

TRAILBLAZER ADVENTURER
INNOVATOR DEFENDER CHALLENGER
ADVENTURER TRAILBLAZER DEFENDER VISIONARY
VISIONARY ADVENTURER TRAILBLAZER CHALLENGER DEFENDER VISIONARY

Syllabus

CHEM 3590: Instrumental Analysis

(Fall 2019)



Faculty of Science

UNIVERSITY
OF MANITOBA

COURSE DETAILS

Course Title & Number:	CHEM 3590: Instrumental Analysis
Number of Credit Hours:	3.0
Class Times & Days of Week:	Lectures: M,W,F 10:30-11:20 am Labs: M/T/W/R 2:30-5:25pm
Location for classes/labs/tutorials:	Lectures: Machray Hall 124 Labs: Parker 318
Pre-Requisites:	CHEM 2470 (C)

Instructor Contact Information

Instructor Name:	Dr. Christian Kuss (lectures), Dr. Tom Ward (labs)
Office Location:	Parker 520 E
Office Hours or Availability:	I'm always happy to discuss with students and answer questions. Don't hesitate to come and see me after class or during my office hours, Wednesday 1pm – 3pm.
Office Phone No.	204-480-1823
Email:	christian.kuss@umanitoba.ca You are welcome to send me an email with any questions about the course and materials. I will endeavour to answer student requests within 2 working days.

Course Description

U of M Course Calendar Description

A course dealing with the theory and use of standard instruments used for chemical analyses. An introduction to the interpretation of data obtained from such analyses. This course is designed to follow a classical analytical chemistry course. May not be held with ENVR 3550. Prerequisite: CHEM 2470 (C).

General Course Description

Analytical chemistry is one of the classical specializations of chemistry with plenty of applications in industry and government labs. Nowadays, few analytical chemistry tasks rely on the traditional gravimetric or volumetric methods. Rather, sophisticated analytical instrumentation has taken their place with standard analytical chemistry labs relying heavily on gas chromatography (GC), high-performance

liquid chromatography (HPLC), and mass spectrometry (MS). This course will deliver an overview of instrumental methods in analytical chemistry and familiarize you with the common elements throughout the different analytical techniques.

Through lectures, labs and student presentations, we will be addressing five modules through the course:

1. General Instrumental Analysis

Signal and noise, data collection and treatment, chemical equilibrium in analytical chemistry

2. Spectroscopy

Revision of spectroscopy methods, instrumentation, FTIR, Raman, UV/Vis, atomic spectroscopy, X-ray spectroscopies

3. Separation techniques

GC, HPLC, hyphenated methods, instrumentation, applications

4. Electrochemistry

Revision of general electrochemistry, potentiometric and voltammetric methods, amperometric methods, impedance spectroscopy

5. Scattering

Revision of elastic scattering, X-ray and neutron diffraction, light scattering, electron microscopies

Course Goals

Students will develop a general understanding of spectroscopic, separation, elastic scattering and electrochemical techniques and will learn to apply this general knowledge in the description, discussion and selection of specialized techniques to address analysis objectives. In the lab component, students will learn new lab skills pertaining to the use of small analyte quantities and specific analytical equipment.

Course Learning Objectives

Within the lecture section, by the end of this course, students will be able to

- Describe signal to noise ratio and its effect
- Calculate, sketch and interpret relative concentrations (alpha plots) for a specified equilibrium and equilibrium constants
- Describe the general composition of a spectrometer
- Describe the general composition of a diffractometer
- Describe the general composition of a chromatograph
- Describe the general composition of an electrochemical setup
- Describe the general composition of an electron microscope
- Describe the general composition of a mass spectrometer
- Explain the purpose of individual components in these instruments
- Give examples of individual components in these instruments
- Sketch typical data outputs from these instruments

- Apply the general knowledge about these instruments to effectively explain the functioning of specialized analytical techniques
- Discuss the physical principles behind absorption, emission and scattering of radiation in spectrometry and diffractometry
- Sketch and explain a Jablonski diagram
- Apply Lambert-Beer's law
- Apply Bragg's equation
- Apply the Tafel equation
- Apply the Levich equation
- Apply the resolution equation for chromatography
- Recommend appropriate instrumental analytical techniques to solve a given analytical problem

Textbook, Readings, and Course Materials

The course is largely based on the text book **Skoog, Holler, Crouch: *Principles of Instrumental Analysis*, 7th Ed., Cengage**

Additional online materials from the book can be accessed at <http://www.tinyurl.com/skoogpia7>

Lecture materials are available on <http://umlearn.ca>

For further reading:

- Skoog, West, Holler: *Fundamentals of Analytical Chemistry*
- Granger, Yochum, Granger, Sienerth: *Instrumental Analysis*

Students may supplement these resources with library resources and open course materials, such as at <https://ocw.mit.edu/>, <https://www.merlot.org/> and <https://oli.cmu.edu/>.

Using Copyrighted Material

Please respect copyright. We will use copyrighted content in this course. I have ensured that the content I use is appropriately acknowledged and is copied in accordance with copyright laws and university guidelines. Copyrighted works, including those created by me, are made available for private study and research and must not be distributed in any format without permission. Do not upload copyrighted works to a learning management system (such as UM Learn), or any website, unless an exception to the *Copyright Act* applies or written permission has been confirmed. For more information, see the University's Copyright Office website at <http://umanitoba.ca/copyright/> or contact um_copyright@umanitoba.ca.

Course Technology

Part of the course requires you, together with a team of other students, to give a presentation in front of the class. For this purpose, you will need to prepare presentation files with MS Powerpoint or pdf presentation. If you do not have IT resources available to prepare this presentation, IST support provides all students with free access to Office 365 for students and computer labs (<http://umanitoba.ca/student/guide/computers-and-technology.html>).

Expectations: I Expect You To

We are here to make sure that you will take the most out of this class. To this end, I expect you to:

- Attend all scheduled lectures, including all student presentations – all lecture material, including material that was presented by students, will be part of assessments
- Participate in discussions, either in-class or on umlearn – participation will be graded
- Be respectful and supportive of your peers – not everyone is comfortable presenting in front of a class - [Respectful Work and Learning Environment Policy](#)
- Be respectful to all staff members that you encounter throughout the course
- Check UMlearn and the lab website regularly for updates

In addition, I expect you to follow these policies around Class Communication, Academic Integrity, and Recording Class Lectures.

Class Communication:

You are required to obtain and use your University of Manitoba email account for all communication between yourself and the university. All communication must comply with the Electronic Communication with Student Policy:

http://umanitoba.ca/admin/governance/governing_documents/community/electronic_communication_with_students_policy.html.

Academic Integrity:

Each student in this course is expected to abide by the University of Manitoba [Academic Integrity principles](#). Always remember to reference the work of others that you have used. Also be advised that you are required to complete your assignments independently unless otherwise specified. If you are encouraged to work in a team, ensure that your project complies with the academic integrity regulations. You must do your own work during exams. Inappropriate collaborative behavior and violation of other Academic Integrity principles, will lead to the serious [disciplinary action](#). Visit the [Academic Calendar](#), [Student Advocacy](#), and [Academic Integrity](#) web pages for more information and support.

Refer to specific course requirements for academic integrity for individual and group work such as:

- I. Group projects are subject to the rules of academic dishonesty;
- II. Group members must ensure that a group project adheres to the principles of academic integrity;
- III. Students should also be made aware of any specific instructions concerning study groups and individual assignments;
- IV. The limits of collaboration on assignments should be defined as explicitly as possible; and
- V. All work should be completed independently unless otherwise specified.

Recording Class Lectures:

No audio or video recording of lectures or presentations is allowed in any format, openly or surreptitiously, in whole or in part without permission of the lecturer. Course materials (both paper and digital) are for the participant's private study and research. Copyright of course materials is with the lecturer, unless noted otherwise.

Student Accessibility Services:

The University of Manitoba is committed to providing an accessible academic community. [Students Accessibility Services \(SAS\)](#) offers academic accommodation supports and services such as note-taking, interpreting, assistive technology and exam accommodations. Students who have, or think they may have, a disability (e.g. mental illness, learning, medical, hearing, injury-related, visual) are invited to contact SAS to arrange a confidential consultation.

Student Accessibility Services

520 University Centre
 Phone: (204) 474-7423
 Email: Student_accessibility@umanitoba.ca

Expectations: You Can Expect Me To

In supporting your learning, I will endeavour to:

- Be available for discussions and questions during my office hours and for 15 minutes after lectures
- Return quizzes within one week
- Be receptive to respectful suggestions for changes in the course delivery
- Make lecture notes available at the latest at the start of every lecture
- Incorporate teaching strategies that allow all students to learn effectively.

CLASS SCHEDULE AND COURSE EVALUATION

I'm providing a schedule below as an estimate of course progress through this term. This schedule is subject to change at the discretion of the instructor and/or based on the choice of student presentations and the learning needs of the students. Lectures that have been marked with (SP) are potential student presentations.

Class	Date	Topic	Lecturer (default: CK)
1	Sept. 4	Intro to lectures	Dr. Tom Ward
2	Sept. 6	Intro to lab (find file in lab section)	
3	Sept. 9	Chemical Equilibria	
4	Sept. 11	Signal / Noise / Blanks / Controls / Backgrounds	
5	Sept. 13	Spectroscopies	
6	Sept. 16	FTIR spectroscopy (SP)	
7	Sept. 18	Raman spectroscopy (SP)	
8	Sept. 20	UV/Vis and fluorescence spectroscopy (SP)	
9	Sept. 23	Atomic emission / absorption spectroscopy (SP)	
10	Sept. 25	Core-electron spectroscopies (SP)	
11	Sept. 27	Spectroscopy in MCAL (find file in lab section)	
12	Sept. 30	Case study	
	Oct. 2	Review for Quiz 1	
	Oct. 4	Quiz 1: Signal handling and spectroscopies	
13	Oct. 7	General chromatography	
14	Oct. 9	Gas Chromatography (SP)	
15	Oct. 11	HPLC (SP)	
	Oct. 14	No class (Thanksgiving)	
16	Oct. 16	Electrophoresis (SP)	
17	Oct. 18	HPLC in MCAL	Dr. Tom Ward

18	Oct. 21	HPLC/MS and GC/MS in MCAL	Dr. Tom Ward
19	Oct. 23	Electrochemistry introduction	
20	Oct. 25	Potentiometry (SP)	
21	Oct. 28	Coulometry (SP)	
22	Oct. 30	Voltammetry (SP)	
23	Nov. 1	Impedance spectroscopy (SP)	
24	Nov. 4	Case study	
	Nov. 6	Review for Test 2	
	Nov. 8	Quiz 2: Separation and electrochemistry	
	Nov. 11	Remembrance Day	
	Nov. 13	No class	
	Nov. 15	No class	
25	Nov. 18	Elastic scattering introduction	
26	Nov. 20	X-ray / neutron diffraction (SP)	
27	Nov. 22	Light scattering (SP)	
28	Nov. 25	Electron microscopies – SEM (SP)	
29	Nov. 27	Electron microscopies – TEM (SP)	
30	Nov. 29	Mass spectrometry I	
31	Dec. 2	Mass spectrometry II	
32	Dec. 4	Case study	
	Dec. 6	Review for final	

Labs

All relevant lab information is available on the lab website

<http://home.cc.umanitoba.ca/~wardat/3590%20Labs.html> or can be requested from Dr. Tom Ward (Tom.Ward@umanitoba.ca).

Grading

Your final grade will be determined according to the following weighting:

Lab Program: 40%

Quizzes: 15%

Presentation: 15%

In-class participation: 5%

Final exam: 25%

Grading will follow the scheme below:

Letter Grade	Percentage out of 100	Final Grade Point
A+	95-100	4.5

A	86-94	4.0
B+	80-85	3.5
B	72-79	3.0
C+	65-71	2.5
C	60-64	2.0
D	50-59	1.0
F	Less than 50	0

Voluntary Withdrawal

The last day to withdraw without penalty is September 17 2019 and the last day for voluntary withdrawal is November 18 2019. Please refer to the [Registrar's Office](#) web page for more information.

Student Presentations

All students are expected to contribute to a student presentation on a specialized instrumental analysis technique as part of their assessment. Presentations will be prepared and presented in groups of 3-4 students. As the subject of this course is not oral presentation skills, these presentations will not be assessed based on the delivery of the presentation, but rather the completeness and quality of the content and the effectiveness of chosen content delivery tools.

Further requirements and assessment rubrics will be published on UMLearn before the first student presentation.

UNIVERSITY SUPPORT OFFICES & POLICIES

Student academic support is available on campus:

Writing and Learning Support

The Academic Learning Centre (ALC) offers services that may be helpful to you throughout your academic program. Through the ALC, you can meet with a learning specialist to discuss concerns such as time management, learning strategies, and test-taking strategies. The ALC also offers peer supported study groups called Supplemental Instruction (SI) for certain courses that students have typically found difficult. In these study groups, students have opportunities to ask questions, compare notes, discuss content, solve practice problems, and develop new study strategies in a group-learning format.

You can also meet one-to-one with a writing tutor who can give you feedback at any stage of the writing process, whether you are just beginning to work on a written assignment or already have a draft. If you are interested in meeting with a writing tutor, reserve your appointment two to three days in advance of the time you would like to meet. Also, plan to meet with a writing tutor a few days before your paper is due so that you have time to work with the tutor's feedback.

These Academic Learning Centre services are free for U of M students. For more information, please visit the Academic Learning Centre website at: <http://umanitoba.ca/student/academiclearning/>

You can also contact the Academic Learning Centre by calling 204-480-1481 or by visiting 205 Tier Building.

University of Manitoba Libraries (UML)

As the primary contact for all research needs, your liaison librarian can play a vital role when completing academic papers and assignments. Liaisons can answer questions about managing citations, or locating appropriate resources, and will address any other concerns you may have, regarding the research process. Liaisons can be contacted by email or phone, and are also available to meet with you in-person. A complete list of liaison librarians can be found by subject: <http://bit.ly/WcEbA1> or name: <http://bit.ly/1tJ0bB4>. In addition, general library assistance is provided in person at 19 University Libraries, located on both the Fort Garry and Bannatyne campuses, as well as in many Winnipeg hospitals. For a listing of all libraries, please consult the following: <http://bit.ly/1sXe6RA>. When working remotely, students can also receive help online, via the Ask-a-Librarian chat found on the Libraries' homepage: www.umanitoba.ca/libraries.

Student well-being support is available on campus:

For 24/7 mental health support, contact the Mobile Crisis Service at 204-940-1781.

Student Counselling Centre

Contact SCC if you are concerned about any aspect of your mental health, including anxiety, stress, or depression, or for help with relationships or other life concerns. SCC offers crisis

services as well as individual, couple, and group counselling. *Student Counselling Centre:*
<http://umanitoba.ca/student/counselling/index.html>
474 University Centre or S207 Medical Services
(204) 474-8592

Student Support Case Management

Contact the Student Support Case Management team if you are concerned about yourself or another student and don't know where to turn. SSCM helps connect students with on and off campus resources, provides safety planning, and offers other supports, including consultation, educational workshops, and referral to the STATIS threat assessment team.

Student Support Intake Assistant <http://umanitoba.ca/student/case-manager/index.html>
520 University Centre
(204) 474-7423

University Health Service

Contact UHS for any medical concerns, including mental health problems. UHS offers a full range of medical services to students, including psychiatric consultation.

University Health Service <http://umanitoba.ca/student/health/>
104 University Centre, Fort Garry Campus
(204) 474-8411 (Business hours or after hours/urgent calls)

Health and Wellness

Contact our Health and Wellness Educator if you are interested in information on a broad range of health topics, including physical and mental health concerns, alcohol and substance use harms, and sexual assault.

Health and Wellness Educator <http://umanitoba.ca/student/health-wellness/welcome.html>
Katie.Kutryk@umanitoba.ca
469 University Centre
(204) 295-9032

Live Well @ UofM

For comprehensive information about the full range of health and wellness resources available on campus, visit the Live Well @ UofM site:

<http://umanitoba.ca/student/livewell/index.html>

A notice with respect to copyright:

All students are required to respect copyright as per Canada's *Copyright Act*. Staff and students play a key role in the University's copyright compliance as we balance user rights for educational purposes with the rights of content creators from around the world. The Copyright Office provides copyright resources and support for all members of the University of Manitoba community. Visit <http://umanitoba.ca/copyright> for more information.

Students may consult further University and Unit policies, procedures, and supplemental information on-line:

Your rights and responsibilities

As a student of the University of Manitoba you have rights and responsibilities. It is important for you to know what you can expect from the University as a student and to understand what the University expects from you. Become familiar with the policies and procedures of the University and the regulations that are specific to your faculty, college or school.

The [Academic Calendar](http://umanitoba.ca/student/records/academiccalendar.html) <http://umanitoba.ca/student/records/academiccalendar.html> is one important source of information. View the sections *University Policies and Procedures* and *General Academic Regulations*.

While all of the information contained in these two sections is important, the following information is highlighted:

- If you have questions about your grades, talk to your instructor. There is a process for term work and final **grade appeals**. Note that you have the right to access your final examination scripts. See the Registrar's Office website for more information including appeal deadline dates and the appeal form <http://umanitoba.ca/registrar/>
- You are expected to view the General Academic Regulation section within the Academic Calendar and specifically read the **Academic Integrity** regulation. Consult the course syllabus or ask your instructor for additional information about demonstrating academic integrity in your academic work. Visit the Academic Integrity Site for tools and support <http://umanitoba.ca/academicintegrity/> View the **Student Academic Misconduct** procedure for more information.
- The University is committed to a respectful work and learning environment. You have the right to be treated with respect and you are expected to conduct yourself in an appropriate respectful manner. Policies governing behavior include the:

Respectful Work and Learning Environment

http://umanitoba.ca/admin/governance/governing_documents/community/230.html

Student Discipline

http://umanitoba.ca/admin/governance/governing_documents/students/student_discipline.html and,

Violent or Threatening Behaviour

http://umanitoba.ca/admin/governance/governing_documents/community/669.html

- If you experience **Sexual Assault** or know a member of the University community who has, it is important to know there is a policy that provides information about the supports available to those who disclose and outlines a process for reporting. The **Sexual Assault** policy may be found at:
http://umanitoba.ca/admin/governance/governing_documents/community/230.html
More information and resources can be found by reviewing the Sexual Assault site <http://umanitoba.ca/student/sexual-assault/>
- For information about rights and responsibilities regarding **Intellectual Property** view the

policy http://umanitoba.ca/admin/governance/media/Intellectual_Property_Policy_-_2013_10_01.pdf

For information on regulations that are specific to your academic program, read the section in the Academic Calendar and on the respective faculty/college/school web site

<http://umanitoba.ca/faculties/>

Contact an **Academic Advisor** within our faculty/college or school for questions about your academic program and regulations <http://umanitoba.ca/academic-advisors/>

Student Advocacy

Contact Student Advocacy if you want to know more about your rights and responsibilities as a student, have questions about policies and procedures, and/or want support in dealing with academic or discipline concerns.

<http://umanitoba.ca/student/advocacy/>

520 University Centre

204 474 7423

student_advocacy@umanitoba.ca