CHEM 751: Special Topics in Physical Chemistry

Advanced Concepts in Nuclear Magnetic Resonance Spectroscopy

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Overview: This Special Topics course will be directed to students who need an advanced-level understanding of NMR spectroscopy. This course will pick up where the previously offered CHEM 751 left off. I.e., whereas the Fall 2007 CHEM 751 course endeavored to provide a graduate-level "foundations" course in NMR, this course will provide advanced instruction in the physics and physical chemistry underlying NMR spectroscopy, particularly for solids.

Grading: *Presentations (3 @ 25% each = 75%)*

- At each class meeting, a talk on a selected topic will be given by a graduate student or participating faculty/postdoc/staff member.
- A student taking this course for a grade must give no fewer than 3 presentations. If more than 3 talks are given, the grade for the lowest one will be dropped.
- The speaker should prepare a talk of suitable length to fill the 90-minute period intelligently and also be prepared to work problems, when appropriate, with the rest of the class. The speaker should also be prepared to answer questions and assist the instructor in leading the discussion.
- The speaker should provide me with one hardcopy of the lecture and/or handouts .

Class participation (25%)

- The quality of the experience in this class and our respective successes will largely depend on our individual investment. Hence, each student is expected to:
  - Read the appropriate sections of the text before coming to class..
  - Work problems before and during the class meeting.
  - Show up every time, on time.
- It is expected that students will treat each other with respect and also be engaged in the class by asking questions and participating in discussions.

Textbook: "Spin Dynamics: Basics of Nuclear Magnetic Resonance, 2nd Edition", Malcolm H. Levitt, Paperback, Wiley, 2008. All students should also have access to the book used in the preceding course, i.e., "Understanding NMR Spectroscopy" by James Keeler (Wiley, 2005).

Credits and Grade Option: 3 credits, A-F. A typical 3-credit course with a lecture format meets 150 minutes weekly over a 15- to 16-week semester. This course will meet weekly for 90-minute meetings over ~26 weeks.

Prerequisites: Successful completion of CHEM 751 ("Foundations of NMR Spectroscopy") or consent.

Student Learning Outcomes: At the completion of this course, a successful student will be able to

- Describe the semi-classical and quantum mechanical pictures of nuclear magnetic resonance.
- Utilize the appropriate tools in physics and physical chemistry to describe a number of model systems and their respective outcomes in various NMR experiments.
- Recognize basic NMR experiments and explain how each has utility in modern applications of NMR spectroscopy to chemical problems.
- Discuss the topic of relaxation with the appropriate mathematical tools and formalisms.

Tentative Schedule of Topics

Week of:	Topic or Event (Chapter in Levitt):
June 9	The NMR Spectrometer (4)
June 16	Fourier Transform NMR (5)
June 23	Quantum Mechanics – Mathematical Techniques (6)
June 30	Review of Quantum Mechanics (7)
July 7	Nuclear Spin Hamiltonians (8)
July 14	Nuclear Spin Hamiltonians (8)
July 21	Internal Spin Hamiltonians (9)
July 28	(no meeting)
August 4	Internal Spin Hamiltonians (9)
August 11	Single Spin-1/2 (10)
August 18	Single Spin-1/2 (10)
August 25	Ensembles of Spins-1/2 (11)
September 1	Ensembles of Spins-1/2 (11)
September 8	Experiments on Non-Interacting Spins-1/2 (12)
September 15	Experiments on Non-Interacting Spins-1/2 (12)
September 22	Quadrupolar Nuclei (13)
September 29	Quadrupolar Nuclei (13)
October 6	Spin-1/2 Pairs (14)
October 13	Spin-1/2 Pairs (14)
October 20	Homonuclear AX System (15)
October 27	Experiments on AX Systems (16)
November 3	Many-Spin Systems (17)
November 10	Many-Spin Systems (17)
November 17	Many-Spin Dynamics (18)
November 24	Many-Spin Dynamics (18)
December 1	Motion and Relaxation (19-20)
December 8	Motion and Relaxation (19-20)
December 15	Motion and Relaxation (19-20)