CHEM4610: ADVANCED CHEMICAL TECHNIQUES

The University of Manitoba, Faculty of Science, Department of Chemistry

Syllabus for CHEM4610 (2019/2020).

General Course Description:

Advanced Chemical Techniques (CHEM4610) is a 6 credit hour course that spans over 2 terms. This course provides the opportunity to learn about and be exposed to state-of-the-art research instrumentation spanning diverse fields of specialization. All instructors are experts in their respective fields and aim at providing a stimulating environment.

The 4 sections include:

1) Spectromicroscopy 2) Nuclear Magnetic Resonance 3) Crystallography and 4) Mass Spectrometry.

You will learn about instrumentation, data collection and data analysis while applying those techniques to diverse chemical and biochemical problems. Because of the diversity of the topics no single textbook is available/assigned for CHEM4610, instead the individual instructors will provide literature resources specific to their sections. The term work and assignments will be determined by the individual instructors and will be announced in a section specific syllabus at the beginning of each section.

I) GENERAL INFORMATION:

Class time: Mondays and Wednesdays 2:30 p.m. – 3:45 p.m.
Room: *t.b.d.*

II) INSTRUCTOR INFORMATION:

Course Coordinator:
Name: Dr. Mario Bieringer
Office: 520C Parker Building
E-mail: Mario.Bieringer@UManitoba.ca
Phone: (204) 474 6258

Course Instructors:

1) Spectromicroscopy Section:
Dr. Kathleen Gough
378 Parker Building
Kathleen.Gough@umanitoba.ca
(204) 474 6262

2) Nuclear Magnetic Resonance Spectroscopy Section:
Dr. Scott Kroeker
458 Parker Building
Scott.Kroeker@umanitoba.ca
(204) 474 9335

3) Crystallography Section:
Dr. Mario Bieringer
520c Parker Building
Mario.Bieringer@umanitoba.ca
(204) 474 6258

4) Mass Spectrometry Section:
Dr. Hélène Perreault
550 Parker Building
Helene.Perreault@umanitoba.ca
(204) 474 7418

III) EVALUATION

Each section is worth 25%. Evaluation of each section will be communicated by the instructor at the beginning of the respective section.

The following letter grade conversion will be applied for the final grades:

92.0 -100.0%	A+	64.0 - 69.9%	C+
83.0 - 91.9%	A	58.0 - 63.9%	C
76.0 - 82.9%	B+	50.0 - 57.9%	D
70.0 - 75.9%	B	0 - 49.9%	F

IV) COURSE SCHEDULE & TOPICS:

Section 1 (Sep. 4, 2019 – Oct. 16, 2019):
Spectromicroscopy – Dr. K. Gough
Technological advances have lead to the development of many new forms of microscopy, with light from X-ray to IR and terahertz. With mid-IR, any material can be imaged based on molecular vibrations of the chemical components; Raman imaging is possible with lasers from Deep UV to near infrared. Each wavelength regime and spatial resolution necessitates a completely different type of instrument and provides different types of chemical information on a different spatial scale. In this section, students will see infrared spectrochemical imaging from mm to sub-micron length scales, in transmission as well as Attenuated Total Reflection and with polarized light microscopy. Tip-based methods that provide nm-scale resolution for Raman (Tip Enhanced Raman Spectroscopy) and for infrared (near-field IR spectroscopy and imaging with Atomic Force Microscopy based instruments) will be presented. Students will have one lab experience and be provided with a data cube which they will analyze with guidance from the instructor.

Section 2 (Oct. 21, 2019 – Dec. 4, 2019):
Nuclear Magnetic Resonance Spectroscopy – Dr. S. Kroeker
The sensitivity of NMR spectroscopy to local electronic environments has made it an indispensable tool for the structural elucidation of solids and molecules in solution. This module will outline the basic physics which makes NMR possible, moving on to practical aspects of typical NMR experiments, including spectral acquisition, processing and interpretation. Internal interactions between nuclei and local fields will be presented in detail, as they form the basis for its widespread utility in chemistry, with a focus on magnetic shielding, and dipolar and quadrupolar couplings. Special techniques for sensitivity and resolution enhancement in solid phases will be demonstrated. Case studies illustrating the applicability of multinuclear NMR spectroscopy in various fields will be highlighted.

Section 3 (Jan. 6, 2020 – Feb. 12, 2020):
Crystallography – Dr. M. Bieringer
An overview of powder and single-crystal X-ray diffraction methods and their use for the determination of solid-state structures will be given. Diffraction is a very versatile method for structure determination of crystalline solids used in all fields of chemistry and biochemistry, material sciences, pharmacy, life sciences, mechanical and electrical engineering and is often used as a tool in archaeology as well. This section will introduce the basic concept of diffraction theory with examples of single crystal diffraction and powder diffraction.

Section 4 (Feb. 24, 2020 – Apr. 6, 2020):
Mass Spectrometry – Dr. H. Perreault
For a long time, mass spectrometry was used for the mass and structural determination of small organic molecules using electron impact and chemical ionization techniques. Nowadays these methods for volatile compounds are still in demand by synthetic, environmental and natural product chemists, but mass spectrometry has evolved much further with the advent of soft ionization techniques permitting the analysis of large, non-volatile biomolecules. This section will discuss instrumental and analytical aspects of several ionization techniques, mass analyzers, sample preparation methods and compilation and understanding of data. From elements to small molecules to large thermolabile biomolecules and polymers, mass spectrometric methods will be described and compared. Virtual lab sessions will guide the students through data compilation and interpretation.

V) ACADEMIC INTEGRITY POLICIES:
Academic Misconduct:
The University of Manitoba treats plagiarism and cheating as serious academic offenses.

- The complete documentation regarding cheating, plagiarism and fraud be accessed in the calendar at: http://crscalprod.ad.umanitoba.ca/Catalog/ViewCatalog.aspx?pageid=viewcatalog&catalogid=380&chapterid=4750&topicgroupid=25112&loaduseredits=False
- Additional documentation is available on the Faculty of Science website http://www.sci.umanitoba.ca/undergraduate-students/academic-resources/academic-integrity-2/