INTRODUCTION TO NMR
CHEM 291
PROF. CEGELSKI
FALL 2013

This course will introduce students to theoretical and practical aspects of NMR Spectroscopy. We will cover the following material: quantum and classical descriptions of NMR; analysis of pulse sequences and nuclear spin coherences via density matrices and the product operator formalism; NMR spectrometer design; Fourier analysis of time-dependent observable magnetization; NMR relaxation in liquids and solids; NMR problem-solving strategies and examples. The course requires a prerequisite undergraduate-level course in quantum mechanics (Chem 173).

INSTRUCTOR:

Professor Lynette Cegelski
Department of Chemistry
Email: cegelski@stanford.edu
Phone: 650-725-3527
Office: Keck 351
Office Hours: Thursday 10:30AM – 12 noon

TEACHING ASSISTANT:

Courtney Reichhardt
Email: crreich@stanford.edu

WEBSITE: The class website is hosted on Stanford's *OpenEdX* platform (https://class.stanford.edu/courses/HumanitiesSciences/CHEM291/Fall2013/). The site contains: the course schedule with suggested reading and supplemental materials; lecture slides when appropriate; and problem sets.

LECTURES: Tuesdays and Thursdays, 9:00 – 10:30 AM, Braun Lecture Hall. 90-minute lectures will be split into two parts, with approximately 60 minutes for the primary lecture and 30 minutes for recent applications and implementation of NMR lessons. In the second half of the course, students will present a paper or a focused topic to the class during the 30-minute portion. Please see the Course Website site for suggested reading for each lecture.

TEXTBOOK: A suggested reference text is Malcolm Levitt's Spin Dynamics, Second Edition. Relevant chapters are listed in the course schedule. Two copies of this text will be available on reserve in the Chemistry Library. Cavanagh et al. Protein NMR Spectroscopy, 2nd Edition is also highly recommended reading and is available online (for free) from Stanford: http://www.sciencedirect.com/science/book/9780121644918. Additional suggested texts and references will be posted on the website.

GRADING: Grading will be based on a midterm exam (30%), individual in-class presentations (20%), and the final exam (50%). The final exam will be closed book with the exception of a handout with product operator multiplication tables that will be provided to you. You can also bring a simple calculator. No iPhones or other smart phones are allowed.

CHEM 291 - FALL 2013 COURSE SCHEDULE (LECTURES: 9:00-10:30AM IN BRAUN LECTURE HALL)

LECTURE #	DATE	TOPIC	SUGGESTED READING/ NOTES
1	9/24	Intro to course; NMR Overview; History and Fundamental Experiments	Stern-Gerlach; Rabi; Rigden; Bloch; Purcell
2	9/26	Magnetic Moments; Density Matrix Representations of Spins and Populations; Angular Momentum Operators	Feynman Lect (Vol. I,Ch. 20 torques); Levitt; Cavanagh et al
3	10/1	Sudden Change for Isolated Spin ½; Time-dependent Interactions; Isolated Spin ½ and the Rotating Frame;	Cavanagh et al; Ernst et al
4	10/3	One-pulse Expt; Product Operator Formalism	Cavanagh et al; Levitt
5	10/8	Prod. Operators (Two-pulse (echo) Expt)	Cavanagh et al; Levitt
6	10/10	Fourier Transform and NMR Spectra	Cavanagh et al; thefouriertransform.com
7	10/15	Classical Description of NMR and the Spin Echo	Levitt; Cavanagh et al
8	10/17	Carr-Purcell and Carr-Purcell Meiboom Gill Refocusing	Levitt; Cavanagh et al
9	10/22	The Spectrometer	Levitt; Fukushima
10	10/24	**Midterm Exam –*Lectures 1-8 (PS 1 & 2)***	
11	10/29	Coupled I-S Pair (Spin-1/2)	Cavanagh et al
12	10/31	Spin Echo for IS Pair	Cavanagh et al
13	11/5	Product Operator Evaluation of SEDOR	
14	11/7	COSY; 2D INEPT (HETCOR)	
15	11/12	Relaxation I - Bloch Equations (classical)	Levitt; Cavanagh et al
16	11/14	Relaxation II – Quantitative (non-classical); Autocorrelation & spectral density	Levitt; Cavanagh et al
17	11/19	Computer evaluation of density matrices	
18	11/21	Introduction to Solid-State NMR	Posted reading
11/26 and 11/28 – Thanksgiving Holiday – No class			
19	12/3	Dipolar Couplings in Solution and Solids	Posted reading
20	12/5	Measuring Dipolar Couplings	Posted reading
	12/xx	***FINAL EXAM***	

STUDENTS WITH DOCUMENTED DISABILITIES: Students who may need an academic accommodation based on the impact of a disability must initiate the request with the Office of Accessible Education (OAE). Professional staff will evaluate the request with required documentation, recommend reasonable accommodations, and prepare an Accommodation Letter for faculty dated in the current quarter in which the request is being made. Students should contact the OAE as soon as possible since timely notice is needed to coordinate accommodations. The OAE is located at 563 Salvatierra Walk (phone: 723-1066, URL: http://studentaffairs.stanford.edu/oae).