DALHOUSIE UNIVERSITY

Faculty of Science Course Syllabus
Department of Chemistry
Chem 5201: Advanced Topics in Separations
WINTER, 2022

Dalhousie University is located in Mi'kma'ki, the ancestral and unceded territory of the Mi'kmaq. We are all Treaty people.

Instructor: Dr. Alan Doucette alan.doucette@dal.ca

Office Hours: Monday, 12:35 – 1:30 pm & Wednesday 10:30 – 11:15 am [1]

I will be available in my office (Chemistry, room 506) at these times. *You can also reach me online (Microsoft Teams). Feel free to request a specific appointment time if office hours do not work for you. I check email 7 days a week.*

Lectures: IN PERSON DELIVERY: MWF, 11:35 am – 12:25 pm (LSC C206) [2]

ONLINE DELIVERY: Remote participation in all lectures will be provided through our Microsoft Teams group. [3] Lectures be livestreamed and recorded and later accessible through Microsoft Teams.

ASYNCHRONOUS LECTURES: Video recordings will be made available on my YouTube Channel (**ShortChemistry**). These videos will replace 3-4 in-person classes when I am away and unable to lecture. Links to these videos will be posted on the course Brightspace webpage.

Tutorials: Optional tutorials may be scheduled as requested, typically as we approach a midterm.

[1] *All times listed in this syllabus are in Atlantic Standard Time (AST)*

[2] *In the event of campus closure, lectures will continue to be offered remotely at times scheduled*

[3] *A laptop with video camera & microphone is recommended for remote classroom participation*

Course Description

Classical methods (solvent and solid phase extraction) are discussed, with emphasis on equilibrium. Column chromatography topics include gas and liquid systems are described, including their coupling to analytical detectors. Multidimensional techniques as well as electrophoretic separations are also presented. Examples in biological analysis are drawn from the current literature.

Course Prerequisites

CHEM 2201.03 (grade of C- or better), or permission from the instructor

Cross listing: Chem 4201.03

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Course Materials

- Course website: Brightspace (accompanied by my YouTube channel, ShortChemistry). Included is a complete set of lecture notes, pre-recorded lecture videos, problem sets and recommended reference materials.

Communication

Announcements related to the course will be communicated through the course website. Additionally, please check your Dalhousie email regularly for course related communications. It is preferred that you post course-material related questions on the Brightspace discussion board, so that my comments can be shared with the entire class.

Course Assessment

The following grading scheme will be used for Chem 4201:

Component	Weight (% of final grade)	Date
Test 1	**10 or 15% [a]**	**Feb 7 (50 min, in class) [b,c]**
Test 2	**10 or 15% [a]**	**Mar 21 (50 min, in class) [b,c]**
Presentation	**20%**	**during final *week of class* [d]**
Written report	**20%**	***(due last day of exam period)***
Final exam	**35%**	***Scheduled by Registrar*** [e]

(a) *The highest score of your two tests will be weighted 15%, and your lowest will be 10%*

(b) *Testing dates & delivery method are subject to change if this class is significantly impacted by Covid (including hosting online tests and presentations) All changes will be through a consensus agreement with the class prior to implementation.*

(c) *Makeup test dates are Feb 8 and Mar 22 (2:00-3:00 pm); please notify me if you wish to write the makeup for any reason.*

(d) *5201 presentations will take place outside of class time at a mutually agreed time*.

(e) *Final exam will be conducted in two parts, with up to 1.5 hours per section and with a 1-hour break in between. The final exam encompasses all material covered throughout the term, including those topics covered through student presentations.*

**** All assessment components in this class must be completed individually.***

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Other course requirements

All students will be required to meet with the instructor (in person or Microsoft Teams), approximately 1 week prior to their in-class presentation (max 1.5 hours) to provide and receive feedback on your in-class presentations.

Conversion of numerical grades to Final Letter Grades follows the Dalhousie Common Grade Scale

A+ (90-100)	**B+** (77-79.9)	**C+** (65-69.9)	**D** (50-54.9)
A (85-89.9)	**B** (73-76.9)	**C** (60-64.9)	**F** (<50)
A- (80-84.9)	**B-** (70-72.9)	**C-** (55-59.9)	

Course Objectives/Learning Outcomes

- Understand the relationship between pH and charge state for polyprotic species
- Classify various forms of analytical separation
- Determine optimal conditions to isolate compounds based on component characteristics, including size, charge and polarity.
- Use diagrams to illustrate chromatographic and electrophoretic separation platforms
- Identify the principle instrumental components used in chromatography and electrophoresis
- Relate how poor chromatographic practices lead to band broadening and describe how to minimize the effects
- Calculate peak width based on plate and rate theory
- Support the application of the most appropriate mode of separation for isolation of specific components from one another
- Apply equations to solve for retention/ migration time in chromatography and electrophoresis
- Predict the extraction efficiency of a compound based on acid/base characteristics, and translate these values into purity of said compound
- Discuss the limitations of calibration methods in reporting the amount of analyte in an unknown
- Describe how analytical separation platforms are coupled to various detectors, including mass spectrometry.
- Organize relevant information into a logical and informative presentation
- Design a PowerPoint presentation that illustrates and outlines a modern application of analytical separations
- Critique student presentations
- Summarize a modern topic in analytical separations in the form of a formal written review.

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Missed or Late Academic Requirements due to Student Absence

At this time, we remain in a pandemic, with several restrictions and recommendations described by Nova Scotia Public Health and by Dalhousie University. This includes policies on mask wearing, vaccination, testing, and physical distancing. All students are required to comply with health and safety requirements on campus and should be considerate of others' health concerns. Non-compliance may be reported under the Code of Student Conduct.

At the time of writing this, case numbers are on a steep include. It is unknown whether there may be partial (or complete) campus closures throughout the winter term. Even if campus remains open, this does not preclude the fact that individuals may still be affected. As recommended by public health, if you are feeling ill or displaying flu-like symptoms, ***stay home!*** It is for this precise reason that all lectures will be available in person as well as remotely. You may also prefer to meet with me online rather than in person. This will also be accommodated.

If, due to illness, you are unable to attend a scheduled meeting, presentation, midterm, or are unable to complete an assignment within the scheduled period, you must contact the instructor **prior to** the missed event. A **student declaration of absence form** is required for accommodating any missed graded component. Makeup test dates are posted, and your presentation will be rescheduled to the next available opportunity. If the makeup test is also missed, marks may be redistributed to other assessment components to determine a final grade. Please note that the makeup test may not necessarily be identical to the original test.

If you miss the final exam, I must be notified within 24 hours, and a student declaration of absence form must be completed. A makeup will be scheduled at a mutually agreeable time. The final exam must be written to complete the course.

Information on regular policy, including the use of the Student Declaration of Absence can be found here: **https://www.dal.ca/dept/university_secretariat/policies/academic/missed-or-late-academicrequirements-due-to-student-absence.html.**

Academic Integrity

At Dalhousie University, we are guided in all of our work by the values of academic integrity: honesty, trust, fairness, responsibility and respect (The Center for Academic Integrity, Duke University, 1999). As a student, you are required to demonstrate these values in all of the work you do. The University provides policies and procedures that every member of the university community is required to follow to ensure academic integrity. https://www.dal.ca/dept/university_secretariat/academic-integrity.html

All midterms and the final exam are to be completed individually. While student presentations are delivered individually, the class is strongly encouraged to collaborate and provide feedback on early drafts of the presentation. Classroom discussions will be a regular feature of our lectures. You are also encouraged to seek feedback on your written report to ensure clarity of writing style.

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Course Content

INTRODUCTORY CONCEPTS (~3 lectures)

(a) Historical perspectives
(b) Forms of separation
(c) Units/ dilutions
(d) Calibration
(e) Detectors

EXTRACTIONS (~5 lectures)

(a) Acid/base chemistry
(b) Solvent extraction
(b) Partition coefficient/ distribution coefficient
(c) Purity/ Yield

CHROMATOGRAPHY (~10 lectures)

(a) Instrumentation
(b) Plate/ rate theory
(c) Gas and liquid chromatography
(d) Column formats (IEX, SEC, Affinity)
(e) Extra column broadening
(f) Multidimensional separations
(g) Coupling to mass spectrometry

ION MOBILITY & ELECTROPHORESIS (~7 lectures)

(a) Ion Mobility Spectrometry
(b) Principles of electrophoretic separation
(c) Capillary electrophoresis
(d) Isoelectric focusing, SDS PAGE
(e) Microfluidics
(f) Protein precipitation

STUDENT PRESENTATIONS (~7 lectures)

List of potential topics is provided.
Topics explore modern applications of separation science.
First student presentation tentatively scheduled for March 23.

NOTE: *You are also responsible for the material delivered through the student presentations, including the 5201 presentations covered outside of class time. This will be covered on your final exam.*

OTHER (4 lectures)

Two classes will be spent writing tests
One class will a workshop in preparation for your presentation
I'm hoping there will be time for a review immediately prior to your tests.

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University Policies and Statements

This course is governed by the academic rules and regulations set forth in the University Calendar and by Senate

Accessibility

The Advising and Access Services Centre is Dalhousie's centre of expertise for student accessibility and accommodation. The advising team works with students who request accommodation as a result of a disability, religious obligation, or any barrier related to any other characteristic protected under Human Rights legislation (Canada and Nova Scotia).

Information: https://www.dal.ca/campus_life/academic-support/accessibility.html

Student Code of Conduct

Everyone at Dalhousie is expected to treat others with dignity and respect. The Code of Student Conduct allows Dalhousie to take disciplinary action if students don't follow this community expectation. When appropriate, violations of the code can be resolved in a reasonable and informal manner—perhaps through a restorative justice process. If an informal resolution can't be reached, or would be inappropriate, procedures exist for formal dispute resolution.

Code: https://www.dal.ca/dept/university_secretariat/policies/student-life/code-of-studentconduct.html

Diversity and Inclusion – Culture of Respect

Every person at Dalhousie has a right to be respected and safe. We believe inclusiveness is fundamental to education. We stand for equality. Dalhousie is strengthened in our diversity. We are a respectful and inclusive community. We are committed to being a place where everyone feels welcome and supported, which is why our Strategic Direction prioritizes fostering a culture of diversity and inclusiveness

Statement: http://www.dal.ca/cultureofrespect.html

Recognition of Mi'kmaq Territory

Dalhousie University would like to acknowledge that the University is on Traditional Mi'kmaq Territory. The Elders in Residence program provides students with access to First Nations elders for guidance, counsel and support. Visit or e-mail the Indigenous Student Centre (1321 Edward St) (elders@dal.ca).

Information: https://www.dal.ca/campus_life/communities/indigenous.html

Important Dates in the Academic Year (including add/drop dates)

https://www.dal.ca/academics/important_dates.html

University Grading Practices

https://www.dal.ca/dept/university_secretariat/policies/academic/grading-practices-policy.html

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Student Resources and Support

Advising

General Advising https://www.dal.ca/campus_life/academic-support/advising.html

Science Program Advisors: https://www.dal.ca/faculty/science/current-students/academic-advising.html

Indigenous Student Centre: https://www.dal.ca/campus_life/communities/indigenous.html

Black Students Advising Centre: https://www.dal.ca/campus_life/communities/black-student-advising.html

International Centre: https://www.dal.ca/campus_life/international-centre/current-students.html

Academic supports

Library: https://libraries.dal.ca/

Writing Centre: https://www.dal.ca/campus_life/academic-support/writing-and-study-skills.html

Studying for Success: https://www.dal.ca/campus_life/academic-support/study-skills-and-tutoring.html

Copyright Office: https://libraries.dal.ca/services/copyright-office.html

Fair Dealing Guidelines https://libraries.dal.ca/services/copyright-office/fair-dealing.html

Other supports and services

Student Health & Wellness Centre: https://www.dal.ca/campus_life/health-and-wellness/servicessupport/student-health-and-wellness.html

Student Advocacy: https://dsu.ca/dsas

Ombudsperson: https://www.dal.ca/campus_life/safety-respect/student-rights-and-responsibilities/where-toget-help/ombudsperson.html

Safety

Biosafety: https://www.dal.ca/dept/safety/programs-services/biosafety.html

Chemical Safety: https://www.dal.ca/dept/safety/programs-services/chemical-safety.html

Radiation Safety: https://www.dal.ca/dept/safety/programs-services/radiation-safety.html

Scent-Free Program: https://www.dal.ca/dept/safety/programs-services/occupational-safety/scent-free.html

Dalhousie COVID-19 information and updates: https://www.dal.ca/covid-19-information-andupdates.html

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A Presentation on Current Topics in Separation Science (Winter 2022)

Your presentation is intended to outline a *current topic* in the field of separations. The suggested topics are meant to complement, but not duplicate the material already covered in this class (see course outline). You will be presenting your topic individually and are given the choice of giving a live presentation (in class), or creating a pre-recorded video, such as those I have posted on YouTube. Regardless of the method of delivery, other students from the Chem 5201 class will watch your presentation and together with the instructor, will ask questions at the conclusion of your presentation.

All students enrolled in Chem 5201 are responsible for the material you will personally present through your lecture. This material will be examined on the final exam. No two presentations will cover the exact same material. As your presentation is an integral component of this class, it as my objective to ensure that every student does the best job possible, not only in the delivery of the material, but also in determining the specific content to emphasize. In addition to your presentation, your slides/ recording will be made available to the class as part of their collection of course reference material.

Presentation Format:

All presentations and associated discussions will take place at a mutually agreed time near the end of term (Mar 23 – Apr 6). Each presentation should aim to be 30-35 min long, allowing ~5-10 min of question & discussion from the audience (including the instructor). Live presentations must be conducted using Powerpoint or similar electronic format (no 'chalk talks'). Pre-recorded videos may involve a multitude of visual aids. Your presentation file (slides, video) should be uploaded to the instructor a minimum 24 hours prior to your presentation, which will be shared with the class. Pre-recorded videos will only be posted to YouTube upon written permission by the student.

Workshops:

To aid the development of your presentation, you will work with the instructor and members of the class. Your first task is to pick a topic and will involve a short meeting with the instructor. This can be done via email exchange, but ideally should involve a discussion with the instructor. You should have selected one or two key references and outline the general topic you wish to cover. Remember no two topics can be identical. Topics must be approved by the instructor, and occur on a first come, first serve basis.

You will next participate in a presentation workshop, (scheduled during class time Mar 4). This workshop is intended to share a 'rough outline' of your presentation, seeking feedback from a group of your peers. You should have a good sense of the material you want to discuss, with at least a couple of completed slides that demonstrate the final look and style of your presentation. At this time, I may suggest specific content to add, emphasize or remove, and will also comments on the delivery style.

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Workshops continued:

For those intending live presentations, your second workshop will be scheduled outside of class at a mutually agreed time (up to 90 min, roughly 1 week prior to final talk). Together with a small group of your peers (typically 3 at a time), you will deliver a formal 'practice talk', sharing approximately half of your final presentation with us for feedback from your peers and instructor. The aim of these meetings is to make final tweaks to your presentation and ensure that everyone does the best possible job in clearly presenting their material, while ensuring that relevant material is presented for the benefit of the class.

For those intending a pre-recorded video, the above-described workshop should take place prior to recording your video and will involve a 'dry run' of your talk, overlaid with your visual aids. It is recommended that this meeting takes place a minimum 2 weeks prior to your final presentation.

Summary of Dates:

Topic Selection:	Feb 18. The earlier the better. First come, first served.
Workshop 1:	Mar 4. In class. Complete an outline of talk, along with a couple of slides.
Workshop 2:	~1 week prior to live presentation, scheduled outside of class. Be prepared to deliver a fully rehearsed talk and give/ receive feedback.

Assessment:

The presentation constitutes 15 % of your total grade, with breakdown as follows:

a) Workshop #1 (rough outline)	2 marks
b) Workshop #2 (full rehearsal)	6 marks
c) Formal presentation	12 marks

A detailed grading sheet will be provided later. Note that the rehearsal talk, presented during your second workshop, will place less emphasis on your delivery style. Also, since pre-recorded talks have the opportunity for multiple takes and/or edit mistakes, the standards of your delivery will be higher than a live presentation. Components of your presentation that factor into the final grade include:

- *Depth and implications of science*
- *Interest level of the content presented*
- *Speaking style and enthusiasm*
- *Quality of visual aids*
- *Your level of understanding of the material (based on audience questions)*

Topic Selection:

A list of past topics is provided as a general guide, though you are free to pick any topic with an emphasis on separations. A literature search (science citation index / web of science) of your topic

would be a good place to start, as I am sure it will yield numerous hits. I do not mind if the topic is close to your own interests or research – in fact, I highly encourage it! But you should not be presenting data generated directly from your personal research. If you're stuck on a topic, please meet with me to discuss.

Once you have selected a potential topic, you must meet with me to discuss the idea. All topics must be approved by the instructor. Include a minimum of two peer-reviewed references (please attach links to these references) and a descriptive title for your presentation. It would be helpful to also provide a short paragraph description of what you hope to cover. Topics will be assigned on a first come, first serve basis, with a tentative presentation date determined by the instructor. No two presentations will cover the identical material.

***** Deadline for *selection and approval* of your topic is Friday Feb 18 *****

Late topic selections will result in a 1-point daily deduction from your total presentation grade. Similarly, students who present late will result in a 1-point daily penalty, unless extenuating circumstances are present.

List of potential topics (for inspiration – your choice can be anything!)

1. Metabolomics / lipidomics or other 'omics fields
2. Coupling separations to mass spectrometry
3. Membrane Filtration
4. Capillary gel electrophoresis
5. Micellar Electrokinetic chromatography (MEKC)
6. Digital Microfluidics (DMF)
7. Industrial applications of separations
8. Affinity-based separations
9. Optoelectronic Tweezers
10. Aptamer selection
11. Solid phase microextraction
12. Immobilized Enzyme Reactors (IMERS)
13. Chiral Separations
14. Preparative Separations
15. New stationary phase design/ construction
16. Green Separations
17. Field Potable Devices and Application

It is hoped that the students gain an appreciation of the many forms of separation, and how essential they are to analytical science (and everyday life). You are welcome to choose any topic on this list, to combine multiple topics, or to select from topics not presented.

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Written Report (Chem 5201)

You are asked to write a mini scientific review of the same general topic that you will present in class. The review should therefore be a direct complement to this seminar. While the research that went into your topic might be the same, the format of a written review allows you to cover the material in a slightly different way. Your writing style should be formal, using properly formatted paragraphs (*ie* do not write in point form!). The material you describe must be fully cited, with references included at the end of the report, in proper scientific format. Websites may be used for some of your references, though you must include a minimum of eight peer-reviewed scientific publications amongst your reference list

Your report will have a strict **limit** of 4000 words (not included reference). That`s not to suggest that it needs to be that long. In fact, I prefer a much shorter report. But I have to define an upper limit! The report should be prepared in Microsoft Word (single column, double spaced, 12 pt Times New Roman font). Use subheadings as appropriate to break up the main topics of your report.

Your report must also include the following:

(1) **A descriptive title**: <120 characters

(2) **Abstract**: < 150 words, summarizing the most important aspects of your review

(3) **Keywords**: 5-10

(4) **Background**: Provide immediately relevant background on your chosen topic. Note that this is a focused mini review, and so you cannot cover everything in your background. The first paragraph should very quickly funnel down from the broader field to your specific topic. Get to the point as quickly as you can, so that you have more opportunity to expand on that specific area.

(5) **Main Body**: (include subheadings where appropriate). Your literature review is presented in this section. Focus on recent works (preferably in the last 5 years). Do not attempt to cover too many articles. I suggest no more than 10, but it could be as few as 3. Include relevant figures or tables (taken straight from your referenced articles) as appropriate. I expect a minimum of 2 figures or tables, but no more than 8 in total. Figure captions and table headers are included in your word count limit.

(6) **'Personal' Commentary and 5-year outlook:** This section should be brief (a paragraph or two), where you discuss the advantages and limitations of the topic, and where future research is heading.

(7) **Concluding Remarks**: This is not meant to be a summary of the review (that's what the abstract is for). Instead, this short section (~100-150 words) should provide some comments on what the reader should take away from this topic. Where does the future lie in this area? Is this an up-and-comer, or has the technique seen better days? What problems remain to be overcome? How does it compare/compete against other related methods?

(8) **References**: Reference formats are specific to journals. Being an analytical chemistry class, you should follow the format of the journal *Anal. Chem.* Use original articles, or books (website references may be ok if they are the primary source). I'm guessing 20-30 references.

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Report Deadlines:

The report is due at the end of term, on the final day of the scheduled exam period. Up to two draft copies of the written report can be submitted to the instructor for feedback. These drafts are not graded, but the feedback will surely help you in preparing the final report.

Deadline for submission of a 1st draft: Mar 4, 2022

Deadline for submission of a 2nd draft: Mar 28, 2022

You may submit as much, or as little as you want. I will provide as much feedback as possible to improve your final report. Please note that I will not provide direct feedback on your report after the above deadlines. Please take advantage of this opportunity to improve your writing!

Grading:

The following breakdown will be used to assess your report. The report itself is worth 25% of your total grade in this course.

STYLE (20%)
Basic format, referencing, figure/ table layout, font styles and grammar

STRUCTURE (20%)
The overall 'flow' of document, paragraph structure, conveying a clear message, easy to read…

SCIENTIFIC ACCURACY (20%)
Is the content correct?

DEPTH (40%)
Includes sufficient depth, with material relevant to the overall objectives of this class.