).