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Syllabus

CHEM 3590: Instrumental Analysis

(Fall 2020)

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# COURSE DETAILS

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| **Course Title & Number:** | CHEM 3590: Instrumental Analysis |
| **Number of Credit Hours:** | 3.0 |
| **Class Times & Days of Week:**  | Lectures: available online, released once per week on MondaysClass discussions, etc: MWF 10:30am – 11:20amLabs: M/T/W/R 2:30-5:25pm |
| **Location for classes/labs/tutorials:**  | Lectures: online onlyLabs: Parker 318 |
| **Pre-Requisites:** | CHEM 2470 (C) |

# Instructor Contact Information

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| --- | --- |
| **Instructor Name:** | Lectures: Dr. Christian KussLab Instructor: Dr. Tom Ward |
| **Office Location:** | Christian Kuss: Parker 520 ETom Ward: Parker 318 |
| **Office Hours or Availability:** | I’m always happy to discuss with students and answer questions. Office hours are held online through my personal webex room:https://umlearn2.webex.com/meet/christian.kuss |
| **Office Phone No.** | 204-480-1823 |
| **Email:** | christian.kuss@umanitoba.caYou 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.

During the first nine weeks we will cover the following five topics through online lectures and discussions:

1. **General Instrumental Analysis**

Signal and noise, data acquisition, data handling and treatment

1. **Spectroscopy**

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

1. **Separation techniques**

GC, HPLC, hyphenated methods, instrumentation, applications

1. **Electrochemistry**

General electrochemistry, potentiometric and voltammetric methods, amperometric methods

1. **Scattering**

Elastic scattering, X-ray and neutron diffraction, light scattering, electron microscopies

The last weeks of the term will be focused on assignments. Assignment 1 will ask you to describe in detail a specialized instrumental analytical application. Assignment 2 will ask you to propose, develop, build and test an analytical instrument at home.

# 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 chromatography instrument
* 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 data acquisition and treatment tools for the analysis of instrumental data
* Apply Lambert-Beer’s law
* Apply Bragg’s equation
* Apply the Tafel 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 and further sample literature 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

Much of the course is delivered online and part of the course requires you to build and test an analytical instrument at home. For this purpose, it is crucial that you have reliable access to a computer. Relevant software is freely available to you as a student (MS Office) or through open access software (web browser, Adobe Reader, ImageJ, Octave). Students enrolled in the course must ensure they satisfy the following minimum technological requirements:

* A computing device where one can create and edit documents,
* An internet connection capable of streaming videos and downloading software, and
* Access to a web-cam and microphone.

# 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:

* Watch all posted online lectures
* Adhere strictly to submission deadlines (you loose 10% of your points if you are up to 1h late, 50% of your points if you are between 1h and 24h late, and all points if you are more than 24h late)
* Participate in discussions on UMlearn
* Be respectful and supportive of your peers - [Respectful Work and Learning Environment Policy](http://umanitoba.ca/admin/governance/governing_documents/community/230.html)
* 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 and Academic Integrity.

**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>.

**Professional Conduct:**

We recognize that these are unusual circumstances and some adjustments need to be made when working virtually. At the same time, we do want to remind you that University policies, such as the Respectful Work and Learning Environment policy, still apply, as do basic expectations around how students will engage with each other and all members of the University. This means that when participating in classes, online meetings, etc., students are expected to behave professionally, and follow the same basic norms as they would in person, such as being properly clothed, not being impaired, and participating respectfully. Essentially, if you wouldn’t do it in an in-person class, don’t do it in a virtual setting.

Please familiarize yourself with the UM Respectful Work and Learning Environment (RWLE) <http://umanitoba.ca/admin/governance/media/Respectful_Work_and_Learning_Environment_RWLE_Policy_-_2016_09_01.pdf>

Section 2.5(c) of the Student Non-Academic Misconduct and Concerning Behaviour Procedure describes types of inappropriate or disruptive behaviour (<https://umanitoba.ca/admin/governance/media/Student_Non-Academic_Misconduct_and_Concerning_Behaviour_Procedure_-_2018_09_01.pdf>).

**Academic Integrity:**

Academic integrity is taking responsibility for and being honest with your work and respecting the work of others. Since you are a member of the university community, we want you to learn what that responsibility and honesty entails and how we respect the work of others.

The Faculty of Science continues to uphold high standards of academic integrity.  We know that our students support us in this endeavour and we count on each and every one of you to do your part.  Same academic standards apply online, remote learning, and in class education. We expect all students to strictly adhere to instructions from their professors regarding what resources can and cannot be used during exams, to follow all rules professors decide to set.

To aid professors in ensuring that all forms of assessments have been administered fairly, the University will be electronically monitoring tests, quizzes and examinations, included, but not limited to overseeing chat-rooms, relevant predatory web-sites and, in so doing, we will analyze scholastic evidence of individual exams.

E-monitoring tools will include one of the following: Respondus Lockdown Browser & Respondus Monitor; WebEx; Zoom or Microsoft Teams.

For students, in exceptional circumstances, who cannot participate in an e-proctored exam, in-person written or oral exams may be administered. The University of Manitoba adheres to the Provincial health and safety recommendations and those will be strictly followed if an in-person examination is administered.

Please carefully review information with regards to academic integrity: **be aware; be proactive; be smart and be honest.**

Academic Integrity Message from Associate Dean Krystyna Koczanski : <https://youtu.be/Ok-lilm4SeE>

UM Respondus Student Guide

<https://universityofmanitoba.desire2learn.com/d2l/le/content/6606/viewContent/1463719/View>

The Student Discipline By-Law may be accessed at:

http://umanitoba.ca/admin/governance/media/Student\_Discipline\_Bylaw\_-\_2009\_01\_01.pdf

The list of suggested minimum penalties assessed by the Faculty of Science for acts of academic

dishonesty is available on the Faculty of Science webpage:

[Faculty of Science – Suggested Minimum Penalties for Acts of Academic Dishonesty](http://www.sci.umanitoba.ca/wp-content/uploads/2018/03/Acad_Dishon_TABLE_RevCSS_AdminC_Jul2012_WEB.pdf)

All Faculty members (and their teaching assistants) have been instructed to be vigilant and

report every incident of academic dishonesty to the Head of the Department.

<https://universityofmanitoba.desire2learn.com/d2l/le/content/6606/viewContent/1463719/View>

**Student Accessibility Services:**

The University of Manitoba is committed to providing an accessible academic community. [Students Accessibility Services (SAS)](http://umanitoba.ca/student/saa/accessibility/) 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 <http://umanitoba.ca/student/saa/accessibility/>
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 scheduled lecture times
* Return quizzes within one week
* Be receptive to respectful suggestions for changes in the course delivery
* Make lecture notes available together with online lecture recordings
* Incorporate teaching strategies that allow all students to learn effectively

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# 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.

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| --- | --- | --- |
| **Week** | **Online material** | **Lecture time** |
| 1 (Sept 7) | General course information | Webex meeting for introductions and explanations |
| 2 (Sept 14) | General Instrumental Analysis – lectures | Webex office hours, discussions, exercises |
| 3 (Sept 21) | Spectroscopies – lectures | Webex office hours, discussions, exercises |
| 4 (Sept 28) | Chromatographies – lectures | Webex office hours, discussions, exercises |
| 5 (Oct 5) | Electrochemistry – lectures | Webex office hours, discussions, exercises, Quiz 1 |
| 6 (Oct 12) | Diffraction and electron microscopy – lectures  | Webex office hours, discussions, exercises |
| 7 (Oct 19) | Mass spectrometry – lectures  | Webex office hours, discussions, exercises |
| 8 (Oct 26) | Data treatment – lectures | Webex office hours, discussions, exercises |
| 9 (Nov 2) | Application examples – lectures | Webex office hours, discussions, exercises, Quiz 2 |
| 10 (Nov 9) | **Fall term break** |
| 11 (Nov 16) | - | Discussions of posters |
| 12 (Nov 23) | - | Discussions of posters |
| 13 (Nov 30) | - | Webex office hours |
| 14 (Dec 7) | - | Webex office hours |

# Assessments and Assignment Deadlines

Your progress in this course will be assessed through two quizzes, two assignments and the lab program. There will be **no** **final exam**.

**Quizzes:**

* Will be held on Friday Oct. 9 and Friday Nov. 6 during regular class time (10:30am – 11:20am)
* Will be held online on UM Learn
* Will be 45 minutes in length each
* Will cover cumulative lecture materials up to the date of the quiz

**Assignment 1:**

* Requires you to submit a written description of a specialized instrumental analytical application
* Needs to be based on peer-reviewed scientific literature
* Sample literature will be made available on UM Learn
* Students have the choice between one of these application samples or their own choice from literature
* **Proposals** of the topic need to be submitted until **5pm central time,** **Friday, October 30**
* Proposals for assignment 1 will not undergo formal assessment, but a proposal submission is mandatory to determine an appropriate topic for this assignment
* Students have the opportunity to obtain feedback on the assignment structure before final submission
* **Final submission** is required until **5pm central time, Friday,** **December 4**
* A rubric with detailed information on how this assignment will be assessed will be made available on UM Learn

**Assignment 2:**

* Requires you to propose, design, build and test a simple analytical instrument at home
* You can work in a group of up to four students in the instrument conception, but each student needs to build and test their own instrument and submit their own work
* Additional documents with ideas and tips and further reading will be available on UM Learn
* Rubrics for the assessment of each submission of the assignment will be posted on UM Learn
* **Proposals** are due by **5pm central time, Friday, October 16**
* **Scientific posters** are due by **10am central time, Monday, November 16**
* Posters will be discussed during lecture time in the weeks of November 16 and 23
* **Final report** submission is due by **5pm central time, Friday, December 11**

**Missed assessments**

Students who are unable to meet a course requirement due to medical circumstances are currently not required to submit medical notes. However, students are required to contact their instructor or academic advisor by email to inform of the missed work and to make arrangements for extensions, deferrals, or make-up assignments. Please follow these guidelines if you are unable to meet an academic requirement for your courses:

* Contact your instructor for term work such as a class, quiz, midterm/test, assignment, lab;
* Contact an advisor in your faculty/college/school of registration for a missed final exam (scheduled in the final examination period);
* Inform your instructor/advisor as soon as possible do not delay. Note for final exams, students must contact within 48 hours of the date of the final exam; and
* Email your instructor/advisor from a U of M email address, and include your full name, student number, course number, and academic work that was missed.

If you are unable to attend a quiz for medical or compassionate reasons, a make-up quiz will be arranged in its place that may be held orally. If you are unable to submit a course assignment before the due date for medical or compassionate reasons, a postponed submission date can be negotiated.

# Labs

All relevant lab information is available on the lab website <https://home.cc.umanitoba.ca/~wardat/lab%203590%202020.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: 30%
Quizzes: 20%
Assignment 1: 20%
Assignment 2: 30% (proposal: 5%, Poster: 10%, final report: 15%)

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 |

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# Voluntary Withdrawal

**Voluntary Withdrawal:** Students have the opportunity to voluntarily withdraw (VW) from a class on or before November 23, 2020. By then, you will have received feedback so you can assess your progress. If you are not likely to pass the course, or achieve your desired grade, you should consider a VW. You may contact the instructor of the course to review your progress in more detail, or you may discuss the VW option with a Faculty academic advisor. Students enrolled in the course after the VW deadline will be assigned a final grade.

 <http://umanitoba.ca/u1/know_yourself/573.html>

**Authorized Withdrawal**: At times medical or compassionate circumstances arise that prevent a student from performing as they would under normal circumstances. If you are in this position you should contact a Faculty academic advisor to discuss your options. Be prepared to provide documentation supporting your situation.

<http://www.umanitoba.ca/student/resource/student_advocacy/authorized-withdrawal/index.html>

**Limited Access Policy**: At present, Limited Access does not apply to students who have previously been subject to this restriction for three consecutive terms. Students will be able to register to repeat a course (or equivalent) during their initial registration time.

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# UNIVERSITY SUPPORT OFFICES & POLICIES

**Ways to stay engaged!**

Your university experience is not only about learning course content but also about connecting with others and establishing a network during your time here. Don’t let this opportunity slip away - reach out to your professors, instructors, teaching assistants as well as classmates. These connections will be helpful for your future endeavors.

Even though much of this term’s academic experience is remote, there are ways for you to connect with others in our community. Here are some suggestions:

For academic Resources , please explore: <https://www.sci.umanitoba.ca/students/undergraduate-students/academic-resources/getting-help-with-courses/>

To get involved with the Faculty of Science Students’ Community, connect with Science Student Association as well as various discipline-specific groups. <https://www.sci.umanitoba.ca/students/undergraduate-students/student-life-and-resources/student-council-associations-and-groups/>

There are so many great opportunities available for research in the Faculty of Science. Gain first-hand experience in our labs as a summer research assistant.

<https://www.sci.umanitoba.ca/students/undergraduate-students/current-students/undergraduate-research-opportunities/>

**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>. When working remotely, students can also receive help online, via the Ask-a-Librarian chat found on the Libraries’ homepage: [www.umanitoba.ca/libraries](http://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>

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** procedurefor 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 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