OHLONE COLLEGE
Ohlone Community College District
OFFICIAL COURSE OUTLINE

I. **Description of Course:**

1. **Department/Course:** CHMT - 104D
2. **Title:** Nuclear Magnetic Resonance (NMR) Spectroscopy
3. **Cross Reference:** Nuclear Magnetic Resonance (NMR) Spectroscopy BIOT - 104D
4. **Units:** 0.5
   Lec Hrs: 0.25
   Lab Hrs: 0.75
5. **Repeatability:** No
6. **Grade Options:** Grade Only (GR)
7. **Degree/Applicability:**
   Credit, Degree Applicable, Not Transferable (D)
8. **General Education:**
9. **Field Trips:** Not Required
10. **Requisites:**
    Prerequisite
    CHEM 106B Principles of Chemistry or Because NMR instrumentation is used to reveal molecular structure, the student needs to understand the structures of organic molecules.
    CHEM 109 Biochemistry for Health Science and Biotechnology or
12. **Catalog Description:**
    An introductory lab-based course geared towards understanding the application of NMR spectroscopy for structural elucidation of compounds in the fields of organic chemistry, physical chemistry, and biochemistry. Topics include basic principles and theory of NMR, and the application of chemical shifts, coupling constants, peak splitting, and peak integration to reveal the molecular sturcture. Labs will include important one-dimensional experiments and their application in assignments and structure determination problems. In addition, the students will get hands-on experience in acquiring NMR spectra using fundamental concepts of instrumentation such as shimming, sample probes, integration, peak and signal parameters, and basic troubleshooting.
13. **Class Schedule Description:**
    NMR theory and hands-on use of nuclear magnetic resonance instrumentation to determine molecular structure.
14. **Counselor Information:**
    This course is well suited for students who are training for careers as technicians in chemical or other scientific laboratories; also useful for students entering any field pertaining to molecular structure, such as chemistry, biology, biotechnology, or nanotechnology.

II. **Student Learning Outcomes**
The student will:

1. Explain how one-dimensional NMR techniques reveal the molecular sturcture of a substance.
2. Describe how to determine specific structural details of a molecule using NMR.
3. Define and describe the significance of all aspects of the instrumentation, including hardware, shimming, field lock, sample probes, pulse generation, probe tuning, and signal strength.
4. Demonstrate proper protocols for sample preparation.
5. Perform basic troubleshooting especially with regards to baseline, signal-to-noise ratio, spinning side bands, and other factors that may influence the quality of the plot.
6. Run, interpret, and analyze spectra using the knowledge of chemical shifts, shielding and deshielding effects, peak splitting, integration, and coupling constants.

III. **Course Outline:**

Introduction to experimental NMR spectroscopy
- Spectrometer components (magnet, probe, transmitter, receiver)
- Field lock
- Shim coils
- Sample probe
- Digitization of signal (Dwell time and dynamic range) filters
- Magnetization, relaxation, pulsed-excitation
- Pulse generation
- Signal detection
- Probe design
- Probe-tuning
- Shimming
- Signal strength
- Sample preparation
- Solvents and solution concentrations
- Reference standards
- Optimication of parameters
- Understanding window functions
- Integration
- Detecting the NMR signal
- Basic troubleshooting (baseline, signal-to-noise ratio, spinning side bands)

Interpreting one-dimensional NMR spectra
- Nuclear spin
- Chemical shifts
- Shielding, deshielding, upfield and downfield shifts
- Integral and number of protons
- Structure and electron density effects on shift
- Ring currents and anisotropy effects of functional groups
- Spin-spin coupling
- Peak splitting and multiplicity (n+1 rule)
- J-couplings and coupling constants
- pi electron functions
- Interpretation/prediction of chemical shifts
- Integration
- Chemical equivalence & structure

IV. **Course Assignments:**

A. Reading Assignments
   1. Textbook
   2. Handouts

B. Projects, Activities, and other Assignments
   1. Laboratory activities such as
   2. - loading and analyzing of samples
   3. - checking system suitability, system parameters and system components
   4. - troubleshooting

C. Writing Assignments
   1. Maintain a laboratory notebook

V. **Methods of Evaluation/Assessment:**

A. Exams and quizzes
B. Instructional laboratory monitoring and supervising and/or individual observations and conferences with students
C. Objective and practical evaluation of students' laboratory skills as demonstrated by the appropriate use of the NMR instrument
D. Demonstration of lab skills in choosing appropriate run parameters, sample preparation, running a sample, and troubleshooting.

VI. **Methods of Instruction:**

A. Discussion
B. Lecture
C. Laboratory
D. Demonstration
E. Audiovisual
F. Computer Assisted Instruction
G. Collaborative Learning
H. Other
   1. Individual assistance
   2. PowerPoint presentations enhanced by electronic notes made available on instructor's web page
   3. Hands-on industry-based lab trials

VII. **Textbooks:**

Required

1. John Kenkel *Analytical Chemistry for Technicians* 3rd Edition, CRC Press, 2003 ISBN: 1-56670-519-3
2. Robert B. Silverstein, Francis X. Webster, David Kiemle *Spectrometric Identification of Organic Compounds* 7th Edition, John Wiley and Sons, 2005 ISBN: 9780471393627

Optional

VIII. **Supplies:**

A. Goggles with indirect venting and side shielding
B. Lab coat
C. Lab gloves
D. Lab notebook
E. Scientific calculator

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